OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

NOVOTRADE

15505

TECHNO-ECONOMIC STUDY FOR THE UTILIZATION OF BROWN MUD OF SHANDONG ALUMINIUM WORKS AS BUILDING MATERIALS

Project No. SI-CPR-84-803

UNIDO Contract No. 84-76

NOVOTRADE

FINAL REPORT

Project Number	SI-CPR-84-803
Project	Techno-Economic Study for the Utilization of Brown Mud of Shandong Aluminium Works as building materials
Contract No.	84-76
Sub-Contract	Pilot scale testing and technical study and specification
Prepared by	Mr. Ferenc PUSKAS, ceramic expert and Susan BATAI, project coordinator

Budapest, December, 1985.

ACKNOWLEDGEMENTS

The author of this Study wishes to express his thanks for all those who helped him in his work and made this Study possible;
Dr. Balázs and Mr. Shen of UNIDO, Vienna,
Mr. Sissingh and officials of UNDP Peking,
Officials of China National Nonferrous Metals Industry Corp.,
Experts of Messrs. DORST West Germany.

Grateful acknowledgements are due to the Management of Shandong Aluminium Works for their valuable help and assistance in promoting this work by giving every essential data to the economic part of the Study.

TABLE OF CONTENTS

NOVOTRADE

NOVOTRADE

CHAPTER ONE

Executive Summary

Following the recommendation from UNEP, the Chinese Government requested assistance from UNIDO in establishing the technical and commercial feasibility of adapting a proprietary method of brown mud (alumina production) waste utilization for the production of building materials, elaborated by Mr. Ferenc Puskás.

Based on a field trip, laboratory tests and a subsequent pilot-scale production demonstration using brown mud and various mineral additives, all of Chinese origin, the following findings have been made and are reported in greater detail in this Report.

1) Brown mud from the current alumina production of the local factory (Shandong) is the waste of the production, can be combined in formular with additives to yield products with acceptable to excellent quality parameters. Possible products include brick, walling blocks by cold technique and glazed floor- and wall tiles by single firing technique. Brown mud content of such products range from 4o p.c. to about 6o p.c. Present production and discharge practices of brown mud require only a little change in the production.

2) Considering the size of the Chinese building materials market the amount of brown mud waste is not limited for building industrial purposes due to the fact that the demand highly surpasses the manufacturing possibilities.

3) As energy accounts for lo to 35 p.c. of total production cost of individual types of building materials, the cost of energy is largerly influenced what kind of fuel is used resp., the product is manufactured by thermic-way of by cold technology.

4) The specific energy demand of the universal floor - and wall tiles is reduced by 4o p.c. in comparison to the energy requirement of the traditional technique. The suggested method of single-firing has been a result great importance all over the world.

5) Semi-industrial scale production test proves the possibility to produce excellent quality bricks, walling blocks and ceramic tiles from brown mud and mineral additives. It is proposed that a plant be built to produce loo mill. pcs bricks annually and an other plant be built for the production of 2.ooo.ooo. sq.m. floor and wall tiles per year. Capacity can be increased according to the requirements. The greater part of the equipment of the plant is of local manufacture.
The value of the import equipment does not surpass 4,5 million US dollars.
The settlement of the plant enables the further development of the industry and the use of the products for the local communal buildings. In addition a lot of cities are within a loo km radius, thus the transport problems can be reduced to a minimum. The brown mud based product produced in China-Shandong permits a flexible marketing strategy because the raw material is available practically free.

6) It is recommended that the Government of China encourage a brown mud waste based production. The method recommended makes it possible that after the expansion of the capacity a greater quantity of the wastes can also be processed.

7) Investment costs of the suggested tile plant (Chapter Seven) if it is in Europe, for the machines and equipment necessary for the technique has been 25 mill. DM, for building and additional costs has been 25 mill. DM, i.e. totally 5o mill DM.
For the erection of a plant for the production of glazed floor- and wall-tiles (according to the offer of Messrs. DORST, Chapter Seven) in China, the investment costs for the equipment has been 13 mill.DM (for buildings 7,5 mill DM not included).
Total investment cost for the production of lo million sq.m. universal floor- and wall tiles factory has been loo mill. DM.

8) Special attention is to be paid to the new method described in the study which enables the highly economic manufacturing of bricks of fired brick quality, walling blocks and gas silicate light insulating blocks of gas concrete quality by energy saving method (cold technology) by using hydraulic bond modificated fly ash produced in coal firing power station boilers and by using brown mud, whereas the ratio of the fly ash in the mixture ranges from 40% up to 60%.

CHAPTER TWO

Project Background and History

2.1. Project Background

The method to produce aluminium by electrolyses was invented by the French Héroult and the American Hall in 1886. The technology of alumina production was patented by the Austrian Bayer in 1892.

Over the part 1oo years the production and industrial use of aluminium have risen from an annual quantity of a few hundred tons to 15 million tons on a global scale. To produce unit quantity of aluminium requires twice that amount of alumina. The Bayer process yields 1.2-1.4 tons of red mud per alumina tons, i.e. not less than 4o million tons of red mud is produced in the alumina factories of the world every single year.

While production figures ran low, the disposal of red mud in mud ponds was no great difficulty. Specialists were confident that by the time red mud disposal was to become a headache for them feasible methods to make the best use of red mud would have been found.

Initial efforts to put red mud to industrial use lay in the direction of smelting, as was indicated by its high ferro-oxide content, which may run up to 4o-6o p.c.

Efforts at smelting resulted in various patented processes but no industrially and economically feasible method has been found to date. Repeated economic analyses have proved that the pre-produce of iron ire subsitute is non-competitive not so much because of its specific

technological parameters as the high capital investment involved.

Up to quite recent times all efforts to find uses for red mud in large quantities have failed, and so this by-product keeps on accumulating year after year.

As is well known to specialists, the Bayer process, although the most successful method of alumina production known to us, has certain disadvantages. Furthermore, its drawback stems from one of its fundamental technological phases that originally put it at an advantage over all other efforts in this direction. Notably, that ground bauxite is transformed at 100-280 ^{o}C, at 6-80 kp/cm^2, with the addition of concentrated caustic soda into water-soluble sodium aluminate and insoluble Si, Fe, Ti, etc. compounds. The insoluble solid parts of bauxite processed with caustic soda are removed by filtering from the sodium aluminate solution, and this removed material is in fact what we call red mud. If the solid residue did not contain free caustic soda of an aggressive character as well as about 10 p.c. sodium oxide equivalent to bound sodium compound, then red mud would not at all be a hazard to the environment. However, the high amount of sodium it does contain makes red mud an ever-growing menace to fields, woods, meadows and river life.

It would be easy to find a way out if we could process bauxite with an alkali whose residue in red mud were no danger to the living world. Also, bauxite exploitation today can be accomplished with the help of acids and acidics coupled with an appropriate closed-system technology and alkali neutralization of solid mud remainders. However,

it would be too early to regard these possibilities as as large scale, industrial solution to the problems outlined. However, it is rather likely that one of these methods - now at an experimental stage - will grow into the basic technology of alumina production and replace the Bayer process by the turn of the century.

Of course the quantity of red mud and the worries it gives us will continue to grow until that time. There is a certain limit to increasing the surface area of artificial mud ponds, which cost money to build, may tie up valuable farmland and which may be positively harmful over a much larger area than the pont itself, if a leakage of sodium solution occurs due to insufficient water insulation. If the sodium solution reaches ground water, rivers and lakes, it will become a hazard not only to plants but animals and humans as well. Some alumina factories try dumping the mud into the sea, a method that has provoked angry public response and is, therefore, radically discouraged by some governments. So the question naturally arises whether there is any good solution to red mud disposal.

A noteworthy technique of storing red mud has been developed by the German Gebrider Guillini Co. After the sodium aluminate solution is separated from red mud sludge, red mud is filtered in a drum filter, washed and chemically processed in a reactor called mixer, then processed with a fluxmaterial and finnally, when the sludge has lost much of its water content, it is carried to the storing area by means of pumps.

Due to chemical processing, natural evaporation and the natural water balance of the storing area, the processed red mud soon looses its surplus water content and hardens

so much that it can even carry heavy machinery. These kinds of red mud storing areas need no special water insulation because the water soluble sodium salt content is below o.5 p.c., so the danger to the environment is at a minimum. Red mud hardened by the Guillini process can be stored in waste-tips 25 metres high, therefore, demand for ground area is reduced to one-fifth of that of traditional mud ponds.

As mentioned before, red mud consists of finely ground silicates, iron-hydroxide and other practically water-insoluble compounds as well as of residual caustic soda and other soluble salts. Recent decades have seen attempts to look at red mud as a finely granulated homogeneous additive material for the ceramic industry rather than a raw material for metallurgy.

The initiative was again taken by the German Guillini Co., and brick production has in recent years been successfully conducted in one factory in South Germany by the method they have developed and patented. The technology is as follows. Red mud is mixed with a hygroscopic material and a large quantity of clay, moulded into bricks by the traditional process, dried and fired at about 9oo^{o}C. The mixture has a red mud content of some 4o p.c.

The Guillini bricks excelled clay bricks in quality, with special regard to strength, the former product was found 2 to 4 times stronger than the latter. It was established, however, that firing gets increasingly difficult with a rise in red mud content, and that the method was only successful in the case of red muds of low or medium ferro-oxide content.

More importantly, the economics of such a production proved to be insufficient to keep balance with the accompanying problems. For one thing, South of Germany is rich in cheap clay of excellent quality and most brick yards own their clay mine. There was little incentive for the brickmaker to replace his clay with red mud, especially as clay could not be replaced totally. Since the cost of mining does not scale well with decreasing quantity, the unit cost of clay to the brick company went up. On the other hand the brickyard would have to be very close to the red mud pond to prevent pollution problems from occuring and to keep costs down. Although no brickyard was close enough to the pond, competition coming from several dozen brickyards already operating in the area questioned the feasibility to set up a new one by the pond. As the author learned from one of Guillini's top executives, now leading another company in the industry, one has to provide for a large value added, larger than in brick making, to get started with the utilization of red mud.

On the basis of his previous experiences in ceramics technology, the author, Mr. Ferenc Puskás, set out to develop a method to utilize large amounts of red mud in the production of ceramics. He described this method in a paper that was later awarded a prize in a contest "Utilization of industrial wastes" sponsored by the Hungarian Academy of Sciences in 1977.

The advantages of this method can be summarized as follows.

- A wide variety of products is now possible, including

high value-added items such as glazed tiles and frost-proof porous products.

- More red mud (over 5o %) and not just clay but many other materials some of them otherwise useless, can be used to make up the body (industrial residues containing silicates , vulcanic products, rock material normally considered dead in quarry and ore mining, slag from a garbage incinerator, etc.).
- Alternative production methods can be used to sit the product and the available raw materials. Ease and low cost of production are key, low shrinkage during firing, fuel saving rapid drying and rapid firing can be applied readily.

The new method has been patented as an invention in Britain, Australia, the United States and a number of other countries. It was also treated in outline in a Hungarian document complied for a UNEP conference on environmental protection for the alumina industry held in Paris, 2o-23 January, 1981. The author was subsequently invited to the Paris conference, where his method won general acclaim and was incorporated into the list of recommendations adopted by the conference. Several delegations were interested in studies geared to the countries' respective conditions.

On the basis of the recommendation of the conference on the initiation of the Jamaican Bauxite Institute the Jamaican government requested UNIDO to prepare a feasibility study and an economic evaluation. The study was completed in 1982-83.
Following the above events several states announced their demand for similar UNIDO studies. In 1983 the Indian Government also requested the author to elaborate technology for the processing of iron-ore washing and gas-washing sludges which are the waste products of direct reductional sponge iron production, for the utilization of building industrial purpose. This work was successfully elaborated in 1984.

In August 1984 the UNIDO invited firms to give offer for the preparation of the present study. The commission was given to the offer submitted by Messrs. Novotrade RT, containing Mr. Puskás's ceramic expert, proposals.
On the basis of the preliminary document UNIDO approved the plan of work and the calculation of the pilot scale feasibility study.

In the possession of the above references Mr. Puskás undertook to prepare the UNIDO study and pilot scale testing through Messrs. Novotrade. In the preparatory work and execution Susan Bátri project coordinator was who help him in his work.

After making the necessary preparation Mr. Puskás by Mrs. Bátri's company travelled to China and carried on discussions in Peking with UNDP, Mr.Sissingh, and management of China National Non-ferrous Metals Co., resp., in the latter case geological survey was carried on in connection with exploring additives, between 8th October - 21st October, 1984, in Shandong.

The material samples collected on the spot were subjected to laboratory tests in Budapest and West-Germany resulting the optimation of pilot-scale formulas. 5 tons of the material were delivered to Budapest by Shandong Aluminium Works.

In conformity with the above this study deals with the quality of the producable goods, the optimation of the manufacturing technologes in respect to the processing possibilities of the brown mud of Shandong Alumina Plant, elaborated by Mr. Puskás. On the basis of the agreement between the parties the economic calculations will be elaborated by Shandong Aluminium Works on the basis of Mr. Puskás's data due to their special circumstances.

Thus the present Study is concerned with the use of alumina factory brown mud for purposes of the building industry specifically in China. Therefore, the results, conclusions and facts established in this paper should not be understood to refer to the alumina industry of any other country only to Shandong Aluminium Works, China.

2.2. Project History

After the respective subcontract entered into force, team leader Mr. Ferenc Puskás and member of the expert team Susan Bátri received their briefing on the project from Mr. Shen Wenrong, UNIDO, Vienna.

A field trip aimed at the familiarization with the local conditions and selection of potential additives took place from 8th October till 21st October, 1984 and involved team leader Mr. F. Puskás and project coordinator Susan Bátri.

In China Mr. Puskás visited the Shandong Aluminium Works and the deposit of brownmud. On the spot the delegation was informed that not only the utilization of brown mud for building industrial materials but the processing method of producing ceramics wall and floor tiles should be elaborated.

From the local additives the most appropriate ones were tested and chosen in the laboratory of Shandong Aluminium Works.

At the same time samples were collected and taken to Hungary, i.e.

1 kg brown mud
o,75 kg bauxite clay
1 kg fly ash
o,25 kg clay-sand

In Budapest Mr. Puskás tested 3 kgs of the samples in short laboratory tests with different components to find out which materials he would like to be included in the 4 tons sample to be sent from Shandong to Hungary for pilot scale testing. After determining the best composition in his own laboratory he made tests and firing experiments.

It was then established that Chinese brown mud and additives of bauxite clay, clayey sand and silica sand yield mixtures which are suitable for the production of floor and wall tiles of the required quality fired out in electric kiln on a temperature of 1o5o - 1o75 °C.

Due to the limited possibilities in Shandong for the testing of all the additives by making compounds of different compositions and by firing, the author only surveyed a few additive deposits on the spot.
Thus in choosing the best of all the materials at his disposal he had only his scanty observations to rely on.

Following the evaluation of the laboratory tests the author requested the Shandong Aluminium Works to send the following materials to Hungary.

- 15oo kg brown mud
- 1ooo kg fly ash
- 1oo kg coal dust (powder used in the power station)
- 25o kg quartz sand
- 15o kg claysand
- 1ooo kg bauxite clay

The author's laboratory tests to produce bricks, blocks by cold technique were successful.

Using the material received from Shandong the author made further laboratory tests to establish the technical feasibility of making light products for building materials by cold technique and of making floor- and wall-tiles by single-firing technology.

Subsequent laboratory tests and the pilot demonstration of the dry pressing technology were performed at the Kochel am See facility of Messrs. Dorst Maschinen und Anlagenbau, something that was special importance since this firm had carried out a series of positive experiments in large laboratories and on an industrial scale with Hungarian, Jamaican and German red muds and additives. Also, one of Europe's most advanced pilot plants and test laboratories were built at Messrs.Dorst in the summer of 1982, and not the Shandong brown mud project was the first complete job that needed all their equipment to perform.

The production demonstration took place at the end of March, 1985. Unfortunately, the Chinese delegation was not in a position to take part on the testing, and demonstration. Very much indeed was at stake, since the size of the pilot equipment and the small amount of material components available allowed for no repetition and even the composition of the mixture had to be modified on the basis of the laboratory tests.

The production of various tiles from Shandong brown mud and additives was successfully demonstrated at the Dorst plant at the end of March 1985. Subsequent reports have been prepared, which are presented in further parts of this Report. With the help of Messrs. Dorst reference visits were organized in Yugoslawia, in Kanjiza and Becej.

CHAPTER THREE

Technical Report

Material testing

The following samples were tested.

1) Fly ash
2) Brown mud
3) Red sandy clay
4) Clayey sand
5) Sand

The folling methods were applied for the material testing.

1. Chemical analyses
2. Mineralogical exeminations
   2.1. Microscopic examinations
   2.2. Derivatographic tests
3. Grain size distribution analyses.

About the geological environment of the sand, clyey sand and "bauxite clay" nothing has been known., most probably they are superficial samples.

1. Fly ash

Chemical composition in weight p.c.

Al_2O_3	22,22 p.c.
SiO_2	43,43 p.c.
Fe_2O_3	17,51 p.c.
TiO_2	o.86 p.c.
CaO	1.29 p.c.

MgO	o,2o p.c.
K_2O	1.52 p.c.
Na_2O	o.24 p.c.
loss on ignition	8.35 p.c.
$C_{org.}$	o.42 p.c.
Total	95.62 p.c.
moisture	28,2 p.c.

Grain size distribution of the fly ash is as follows.

- clay fraction 26 p.c.
- mud fraction 36 p.c.
- silt fraction 35 p.c.
- sand fraction 3 p.c.

2. Brown mud

Chemical composition is as follows.

Al_2O_3	5.85 p.c.
SiO_2	21.87 p.c.
Fe_2O_3	7.14 p.c.
TiO_2	o.79 p.c.
CaO	45.9 p.c.
MgO	1.61 p.c.
K_2O	o.38 p.c.
Na_2O	1.84 p.c.
total	98.o3 p.c.

The material is the by-product of Shandong Aluminium Works using pyrogen technology. The high CaO content of brown mud is bound to $CaCo_3$ while the other part has been primarily in dicalciumsilicate (Ca_2SiO_4) subordinately in sodalite (sodium-aluminium-silicate) and in gehlenite ($2CaO.Al_2O_3.Fe_2O_3$).
The Al_2O_3 is to be found in the sodalite beside the gehlenite approx. fifty-fifty per cent. The iron is

bound to gehlenite, and other iron gels. On the derivatographic courves (see fig. 6.) The DTA indicates this state of iron by an elongated exotherm peak between 1oo-4oo°C.
The exothermia beginning on 8oo°C shows the decomposition of $CaCO_3$ and the polimorf transformation of dicalcium-silicate.
Grain size distribution of the natural (dry) material is as follows.

a) bigger than 2 mm is 58 p.c.
b) between 1-2 mm 24 p.c.
c) less than 1 mm 18 p.c.

The $CaCO_3$ content of the fractions above 2 mm, is between 3o-36 p.c, that of in the fraction below 2 mm is between 25-3o p.c.

Grain size distribution of the soaked mud is as follows.

clay fraction 25 p.c.
mud fraction 55 p.c.
silt fraction 2o p.c.

Distribution is shown on Fig. 2.

3. Red sandy clay

The sample was named as "bauxite clay". Due to the fact that it does not contain aluminium oxydes or hydroxides it cannot be decided that it has to do with the bauxite or not. It may derive from the denudation or reworking of some bauxitic material with a significant sandy contribution.

Chemical composition is as follows.

Al_2O_3	19.34 p.c.
SiO_2	59.28 p.c.
Fe_2O_3	8.75 p.c.
CaO	o,9o p.c.
MgO	o.2o p.c.
K_2O	2.o4 p.c.
Na_2O	o,18 p.c.
loss on ignition	6.74 p.c.
Total	97.43 p.c.

As to the mineralogical composition of the rock, 4o p.c. of kaolinite was detectable. The exotherm peak of kaolinite can be explicitely seen between 56o-64o°C. The small exotherm peak between loo-2oo°C relates to adhesive moisture of 3o p.c. (see fig.7.) Its red colour is due to the ferri, namely to hematite (Fe_2O_3) , (8.75 p.c.). The alkalines may be bound in feldspars in sandy fraction. The sandy fraction (26 p.c.) consists of predominantly quartz.

Grain size is as follows.

clay fraction	32 p.c.
mud fraction	18 p.c.
silt fraction	23 p.c.
sand fraction	27 p.c.

See detailed in Fig. 3.

4. Sandy clay

More exactly - as it is shown by the grain size distribution curve- (fig.4.) it is a clayey sandy silt.

Chemical composition is as follows.

Al_2O_3	1o.6. p.c.
SiO_2	72,3 p.c.
Fe_2O_3	4.2 p.c.
TiO_2	2.13 p.c.
CaO	2.86 p.c.
MgO	o.56 p.c.
K_2O	1.84 p.c.
Na_2O	1.o4 p.c.

loss on ignition 4.52 p.c.
Total 1oo.o5 p.c.

With the derivatographic test beside an adhesive moisture of 2o p.c. only kaolinite can be explicitely detected. Its quantity has been approx. 2o percent. The endotherm peak above 8oo ^{o}C proves the presence of fine detritic rock, mainly limestone. The iron has been found also in hematite, the geothite peak is to be seen between 3oo-4oo ^{o}C (see Fig.8.)

Grain size distribution is as follows.

clay fraction	25 p.c.
mud fraction	15 p.c.
silt fraction	42 p.c.
sand fraction	18 p.c.

See detailed on fig. 4.

5) Sand

As it is shown by the grain size curve, it is well classified probably river sand, having a perdominant grain size of o.3 and lo mm (see fig.5.)
Microscopic mineralogical tests shows that the bulk of the material has been quartz and feldspar.
The ratio of the two materials could not be determined because the material is rounded to subangular forms.
Among the coloured particulars magnetite, pyroxene, rutile can be rendered probable. Besides these materials biotite, or muscovite can be detected.

KERAPROGRESS

Grain size distribution

FLY ASH

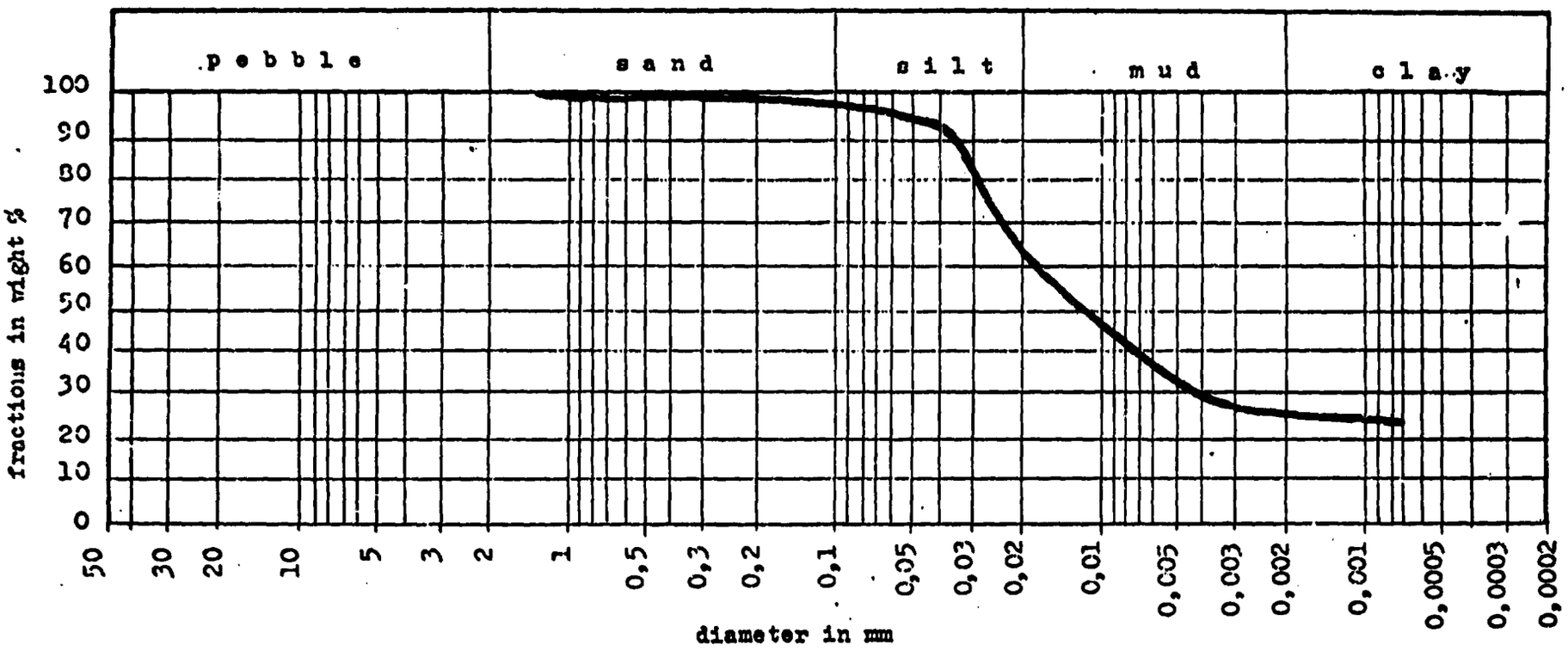


fig N° 1.

73/506

KERAPROGRESS

Grain size distribution

RED SANDY CLAY

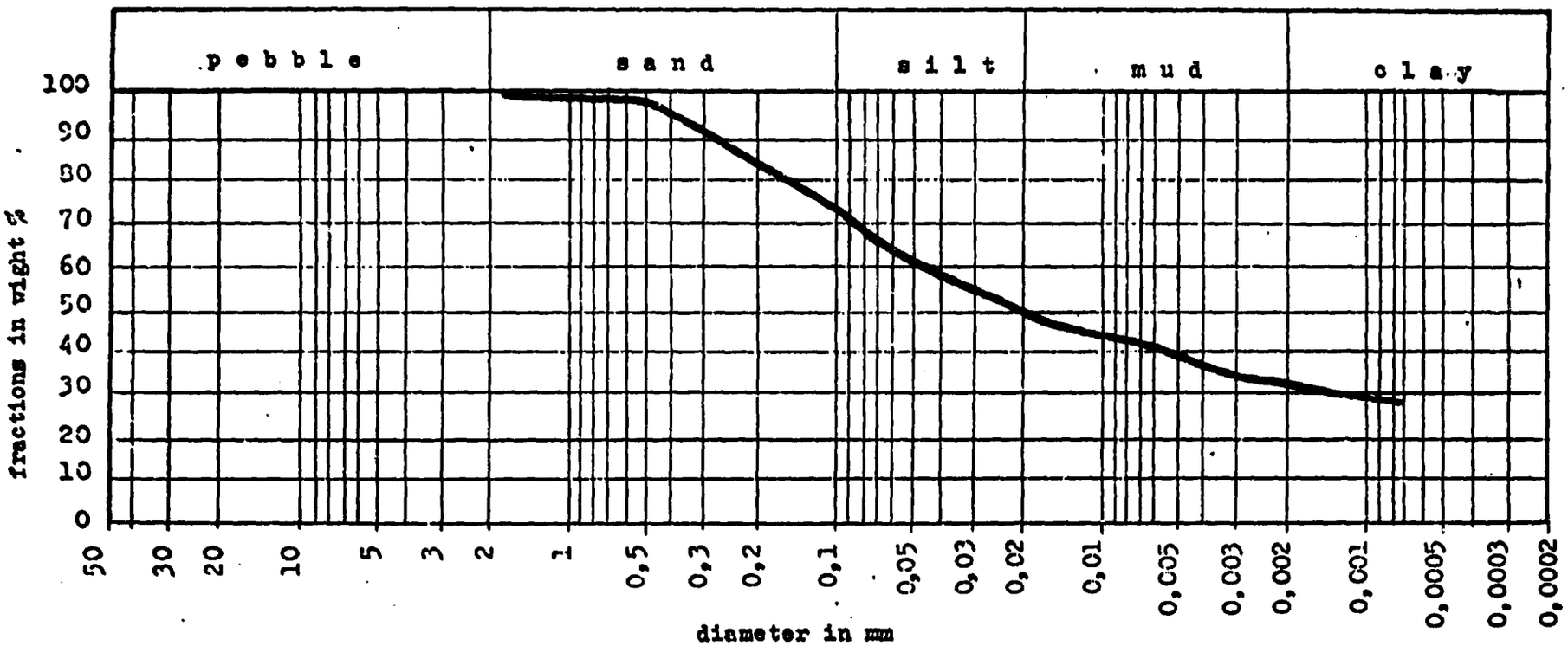


Fig. N° 3.

73/506

KERAPROGRESS

Grain size distribution

BROWN MUD

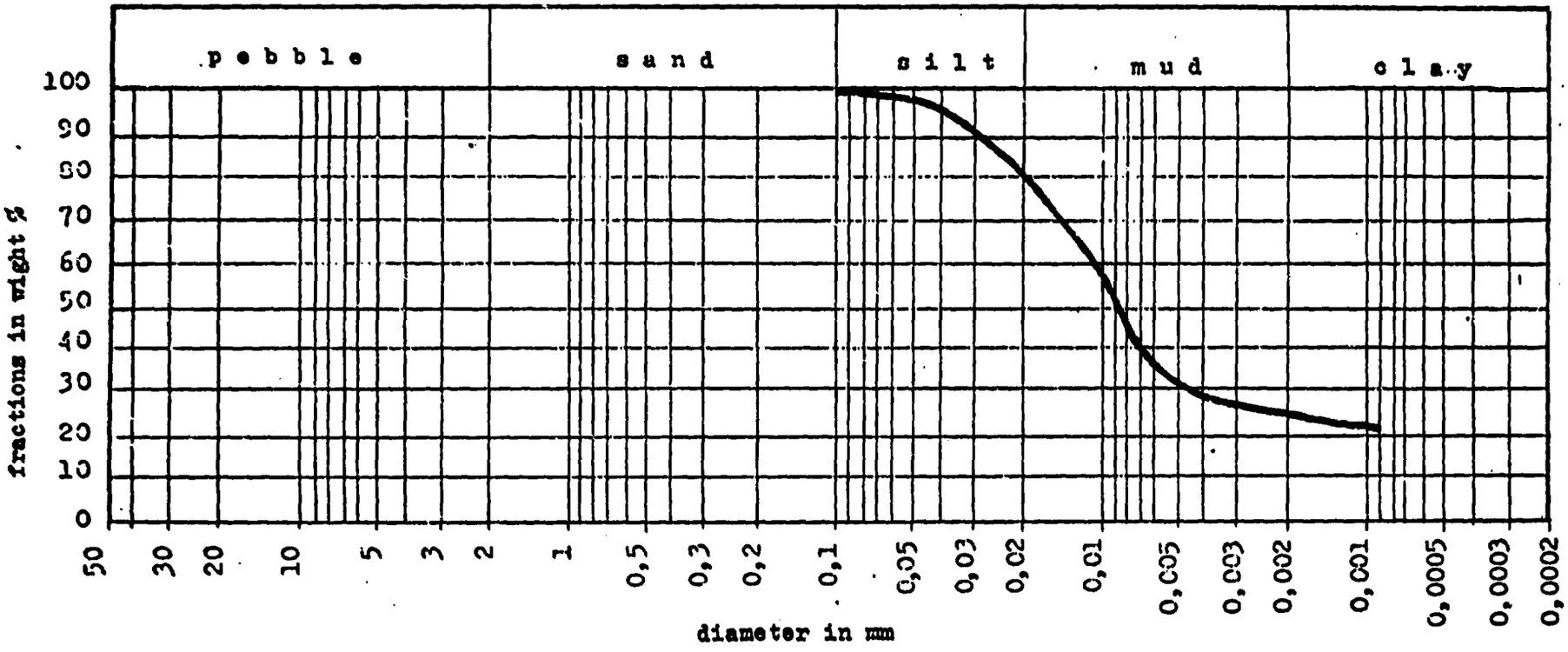


Fig N° 2.

73/506

KERAPROGRESS

Grain size distribution

SANDY CLAY

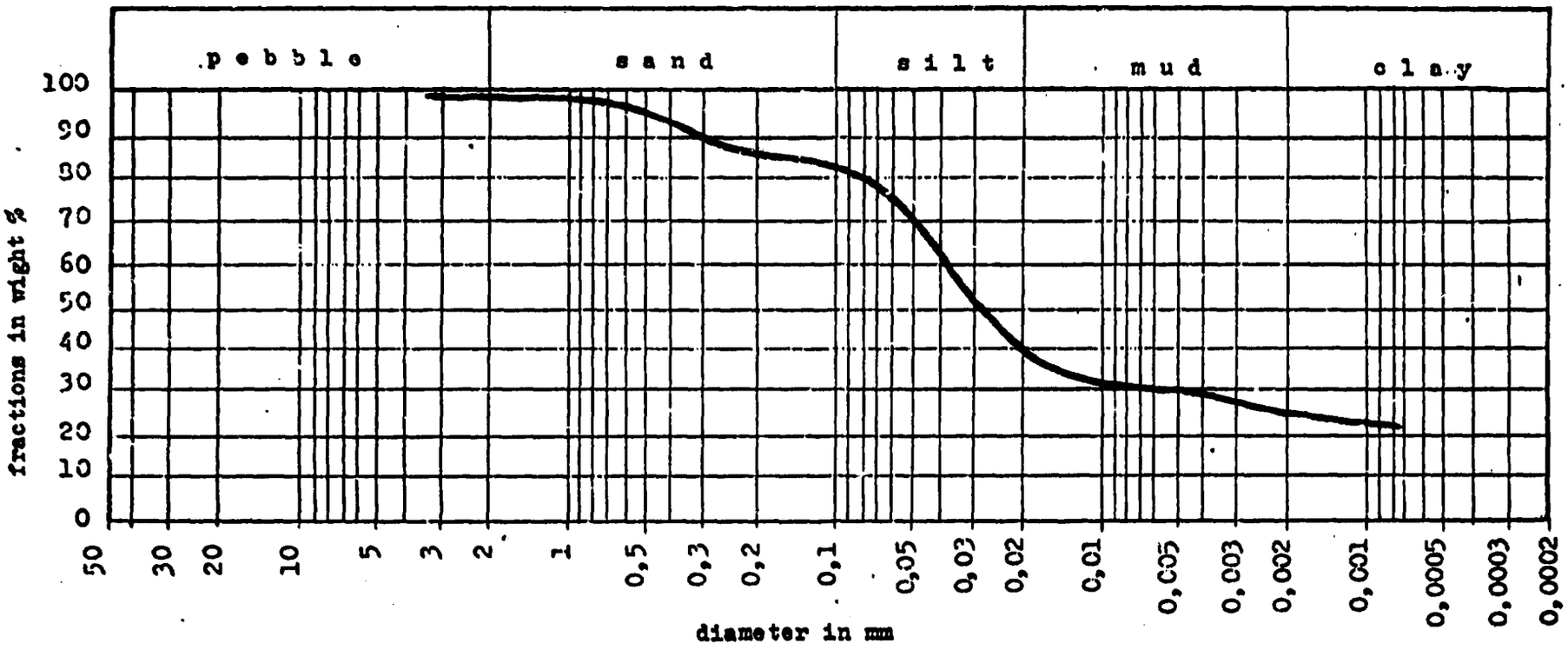


Fig. N° 4.

73/506

KERAPROGRESS

Grain size distribution

SAND

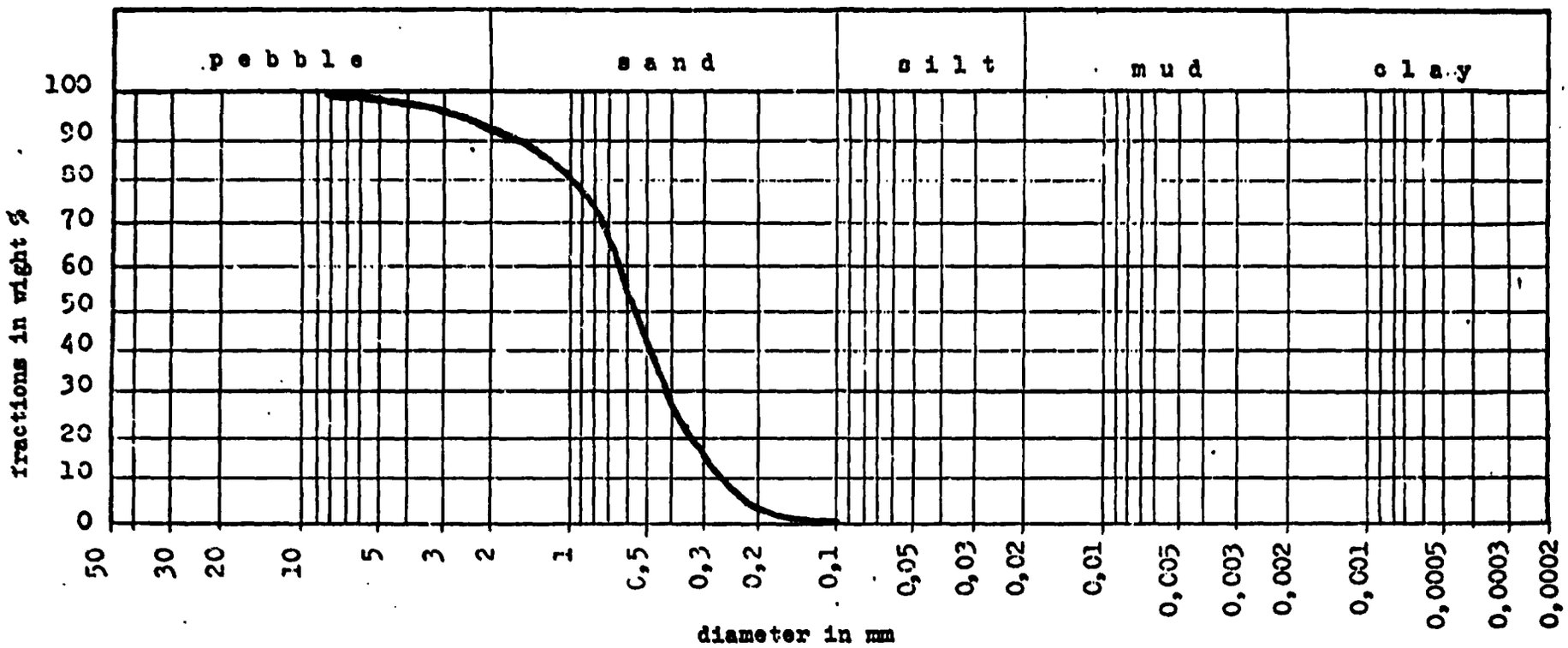


Fig N° 5.

sand

73/506

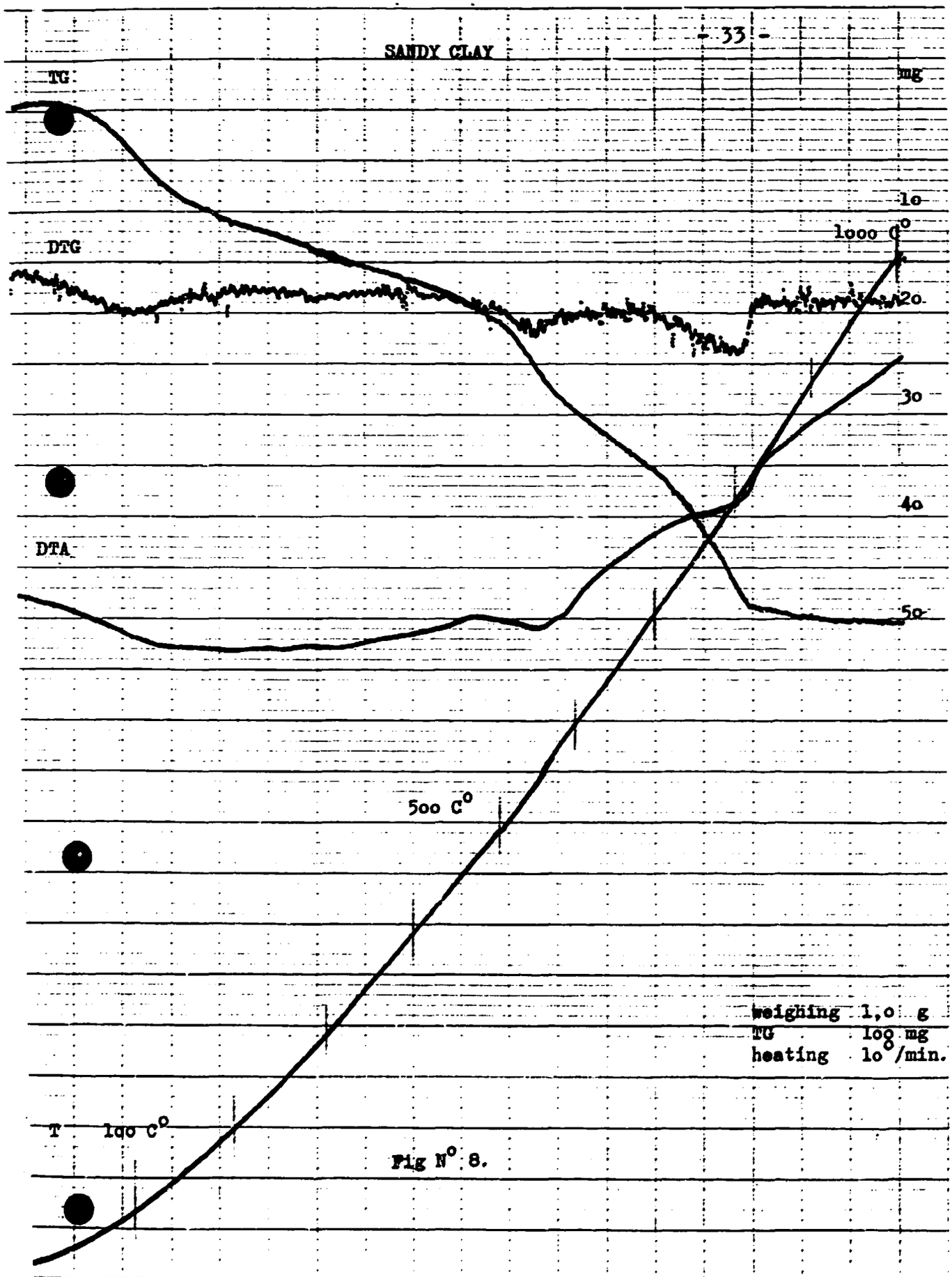

SANDY CLAY
TG
mg
DTG
DTA
1o
1ooo C°
2o
3o
4o
5o
5oo C°
1oo C°
T
weighing 1,o g
TG 1oo mg
heating 1o°/min.

Fig N° 8.

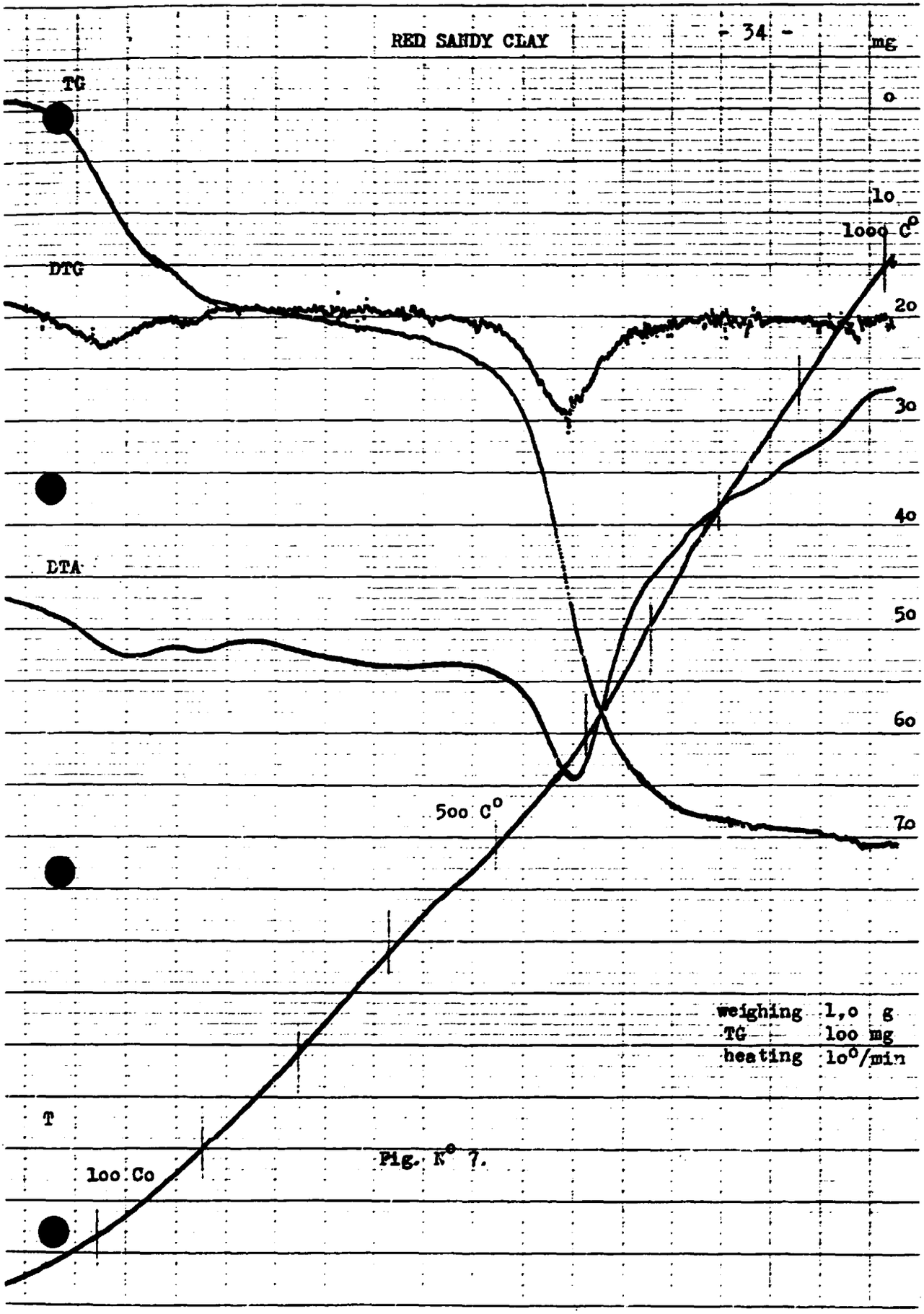

RED SANDY CLAY
mg
TG
o
1o
1ooo C°
DTG
2o
3o
4o
DTA
5o
6o
5oo C°
7o
weighing 1,o g
TG 1oo mg
heating 1o°/min
T
1oo Co

Fig. K° 7.

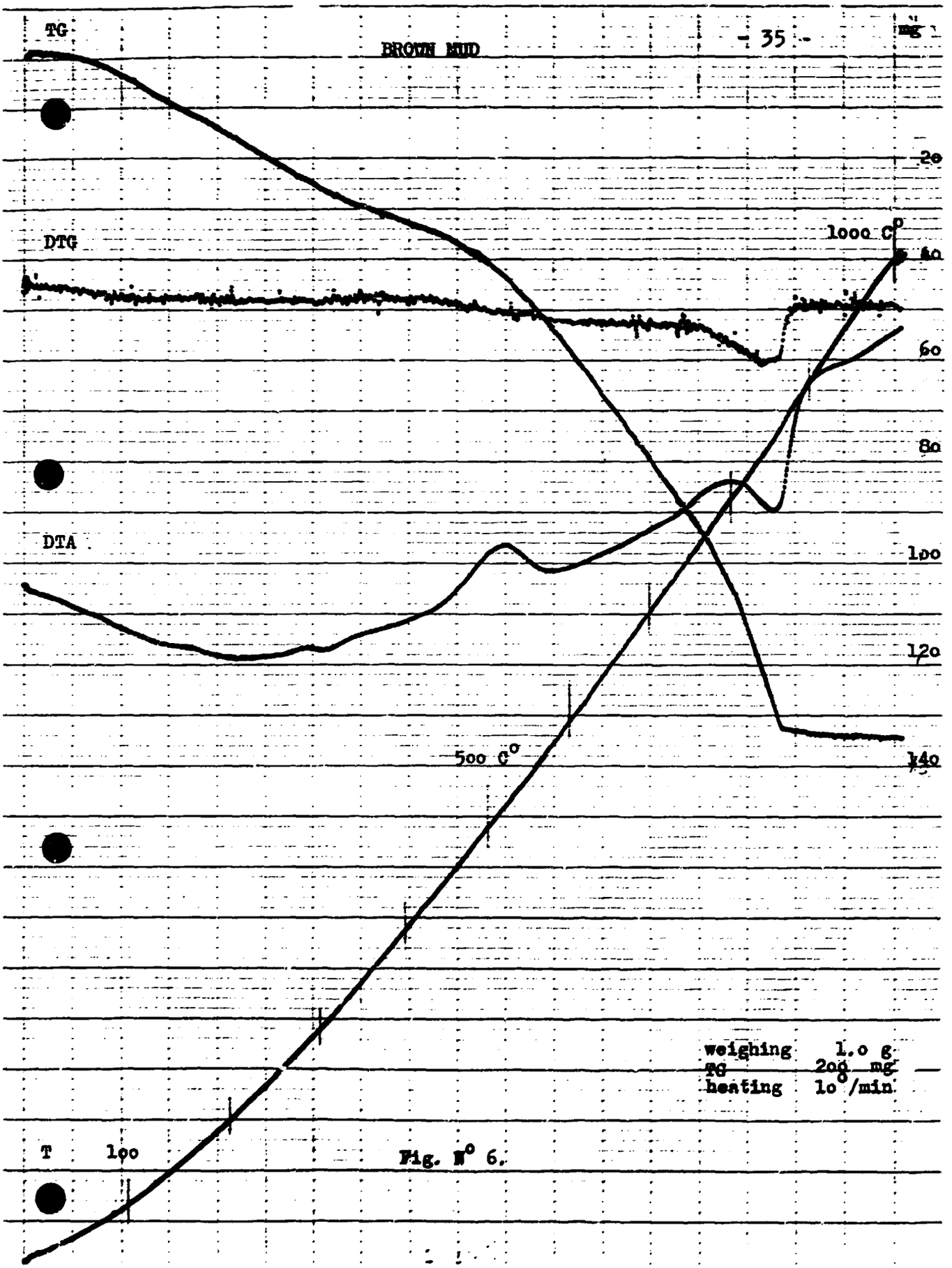

TG
BROWN MUD
mg
2o
1ooo C°
4o
DTG
6o
8o
DTA
1oo
12o
5oo C°
14o
weighing 1.o g
TG 2oo mg
heating 1o°/min
T 1oo

Fig. N° 6.

Optimation

The main oxide composition of the available raw materials and additives, in percentage

	Brown mud	fly ash	"bauxite clay"	clayey sand	sand
SiO_2	21.78	43.43	59.28	72.3	76
Al_2O_3	5.85	22.22	19.34	1o.6	14
Fe_2O_3	7,14	17.51	8.75	4,2	3
CaO	45,9	1.29	o,9	2.86	2,1
MgO	1.6	o.2	o.2	o.56	o,3
Na_2O	1.84	o.24	o.18	1.o4	4
K_2O	o.38	1.52	2.o4	1.84	
TiO_2	o.79	o.86		2.13	o,5
loss on ignition		8.35	6.74	4.52	
moisture		28.2			

I. For the production of single-fired floor- and wall-tiles on the basis of laboratory tests the following optimal composition can be suggested.

Brown mud	4o percent by weight
"Bauxite clay	3o "
clayey sand	2o
sand	1o

The main oxide composition of the floor- and wall-tiles made of the optimated mixture (after firing) is as follows.

SiO_2	5o,45
Al_2O_3	15,39
Fe_2O_3	5,61
CaO	2o,89
MgO	o,84
Na_2O	1,14
K_2O	1,38
TiO_2	o,79

Preferred preconditioning

On the basis of the optimal composition, the chemically transformed (inert) brown mud and additives (with regard to their moisture content) are measured in a wet ball-mill so that the solid content in the mill is 58 p.c. and the water content should be 42 p.c. The necessary water content may be achieved by adding water if required. Due to the high $CaCO_3$ content of the brown mud the mixture can be ground only by an essentially higher quantity of water, consequently electrolyte is to be added. To our own laboratory experiments, the electrolyte Gesfix 5o produced by the West-German Zsimmer & Schwarz was used, to the extent of o,5 p.c. This electrolyte has an increasing green strength effect. According to our estimates for the grinding of the mixture, 6-7 hours are necessary, because under these circumstances the screened residue of the ground mud on a sieve of DIN 1o.ooo has been less than 5 p.c. The dewatering of the mud to approx. 6 p.c. water content and the granulation we suggest by means of an atomizer in one phase. The spray drying, although it requires a lot of energy, enables the production of most ideal pressed granulate. After granulation, at least a conditioning time of 12 hours is necessary.

Optimum method of shaping

From the granulate homogenized by conditioning and of approx. 6 p.c. moisture content tiles are to be pressed on a hydraulic press with dimensions of 15ox15ox7,5 mm, on a large-scale automatic press in comparison with a laboratory press on a double specific pressure of 5oo kp/cm2.

For the removal of the moisture content remaining after pressing we suggest a vertical dryer of 2 hours cycle time at a max. temperature of 150 °C. The dried tiles having at least 50°C temperature can be glazed traditionally, on glazing line (as it is usual in case of single fired biscuit tiles) and might as well be decorated by sieve press.

Optimum conditions of firing

For the firing, we suggest a rollkiln having the smallest energy requirement (most economical) enabling the firing to be carried out without firing auxiliaries.
The optimal conditions of the firing were defined by using a simulator made by the West-German company Messrs. Naber. According to this experiment, the product planned can be fired out without any torsion with perfectly glazed surface by a 2 hours cycle time and at a maximum temperature of 1050°C.
The best samples made of the preferred mixture rendered the producibility of products of high breaking strength probable at a temperature of 1050-1075°C. It was also proved by the experiments that for the production of unglazed clinker tiles the brown mud content of the mixture has to be decreased to 25 p.c. This does not meet with the requirements of the experimental work , i.e. the large quantity for the utilization of brown mud.
The colour of the surface of the fired product (green-yellow) does not meet with the aesthetic requirements.

The green break-strength of the test samples made of the preferred mixture by laboratory press at a specific pressure of 25o kp/cm2 has been 7 kp/cm2. This value can be increased to the optimal lo kp/cm2 by further development. The bulk density of the test samples fired on lo5o°C 1,5 g/cm3, water adsorption 12,o weight p.c. and break strength 365 kp/cm2.

II. Following preferred composition can be suggested for the production of wall bricks by cold technique.

Optimal composition. (in percentage)

	1.	2.	3.	4.
Brown mud (dry, passed through a sieve of 1 mm)	8o	7o	67	6o
fly ash (quality developed under the present power station conditions)		lo	15	
portland cement (quality 35o)	2o	2o	15	
fired lime (ground to o-o,1 mm)			3	
fly ash-cement				4o

Preferred preconditioning

On the basis of the optimal composition, the inert, chemically transformed brown mud powder (with a grain size between o-1 mm) is put in a premixer where dry power station fly ash having o-o,5 mm grain size, and portland cement of quality 35o are mixed. The bown mud instead of power station fly ash and portland cement (the faly ash-cement made according to the Hungarian process) are to be mixed in the same way. The dry powder mixture undergoes an intensive mixing in the

homonenising reactor. The optimal water contenct of the mixture should be 12,o [illegible]cent.
For the adjustment of the water content, water at about 5o °C temperature is to be applied.
The wet mixture is to be moulded after a further period of half an hour.

Required shaping

The conditioned material mixture can be pressed into bricks by hydraulic brick presses applied for the shaping of lime bricks . In Europe, for the pressing of lime bricks, presses S-SP 500 type front loaded Speakman-Sutcliff are generally used.
The normal pressing force has been 3oo kp/cm2 . The press is of automatic pick up and the pressed bricks will be put directly on the autoclave hardening carriages.

Method for brick conditioning

For the increase of the brick strength and for the reduction of the hydraulic-binding time, we suggest the well-proven autoclave-hardening at the lime brick production. The cycle time of the hardening by saturated steam in autoclave has been 7 hours. For the effect of the autoclave hardening the strength of the pressed bricks has been 13o kp/cm2, enabling the immediate delivery ex-works. The production without autoclave hardening increases the conditioning time necessary for the hydraulic-binding, consequently the basic area demand and the architectural investment costs are also increasing.
On the bais of the laboratory experiments, it was stated that for cold-technology brick production only the so-called old-mud or the fresh mud dried under suitable circumstances is suitable as a raw material.

The C_2S (didalcium silicate) content of the fresh-mud if used straightaway, in wet condition, will be altered after hardening of the shaped product by the effect of the CO_2 content of the air which will decompose it to $CaCO_3$ and SiO_2. Due to this chemical transformation, the product looses its strength and crumbles into powder. If however, the brown mud coming out of the alumina factory has enough time to combine with the CO_2 content of the air and, consequently, the C_2S content of brown mud is altered and transforms chemically, then the product made of this brown mud does not lose the strength gained by the hydraulic binding. An economic (energy saving) solution could be the drying of fresh mud in hot waste gas (flue gas) with rich CO_2 content. Due to the fact that we were not in a position in China to visit the powder station and the power plant of the alumina factory, we could not elaborate the best method to be realized on the spot for the chemical transformation and drying of brown mud. Consequently, we can give only theoretical considerations supported by laboratory results.

By way of experiment, it was stated that the grain size of brown mud derived from China does not require the purification (refining by further grinding), on the contrary, it is harmful, bearing in mind the strength of the product and the hydraulic binding material application.

It can be presumed that, by the chemical transformation of the C_2S content of the brown mud and drying, the grain size can also be influenced. During the experiments, problems were caused by the high loss on ignition, of the power station fly ash (8,35 p.c.) which also contained combustible carbon to the extend of o,5 p.c. The firing temperature of power station boilers, the speed of firing and the air supply not being suitably regulated are all adverse factors affecting the regulation of the operation.

By way of experiment, it was stated that the firing temperature of the power station boiler could be lower that the 12oo°C quoted to us. Due to the fact that to the production of fly ash cement suggested by us as a hydraulic bining material, power stations with well-regulated bolers of higher than 12oo°C firing temperature are necessary. The possibilities of Shandong are not known to us but other energy saving methods had been elaborated successfully by us.
From the fly ash placed at our disposal with fly ash cement prepared in laboratory circumstances, successful tests were carried out for the production of cold-bond bricks. This testing enables the Chinese partner to take into consideration our results in case of power station reconstruction or additional investment.

Testing results of solid wall bricks test specimens produced by cold technique

	Mixture no.			
	1.	2.	3.	4.
pressing strength kp/cm2	5	7	8	6
autoclave strength kp/cm2	16o	2oo	12o	13o
28 days' strength kp/cm2	2oo	25o	15o	15o
dry bulk density g/cm3	1,5	1,4	1,6	1,4
water absorption weight p.c.	11	13,5	1o	13
porosity w.p.c.	16,5	17,5	16	18,2

III. Walling block of lightfoam construction

Test results of walling blocks test specimens of light foam construction by cold technique

	Mixture no.			
	1.	2.	3.	4.
green strength kp/cm2	1,5	1	2,5	2
autoclave strength kp/cm2	6o	55	65	7o
28 days' strength kp/cm2	9o	8o	1oo	8o
apparent density g/cm3	o.87	o,8	o,78	o,68
actual density g/cm3	1,5	1,6	1,6	1,4
voids volume in w.p.c.	42	5o	51,25	51,4

Optimal preconditioning

On the basis of the preferred composition, the chemically inert, transformed brown mud powder with a grain size between o-1 mm in dry condition, is put in a premixer and during mixing the necessary additives for the hydraulic binding are added, also in dry condition. Finally the aluminium paste for foaming is added. After the additives become homogeneous, the mixture is then put into the wet reactor. In the wet reactor, the water content of the mixture is adjusted to loo p.c.

For the adjustment of the temperature to 4o°C water is added. In the wet reactor, the mixture is held for lo minutes with vigorous mixing.

Preferred method of shaping

The mixture coming from the reactor is put into wooden forms within 2o minutes in case it becomes unusable. The forms have to be filled evenly according to the decreased ratio of the final voids volume (by 5 p.c. more than the effective ratio).
For instance, in case of 5o p.c. voids volume, 5o p.c. increased by 5 p.c., i.e. 52,5 p.c. of the form volume is to be filled with wet mixture. The wet mixture is poured into the form within a period of 15 minutes at the most. If the level of the mixture should swell above the upper edge of the form due to foaming, the surplus can be removed by a string cutting device within 5 minutes at the end of swelling. The form box together with the bottom plate is put onto the hardening carriage of the autoclave and is covered by a plate made of wire cloth (2x2 mm). Another form box can be put together with bottom plate, onto the wire cloth. Thus, with the form boxes arranged beside and above each other the whole charge of the hardening carriage can be set up.

Preferred method of conditioning

It is an essential requirement that before the hardening in the autoclave, the hardening carriages with other loads should be conditioned over 2 hours.
The conditioning can be achieved through passing over a so-called waiting tunnel. The temperature of the waiting tunnel is 4o^{o}C, the moisture content is determined as 9o p.c. The cycle time of the hardening by saturated steam has been determined by us as 8 hours. For the effect of the hardening in the autoclave, the foamed blocks can be removed from the form box and their strenght of loo kp/cm2 enables their immediate transport ex-works.

In the course of further experiments followed by the review meeting on the Project Area in September 1985 it became obvious that autoclave hardening can be taken out of consideration because the technical data (strength etc) without autoclave give better results than that of reached by autoclave conditioning. Consequently, production costs can be largerly decreased as it is shown by the economic calculation. This result meets with the requirements of the Chinese side i.e. to reduce investment cost of the factory and in paralel to this to increase economic efficiency and technical indices and parameters.
Therefore, in the further part of the Final Study the description and specification of a brick factory is contemplated without any autoclave hardening.

CHAPTER FOUR

Technological Description and specification of a brick factory for the production of universal walling-blocks, for brown mud based cold technology, with an annual capacity of loo.ooo.ooopcs, with dimensions of 24o x 175 x 115 mm

1. Introduction, basic data

Our offer was elaborated with due consideration of the general settlement possibilities.
On the basis of our local survey we contemplated to get the brown mud from the mud pond near to the alumina factory , it goes to the dryind area by pumps of high pressure in pipe-line where it is dried out by waste gases (favourable by flue gase)
The brown mud is forwarded back to the plant in pipe-line by high pressure pumps and its moisture content is changed to 2o p.c. by DORR-OLIVER filters having a capacity of loo kg)m2)h. It is then granulaed by a filtering-mixing equipment and is dryed out in a counter-current dryer by hot flue gas. The equipment necessary to the technology can be obtained by Messrs. DORR-CLIVER and Messrs. KERAbedarf.
Finally the brown mud is sieved and conveyed to the brick production. The fly ash-cement is delivered to the factory by tank-vehicle, on public road.

The elaboration of technology process, and the selection of machines and equipment was done on the basis of the available information on the Chinese raw-materials and tests carried out with these materials. The following initial data were taken into consideration regarding the production technology.

1.1. Annual gross production of the factory

At the calculation of the annual gross production of the factory we assumed to produce maximum quantity of building material on the lowest investment costs without giving any compromise in the quality of the manufacturing equipment or in the technology process.

1.2. Naming of the product and dimensions

The product produced has been yellow-reddish or green solid mud brick in one size, 24o x 175 x 115 mm.

The size of the brick is identical with the triplicate that of given in China made of clay.

1.3. Timing of work

Number of annual working days:	350.
Number of working days per week:	7.
Number of daily shifts:	2-3 shifts per day.
Effective working hours:	7 hour per shift.
Working in two shifts per day:	raw material delivery
Working in three shifts per day:	measuring,
	mixing,
	pressing,
	handling of the finished product and
	energy supply

1.4. Other initial data

- The settlement of the factory buildings can be made by turning away the axis A and B, if necessary. Thus, according to the local conditions, the optimal settlement can be planned.
- The economic efficiency can be increased without any limitation because the net production of the factory and the timing of work can be raised if we increase the number of staff and if we apply additional equipment.
- The planning of the internal road network of the factory makes it possible that the raw material delivery and finished product delivery do not travers (intersect) each other.
- The heating value of the available fuel, heating oil 10.000 kcal/kg, i.e. 42.000 kJ/kg

We assumed that the oil supply is secured at the fence of the plant, therefore, only interconnecting pipes, oil receiption station and the pipe-line inside the plant are to be built.

- The transformer station is built inside the plant, it connects to the external network by 2 pcs overhead line of 3o kV.
- Water supply available at the fence of the factory.
- Compressed air supply is secured by the planned air compressors.
- Separat laboratory is not planned. Strengtn tests of the brown mud powder, fly ash-cement, and finished product can be made on the equipment placed in the workshop.
- Regarding the complementary secondary establishments we meet only the most necessary demands with the planning of washing and catering.
- Regarding the offices, only the absolutely necessary demands are met.
- Regular maintenance is planned, only for transport carriages.
- Measuring and control equipment will be placed in the workshop, in the airconditioned small premises beside the reactor.

1.5. Main phases of the production technology

- The brown mud arrives in dry condition, is sieved to the requested grain size to the plant and is storaged under shelter against rainfall. (practically in spaded-finish silo bunker.)
- The fly ash-cement is delivered to the plant on a tank car in dry condition, and is stored in cement silos.

- The measuring of the brown mud, and fly ash-cement in the appropriate ratio, the automatic moistening, the intensive rapid mixing, are carried on, the mixture then goes through a double-axe trough mixer to the front loaded hydraulic press. After the automatic loading to the transport carriage the pressed bricks go through conditioning on the waiting track then go for delivery or to the open-air storage area.

2. Technical description of production technology

On the basis of the initial data the production technology consists of the main phasis as follows.

2.1. Receiption of brown mud and storage thereof
2.2. Receiption of fly ash-cement and storage
2.3. Measuring of brown mud and fly ash-cement, mixing
2.4. Pressing of the mixture into bricks
2.5. Storage of finished products or delivery

Hereinafter we outline the technology process according to the above production phases.

2.1. Receipt of brown mud and storage

The tipping ear car full with brown mud powder pours its charge to one of the bunkers of 18 m3 (1o) in the covered storage area. From the covered bunker the brown mud powder is picked up by a handspike front elevator and is conveyed to the feeding bunker. The steel-plate bunker sunk under the level has two outlets, discharge is made by an electromagnetic vibration loading tray, each (11.) Discharge is promoted by a plate vibrator fixed on the side wall of the bunker.
The vibration charger charges the mud to a rubber-textile conveyor belt (12),which deliveres it to the scale tank (15) staying on a steel construction.

2.2 Receipt and storage of fly ash-cement

The fly ash-cement is delivered to the brick factory by a tank-car. The discharge, resp., the pouring into the cement silo of 29c m3 is made by a pneumatic conveyor being on the car. The filling capacity of cement silo is for 11 days' fly ash-cement demand. From the big cement silos the fly ash-cement is conveyed pneumatically according to the demand in smaller cement silof of 25 m3 (13) and from here by worm feeder (14) to the cement scale (17) tank in the mixing hall.

2.3. Measuring of mud powder and fly ash-cement, mixing.

The puffer tank above the mud powder scale in the mixing hall is feeded by a conveyor belt (12). The measuring is started by a controller from the control point. The weight to be measured can be adjusted on the control table, thus the filling and discharge of the scale is automatic. The measuring capacity of the brown mud scale (15) has been 2ooo kg.
The mud powder goes from the scale tank by gravity to the intensive reversed current rapid mixer (18) under the scale. The fly ash-cement goes to the cement measuring tank (17) of o,4 m3, into the mixing hall by worm feeder. The measuring capacity of the cement has been max. 4oo kg. After finishing the measuring the fly ash-cement goes by gravity to the reversed current intensiv rapid mixer (18).
The mixing process continues automatically after starting the measuring if the conditions are given.

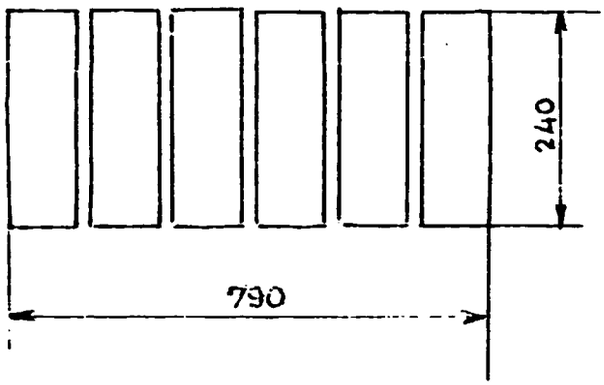
- the mixer is operating,
- the door of the mixer is closed,
- the measuring of the mixture is finished,
- the bunker under the mixer (19) is not full.

After the simultaneous measuring of fly ash-cement and mud powder dry mixing is made, then after automatic water addition (16) homogenisation is the following step.
Max. filling charge of the premixer is 2000 plus 400 i.e. 2400 kg.
The operating charge of the premixer has been 2000 kg.
Number of mixing per hours has been 12,5.
Mixing capacity has been 12,5 x 2,0 = 25 tons per hour.
Mixing cycle time is approx. 4,8 min.

After finishing the mixing the homogenized mixture goes to the mixture bunker of 2 m3 under the mixer (18), then a cellular feeder (19) feed it to a conveyor belt (30), from where it goes by gravity to the double-axe trough mixer (32) of continuous work for the purpose of second mixing. Here further water quantity will be added (33) for the adjustment of the most appropriate water content, necessary to the pressing.
The quantity of fly ash-cement within the mixture can be altered in the function of the required strength.

As a rule, the mixture consists of 40 weight percent but it can reach the 50 weight percent as well, in the bricks of high strength. Keeping the optimal value of the quantity of water added is very important because this significantly influences the strength of the product after pressing. The excessive adding of water causes problems with the filling of the press form

240 x 175 x 115 mm



Settlement of pressing dies on the press table.

2.4. Hydraulic pressing of the bricks

From the double-axe trough mixer the powder is delivered by a conveyor belt (34) to the feeding hopper (4o) of the hydraulic press (41) of 1 m3 and of 5oo tons pressing force, and from here to the press dies. The level indicator built in the feed hopper stops or starts automatically the conveyor belt and the trough mixer, according to the filling level.

The height size of the brick can be regulated by the bulk of filling volume.

The pressing procedure consists of 4 basic steps.
- Filling of the press form.
- Pressing
- Dejection of the brick from the form
- Loading of the pressed bricks to the transportcarriage.

The specific pressure of the hydraulic press on the surface of the brick has been 3oo kp/cm2. The press is only then working if there is mixture in the feed hopper and if the transport carriage is ready for loading at the loading machine, belonging to the press. To achieve the required production 8 pcs hydraulic presses are necessary. (capacity data of the presses can be found in point 3.2.)
Length of the transport carriage 136o mm

Number of transport carriages in the conditioning area has been 32 pcs.

The pressed bricks are picked up from the press table by a pneumatic catch and according to the pre-programmed data it places the bricks to the transport carriage (44) on the two sides of the press.
During the loading, the moving of the transport carriage is made electronically on the tracks, i.e. to the place of the loaded carriage the empty one automatically enters.
The automatic loading of the transport carriages can be pre-programmed according to the bricks of two different height sizes.
The number of transport carriages to be loaded; 6,79 pcs per hour.
The waste developing at the press is conveyed through the collecting hopper by a shain link transporter (6o) and a conveyor belt (61) and gets back to the double-axe trough mixer.

After loading the transport carriage with the fresh-pressed bricks, the pusher pushes elektromechanically the car to the conditioning track.
The length of the waiting track corresponds to the length of 32 pcs transport carriage (45 m).

We planned 8 waiting tracks with 32 carriages per track.
The filling time of the waiting track has been (in full length) 2 hours and 3o minutes.
Consequently in each shift 3,2 pcs waiting track equivalent transport carriage get into the same waiting track. Per one track and as per day 15o pcs transport carriage will be conditioned. The moving of the carriages insures the defectness of quality of the goods due to their vibration-proof and careful operation.

Note; In the selection of the hydraulic presses the following facts were taken into consideration.

- Among the SS-type hydraulic presses there are a lot in operation, well-proven equipment.
- The single side pressing means a mashine of lower costs, it is less complicated, consequently its maintenance is simple, its operation is easier due to its endurance.
- Maintenance demand of the mechanical presses are higher because they have more moving parts in where material granules can get. The mechanical presses in West-Europe were replaced by hydraulic ones as per offered by us.
- With the mechanical presses the conversion to the production of bricks of different sizes requires long-lasting work with a specialized knowledge.

2.5. Conditioning of bricks on the waiting tracks

From the waiting track 32 pcs transport carriage are pulled in one cycle. The conditioning time has been 7 hours. During this time developes the specified compression strength of the brick. The brick has reach its strength during 7 hours by which it can be stored till the delivery in one week. If we consider the traditional way of brick manufacturing the time from the raw material till the delivery of the finished product has been several weeks or months. By our method, however, this time can be reduced to a minimum of one week.

2.6. Storage and delivery of the finished product

From the conditioning tracks the goods are delivered by a grab (48) of the mobil portal crane of 14 mm span and are placed to the storage area or are loaded to vehicles. Above each other 4 charges can be placed at the most.

The crab way of the portal crane on the discharge-side of the transport carriage has been 5,6 m; on the loading-side 4 m with cantilever execution. The working length of the crane has been 8o m.

The empty transport carriages go b y a manual pushing plate (45) to the transport carriage cleaning equipment (87), here the platform of the carriage is cleanded, then the cars go through the storage track and the manual pushing table go back to the right or left side of the loading track.

From the nineth da y of the storage the moisture content of the storage area is to be raized up to 7o-9o p.c. in order to increase the strength value. (The bending strength of the bricks can be increased by some 2o p.c.)

3. Technical data

3.1. Production data

3.1.1. Name of the product has been cold-bond brown mud brick

3.1.2. Nominal capacity of the plant 3oo.ooo.ooo pcs
brick unit = loo mill.pcs walling block

3.1.3. Size of the product
24o x 175 x 115 mm
Maximal breaking strength 15o kp/cm2

3.1.4. Operating time, operating program.
Number of effective working hours; 7 hours per shifts (theoretically 8 hours)
Number of shifts; material delivery and storage; 2 shifts/day
measuring, mixing, pressing, hardening, finished products treatment, energy supply 3 shifts per day
Number of working days per week 7
Number of working days per year 35o
Number of working weeks per year 5o

3.1.5. Production data (with nominal capacities)

Size of brick	24o x 175 x 115 mm
Number of stroke of the press per hour	38o
Brick pc per stroke	6
Brick pc per hour	19oo
Volume of 1 pc brick (m3)	o,oo483
1 m3 per brick pc	2o7
Weight of brick per pc	6,75
Average volume weight (kg/m3)	14oo
press capacity (m3/h)	9,18

Material demand ton per hour per press	12,825
Brick pc per transport carrige	418
Transport carriage pc per hour per press	4,5

In the above calculation we started from the volume weight of the finished product being 14oo kg/m3.

3.1.6. Yearly production data of the brick factory

In case of production of bricks of 24o x 175 x 115 mm the technical (nominal) capacity has been

loo.ooo.ooo	pcs/year
483.ooo	m3/year
675.ooo	to/year

3.2. Material demand

The data relate to nominal production.

Ini ia data of calculation	alternative No.1.	No.2.
dry brown mud content 6o w.p.c.	8o w.p.c.	7o w.p.c.
fly ash-cement content 4o w.p.c.		
fly ash content		lo w.p.c.
portland cement content (type 35o)	2o w.p.c.	2o. w.p.c.

3.2.1. Specific material demand per m3 brick

name	unit of measure	size of brick in mm	
brown mud powder	kg/m3	24o x 175 x 115	838,35
fly ash-cement	"		558,9
water (at mixing)	l/m3		167,64
water (steam prod)	"		342
water total	"		51o

3.2.2. Material demand for hour, shift, working day, year

name	unit of measure	hour	shift	working day	year
brown mud powder	ton	55	385	115,7	4o5.ooo
fly ash-cement	"	37	257	771	27o.ooo
water (for mixing)	m3	11	77	231	81.ooo

3.3. Energy demand

Basic data of calculation

- energy demand of the heating oil 3.3oo kcal/kg,
  i.e. 14.ooo kJ/kg

heating value of the heating oil lo.ooo kcal)kg

3.3.1. Specific energy demand; per m3 brick and per looo pcs brick.

Brick size in mm 24c x 175 x 115 mm

Name	unit of measure	
heating oil	kg/m3	4,1
	kg/looo pcs	21,5
heating oil	kcal/m3	41.ooo
	kcal/looo pcs	215.ooo
electric energy	kWh/m3	15
	kWh/looo pcs	72

3.3.2. Energy demand per hour, shift, working day, year

Name	hour	shift	working day	year
heating oil (kg)	289	2o25	6.o76	2.126.666
electric energy (kWhour)	979	6857	2o.571	7.2oo.ooo

3.4. Required staff

Activity	Shift I.	II.	III.	Total
Production staff				
Engineer	1	1	1	3
material preparation	4	4	4	12
pressing	4	4	4	12
crane operation	2	2	2	6
transport carriage operation	4	4	4	12
raw material storage	2	2		4
finished product handling	2	2	2	6
carriage cleaning	4	4	4	12
safety reserve	3	3	3	9
Production. staff total				76
Non-production staff				
management administration	7			7
engineer	1	1	1	3
assistant engineer	1	1	1	3
ironworker	2	2	2	6
electrician	1	1	1	3
quality controller	1	1	1	3
assistant staff	2	2	2	6
Total non-production staff				31
Total number of staff				107

3.5. Storage capacity

3.5.1. Brown mud powder

7ooo tons. This quantity secures 7 days' requirement.

3.5.2. Fly ash-cement.

5ooo tons. This quantity secures 7 days' requirement.

Technological machine list

1. 4 pcs bunker for the reception of
   brown mud powder,
   volume 18 m3
   consists of the following equipment;
   1 pc welded, resp., screwed steel plate
   bunker, with two outlets, with hand
   operated spindle pushing plate, with
   footpath,
   installation materials,
   volume 5.5oo kg
   - 1 pc bunker supporting steel device
     made of "U" profile
   - 2 pcs bunker vibrator

2. Vibration feeder, for the discharge of
   brown mud powder
   material to be transported; brown mud powder,
   transport capacity max. 5o to per hour,
   - electro-magnetic inductor,
     material to be transporten; brown mud
     powder,
     grain size o-1 mm,
     moisture content max. 5 p.c.

3. Conveyor belt for the delivery of brown mud
   powder to the powder scale no. 15.
   transport capacity 5o tons per hour
   width of belt 5oo mm
   axial distance of cylinder 25,5 m
   lifting height 8 m
   in elevating execution,
   angle of the belt with the horison 21°

speed of conveyor belt 1 m sec,
drive by current (three-phase) electromotor,
by industrial drive, by electric switch,
with rotation sensing device.
The upper roller position consists of
three rollers, with trough, the down rollers
are horisontal rollers, with profile-steel
construction, with screw tension, feedig
trough, discharge outlet,
with catch-net, with steel hood above the
belt in the open-air. For the maintenance
of the belt with foot-patch, stairs, and
fender, with emergency switch, with
connecting elements for the mounting of the
belt, with foundation bolts,
electric capacity 7,5 kW

4. 4 pcs <u>fly ash-cement silo</u>
volume 23 m3=23 t from steel plate,
with profile steel supports, welded resp.,
screwed execution, with circular section,
pipe-connection for pneumatic feeding, by
manual pushing plate, continuous level-
indicator, protecting fender, supporting
steel construction, welded resp., screwed
from profile steel, till floor level,
with installation materials, foundation bolts,

5. 4 pcs <u>exhauster</u> with filter equipment, mounted
onto the top of cement silo, against dusting out,
with electric vibration (o,2 kW)
filtering surface lo m2
volume loo kg

6. 4 pcs <u>deareation equipment</u> to the
fly ash cement bunker no. 13.
volume approx. 1oo kg

7. 4 pcs <u>screw conveyor</u>
for the delivery of fly ash cement to the
scale silo no.15.
angle of elevation max. 22^{o}
delivery capacity 1o t/h
length 5,66 m
drive by current electromotor,
intermittent running, with rectangular
in- and outlet, with profile steel supporter,
fixing bolts,
electromotor N= 4,5 kW
volume approx. 4oo kg

8. 4 pcs <u>scale</u> for the measuring of brown mud
powder,
measured unit o-2ooo kg,
scale division 2,5 kg
for the discontinuous measuring of sand
with steel plate tank of 1,5 m3, with
pneumatic operating closing device
(interlock), with dial plate pointer,
with automatic control for the vibrating
device (o,4 kW) in order to make easier
the discharge, with flexible connection to
the mixer. In case of faulty measuring with
alarm signal.
volume approx. 12oo kg

9. 4 pcs automatic water feeder to the rapid mixer no.18.
volume 3oo kg

1o. 4 pcs scale for the measuring of fly ash-cement,
measuring unit o-4oo kg,
for the discontinuous measuring of fly ash-cement, with steel plate, with a measuring tank of o,75 m3, with pneumatic operating interlock,
vibrating device for the help of discharge with automatic control,
volume approx. 7oo kg

11. 4 pcs countercurrent rapid-mixer,
filling capacity 15oo liters i.e. 24oo kg mixture, drive by current electromotor,
with electrohydraulic operating discharger,
with rotary mixing pan, with mixing deaeration,
with ventilation, with automatic control,
with replaceable wear elements, with shield,
with central lubricator, with foundation bolts,
for the mounting, with supports,
electric capacity 4o kW
volume 9ooo kg

12. 4 pcs rotary feeder
capacity max. 5o m3 h,
revolution of plate 6,3/ min.
with feeding hopper (approx. 2 m3)
with steel supporter for the hopper,
drive from electromotor, with vibrating device, with level indicator and support,
with electromotor of 4,4 kW
volume 34oo kg

13. 4 pcs <u>cement silo</u>
filling capacity 29o m3/3oo to, made of steel plate, built-up execution of cylindrical rings, with reinforcement, in welded resp., screwed execution,
with pneumatic feeding,
ring diameter 573o mm
height of socket 6,6o m
total height 19,91 m
outlet height 2,51 m
- with outlet of 3oox3oo mm, with manual locking, with filling level indicator with exhauster against dusting out, mounted on the top of the silo
with stairs, to the silo,
lightning protector,
for the maintenance of filters foot-path and fender, materials for the assembling, foundation bolts,

volume approx. 3o.5oo kg

14. 4 pcs <u>filter</u>
mounted to the top of cement silo
with electric vibrating equipment (o,2 kW)
filtering surface approx. 15 m2
quantity of filtered air 7 m3/min.

15. 4 pcs <u>pneumatic conveyor</u>
for the transport of fly-ash cement from silo no. 2o.
to silo outside the workshop no. 13.
grain size of fly ash-cement o-o,o9 mm
transport capacity lo m3/ h

consisting of 1 pc screw feeder, with a capacity of 1o m3/h, with electric drive
- blower with pipes mounted on the construction, valves, with sealing, electromotor drive 3x38o V, 5o Hz, with slide rails, with V-belt disc, sealing to the assembling, electric capacity 33,5 kW, volume 145o kg

16. 4 pcs <u>conveyor</u>
for the transport of fly ash-cement to the reactor, density of the mixture 1,7 t/m3, temperature max. 1oo°C, transport capacity 5o t/h, with discontinuous running, width of belt 5oo mm, distance of axle 42,oo m, angle of elevation 21°, speed of conveyor belt 1 m/sec The upper roller position consists of 3 rollers,with feeding trough, the down rollers are horizontal rollers. with profile steel construction, screw tension, discharge outlet, with catch-net, with steel-hood, with emergency switch, and with foundation bolts, with foot-path, stairs and fender.
electromotor approx. 7,5 kW
volume 5.25o kg

17. 4 pcs biaxial <u>trough mixer</u>
for the second mixing, distance between inlet and outlet approx. 28oo mm,

propellers are mounted to the axis,
angle can be adjusted
capacity 35 t/h
with water injection pipelines
with steel support, with clutch, lubricator,
rubber trough,
electromotor 22 kW
volume 4ooo kg

18. 4 pcs <u>automatic water feeder</u>
to the biaxial trough mixer, 3/4"
volume 5oo kg

19. <u>conveyor belt</u>
for the transport of the mixture from the biaxial trough mixer to the press, with heat-proof (till loo ^{o}C) rubber-textile belt
capacity 5o t/h
width of belt 5oo mm
distance of axes 17 m
angle of elevation 21^{o}
in ascensional execution in full length
speed of transport belt o,8 m/sec
with switch, with rotation sensing element,
the upper rollerposition consists of 3 rollers,
with trough, down rollers are horisontal ones.
With profile steel construction, with screw tension, feeding trough, discharge outlet,
with catch-net, steel-hood, emergency switch,
foundation bolts, steel construction supports,
for the assembling,
electromotor 4 kW
volume 22oo kg

2o. 8 pcs magnetic metal separator,
above the conveyor belt no. 34.
lifting capacity of the permanent
magnet max. 5 kg,
with cleaning device
volume 25o kg

21. 8 pcs press feed hopper, the hydraulic
brick-press,
filling capacity 1,5 m3
made of steel plate in welded execution,
with profile steel, with level indicator
(min.-max.) vibrator for the hopper (2,3 kW)
volume 17oo kg

22. 8 pcs hyraulic press (front loaded)
type Speakman-Sutcliff S-SP 500
for the pressing of solid bricks,
max. length of the bricks 3oo mm,
max. pressing force 5oo to, pressing cycle time
per hour max. 425.
Cooling water demand of hydraulics 5o 1/min.2o°
press air demand 6 m3/h, 6 att.
with pneumatic loading machine, which delivers
the pressed bricks/blocks from the press above
the hardening carriage to the left and right
side and loads the carriages. The moving of the
hardening carriages is made automatically
or by hand operated buttom.

23. 8 pcs stamping die, for the pressing of bricks
dimension 24o x 115 x 55

24. 8 pcs stamping die
for the pressing of bricks/blocks of
24o x 175 x 115 mm

25. Base-frame for pressing,
made of steel plate construction
for the fixing of the pressing wastes
to the transport device, with foundation
belts,

26. Accessories
- form box replacing device
- protective device
- special tools

27. 8 pcs cooling device
cooling capacity 3o kW
for the holding of the temperature of
recycled oil of the hydraulic press on
max. 5o°C, the cooling agent is circulated
cold water in insulated pipeline.
With water supply tank, with pumps, filter,
pipe-line, fittings, built-in electric
capacity 17,5 KW
volume approx. 1o5o kg

28. Bridge crane
loading capacity 3ooo kg
above the hydraulic press for maintenance
purpose,
span 7,oo m
lifting height approx. 8,oo m
with electromotors for the moving of crane
bridge, in travelling crane with trolleyway,
inside execution with normal a nd fine
lifting possibility
working length of crane bridge approx.1o . m.

with profile steel construction crane track entirely independent from the workshop, with electric supply and with safety devices,
built-in electric capacity 4,25 kW
volume approx. 1600 kg

29. 8x64 transport carriage
for the transport of pressed bricks from the presses to the storage area, with profile steel construction, with a loading surface of 1360 x 1820 mm,
length of carriage 1360 mm,
wheel track 750 mm
height of plato above rail 470 mm,
with 4 pcs needle-roller bearing wheels.
To the transport carriage a quantity of 168 pcs and a size of 240x175x115 mm brick can be placed.
volume 506 kg/pc

30. 8 pcs manual travel table,
for the transport of empty hardening carriages, with welded profile steel frame,
with 4 pcs ball bearing wheels,
wheel track 1700/750 mm, with gear system and fixing.
volume 550 kg/pc

31. 8 pcs track network
- for transport carriages, rail of 80/14,
wheel track 750 mm
length of track 250 m
volume 8000 kg

- for pushing table of single carriage
  rail 93)18,5
  wheel track 17oo mm,
  length of track 26 m
  volume 11oo kg

- for moving portal craine,
  rail of 128)3,45
  wheel track 14,oo m
  length of track approx. 8o m
  volume 32oo kg

32. 4 pcs <u>portal moving crane</u>
useful load 5ooo kg
for the lifting of brick from the carriages to the storing area, for loading to the transport facilities by a hydraulic grab,
span 14,oo m
lifting height 4,oo m
lifting speed 12 m/min.
travelling speed of the running block 6o m/min.
- with cable drum electric supply (3 phase and earth)
- hyraulic grab for the lifting of the charge, in one phase to the storage area or to transport-facilities

built-in electric capaciaty 3o kW
volume approx. 28.ooo kg

33. 8 pcs <u>electric drive cable winch</u>,
for the moving of transport carriages, drive by electric motor, with 2 guide rolls, with cable and connecting elements
pull force 15 kN
built-in electric capacity 7,5 kW
volume 15oo kg

34. 8 pcs <u>scraping conveyor</u> (trough-chain conveyor), for the transport of pressing wastes
capacity 1o t/h
electric drive, with feeding and discharge hopper,
transport length 13 m
electromotor 3 kW
volume approx. 28oo kg

35. 8 pcs conveyor belt
for the retransport of pressing waste,
length of the belt 500 mm
tumbling shaft 9 m
transport capacity 10 t/h,
speed of transport belt 0,8 m/sec
electric drive, the upper roller position
consists of 3 rollers, the down rollers
are horizontal ones.
profile steel construction frame,
with screw tension, with feeding and
discharge hopper, with emergency switch,
and assembling units, and foundation bolts,
electromotor 2,2 kW
volume 1000 kg

36. Steel constructions
podests for the support of machines and
equipment, with foot pathes, with steel
construction stairs, ladders, coverings,
covering plates of scuppers, etc.
total volume approx. 4000 kg

37. 8 pcs transport carriage cleaning machine,
for the cleaning of the empty
carrieges and grinding thereof, with
rotating wire brush head, with electric
control,
electromotor 8 kW
volume 2700 kg

38. 8 pcs air-compressor, for the supply of compressed air without oil and water capacity 186 Nm3)h (8 Lar), operating pressure 7 bar

volume approx. 875 kg
- coal drying equipment, in air-cooling execution, built-in electric capacity 1,5 kW volume 287 kg
- air tank, 1 m3 volume,

39. pipe-line system

39.1. water supply system (3-5 bar), inside and outside the buildings,

39.2. with pipe-lines, fittings and firing elements,

39.3. pressed-air supply-system (7 bar) with pipe-lines and armatures, volume approx. looo kg

4o. mashines for maintenance, 1 pc each

4o. 1. drilling machine together with accessories
drilling capacity max 4o mm

4o. 2. manual thread cutting device

4o. 3. grinder with 2 abrasive discs

4o. 4. manual plate sheers

4o. 5. hydraulic frame saw

4o. 6. electric welder with arc-welding rectifier, in portable execution, with welding cable and electric holding fixture with face shield protection, electric capacity 25 kVA,
volume 368 kg

4o.7. autogen welding machine with
cutting device, with carriage
4o .8. mechanic tool kit
4o.9. welding tool kit
4o.lo.hand-mashine tools
- manual drilling machine
- manual grinding machine
- manual cutting machine
4o.11.file bench
4o.12.electrician tool kit

41. <u>laboratory equipment,</u>1 pc each
41.1. boiling plate 2ooo W,
41.2. precision scale, measuring limit
21oc gr plus-minus o,1 gr
41.3. pH-measuring device
for the determination of hydrogen ion
concentration
41.4. weigh beam,
measuring limit 2o kg
41.5. bending strength-crushing,
strength-pressing, strength-measuring
device for the measuring of the strength
of test specimens,
crushing force 18oo-2oookN
41 .6. CaO content determinator
41 .7. different chemical industrial devices
41 .8. labor-table, dimensions 15oox75ox9oo mm
41 .9. labor rinsing table,
dimensions looox5oox9oo mm

Chapter Five

Testing and Pilot Scale Demonstration Report

TEST REPORT

on the production of ceramic wall tiles from a body with red mud components in single firing.

Carried out for:

Novotrade RT,
Fürst Sandor u. 24-26,

1136 Budapest,
Hungary.
Novotrade team included Dr. P. Juskás ceramic expert
Mrs. Metri, project coordinator

by:

DORST-Maschinen- und Anlagenbau
Mittenwalder Straße 61
P.O. Box 109 + 129

D-8113 Kochel am See
West Germany
DORST team included Mr. Roschlau, leader of laboratory
Mr. Seitz, ceramic engineer

17th April 1985
Iv/De/rw

LIST OF CONTENTS

1. Scope of order

Company Novotrade RT of Budapest had given us the order to investigate the possibility of production of tiles from a ceramic body with red mud components. batch consisting of four raw materials was to be processed as follows:

- preparation by means of wet-grinding mills,
- spray drying of the slip,
- pressing of tiles with this granule and subsequent drying,
- glazing of the dried tiles,
- firing of the glazed tiles.

The tests have been carried out in the Test and Research Centre in Kochel am See from 26th to 29th March 1985 under the supervision of Novotrade RT.

2. Performance and results

2.1 Body preparation

For the trial the following raw materials had been placed at disposal:
200 kg dried brown slurry (red mud)
150 kg bauxide clay
120 kg clay (residual moisture 16 %)
50 kg sand

The raw materials had been weighed and ground in two batches of each 260 kg with 165 l of water in a wet-grinding ball mill (Dorst NM 110/90).

Dorst Company placed at disposal the liquifying agents Gießfix C 30 and Dolapix PC 67. When adding 0.2 % of Gießfix C 30 to the first batch no liquifying reaction was revealed, thus the more effective liquifying agent Dolapix PC 67 was used. Hence, both batches were liquifying with 0.8 % of Dolapix PC 67, the grinding time for each batch five hours. After this period of time the residue was smaller than 5 % on a sieve with 63 µm mesh aperture.

The slip ground in two batches was subesequently put into a container with electric stirrer and kept in constant elutriation until the spraying was effected in the spray drier.

2.2 Spray drying

By means of a diaphragm pump (Dorst MPz 80/25 R) the prepared slip was pumped to the spray drier (Dorst D 400), which has a water evaporation capacity of 400 l/h. The entire slip was sprayed into the tower with a nozzle (Ø 1.9 mm) whereby the air entry temperature in the tower was 280 °C. The heating medium was liquid gas and the pre-heating of the air was done by a integrated heat exchanger.

All technical data as to the spray drying have been listed in annex. 1. The sieve analysis of the granule revealed that the main range of the granule distribution is at 250 to 400 µm. This distribution being very favourable for pressing had been achieved by the fact that the spray drier has an automatic dust recycling, i.e. small particles which are sewpt out of the tower with the exhaust air can be separated by means of a cyclone.

The separated particles are transported into a pressure line with which the dust is blown into the tower again near the spraying nozzle. Thus an additional agglomeration of the dust particles is achieved so that the very fine proportion of the granule remains relatively small.

In the spray drier approx. 450 kg of pressing granule with a residual moisture content of 4 % to 6 % was produced.

2.3 Pressing

The granule produced by the spray drier was pressed on a fully-hydraulic tile press (Dorst HPP 750). By means of a five-cavity die (size 150.3 x 150.3 mm) tiles with an edge length of approx. 154 x 154 mm were produced. The specific pressing force was approx 500 kg/cm² at a tile thickness of 7 mm. The adjustment of the various pressing forces at the machine can be calculated from annex 2 "industrial trial on hydraulic plate press HPP 750".

After pressing the tiles were placed on a perforated metal sheet and were dried over night in a chamber drier at 110 °C.

By means of a three-point testing device the modulus of rupture of the tiles were tested before and after drying. The results have been listed in annex 3. As to the modulus of rupture in undried green tiles it can be derived that in comparison tile bodies the lower margin of strength was achieved at approx. 6 kp/cm².

In summarizing it can be stated that the granule with red mud components has a good pressability and reacts relatively insensitive to change of pressing force.

2.4 Glazing

For the glazing of the tiles Company Novotrade placed a liquified glaze at disposal which based on a Zirconia frit. This frit was kept in a homogeneous condition by intensive stirring, and shortly before use it was provided with an additive tylosis (2 g/l). The specific weight of the glaze was 1,380 g/l.

The hot tiles were removed from the chamber drier and were placed manually on a glazing line. After machine brushing of the tiles the glaze was applied in a cabin with a rotating disc. By varying the speed of the conveyor belt a glaze thickness on the tiles of approx. 1 kg/m² was achieved. On account of the low slip weight of 1,380 g/l a very slow speed of the conveyor belt had to be chosen resulting in the fact that a dripping of the glaze from the edges of the tiles could not be prevented. The glaze was fixed by means of heating up with IR-radiation.

2.5 Firing

For the firing tests a RIEDHAMMER sledge kiln with a total length of 16 m was used in our Test and Research Centre. It has to be point out that the firing tests have not been simulated but rather have been carried out on an industrial scale in placing firing material on all sledges of the kiln.

During firing the glazed tiles were placed on Cordierite plates which were supported by a mesh of ceramic pins. The sledges were continuously moved through the kiln with four burner groups heated with gas.

With this arrangement the firing programme can be set by selection of the suitable temperature and the passage time of the tiles.

The following temperature curves have been examined as to the four burner groups:

test No.	T_1 in °C	T_2 in °C	T_3 in °C	T_4 in °C	passage time in min.
1	850	970	1070	1070	98
2	850	1050	1120	1150	60
3	870	950	1060	1050	110
4	870	950	1060	1060	110
5	850	930	1060	1065	110

Test No. 1:

In this adjustment a deformation of the tiles resulted with the corners bulging.

Test No. 2:

With this considerably higher temperature the bulging corners flattened again. When the sintering process set in heavily at T > 1,070 °C the tiles were even more deformed.

Test No. 3:

The bulging of the corners was reduced by decreasing the maximum temperature to 1,060 °C as opposed to 1,070 °C in the first test, however, the glaze revealed heavy blistering.

Test No. 4:

By increasing the temperature in the last phase of the firing process (T_4) a better distribution of the glaze was achieved, however, still the formation of blisters was noticed.

Test No. 5:

After reducing the temperature in the heating up phase (T_1 und T_2) a distinct decrease in blister formation was noticed. It was to be assumed that the outgassing of the tile body when melting the glaze had not been finished in test 3 and 4.

The tiles fired in test 5 revealed in isotropic firing shrinkage of 1.53 %.

2.6 Laboratory tests

The fired and unfired samples were subjected to thermal analyses in the DTA and dilatometer tests which have been listed in annexes 4, 5, and 6. From the dilatometer curve (annex 5) the linear thermal expansion coefficient was determined:

$$\alpha_{AK\ (200)} = 7.02 \times 10^{-6}\ K^{-1}$$
$$\alpha_{AK\ (400)} = 7.38 \times 10^{-6}\ K^{-1}$$
$$\alpha_{AK\ (600)} = 8.54 \times 10^{-6}\ K^{-1}$$

As to the dilatometer curves of the unfired tiles (annex 4) a heavy contraction of the sample was revealed as a temperature of 770 °C. This can be refered to the setting in of the sintering process which is accompanied with exothermal and endothermal reactions (DTA, annex 6). The increase of the dilatometer curve at $T > 900$ °C could be assumed being due to a slight bloating of the tile.

The modulus of rupture was determined at the fired and glazed tiles by means of a three-point testing device, the results of which have been listed in annex 7. The average value of the modulus of rupture was 155.7 kp/cm².

3. Summary

The tests carried out, have clearly shown that ceramic-tiles can be produced in a rapid single-firing process by means of using a ceramic body which contains red mud as main-component. Also the laboratory tests pointed out that the properties of the produced tiles correspond to the German standards.

The fact that the firing tests were carried out in semi industrial scale test in a sledge kiln with a total length of 16 m only it enables us to point out, that the firing in a rapid firing kiln is possible. On an industrial tile production line using a roller hearth kiln the tiles can be produced with a better quality due to the more favourable firing conditions.

DORST-MASCHINEN UND ANLAGENBAU - KOCHEL

Semi Industrial Trial on the Hydraulic Tile Press HPP 750

PROJECT/CUSTOMER: Novotrade RT — Order no. : 97.265

Body : tile body — DATE : 27.3.85

Granulate moisture content: 6% — Quantity pressed : ~ 450 kg

Press die : Wall-Tiles — Size of press die: 150,3 x 150,3

Size of tile : 151,0 x 151,1 — Weight of tile: ~ 290 g

Adjustment of machine: p_1 = 220 bar, p_2 = 110 bar, p_3 = 140 bar

1st pre-pressing force: F_{V1} = 208 t; F_{V1} spez. = 180 N/mm²

2nd pre-pressing force: F_{V2} = - t; F_{V2} spez. = - N/mm²

main pressing force : F_H = 580 t; F_H spez. = 500 N/mm²

Time sequence of pressing :

start	stop	function	s	start	stop	function	s
0	0	filler forward 1st fall		10	10	2nd pre-pressing	
1	1	filler forward - reverse		11	11	main pressing	
2	2	filler reverse during shaking		12	12	delay crosshead upwards	
3	3	filler return time		13	13	crosshead upwards	
4	4	crosshead downwards		14	14	over-all cycle time	
5	5	additional de-airing T_2		15	15	filler return 2nd fall	
6	6	delay compacting force		0	3	over-all filler movement	
7	7	1st pre-pressing		6	11	over-all pressing time	
8	8	delay de-airing		4	12	over-all crosshead movement	
9	9	de-airing		/	/	strokes per minute : 22	

Filler: Wall-Tiles — Number of stripes: 6

Filling height: 18 — Thickness of tiles : 7,8 mm

Green bending strength: 6.7 kg/cm²

DORST-MASCHINEN UND ANLAGENBAU - KOCHEL

Semi industrial Trial

Spray drying

PROJECT / CUSTOMER : Novotrade RT ORDER NO. : 97.265
BODY : tile body DATE : 27.3.85

Solids	520	kg		61,2 %
Water	330	kg		38,8 %
Deflocculant		kg	Dolapix PC 67	0,8 %
liter weight	1590	g/l		
Viscosity	480	cP		
Residue on				%

Nozzle-upright	: 1		Hot air	270 °C
Number Pcs.	: 1		Waste air	85 °C
Nozzle Diameter	: 1,9	mm	Tower	20 mm W.G.
Twisting worm	: 5	mm	Main fan	180 mm W.G.
			Pump	20 kp/cm2

Residual moisture content : 6 %

Bulk density	827	g/l
Granulated material		kg/h
Water evaporation		kg/h
Consumption of gas		m3/h
Binding admixture		%
Type :		
Modulus of rupture: (raw body, material)		N/mm2
Pressed with 30 N/mm2		

Particle size distribution :

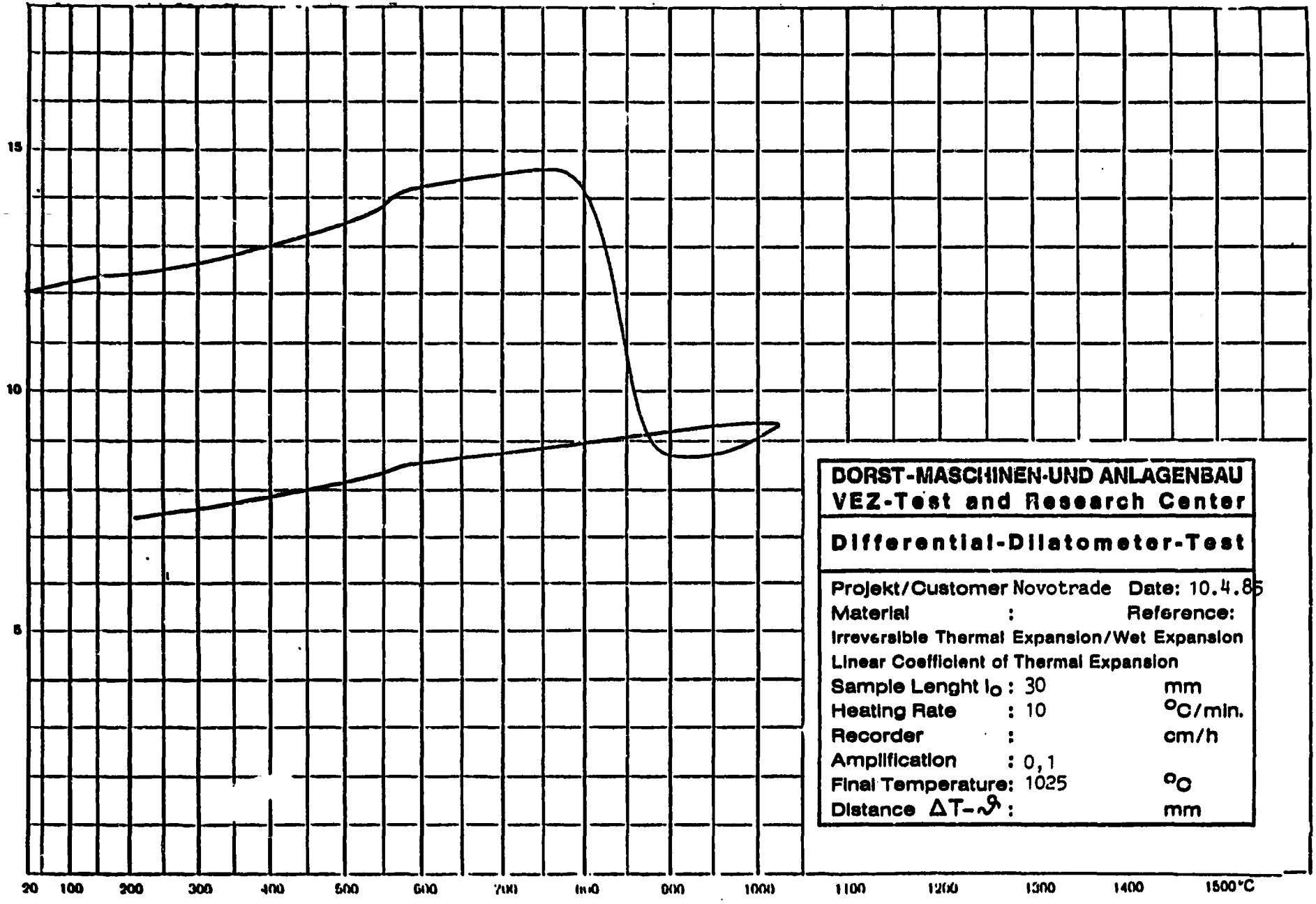
> 500 micron	0,1 %
500 - 400 micron	3,6 %
400 - 315 micron	23,9 %
315 - 250 micron	36,1 %
250 - 200 micron	19,9 %
200 - 160 miron	7,3 %
160 - 100 micron	6,6 %
100 - 50 micron	1,5 %
< 50 micron	- %

Enclosure 3 : modulus of rupture

material			before drying			after drying	
sample-No.:			1	2		3	4
pressing load		bar	250	250		250	250
before drying	size	mm	154,0 x 154,0	154,0 x 154,0			
	weight	g					
after drying	size	mm				151,1 x 151,1	151,0 x 151,1
	weight	g					
modulus of rupture	Pmax.	kg	2,6	2,7		8,8	8,25
	Ls	cm	13,0	13,0		13,0	13,0
	b	cm	15,4	15,4		15,11	15,10
	a	cm	0,705	0,71		0,695	0,70
	σ_{RB}	kp/cm²	6,6	6,8		23,5	21,7

P = fracture load
Ls = distance of edges
b = width of tile
a = thickness of tile

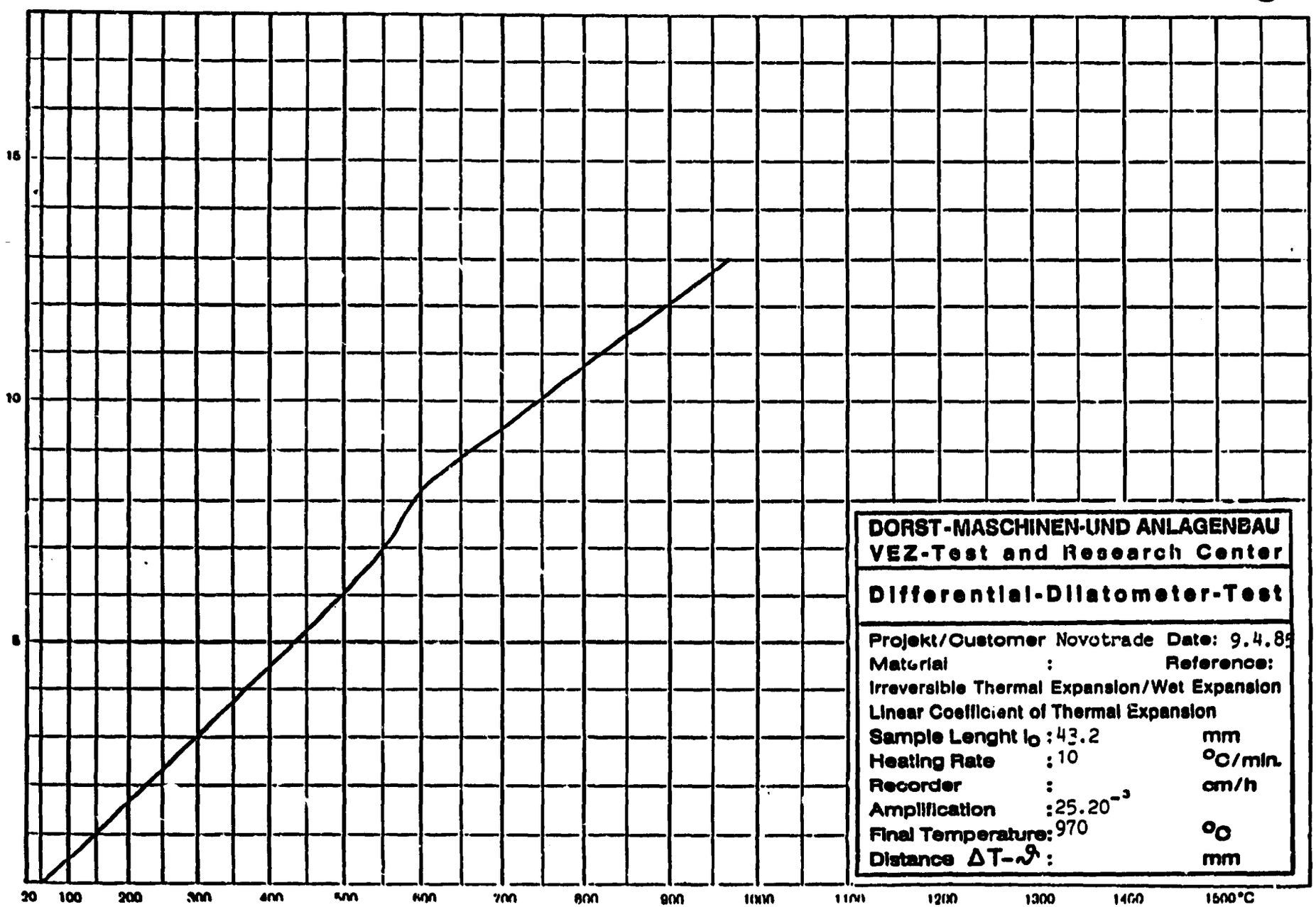
$$\sigma_{RB} = \frac{3\ P_{max.}\ Ls}{2\ a^2\ b}$$

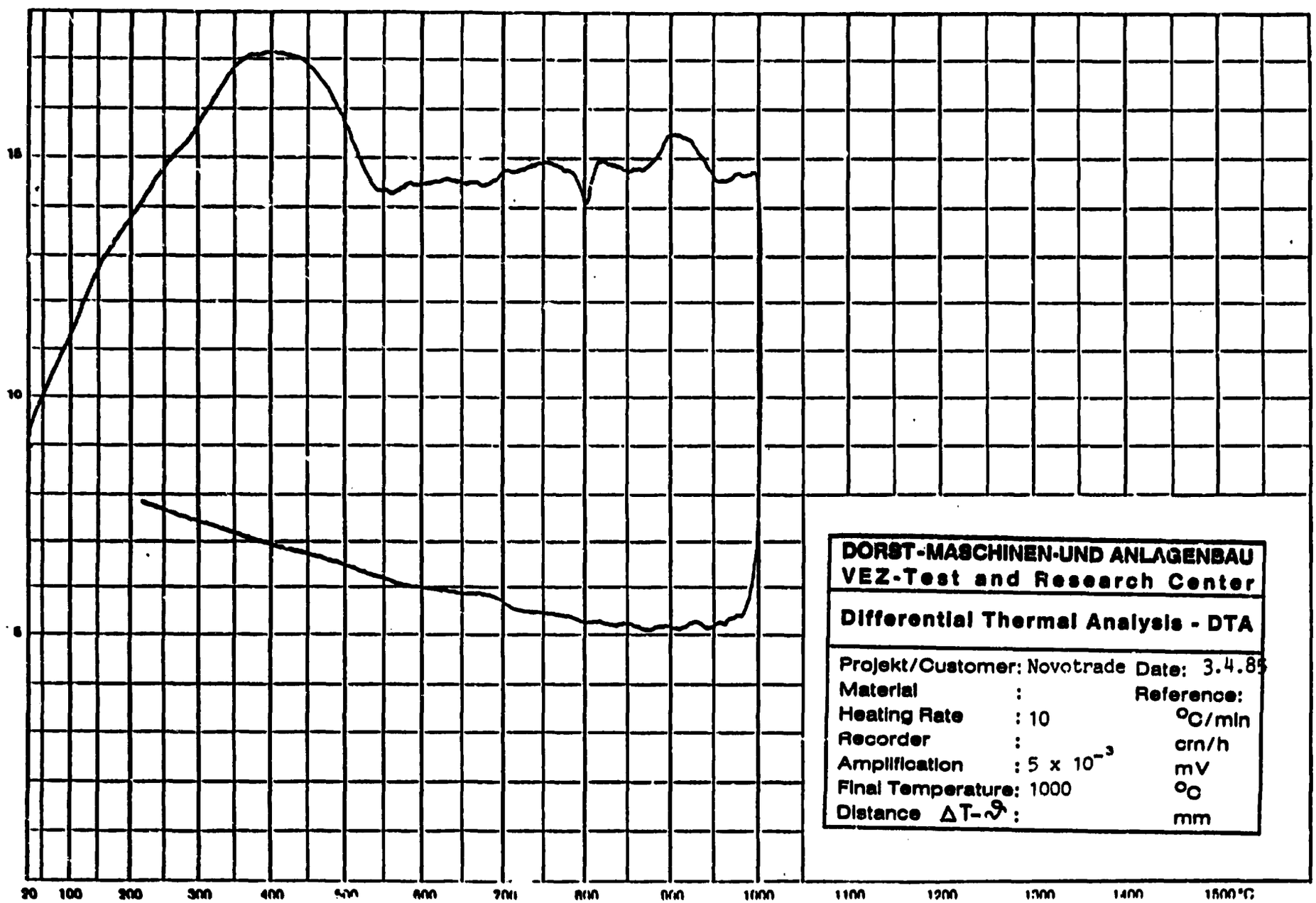


DORST-MASCHINEN-UND ANLAGENBAU
VEZ-Test and Research Center

Differential-Dilatometer-Test

Projekt/Customer Novotrade Date: 10.4.85
Material : Reference:
Irreversible Thermal Expansion/Wet Expansion
Linear Coefficient of Thermal Expansion
Sample Lenght l_o : 30 mm
Heating Rate : 10 °C/min.
Recorder : cm/h
Amplification : 0,1
Final Temperature: 1025 °C
Distance ΔT-ϑ : mm


15
10
5
20
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500°C
DORST-MASCHINEN-UND ANLAGENBAU
VEZ-Test and Research Center
Differential-Dilatometer-Test
Projekt/Customer Novotrade Date: 9.4.8
Material : Reference:
Irreversible Thermal Expansion/Wet Expansion
Linear Coefficient of Thermal Expansion
Sample Lenght l_o : 43.2 mm
Heating Rate : 10 °C/min.
Recorder : cm/h
Amplification : 25.20^{-3}
Final Temperature: 970 °C
Distance ΔT-ϑ : mm



DORST-MASCHINEN-UND ANLAGENBAU
VEZ-Test and Research Center

Differential Thermal Analysis - DTA

Projekt/Customer: Novotrade		Date: 3.4.85
Material	:	Reference:
Heating Rate	: 10	°C/min
Recorder	:	cm/h
Amplification	: 5×10^{-3}	mV
Final Temperature:	1000	°C
Distance ΔT-∂	:	mm

Enclosure 7: modulus of rupture

material						
sample-no.		1	2	3	4	5
	size mm					
	weight g					
	Pmax. kg	59,3	13,0	0,705	14,91	156,0
	Ls cm	62,8	13,0	0,70	14,95	167,2
	b cm	51,6	13,0	0,70	14,95	137,3
	a cm	54,4	13,0	0,685	14,95	151,8
	σ_{RB} kp/cm²	59,9	13,0	0,685	14,95	166,5

P = fracture load
Ls = distance of edges
b = width of tile
a = thickness of tile

$$\sigma_{RB} = \frac{3\ P_{max.}\ Ls}{2\ a^2\ b}$$

σ_{RB} = 155,7

CHAPTER SIX

Economic calculation and market analysis

Introduction

The brown mud from alumina production process is the waste of the production. Shandong Aluminium Works produces alumina by the utilization of the low-grade diaspore type bauxite in the soda-lime sintering process. The amount of the brown mud given off is 1.5 - 1.7 tons while producing 1 ton alumina. At present the productivity of alumina is 360.000 tons per year and the amount of the brown mud is 550.000 - 600.000 tons per year. In Shandong Aluminium Works there has been a branch which produces portland cement by utilizing the brown mud, the used brown mud is 250.000 - 300.000 tons per year. The spare brown mud is piled up, the area of the mud pile place has covered 55 hectares. In there the stored brown mud is about 10 mill. tons, they have already polluted natural environment.

With the development of Chinese city and countryside constructions, the production of wall building materials is increasing rapidly. The production of the clay bricks went up to 205.500 mill. pcs in 1985. Production of clay bricks went up to 40.800 mill. pcs in Shandong in 1992 and it went up to 700 mill. pcs in Zibo city. It is favourable to the development of production of wall building materials that needs of bricks is quite large. Today in China the clay bricks make up 95 % of whole wallbricks. The clay bricks therefore, occupy a dominant position in Chinese markets. The price of Chinese clay bricks is 50-60 Yuan per 1000 pcs. In the year of 1990 Shandong will produce 350.000.000 pcs per year of common bricks, and 5.000.000 sq.m. of glazed tile.

On the basis of the above figures it can be stated that the clay consumption for brick making has been 513 75o mill. kg annually, ıle. 513 75o ooo t clay which is the best top soil for the agriculture.

1. The production cost of the Chinese brown mud bricks.

Today in China the clay bricks make up 94,2 % of wall building materials, among them the clay bricks produced by small towns' factories make up 8o % of all bricks. The economy feasibility analysis of production of the brown mud bricks is based on the Chinese clay bricks.

1.1. Technical data of Chinese clay bricks

a. size 24o x 115 x 53 mm = 1462,8 cm3
b. absolute density 2,3 - 2,68
c. weight of brick per pc (dry) 2,5 kg
d. average volume weight (apparent density) 17oo kg)cm3
e. volume of brick per pc o,oo1462ᵹ8 m3
f. amoung of bricks per m3 683,6 pcs
g. quality of the bricks
i. water absorptivity 8 % - 2o %

ii. strength

	15o	125	1oo	75	5o
compressive strength (kg per cm2)					
	15o	1ᵹ5	1oo	75	5o
breaking strength (kg per cm2)	28	25	22	18	16

h. material object productivity

general level o,± - o,2 mill. pcs each person per year
advanced level o,6 mill. pe per each person per year

1.2. The production cost of Chinese clay bricks (Zibo Shandong)

a. rate of qualified products 85 %

rate of first grade products 9o %

b. unit cost RMB Yuan)1ooo pcs

No.	items	unit price	unit consumption	unit cost	note
1.	clay	3,5 yuan)m3	2.35 m3	8.225 (2o%)	
2.	coal	4o yuan)ton	14o kg (standard)	7.12 (17.8%)	
3.	electrical energy	o,o8 yuan)kWh	6o kWh	4,8 (12%)	
4.	labour cost	4,7 man-day	1,53 man-day	7.19 (17.9%)	
5.	depreciation charge of equipment			3.75 (9.4%)	2o year - 0
6.	maintenance cost of equipment			4,5 % (11.2%)	
7.	business management and other			4,5 % (11,2 %)	
8.	production cost			4o.o84)1oo %)	
9.	tax			2.4	
1o.	profit			8.o17	
11.	price			5o.5o2	

Capital construction investment is 8-lo mill. RMB)loo mill. pcs bricks in accordance with Chinese circumstances. Price of the bricks in Shandong is 45-76 Yuan)looo pcs

1.3. The technical data of brown mud walling blocks on the basis of the data of the Draft Final Report

a. raw material brown mud (dry), fly ash-cement (dry)
b. formulation brown mud 5o %, fly ash-cement 5o %
c. production technique cold technique
d. product of walling blocks
3oo mill. brick unit = 3 pcs Chinese brick
dimension 115 x 175 x 24o mm
e. unit heat consumption 42,97 kg coal, 5.5oo Kcal per looo pcs brick unit
f. electric consumption 24 kWh per looo pcs brick unit
g. productivity 2,4 mill. pcs unit each person per year (The other data is calculated according to Chinese standard) , i.e. this productivity is four times higher than that of the best Chinese advanced level.

A. Cost for stoving brown mud

The process for stoving brown mud must be built with utilizable industrial waste heat (low pressure steam resp., waste gas)

Stoving method; we can use more advanced gas-flow drying technique
Sourse of brown mud; wet brown mud from the pile place

Unit cost for stoving brown mud RMB Yuan) ton

KERAprogress

Unit cost for stoving brown mud RMB Yuan)t

No.	name	unit consumption	unit price	unit cost	note
1.	brown mud	1,62 t	2,5 Y)t	4,o5	water content of mud 35 %
2.	electric energy	2o kWh	o,o8 Y)kWh	1,6	
3.	depreciation of equipment and factory building			1,75	
4.	labour cost			1,94	
5.	business management cost			1,2	
6.	production cost			1o,34	

B. Fly ash-cement cost

Data of fly ash-cement is calculated on the basis of the Hungarian Europe-Patent

Fly ash cement cost (on the basis of Hungarian data)

unit cost of fly ash cement RMB Yuan)t

name	unit price	unit cost
fly ash o,9 t	7 Y)t	6,3
lime o,1 t	25 Y)t	2,5
mix and mill		2,5
cost		11,3

1.4. Production cost of brown mud walling blocks

Takint into consideration that investment cost has been 5o mill DM the production cost of brown mud walling blocks related to looo pcs brick unit with a dimension os 5) x 115 x 24o mm RMB Yuan)looo pcs

No.	name	unit consumption	unit price	unit cost	note
		6o %			
1.	brown mud	1,2 t	1o,54	12,65	
2.	fly ash-cement 4o %	o,8 t	11,3	9,o4	
3.	electric energy	24 kwh	o,o8 Y)kWh	1,92	
4.	labour	o,125 man -day	4,7 Y) man-day	o,59	
5.	depreciation charge			8,34	
6.	water	1 m3	o,15 Y)m3	o,15	
7.	maintenance cost of equipment			2,1	
8.	business management			o,75	
9.	production cost			35,54	
1o.	tax			2,4	
11.	profit			12,562	
12.	price			5o,5o2	

The analysis of the cost shows that while the profit in the traditional Chinese clay production technology has bean 8,017 p.c. , on the basis of the cold technology described in the Final Study, this value has been 12.562 per cent, which is higher by 5o p.c. The production cost of the Chinese brick has been 4o,o85 yuan)looo pcs, this cost by our cold technology on brown mud base has been only 35,54 yuan per looo pcs.

Making walling blocks and bricks by utilization of brown mud is a good way of processing brown mud in original place. It can not only get rid of pollutions by the industrial waste, but also can reduce the farmland covered by mud pile and at the same time 3,5 hectares farmland can be saved in Zibo area.

Therefore, on the basis of the above data and statements the Techno-Economic Final Report will suggest to erect a pilot factory as follow-up work which was also adopted and supported by UNDP and the goernment officials because the energy saving and environment protecting new technologies have priority in China.

KFEAprogress

2. The cost analysis on the production of tiles from bown mud in single firing

In order to compare with cost of the method decribed in the draft final study we consider the cost of industrial production of one mill. m2 tiles per year in Zibo.

2.1. Technical data of Shandong tiles

a. size 152 x 152 x 5 mm
b. grade Nol, No2, No3
c. rate of qualified products 9o %
d. rate of first product 45 %
e. physical and mechanical properties

water absorptivity < 22 %
shiteness > 78 %
without crackles after rapid hot and cold tests.
average compressive strength $>$ 17o kg)cm2

2.2. Cost of Zibo white ceramic tiles

no.	name	unit consumption	unit cost
1.	raw materials	8.63 kg)m2	1.39
2.	coal	16,37 kg)m2	0,81
3.	electrical energy	5,28 kWh)m2	0,38
4.	labour		0,44
5.	loss of waste product		0,99
6.	cost of workshop		1.42
7.	cost of business management		0.84
8.	production cost		6.25
9.	tax		1.04
10.	profit		1.34
11.	selling price		8.63

2.3. Technical data of the brown mud glazed tiles

a. formulation
brown mud 40 %
high iron content clay 30 %
clay 20 %
sandstone 10 %

b. size 200 x 200 x 10 mm floor tile
weight of 1 m2 18 kg)m2

200 x 200 x 5 mm floor tile
weight 9 kg)m2
compressive strength 500 kg)cm2

KERAprogress

d. heat consuption for wall tile 35.000 kcal)m2
for floor tile 17.500 kcal)m2

e. electric consumption
for wall tile 8 kWh)m2
for floor tile 4 kwh)m2

f. water consuption
for wall tile 30 lit.)m2
for floor tile 15 lit.)m2

g. glaze consumption
for wall tile 1,25 kg)m2
for floor tile 1,25 kg)m2

h. productivity
for wall tile 2 mill. m2)year
for floor tile 2 mill. m2)year

i. labour for wall tiles 200 men
for floor tiles 200 men

j. whole investment /offer of DORST/ for wall tile ~~65,15~~ 13 mill. DM
for floor tile ~~58,15~~ 13 mill. DM

2.4. Cost of brown mud glazed wall tiles

Taking into cosideration that the investment cost will not surpass DM 13,oe mill the production cost of wall glazed tiles having a dimension of 2oo x 2oo x 5 mm, unit ccst RMB Yuan)m2

No.	name	unit consumption	unit price	unit cost	note
1.	brown mud	4,44 kg)m2	1o,54 Y)t	o,o47	
2.	high iron content clay	3,33	24 Y)t	o,o8	
3.	clay	2,22	3,5 Y)t	o,o8	
4.	sandstone	1,11	1o Y)t	o,o11	
5.	glaze material	1,25	16o Y)t	o,2	
6.	coal	2,75	7o Y(t	o,19	7ooo kcal)kg
7.	electric energy	4 kWh	o,o8 Y)kWh	o,32	
8.	labour	o,o3 man-day	o,6 Y)man day	o,o18	
9.	loss of waste product			1,›	
1o.	depreciation charge of equipment and factory buildings			1,52	2o year - O
11.	cocst of business management			o,84	
12.	production cost			4,3o6	
13.	tax			1,o4	
14.	profit			3, 284	
15.	selling price			8,63	

16. Payback period of the suggested wall glazed tile factory has been 3,8 years calculated from the net profit.

KEKAprogress

2.5. Cost of brown mud glazed floor tiles

Taking into consideration that the investment cost will not surpass DM 13,oo mill, the production cost of glazed floor tiles having a dimension of 2oo x 2oo x 1oo mm , unit cost RMB Yuan)m2

No.	name	unit consumption	unit price	unit cost	note
1.	brown mud	8,88 kg)m2	1o,54 Y)t	[illegible]	
2.	high iron content clay	6,66	24	o,16	
3.	clay	4,44	3,5	o,16	
4.	sandstone	2,22	1o	o,o22	
5.	glaze material	1,25	16o	o,2	
6.	coal	5,5	7o	o,385	7ooo kcal)kg
7.	electric energy	8 kwh	o,o8	o,64	
8.	labour	o,o35 man)day	o,6 Y)man)day	o,o21	o,o1 mill)P.Y.
9.	loss of waste product			1,o	
1o.	depreciation charge of equipment and factory buildings			1,52	2o year - O
11.	cost of business management			o,84	
12.	production cost			5,o41	
13.	tax			1,o4	
14.	profit			8,339	
15.	selling price			14,4 Y =(5 USD)	

16. Payback period of the suggested floor glazed tile factory has been 1,5 years calculated from the net profit.

Above analysis shows that the cost of raw material is less, the consumption of energy is also less, but efficiency is higher by making brown mud tiles by single firing technology. The production cost is less than that of the tiles made by twice firing.
From the figures it can be stated that while the production cost with the traditional technology in Zibo has been 6,25 Y)m2 the production cost of the new technology has been only 4,3o6 Y)m2. The profit in the first case has been 1,34 per cent while the profit of the new technology has been 3,284 per cent, which is the triplicate of the original profit.
In case of floor tiles with a thickness of lo mm, considering the world market price 5 USD = 14,4 Yuan the production cost is 5,o41 Yuan)m2 while the prefit has been 8.319, which is seven times higher than the profit at present.

The technique of production of brown mud glazed tiles can be adapted for industry, because according to this technique the cost of raw material is less, energy consumption in single firing is also less, efficiency is higher, the production cost is less .

On the basis of the result the Techno-Economic Final Report will suggest the realization of the tile factory because of the inland and export demand (Japanese market) In this respect we call the attention to the offer and letter of Hrssrs. Dorst attached to the Study.

Chapter Seven

OFFER OR MESSRS DORST

DORST-MASCHINEN
UND ANLAGENBAU

Shandong Aluminium Works

Shandong
People's Rep. of China

Our ref:	Phone:	Date:
Gf/De/bü	(0 88 51)188-227	06/12/1985

Tile production line

Dear Sirs,

We make reference to the semi-industrial tests which have been carried out in our pilot plant in April this year together with representatives of your factory and of company Keraprogress/ Hungary for the purpose of getting knowledge whether tiles of good quality can be produced from a ceramic body which is composed mainly of brown mud. These tests have been concluded successfully. In this respect we refer to the test report elaborated on that occasion.

On 19 April 1985 we have forwarded to you, via company Novotrade/ Budapest a survey on the estimated investment costs for a tile production plant with a capacity of 2 million m^2/year. These rough investment costs comprised a complete plant including building, machinery and auxiliary equipment. As announced at that time we have now worked out the enclosed detailed offer on the basis of the specifications of company Keraprogress, being tailor-made for your requirements and wishes. The offered machines and equipment base on the results and conclusions of the semi-industrial tests made in our pilot-plant and are in conformity with the specifictions of M/s Keraprogress.

As we have been informed, all preparation machines for the ceramic body and the glaze will be procured by you locally. In this

connection it has to be paid attention to the fact that approx. 117 t of dry tile body and 7 t of dry glaze have to be prepared per day. Tile scrap arising during pressing and after rapid drying can be recycled by stirring it together with water in the body blungers in which the slip coming from the wet grinding ball mills is located.

Although we have been informed that you are not interested in an offer for a spray drying plant for the manufacture of pressing granules, as this shall also be procured locally, resp. is already existing, we have included such a plant in our offer, sized for your tile capacity, as the quality of the produced tiles is largely depending on a well-pressed tile which depends on a good press granule. A press granule has the required good pressing properties only if its grain size distribution and residual moisture content remain constant within narrow limits. Being the first company which has introduced the spray drying technology into ceramics industry we have had great experience for about 30 years in this field and we know about the enormous importance of these details. The offered pressure nozzle spray drying plant of type D 6000 is dimensioned in such a way that your production expansion plans have been taken into consideration. For the envisaged final production of 10 million m^2/year three spray drying plants type D 6000 will be necessary.
As optional equipment we have offered you for the spray drying plant a heat recovery system, with which approx. 8 - 10 % fuel energy can be saved. Moreover, we have offered you as optional a wet-dust separator, which would only be necessary if the authorities of the area where the plant will be installed demand a residual dust content in the waste air of the plant of max. 75 mg/m^3. As further optional we have offered you a dust-recycling system, with which the fine dust which is discharged from the cyclone is blown again into the drying tower so that the dust particles are absorbed by the atomized slip drops. With this system the content of fine dust particles in the produced pressing granule is kept very low, which in general improves the pressing properties of the granule very much.

In the pressing section we have provided for a stand-by press in addition to the two production lines, comprising each a press, rapid drier and glazing line. Thus, a perfect and thorough maintenance of the presses, resp. pressing dies exchanges, are possible without having negative influence on the production which is in operation 24 h per day. At the end of the fettling ma-

chines, subseqent to the presses we have provided for automatic vertical tile compensators which shall further charge the production lines continously with tiles while the punches of the pressing dies have to be cleaned periodically from sticking pressing body whereby the presses are stopped. The following rapid driers are of a most modern construction type and feature a low specific heat consumption.

With the offered glazing lines uni-coloured glazed tiles as well as tiles decorated with mottles, droplets, screen printing patterns and coloured shades can be produced. For the manufacture of the screen printing stencils and the preparation of the printing paste we have offered the suitable equipment.

According to your wishes we have quoted a storage plant for glazed tiles and for fired tiles for a kiln production capacity of 30 hours.

With regard to the kiln plant we have for the time being provided for the use of 3 roller passage kilns, each one 100 m long, in order to fire the requested tile production. Yet, we would like to still discuss in detail with you and company Keraprogress the kiln concept as there is the possibility of employing kilns which feed and fire the tiles in 2 levels and not only in one level as offered. In this regard the investment costs could eventually be reduced as only 2 kilns with a length of approx 75 m would be required instead of the 3 kilns with a length of 100 m. The length of the suggested kilns depends only on the passage time of the tiles which we have assumed to be 80 min.

Moreover, we have offered to you a semi-automatic sorting and packing line for the fired tiles as with the single-firing technology there is the possibility that some tiles will be produced with no plane surface resp. with not the same dimensions.
In order to allow classification into different qualities an automation of the corresponding sorting process is necessary. The sorting of the glazed surface, which is carried out according to visual criteria, can then be effected manually by shifting the tiles according to their quality onto the transport lines provided for these. Taking these criteria into account we have offered a suitable sorting line.

Finally we have offered to you a complete laboratory equipment with which the quality of the products in the individual stages of production can be controlled as well as the body and glaze development can be carried out with the exception of chemical analyses.

For the engineering of the plant we have listed in detail our services. The engineering to be elaborated will base extensively on the knowledge which was gathered during the tests made with your raw materials in our pilot plant on a semi-industrial scale.

Moreover we have listed the scope of our services for the installation and commissioning of machines and equipment to be supplied by us.

As the production of tiles based on brown mud requires a very special technology and know-how and as the results of the semi-industrial tests must be transferred into industrial scale on occasion of the putting into production of the plant, a corresponding technology and know-how agreement between your company and M/s Keraprogress, who is the inventor of this process, must be made.
We, as partners of M/s Keraprogress, will support them to the best of our experience and knowledge in order to grant the success of your tile project.

We hope to have been of service to you.

Yours faithfully,

Dorst-Maschinen- und Anlagenbau
Otto Dorst u. Dipl.-Ing. Walter Schlegel
GmbH & Co.

Enclosure
offer

DORST-MASCHINEN UND ANLAGENBAU

DORST-MASCHINEN- UND ANLAGENBAU D-8113 Kochel a. See

Keraprogress
z. H. Frau Batri
Ságvári Endre utca 16.

2011 Budapest
U n g a r n

Maschinen und
Anlagen für die
feinkeramische Industrie.
Maschinen und
Anlagen für die
Pulver-Presstechnik.

Otto Durst und
Dipl.-Ing. Walter Schlegel
GmbH & Co

P.O.Box 109 + 129
D-8113 Kochel a. See
Bundesrepublik Deutschland
Telefon: 08851-188-1
Telex: 59842
Telegr. Maschinendorst Kochel

Ihr Schreiben und Zeichen	Unser Zeichen	☎ Durchwahl	Datum
18.10.85	Gf/De	08851-188-x 227	12.12.1985

Fliesenprojekt Shandong Aluminium Works / China

Sehr geehrte Damen und Herren,

wir beziehen uns auf Ihr obiges Schreiben, mit dem Sie uns über das Resultat Ihrer Verhandlungen mit dem chinesischen Kunden informierten. Wir bedanken uns herzlich für Ihre Information. Sie bemerkten noch, daß unsere Investitionskostenübersicht über ca. DM 66 Mio. von dem chinesischen Kunden für zu hoch gehalten wurde im Vergleich zu Konkurrenzangeboten. Vielleicht ist dem Kunden nicht ganz klar geworden, daß wir damals eine Investitionskostenübersicht über die gesamten Kosten dieses Projektes einschl. Gebäude, Maschinenpark und Nebeneinrichtungen abgegeben haben. Der reine Maschinenparkanteil belief sich dabei auf nur ca. DM 30 Mio.

Beiliegend erhalten Sie nun unser detailliertes Angebot über Maschinen, die gemäß Ihren Angaben für obiges Projekt nach China zu importieren sind. Wie Sie daraus ersehen können beläuft sich nun der Maschinenanteil auf einen Betrag von ca. DM 13 Mio. Hierbei haben wir berücksichtigt, daß alle Einrichtungen für die Masse- und Glasuraufbereitung nicht anzubieten sind, da diese gemäß Kundenwunsch in China beigestellt werden sollen.

Das technologische Know-How für den Produktionsprozeß, mit allen in diesem Zusammenhang erforderlichen Leistungen, haben wir in unserem Angebot nicht berücksichtigt. Wir gehen davon aus, daß Sie eine entsprechende Offerte direkt in China vorlegen werden und daß es zu einem diesbezüglichen Vertrag zwischen Ihnen und der chinesischen Seite kommt.

...

Angesichts der von Ihnen und uns gemeinsam bisher schon in die Vorarbeiten für dieses Projekt investierten Kosten betrachten wir es als vereinbart, daß Sie unser Maschinenangebot exklusiv unterstützen werden. Bitte sind Sie so freundlich, uns über die weitere Entwicklung auf dem laufenden zu halten.

Wir bitten Sie, unseren Projektvorschlag mit den entsprechenden Erläuterungen nach China weiterzuleiten. Sollten Sie von uns dazu noch Erläuterungen benötigen, so lassen Sie uns dies bitte wissen.

Mit großem Interesse erwarten wir Ihre weiteren Nachrichten und verbleiben

mit freundlichen Grüßen

Dorst-Maschinen- und Anlagenbau
Otto Dorst u. Dipl.-Ing. Walter Schlegel
GmbH & Co.

Anlage
Projekt

O F F E R

In compliance with our enclosed General Conditions for the Supply we submit you the following offer abt.:

Special equipment to be imported for a production line for tiles based on brown mud with an output capacity of

about 2 mio. m²/year

Worked out for : Shandong Aluminium Works

Shandong
Peoples Rep. of China

Worked out by : DORST-Maschinen- und Anlagenbau
Mittenwalder Str. 61
P.O. Box 109 + 129

8113 Kochel am See
Fed. Rep. of Germany

Kochel, December 1985
Gf/De

TECHNICAL DATA

Product	: glazed and decorated tiles of the size 200 x 200 x 7.5 mm single fired
Capacity	: about 2.000.000 m²/year
Weight of fired tiles	: about 18 kg/m²
Body requirement net	: about 36.000 tons / year
Body requirement gross	: about 42.000 tons / year
Glaze requirement gross	: on average 1.2 kg/m² corresponding to about 2.500 t/year
Working days	: 360 days/year
Working time of equipment per day	: 3 shifts = 24 hours
Electricity	: 380 V, 50 cycles, 3 phases
Installed power for the complete factory	: assumed with abt. 1500 kW
Consumption of el. energy for the complete factory	: assumed with abt. 24.000 kWh/day

Peak load of el. energy	: assumed with abt. 1200 kW
Heating fuel	: producer gas, dry and clean with a content of sulphurous components of max. 0.2 Vol.%/Nm^3
Net calorific value of fuel assumed	: 1350 kcal/Nm^3 $\pm$ 10 %
Consumption of fuel	: abt. 273000 Nm^3/day $\pm$ 10 %
Water requirement	: abt. 80 m^3/day for body and glaze abt. 50 m^3/day for cooling presses (abt. 5 m^3/day in case of using water recooling plant) (abt. 10 m^3/day for washing the equipment and factory)
Compressed air	: abt. 15 - 20 Nm^3/min at 6 bar pressure

PROPOSED TECHNOLOGY

The various raw materials for the tile body composition, which is composed mainly by brown mud, a waste product which results from your aluminium production, are processed by wet grinding process so that a sprayable ceramic slip is obtained.

Details about this technology and about the necessary equipment which according to your wishes you want to procure locally will be informed by the know-how supplier M/S Keraprogress. We are ready to assist and collaborate with the know-how supplier in this context.

The obtained ceramic slip body will be pumped by high pressure diaphragm pumps to the spraying nozzles of the spray drier plant. The slip is sprayed into the spray drying chamber and is dried to pressable granule. The granule leaving the spray drier plant is transported to the storage silos via sieve and via a transport system consisting of belts and a bucket elevator all locally supplied. The distribution of the granule coming from the silos to the presses is also effected by conveyor belt system of local supply.

The press granule is pressed to tiles of different sizes by means of fully hydraulic tile presses. The pressed tiles are subsequently cleaned by fettling machines, and conveyed to the rapid dryers, where the tiles are dried to a residual moisture content below 1 %. By this process the strength of the tiles is increased and the tiles are heated up, which is necessary for the subsequent glazing and decorating process.

By means of a platform scale the individual glaze raw materials are weighed to a glaze batch, which is transported to the wet grinding ball mills. After grinding with water and additives the glaze slip is pumped into intermediate containers equipped with slowly running stirrers, for quality check. The examined glaze slip is discharge into a storage container equipped with slowly running stirrer and magnetic rods for the removal of iron particles. Subsequently the glaze slip is pumped into mobile containers via vibrating sieves and via permanent magnets for the separation of iron particles. After stirring the glaze a glue-water mixture is added and the containers with the final glaze slip are moved to the consumers at the glazing lines. As informed all glaze slip preparation equipment will be of local supply.

An engobe slurry is prepared by stirring china clay into water. The engobe slip is then screened into containers and moved to the engobing stations at the glazing lines.
The predried tiles are provided with different coloured glaze and decoration effects on the glazing lines automatically.

In order to allow an uninterrupted kiln operation a storage and buffer system has been provided for.

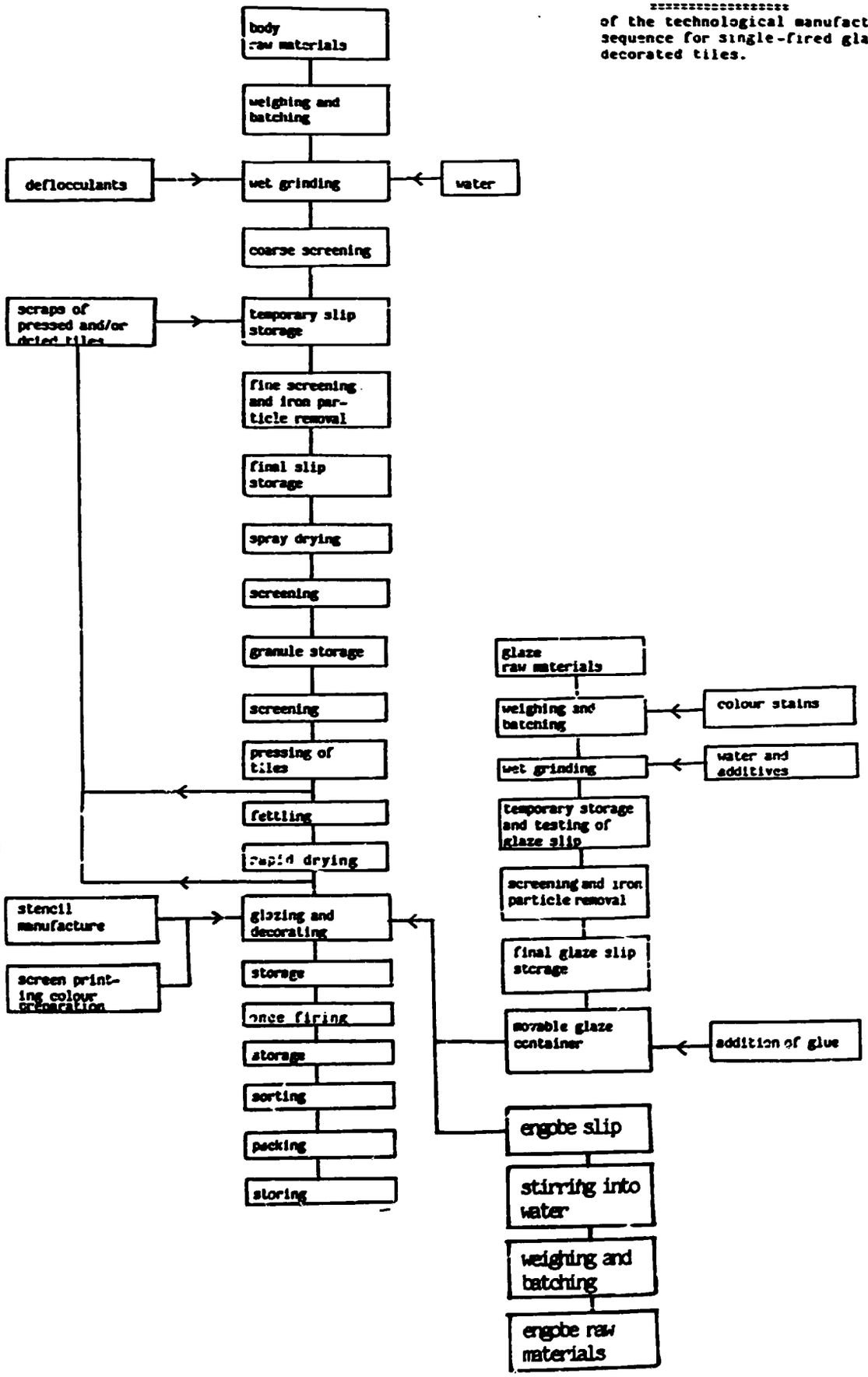
The glazed tiles stored in containers are transferred to the rapid firing roller kiln and fired in a single-layer tile carpet. After firing the tiles are restored in containers.

The ware coming from the storage plant of fired tiles is transported to the sorting lines and separated into quality groups. Thereafter the tiles are transported to the packing units.

In order to guarantee a constantly good quality of the product and for checking the production quality a works- and a test-laboratory have been proposed.

FLOW SHEET

of the technological manufacturing sequence for single-fired glazed and decorated tiles.



Press granule production

1 Nozzle-type spray dryer , specifically designed for the building industry

type D 6000

latest design, all parts coming into contact with the product made of rustproof material, outfitted for nozzle atomization using the fountain principle, counter-current flow and direct heating by producer gas

Water evaporation capacity	:	6000	kg/h
Output capacity of dried material with a residual moisture content of 6 %, about	:	11000	kg/h
Water content of the slip, assumed to be	:	39	%
Residual moisture content of the spray dried material, adjustable up to about	:	8	%
Average consumption of producer gas net caloric value assumed with 1200 kcal/Nm³	:	3700	Nm³/h ± 10%
Average consumption of electric power at			
a) dry dust separation	:	90	kW
b) additionally for wet dust separation	:	40	kW
c) additionally for return conveyance of the dust	:	2	kW
d) additionally for heat recovery plant	:	15	kW
Hot air temperature, depending on the water content of the slip and on the desired residual moisture content	:	400 - 450	°C
Waste air temperature, depending on the residual moisture content	:	90 - 130	°C
Required space	:	as per drawing	

Structural parts

1.1 1 drying tower of special design including hot air guidance hood and air guidance elements, cylindrical section and conical section at the bottom.

height of the cylindrical section	:	8200	mm
inside diameter	:	8000	mm

Inner lining of the tower made of rustproof steel, 2 mm thick.

The drying tower is equipped with inspection and illumination windows (light fittings to be provided by the customer), inspection doors and adaptors allowing the rapid exchange of the nozzles while the burner, the pump etc. continue operation. Besides, with all required built-in parts.

The drying tower is prefabricated in a special technique. It consists of several parts, which are partially trial assembled in our workshop.

The supporting skeleton for ridgidizing the lining of the tower is dimensioned in such a way as to allow construction with the upper portion of the tower protruding above the roof.

1.2 1 set of main air ducts within the system, viz., the hot air duct of heat-resistant boiler plate from the air heater to the hot air inlet hood of the drying tower and the waste air duct of rustproof steel from the drying tower to the dust separating system.

1.3 The special electrodes required for the welding of rustproof steel lining as well as the pickling paste to be used for the pickling of the inner wall of the tower.

1.4 The necessary insulating material of rock wool for

the drying tower,
the hot air duct,
the waste air duct,
the dust separation system.

The insulation will be 60 - 200 mm thick, depending on the temperatures required. The jacketing of all the insulation will be made of hot dipped galvanized steel sheet.

1.5 1 weight-controlled pendulum discharge gate of rustproof steel for the continuous discharge of the dried granulate.

1.6 2 double-acting high-pressure diaphragm pumps, type MPz 125/25 R for pumping the slip under constant pressure to the nozzle units.

diameter of piston	:	125	mm
stroke of piston	:	220	mm
number of strokes, adjustable up to	:	32	/min
pumping capacity, adjustable up to	:	8	m^3/h
max. operating pressure	:	25	bar
diameter of inlet pipe and outlet pipe	:	80	mm
motor power	:	11	kW
speed of motor	:	1500	rpm

Drive by three-phase motor via a variable speed spur gear unit, driving crank mechanism and connecting rod of the pump piston. Displacement volume infinitely variable in the ratio 1 : 3 by means of a hand-wheel. With 2 regulating devices, acting independently of each other, for the exact setting of the operating pressure. With adjustable pressure safety valves. With pre-set pressure and actual pressure manometers.

This pump has been developed specifically for our spray dryers and is equipped with wear-resistant diaphragms of synthetic material and with ball valves of hardened rustproof steel.

Cast-iron pump housing, internally coated with red lead/plastic mixture to protect against corrosion.

1.7 The required high-pressure tubing of galvanised steel pipe up to a length of 20.000 mm from high-pressure diaphragm pump to the nozzle pipe, including the necessary high-pressure fittings.

1.8 1 set of nozzle units, consisting of 5 nozzle pipes, (1 pipe for rapid changeover) 5 distribution assemblies with 4 arms each and 5 sets = 25 pcs. complete nozzles. With 250 spare nozzle inserts of highly wear-resistant special material.

The nozzle pipes are equipped with the necessary screwings, quick disconnects and high-pressure hoses between high-pressure line and nozzle pipes.

The nozzle units are of special design developed by us, with wear-resistant and rapidly exchangeable inserts.

1.9 1 vertical high-efficiency combustion chamber of heat-resistant and non-scaling material, whereby the lining with refractory material results obviated. With the necessary adjusting elements for the fresh air inlet.

1.10 1 fully automatic burner system designed for the infinitely variable control of gas and fresh air depending upon the hot air temperature, with electric controls to guarantee a constant inlet temperature.

The gas process system as well as the monitoring instruments, as per DIN standard, make part of our scope of supply. We assume that the customer will provide gas at a constant pressure of 200 mbar.

1 .11 1 control panel for the entire plant including burner system, completely wired with all protective motor switches, all switching devices, fuses, signal lamps and with built-in temperature measuring and regulating devices, consisting of:

- the required automatic switching device for the burner system,
- the flame controller,
- the fuse units with fuses,
- the signal lamps,
- the temperature regulator for the burner regulation via the hot air,
- the temperature indicating device for the hot air with integrated temperature limitating device,
- tne temperature indicating device for the waste air with integrated temperature limitating device.

Both hot air and waste air temperature regulating device can be adjusted to a certain temperature. In case of surpassing the rated value a control lamp lights up and at the same time the burner plant switches off.

The control panel, moreover, includes all switching devices, fuses and signal lamps for

- the main power supply,
- the main ventilator,
- the high-pressure diaphragm pump.

Also there are included two indicating devices for the negative pressure measuring:

- 1 device for the measuring of the negative pressure in the tower -10 to 0 mbar,
- 1 device for the measuring of the negative pressure in the cyclone -40 to 0 mbar.

1 .12 1 high-efficiency cyclone dust separator of rustproof steel for the recovery of the fines contained in the waste air, with channels for dust laden air and clean air, as well as with dust collecting bin attached underneath, likewise made of rustproof steel with the required openings for cleaning.

1 .13 1 main ventilator including three-phase motor N = 90 kW, n = 1500 rpm with cyclone dust separation. N = 132 kW, n = 1500 rpm in case of additional wet dust separation.

The main ventilator provides suction for the entire drying air into the combustion chamber and from here through the drying tower and the cyclone system.

This main ventilator is of special construction with housing and impeller of rustproof steel, and in case of wet dust separation, also acid-proof steel. The ventilator blades and the housing are of strengthened construction.

1 .14 The connecting pipe of rustproof steel between the clean air duct of the cyclone system and the suction inlet of the main ventilator.

Net-weight of the entire system : abt. 55 t

P r i c e

for the supply of the complete plant as aforementioned, ex works, unpacked DM 1.188.400,--

Costs for seaworthy packing and delivery f.o.b. EC seaport DM 56.600,--

As a stand-by unit:

1.15 1 double-acting adjustable high-pressure diaphragm pump type MPz 125/25 R

diameter of piston	:	125	mm
piston stroke	:	220	mm
adjustable number of strokes	:	10 - 32	strokes/min
max. operating pressure	:	25	bar
displacement volume adjustable	:	3 - 8	m^3/h
diameter of suction and pressure pipe	:	80	mm
motor power	:	11	kW
revolutions of motor	:	1500	min^{-1}
net weight of one pump	:	2150	kg
gross weight, dispatch by rail	:	-	kg
gross weight, seaworthy packed	:	2600	kg
shipping volume	:	5	m^3

Structural parts

1 cast-iron pump housing with anti-rust coating. Easy replacement of all machine parts. Diaphragms of wear-resistant, synthetic material. With burnished valve balls and valve seats made of hardened stainless steel.

1 double-acting piston of rustproof steel with replaceable cylinder guide bushing. Piston rod running on guides. Including dirt scraper and all seals.

1 complete drive by electric motor and variable speed geared unit for inifinitely variable adjustment of the displacement volume by means of a handwheel. Crank shaft running in ball bearings. With easily removable guard.

2 independently acting pressure regulating valves for infinitely variable adjustment of the operating pressure. Pressure regulating valves working also as pressure safety valves. With pressure gauges for pressure control.

P r i c e ex works, unpacked	DM	85.850,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	DM	3.870,--

1.16 2 double slip filters

to prevent clogging of the nozzles
and to be built into the slip
pressure pipe line.
With 2 filtering chambers to be
used alternatively to ensure continuous
operation of the atomization assembly.
Incl. switch over ball globe valve

P r i c e ex works, unpacked	each	DM	9.830,--	DM	19.660,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	each	DM	490,--	DM	980,--

optional

1.17 1 Heat recovery system

Equipment of the plant with a heat recovery system, usually installed after the cyclone dust separator for partial exploitation of the heat energy which is still contained in the waste air,

comprising :

- heat exchanger,
  functioning according to cross-flow principle with integrated bank of tubes which contain the evaporation liquid, including all corresponding guiding elements, gills and radiators made of aluminium alloy, casing of galvanized steel sheet,

- necessary cleaning device for the removal of dust deposits from the heat exchanger,

- fresh air ventilator
  made of standard steel, for the admission of the drying air from outside trough the heat exchanger into the combustion chamber, with drive motor
  N = 15 kW, n = 3000 rpm.

- necessary air pipes of standard steel
  from the cyclone dust separator to the heat exchanger,
  from the heat exchanger to the main ventilator,
  from the fresh air ventilator to the heat exchanger,
  from the heat exchanger to the combustion chamber.

Additional price ex works, unpacked	DM	316.690,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	DM	22.000,--

optional

1.18 1 Wet dust separator

Equipment of the plant with a wet dust separator in special design, developed by us, of non-corrosive and acid-proof steel, suitable for the direct connection to the flange of the blow-out side of the main ventilator,

comprising :

- Venturi pipe
  with Venturi neck including
  water injection,

- drop collector
  with integrated twister for
  elimination of dust-charged
  water,

- water injection pump
  made as armoured rotary pump
  with drive motor,
  N = 5.5 kW, n = 1500 rpm

Additional price ex works, unpacked	DM	142.450,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	DM	10.700,--

optional

1.19 1 Dust recycling system

Equipment of the plant with a dust recycling for the returning of the dust into the drying tower for the purpose of agglomeration,

comprising :

- a flexible connection piece between the dust collecting bin of the cyclone de-dusting plant and the injection nozzle,
- an injection nozzle with wear-resistant plastic insert,
- the piping for the recycling of the dust made of wear-resistant plastic material and of rust-proof steel inside the drying tower,
- the dust delivery fan with drive motor N = 2.2 kW, n = 3000 rpm.

Additional price ex works, unpacked	DM	20.570,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	DM	1.400,--

2. Pressing and drying of tiles

2.1 3 fully hydraulic tile presses type HPP 750 "Hydrorapid"

for the manufacture of ceramic tiles.
One being a stand-by equipment.
Output according to material properties, approx.

tiles 400 x 400 mm	:	15 - 18/min
tiles 300 x 300 mm	:	32 - 40/min
tiles 300 x 200 mm	:	48 - 60/min
tiles 200 x 200 mm	:	72 - 80/min
tiles 200 x 100 mm	:	128 - 144/min
tiles 150 x 150 mm	:	128 - 144/min
first pre-press	max.:	7.5 t
second pre-press	max.:	750 t
third pre-press	max.:	750 t
full load	max.:	750 t
ejection power	max.:	15 t
strokes	max.:	25/min
filling height	max.:	37/50 mm
clearance between columns	:	1150 mm
installed power	:	58 kW
punch heating	:	11 kW
net-weight of one press	abt.:	18.500 kg
gross-weight, dispatch by rail	abt.:	20.600 kg
gross-weight, seaworthy packed	abt.:	21.500 kg
shipping volume	abt.:	33 m3

Structural parts

1 press frame with 2 press-burnished columns. Table of the press and press traverse made of spheroidal cast iron. With patented built-in hydraulic cylinder for high speed during no-load stroke and deceleration before the punches enter the die-frame or come to rest on top of it.

1 hydraulically driven filler with infinitely variable speed for best match of filler speed and ceramic body. With filler according to requirement and the necessary specific pressure, optionally for:

1-cavity die 400 x 400 mm
2-cavity die 300 x 300 mm
3-cavity die 300 x 200 mm
4-cavity die 200 x 200 mm
8-cavity die 200 x 100 mm (2 rows/across)
8-cavity die 150 x 150 mm.(2 rows)

With possibility of using 10-cavity dies for tiles 150 x 150 mm if a specific pressure of 300 kg/cm² is sufficient.

1 automatic cleaning device for cleaning the upper punches after each stroke. Number of revolutions of the brush about 1500 rpm by means of hydraulic motor. With provision for connection to an existing dust exhausting system.

1 fill hopper having 0.16 m^3 volume, with built-in level control for automatic stopping of the press at low level of ceramic body. With special device for even pressure of the ceramic granulate on the filler, independent of fill level in the hopper.

1 hydraulic ejection device with maximum ejection force of 15 t. Fill height continuously adjustable by max. 10 mm by means of a hand-wheel. With hydraulic device to lift up the lower punches at manual cleaning, as well as with hydraulic lowering of the lower punches after each filling. Ejection device demountable, without pit under the press.

1 separate hydraulic system to produce the pressing and ejection forces as well as the motions of filler, cleaning brush and punches. Operating pressure continuously adjustable up to 300 kp/cm^2 with indication on pressure gauges. With all valves, regulating devices, connecting lines and safety devices.

Volume of the oil tank 350 l. Drive by electric motor N = 55 kW, n = 1500 rpm.

1 cooling device to cool the hydraulic oil. With pump, oil filter and water cooler including water flow valve controlled by thermostat. Drive by electric motor N = 3 kW, n = 1500 rpm. Cooling water requirement about 20 l/min at max. 15 °C inlet temperature.

1 fully electronic control pulpit for the control of all motions using proximity switches and integrated circuits of modular construction. Individual control cards, easily replaceable by means of plug connections. With all signal, control and regulating devices.

1 electric switch cabinet with main switch and 2 transformers for the heating of upper and lower punches. Furthermore including all fuses and protective motor switches as well as all cable connections between press, hydraulic system and electronic switch cabinet.

P r i c e			
ex works, unpacked	each DM	474.200,--	DM 1.422.600,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	each DM	19.250,--	DM 57.750,--

2.1.1 3 granule distribution devices

for homogeneous distribution of the press granulate in the filling box above the press filler, hydraulically moved incl. filling box and set of switching and control elements as well as flexible connection tube to pre-silo.

P r i c e				
ex works, unpacked	each DM	9.100,--	DM	27.300,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	each DM	650,--	DM	1.950,--

2.2 3 complete 4-cavity dies

for the manufacturing of tiles of the size 200 x 200 mm

comprising:

die frame,
cushioned upper and lower punches including engraving,
wearing slats,
lower punches block and punch heating,
upper punches mounting device.

P r i c e				
ex works, unpacked	each DM	31.150,--	DM	93.450,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	each DM	1.550,--	DM	4.650,--

2.3 1 hydraulic die handling unit

for easy changing of the dies at the presses, consisting of roller table which can be adjusted in height by means of a hydraulic system.

P r i c e ex works, unpacked		DM	11.680,--
Costs for seaworthy packing and delivery f.o.b. EC seaport		DM	850,--

2.4 3 automatic fettling machines

for fettling, cleaning and conveying the pressed tiles

fettling capacity : according to press output
installed motor capacity : abt. 2.2 kW

In sectional steel construction. Equipped with tiles transport V-belt tracks from press to compensator item 2.5 and from compensator to rapid drier item 2.7, fettling units, cleaning rotary brushes and tilting device for tiles which must be pressed upside down.

Including switching elements

P r i c e ex works, unpacked	each DM	57.890,--	DM	173.670,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	each DM	4.100,--	DM	12.300,--

2.4.1 1 tile transfer belt system

In order to transfer the tiles pressed by the stand-by press to the end of either one or the other fettling line of the two production presses before the corresponding compensator item 2.5 comprising:

- one tile reception transversal track installed at the end of the stand-by press fettling machine, which transfer the fettled tiles sidewise either left or right to the end of the fettling machines of the normal production lines before the tile compensators

- two tile reception transversal tracks installed at the end of the fettling machines of the normal production lines before the tile compensators, which are laid out for tile reception either from left side or right side from the stand-by press

- two tile transport belts outfitted as liftable bridges in order that it is possible to traffic between the two production lines from the presses to the glazing lines.

  These belts connect the above mentioned tile reception transversal tracks.

total installed power abt. : 4 kW

P r i c e ex works, unpacked	DM	53.460,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	DM	3.750,--

2.5 2 automatic vertical tile compensators

for accumulating tiles during pressing operation and continuous supply of tiles to the rapid drier during down times of press when punches are washed.

Inserted in the fettling track of above-mentioned fettling machines. Not necessary for the stand-by press.

storage capacity : abt. 3 - 6 min of press output
installed motor capacity : abt. 2 kW

P r i c e ex works, unpacked	each DM	36.340,--	DM	72.680,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	each DM	2.540,--	DM	5.080,--

2.6 2 rapid driers

for the drying of the tiles arriving from the tile press down to a residual moisture content of below 1 %.

The drier capacity is according to the press output.

drying temperature	: max.	150 °C
installed heating power	: abt.	450.000 kcal/h
installed overall electrical power	: abt.	40 kW
heating fuel	: producer gas	1350 kcal/Nm³
specific fuel consumption	: abt.	1.000 kcal/ kg H_2O ± 10 %
average fuel consumption	: abt.	185 Nm³/h ± 10 %

comprising:

- sectional steel structure with outer walls of insulating material.
- tile transport system including drier feeding and ejection equipment.
- drying gases generator with direct heating by means of producer gas burner and combustion air fan.
- suction fan including pipings for the extraction of the humid air.
- flue for exhaust air above the suction fan.
- all necessary air ducts.
- complete control cabinet with switches and contacts for all motors, as well as temperature control devices for the drier.

P r i c e ex works, unpacked	each DM	331.800,--	DM 663.600,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	each DM	24.900,--	DM 49.800,--

3. 2 glazing lines system Dorst-Cmic for predried tiles

consisting of:

3.1 1 90°-curve
to connect the rapid drier to the glazing line.

3.2 1 tile concentrating unit
for delivering the tiles to the line at an equal distance between them

installed power : 0.2 kW

3.3 1 brushing station
for removing dust and tile particles, left on the surface of the tiles, by means of single vertical rotating brush and additional horizontal brush for cleaning tiles lower surface.

Including cabin in fibre glass reinforced plastic with connecting pipe piece to local dry de-dusting.

installed power : 0.4 kW

3.4 1 blower
to blow off dust left on the tile surface on the brushing station.

Including cabin in fibre glass reinforced plastic with connecting pipe piece to local dry de-dusting.

installed power : 0.2 kW

3.5 1 motorized tile turning device
for turning eventually produced rectangular tiles

installed power : 0.13 kW

3.6 1 glazing station
for application of base glaze by double disc sprayer

consisting of:

- wheeled glaze container of rust-proof steel shaped like an eight, whereby in the smaller compartment the glaze pump is located, and in the bigger one a slowly running electric stirrer maintains the glaze in suspension and homogenizes it. Including stirrer, pump and glaze filter.

- glazing unit consisting of rust-proof steel cabin with two rotating spraying disc packs which are driven by motor via cone pulleys for different rotation speeds. Cabin to be connected to local wet de-dusting.

- recovery through for scraped glaze including conical belt scraping units.

total installed power
each station : 2.65 kW

3.7 1 decoration station
for application of mottling or droplets

consisting of:

- wheeled glaze container with pump and stirrer as described before.

- glazing unit consisting of rust-proof cabin with rotating perforated glazing pipe which is driven by motor via cone pulleys for different rotation speeds. Cabin to be connected to local wet de-dusting. Instead of a perforated pipe disk packs in different designs can be used for various decorating effects

- recovery through for scraped glaze including conical belt scraping units

total installed power : 1.9 kW

3.8 1 glaze fixing station
for fixing the glaze surface and to avoid sticking of the glaze on the stencils of the silk screen printing machines.

Cabin of glass fibre reinforced plastic, including spray gun and feeding pump. Cabin to be connected to local wet de-dusting.

installed power : 0.375 kW

3.9 1 automatic vertical tile compensator
for accumulating tiles during the cleaning of the stencils of the silk screen printing machines

capacity : 40 tiles
installed power : 2 kW

3.10 1 automatic silk screen printing machine
for 1 colour decoration by stencil printing

capacity acc. to tile size : 100 - 140 tiles/min
installed power : 0.35 kW

incl. 1 set of accessory for further tile size

3.11 1 spraying unit for application of white or coloured shades on the glazed tiles consisting of:

- wheeled glaze container with pump and stirrer as described before
- spray cabin in rust-proof steel with glaze retaining grids and connecting pipe pieces to local wet de-dusting plant
- spray gun for 4 bars pressure with rapid tip unclogging device
- moving unit which gives a pendular movement to the spray gun producing an irregular shading effect on the tiles surface. Including geared motor with adjustable speed.

- glaze pressure regulating device, for the exact setting of the feeding glaze pressure to the spray gun, and therefore to obtain constant shading effects.

1 glaze filtering unit with double filters for separating possible impurities of the glaze to be fed to the spray gun, and thus avoiding clogging of spray tip

1 compressed air filtering and pressure regulating unit for atomizing and fan air of the spray gun, with exact setting of the pressures via corresponding pressure gauges

total installed power : 1.5 kW

3.12 1 engobing station

for application of an anti-sticking coating on the lower tile surface to avoid sticking of the body to the rollers of the roller hearth kiln

consisting of:

- tile holding roll in synthetic sponge
- engobing vat with transfer rolls in sponge
- feeding pump

installed power : 0.75 kW

3.13 1 complete tile transport line

of 80 m length, complete with V-belts, roof-shaped in the glazing sections, pulleys, tile guides, hand protections and supporting structure.

- 13 driving motors with stepless adjustable speed

total installed power : 7.5 kW

3.14 Electric equipment

consisting of switch cabinet, including about 7 switching units and emergency stops along the tile transport line.

P r i c e ex works, unpacked item 3.1 until 3.14	each DM	195.100,-- DM	390.200,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	each DM	13.700,-- DM	27.400,--

4. Preparation of silk screen printing stencils

for the printing machines inserted in the glazing lines.

4.1 1 illumination unit

for red and yellow light to be used in the dark room.

4.2 1 pneumatic silk screen tensioning device

for stretching evenly the silk screen cloth and for sticking it to the stencil frames.

4.3 1 electric stirrer and mixer

for mixing the photosensitive emulsion for stencil coating.

4.4 1 coating chute

for application of photosensitive emulsion on screen cloth

4.5 1 vacuum device

for perfect contact of tile decor pattern with silk screen of stencil

4.6 1 halogenite lamp

for exposure of silk screen stencils coated with photosensitive emulsion.

4.6.1 1 light dosing device

for halogenite lamp

4.7 1 stencil developping and washing cabin

4.8 1 stencil drying cabinet

4.9 1 high pressure water jet device

for removing coatings from stencils

4.10 1 refining grinding mill

for super fine grinding and mixing of components for the production of screen printing pastes.

P r i c e ex works, unpacked item 4	DM	79.180,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	DM	5.540,--

5. Storage plant

5.1 1 storage plant for glazed tiles

for allowing continuous operation of the roller passage kilns when pressing drying, glazing and sorting line are interrupted

storage capacity	:	30 hours
corresponding to	:	7810 m²
installed motor capacity abt.	:	45 kW

comprising:

5.1.1 2 loading units

installed at the end of the glazing lines for automatically loading glazed tiles into the storage containers, consisting of V-belt track, tile transfer device, roller table, tile compensator and tile feeding unit.
Including electric switching elements.

5.1.2 3 kiln loading machines

for unloading the tiles from the storage containers and feeding them to the roller passage kilns. Comprising roller table, tile compensator tile transfer device and kiln feeding unit.
Including electric switching elements.

5.1.3 1 storage car transfer and transport system

comprising:

- 2 transfer cars with 2 parkings for 2 storage containers simultaneously for servicing the tile loading units and the roller kilns loading machines with container cars. Equipped with electric driving system.

- 1 transfer car with 1 parking for 1 storage container, equipped with electric driving system.

- storage container transport system, installed between the rails for storing the storage containers, consisting of hydraulic pushing machines and pushing jack bars.
  Including electric switching elements.

5.1.4 100 storage containers

for storing the glazed tiles

storage capacity per container : abt. 90 m²

containers consisting of various levels made of sectional steel elements. One supplied by us as a sample, the rest to be manufacture locally.

5.2 1 storage plant for fired tiles

for overnight storage of fired tiles

storage capacity	:	30 hours
corresponding to	:	7810 m²
installed motor capacity abt.	:	20 kW

comprising:

5.2.1 3 roller kiln tile unloading devices

with roller table, tile aligning equipment, tile transfer system and tile conveying belt equipped with sorting device for cracked tiles, as well as 1 emergency tile stacker.
Including electric switching elements

5.2.2 4 container loading and unloading machines

3 for loading automatically the storage containers with carpets of fired tiles coming from the roller passage kilns and 1 for unloading these carpets from the containers in order to feed the tile sorting line.

consisting of:

tile carpet forming equipment and tile carpet transfer device by means of suction head with subsequent feeding of the storage containers with the tile carpets layer by layer. Including electric switching elements

5.2.3 100 storage containers

for storage of fired tiles

storage capacity each abt. : 100.8 m²

Containers in box form, open on top, in metal execution, outfitted for transport with fork lift truck. One container is supplied by us as a sample, the rest to be manufactured locally.

P r i c e ex works, unpacked	DM	1.393.200,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	DM	97.500,--

6. Firing plant

6.1 3 roller passage kilns

for once firing of glazed tiles.

ware to be fired	:	glazed floor tiles
tile size	:	200 x 200 mm
firing temperature max.	:	1100 °C
firing cycle assumed	:	80 min
inner width of firing channel	:	abt. 1450 mm
total kiln length	:	abt. 100 m
kiln holding capacity with tile size 200 x 200 mm	:	abt. 350 m²
kiln production per day	:	abt. 6250 m²
heating fuel	:	producer gas
net-calorific value of fuel	:	1350 kcal/Nm³ ± 10 %
specific fuel consumption of ware	:	abt. 700 kcal/kg ± 10 %
fuel consumption	:	abt. 2430 Nm³/h ± 10 %
installed motor capacity	:	abt. 120 kW

comprising:

- pre-assembled modules for drying, pre-heating, firing, rapid cooling and cooling zones which will be mounted at the site. The individual modules consists of steel structure, insulation and inner lining with refractory material laid out according to the firing temperature needed for the ceramic body composition and the glaze.

- the complete firing system with burners, fuel supply line including fuel pressure regulator, fuel meter and pipings in the area of the firing zone, pre-heating system for the combustion air.

- all fans and ducts for hot gas circulation, combustion air, cooling air and waste gases including corresponding fittings and supporting platforms

- the complete tile transport system consisting of rollers and corresponding special driving units which ensure smooth and constant flow of tile carpet through kiln

- the control system for the regulation of combustion air and fuel, for the pressures of combustion gases and exhaust gases in the firing channel and for the temperature in the individual kiln zones. This control system is located in a completely wired switch board, which on its front panel contains all necessary switches and displays for the control values of pressures and temperatures with corresponding recording units

- the optical survey unit for detection of whether firing channel is free of tile jammings, including alarm system.

Note: the total length and the specific fuel consumption of the kiln depends on the firing properties of the ceramic body and glaze composition, and the correspondingly needed firing cycle. The given kiln length is based on the assumption of a 80 minutes firing cycle and is subject to alterations. Thus, the kiln price is to be regarded as orientative.

P r i c e			
ex works, unpacked each	DM 1.882.000,--	DM	5.646.000,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	DM 43.000,--	DM	129.000,--

optionals :

6.2 3 monitoring systems

for survey of kiln entrance by the kiln operator on a TV screen located on the front control panel of the swithch cabinet. Including TV camera and cables.

P r i c e				
ex works, unpacked	each	DM 10.450,--	DM	31.350,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	each	DM 750,--	DM	2.250,--

6.3 2 cleaning and reeling machines

for kiln rollers. Necessary for removing glaze and/or ceramic body coatings accumulated on the roller surfaces, and also for perhaps needed reeling of bent rollers.

P r i c e				
ex works, unpacked	each	DM 36.100,--	DM	72.200,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	each	DM 2.550,--	DM	5.100,--

6.4 3 emergency electric power generating sets

for keeping the rollers of the kiln in movement during electric power failure

P r i c e ex works, unpacked	each DM	28.200,--	DM	84.600,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	each DM	1.970,--	DM	5.910,--

7. Sorting and packing

7.1 1 double sorting line

for sorting coloured and decorated tiles of various sizes into three qualities and scrap. First quality will comprise tiles of a pre-established size range and defined colour tonality.
Second quality will comprise tiles out of established size range but inside colour tonality.
Third quality will comprise tiles which differ from size and pre-established colour tonality and which will have small surface defects.
Scrap will be all tiles which are broken, which will be concave or convex, which differ very much from established colour tonality and which have big surface defects.

The line consists of:

7.1.1 1 connection line from the tile storage unloading device to the sorting tables, with supporting structure in sectional steel construction and V-belts tile transport line.

7.1.2 1 90° tile turning device for rectangular tiles in V-belt execution with steplessly regulable gear motor for belt speed control
installed power : 0,33 kW

7.1.3 1 automatic sorting device for cracked tiles with pneumatically loaded pressing roll
required air pressure: 4 - 5 bar

7.1.4 1 blower for blowing off tile particles from the upper tile surface. Including dust protection hood with pipe piece for connection to locally supplied dust extraction plant.
installed power : 0,19 kW

7.1.5 1 control device for concave and convex tiles with automatic marking of different grades of non planarity and ejection of tiles which are out of established tolerance.
required air pressure: 4 - 5 bar
installed power : 0,1 kW

7.1.6 1 automatic vertical tile compensator for the accumulation of tiles when tile flow is too fast, and for constant tile supply to size control device and sorting tables
storage capacity : abt. 90 tiles
installed power : 2 kW

7.1.7 1 driving motor for transport line with steplessly regulable speed
installed power : 0,37 kW

7.1.8 1 size control device which marks visually upto 4 different size levels which can be freely established. Size control effected by measuring the length between two opposite tile sides.

7.1.9 1 90° turning device for rectangular tiles in V-belt execution with steplessly regulable gear motor for belt speed control
installed power : 0,33 kW

7.1.10 1 driving motor for transport line with steplessly regulable speed
installed power : 0,37 kW

7.1.11 1 electronically controlled deviator type OR 3 for distribution of the tiles coming on one line onto two subsequent lines. Including electronic control.

7.1.12 1 s-line track for the conveyance of tiles to the first sorting table consisting of corresponding initial downwards section followed by an upwards section and subsequent horizontal straight track. Equipped with steplessly regulable gear motor for line speed regulation
installed power : 0,75 kW

7.1.13 1 straight-line track for the conveyance of tiles to the second sorting table. Equipped with V-belts and steplessly regulable gear motor for line speed regulation
installed power : 0,75 kW

7.1.14 2 sorting stations
with 3 lanes for the sorting of the tiles in 3 quality grades, incl. variable gear motor and neon lighting
installed power : 0,75 kW each

7.1.15 6 connection lines
from the sorting stations to the box-filling machines in tubular steel construction, sectional steel support frame, height-adjusted V-belt pulleys and V-belts, equipped with electro-pneumatic cylinders for the space-adjustment of the tiles at the entrance to the box filling machines and with variable gear motor
installed power : 0,37 kW each

7.1.16 6 tile stacking and box filling machines, type PAM 2
for automatic forming of sorted tiles stacks and automatic pushing of stacks into manually hold carton boxes. Including roller track for conveyance of filled boxes onto a subsequent conveyor system.

7.1.17 1 roller curve
width :abt. 400 mm
turning angle : 90 degrees

7.1.18 1 transport belt
length :abt. 2 m
width :abt. 400 mm
installed motor power : 0,37 kW

7.1.19 1 steep roller track
for closing and accumulation of tile filled carton boxes
length :abt. 8 m
width :abt. 400 mm

7.1.20 1 switch cabinet
for the double sorting line with all switching elements and control lamps.

Price ex works, unpacked item 7.1	DM	281.000,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	DM	19.700,--

8. Laboratory

8.1 Works Laboratory

8.1.1 1 torsion viscosimeter
with electrically moved turning spindles of various sizes including supporting pedestal

8.1.2 1 laboratory screening machine complete with integrated electro-magnetic variable vibrating amplitude from 0-3 mm, adjustable timer, incl. wet-sieving equipment and 1 set of test screens with mesh apertures of 1, 0,5, 0,355, 0,25, 0,18, 0,125, 0,09 and 0,063 mm.

8.1.3 3 sieves of 0,063 mm mesh aperture for grinding control.

8.1.4 1 rapid moisture tester
with metal pressure bottle equipped with dial gauge including carbide reagent

8.1.5 2 mixers and stirrers
with steplessly variable number of revolutions. Including stirring propeller

8.1.6 1 drying cabinet with stainless steel perforated shelves

content	: abt.	53 l
temperature	: max.	200 °C
Internal dimensions:		
width	: abt.	400 mm
depth	: abt.	330 mm
height	: abt.	400 mm

including blower for humid air removal

8.1.7 10 precision mechanical balances, with tare setting and hanger weights for weighing glaze coatings at the various cabins on the glazing lines and for general weighing purposes

weighing range	2610 g
readability	0,1 g
tare	0-250 g

8.1.8 miscellaneous laboratory material as plastic funnels, measuring cylinders, measuring flasks, pipettes, stop watches thermometers, washing bottles, pycnometers, outflow viscosimeters, calipers

8.2 Central laboratory

8.2.1 1 weighing scale
weighing range 15 kg
readability 5 g

8.2.2 1 wet-grinding ball mill NM 50/44 Kv steatite lined including steatite grinding balls

8.2.3 1 stirrer EMK 40 with two propeller speeds, including holding device for vertical movement to be wall mounted.

8.2.4 1 vibrating screen VS 45 including discharge funnel with 2 permanent magnets and wheeled holding structure.

8.2.5 1 analytical mechanical balance with digital readout including pre-weighing system and suited also for density determination.
weighing range 160 g
readability 0,1 mg

8.2.6 1 laboratory screening machine complete with integrated electro-magnetic variable vibrating amplitude from 0-3 mm, adjustable timer, incl. wet-sieving equipment and 1 set of test screens with mesh apertures of 1, 0,5, 0,355, 0,25, 0,18, 0,125, 0,09 and 0,063 mm.

8.2.7 2 sieves of 0,063 mm mesh aperture for grinding control.

8.2.8 2 mixers and stirrers
with steplessly variable number of revolutions. Including stirring propeller

8.2.9 1 torsion viscosimeter
with electrically moved turning spindles of various sizes including supporting pedestal

8.2.10 2 outflow viscosimeters

8.2.11 1 moisture tester
with electronic power regulator for control of the radiation intensity, voltmeter for the indication of the set power of the infra-red radiator and alarm timer.

8.2.12 1 combined dilatometer - DTA unit
temperature range from 20° to 1500°C
automatically controlled incl. automatic temperature and sample variation recording units

8.2.13 1 adjustable diamond saw
for cutting dilatometer test samples from fired tiles

8.2.14 1 hydraulic press
for pressing sample-tiles with a size of 100 x 200 mm
compacting pressure from 0-200 bars corresponding to max. 70 tons

8.2.15 2 drying-cabinets
with stainless steel perforated shelves
content abt. 115 l
temperature max. 200 °C
internal dimensions:
width : abt. 600 mm
depth : abt. 400 mm
height : abt. 480 mm
including blower for humid air removal

8.2.16 1 pot-mill turning stand
with 4 grinding pots of 5 l cap.
and 6 grinding pots of 1 l cap.
including corresponding grinding balls of hard porcelain

8.2.17 1 spraying cabin with water flushed
spray wall, exhaust fan and spray gun
with glaze cup

8.2.18 1 electrically heated laboratory chamber
kiln
internal dimensions abt. 400 x 560 x 475 mm
temperature : max. 1260 °C
including automatic time/temperature processor

8.2.19 1 electric heating plate
for water absorption tests acc. to boiling
water method

8.2.20 1 autoclave
for testing crazing resistance of glaze
coatings on ceramic bodies according to
European Norms

8.2.21 miscellaneous laboratory material
as plastic funnels, evaporating dishes,
pipettes, measuring cylinders, measuring
flasks, calipers, stop watches, pycnometers,
thermometers

8.2.22 1 abrasion tester
for determining the abrasion resistance
of glazed tiles with 9 testing stations
rotary table

8.2.23 1 tile measuring device
for the control of parallelism of
tile opposite sides as well as
squareness of adjacent sides

8.2.24 1 tile flatness measuring device
for the control of tile surface warpage
and of straightness of tile sides

8.2.25 1 bending breaking load tester for finished tiles
pneumatic operation with pressure regulators
max. force 4000 N
including set to adapt instrument
for bending breaking load test of pressed tiles
with a max. force of 800 N

P r i c e
ex works, unpacked
item 8.1 and 8.2 DM 386.000,--

Costs for seaworthy packing and
delivery f.o.b. EC seaport DM 28.950,--

9. Spare parts

The scope of supply includes the most important spare parts for an operation period of approx. one to two years. These do however not include so-called consumption and operating materials.

An exact specification of the above-mentioned spare parts will be established 3 months after coming into force of an contract.

P r i c e ex works, unpacked	DM	800.000,--
Costs for seaworthy packing and delivery f.o.b. EC seaport	DM	72.000,--

10. Engineering

For the carrying out of the complete engineering, our services comprise:

- Preparation of a total plan of the factory with determination of the technological flow.
- Detailed plans for each manufacturing department.
- Preparation of pipe line schemes for slip, water, fuel, waste-water, compressed air with material parts lists.
- Preparation of electrical schemes for the current supply from the transformer station to the low-voltage main distributing points and from these to the switch cabinets and to the consumers.
- Preparation of general drawings for the steel construction to be provided by yourselves, as for instance silo groups, charging and operating platforms, etc.
- Description, schemes and diagrams concerning the working process and material flow for each individual product.
- Calculations with determination of the entire need of material, energy and personnel.
- Indications concerning number and qualification of the required personnel with description of working places.
- Technical records and information for all machines and equipment to be placed at disposal by the customer.
- Detailed workshop drawings for the manufacture of dies for the hydraulic presses.
- Detailed technical documentation about the machinery and equipment supplied.
- Technical discussions and meetings concerning essential prolems, as for instance coordination with the local architects and consultants; for this, we would only charge you costs for stay and travelling.

Lump sum DM 200.000,--

11. Erection and commissioning

Personnel for erection and commissioning

We place at your disposal our expert staff for the suppervision of the erection as well as for the commissioning of all technologically necessary machines and equipment. For conditions of erection please consult our enclosed "General Terms for Plant Construction and Large Scale Installation Projects".

Survey of approximate requirement:

personnel to be sent from Germany for the supervision of the erection and for the commissioning:

personnel	time in weeks 1 week 38,5 hours	working hours	allowance days
total 14 specialists	110	4235	770

All periods of time indicated hereinafter are approximate and can only be adhered to if the project progresses undisturbedly and the execution of the work is not interrupted.

Herein not included is the necessary personnel for earthmoving, concrete and building construction work as well as for the equipment of all auxiliary facilities including buildings and the erection and commissioning personnel for the machinery and equipment, which will be supervised by the above mentioned specialists.

Lump sum DM 780.000,--

12. To be procured by yourselves

The following items are not included in our scope of supply:

12.1 for the machinery:

- Silos for the daily storage of raw materials, granule etc., complete with supporting frame, ladders, attendant's platform as well as the press silos.

- All Equipment for transporting raw materials, weighing, wet grinding, screening and storing of the slips for the ceramic body and the glaze

- The supporting construction, platform and ladders for the spray dryer.

- All required electric chain hoists within the areas of the slip and glaze preparation, as well as within the area of the pressing plant, which are not specifically mentioned in the specification.

- All required switching centrals and electric controls in the various manufacturing sections as far as they are not specifically mentioned in the technical specification.

- All pipe lines for fuel, oil, water, compressed air, slip, glaze etc., further all fittings and connection pieces as flexible tubes, unless specifically mentioned in the specification.

- The complete dust-extraction plant as well as the dedusting equipment for the wet dust on the glazing lines including all necessary corresponding pipe lines.

- The waste air chimneys for the dust extraction plant, including the chimney for the spray drying plant, the dryers and kiln.

- The waste air ducts of the factory.

- Waste water pumps, installed in the waste water channels.

- Required fork lift trucks for the transportation of the storage containers of fired tiles as well as packed finished ware inside and outside of the store for finished products, as far as they have not been specified in the offer as being included in our scope of supply.

- The required wooden pallets in the store for finished products.

- All containers of the storage plant.

- The rails for the storage containers.

- All operating stock such as ceramic body and glazes, raw materials, colours, copying solutions, coating emulsions, deflocculants, grinding media, printing frames, screening cloths, etc.

- Nitrogen pressure bottles for accumulators at the hydraulic presses.

- Compressor station

- Electric emergency power generating set

- All components of the plant and their accessories which are not specifically mentioned in our technical specification.

12.2 for general equipment:

- All buildings including civil engineering works like lighting, heating, water supply system, sanitary installation and so on for the factory, for subsidiary equipment etc..

- All earth-moving, concreting, masonry, tiling, painting and roof-covering work.

- The station for electric power, fuel, compressed air, water as well as purification for waste water, including the complete pipe distributing system.

- The electric current supply for the entire factory, consisting of:

  high-tension plant
  transformer station
  central distribution

  Earthing and lightning protection system, as well as all electric cables between the current supply, the distributors, switch cabinets and consumption points as well as the installation material.

- Tools for general erection and commissioning of the factory.

- Equipment for an electrician's workshop.

- Equipment for a mechanical workshop and a press dies making shop.

- Equipment for a joinery.

- Telephone and calling plants.

- Required fire-fighting equipment.

- Lubricants and transmission oils.

- Transportation within the factory of the machines and equipment as well as their proper storage.

- Installation of gas, electricity, water etc. during the period of erection and commissioning.

- The producer gas generating plant.

- All skilled and unskilled workers for the erection and commissioning as well as all required tools, scaffolds, hoists, cranes etc..

- The complete erection and commissioning of the factory except the special personnel for the supervision of erection and commissioning specified in the offer.

- All components of the plant and their accessories which are not specifically mentioned in our technical specification.

SUMMARY OF PRICES

without optionals

Items		price, ex works unpacked		f.o.b costs	
1.1 - 1.14	1 spray drier plant type D 6000	DM	1.188.400,--	DM	56.600,--
1.15	1 double acting diaphragm pump, type MPz 125/25 R	DM	85.850,--	DM	3.870,--
1.16	2 double slip filters	DM	19.660,--	DM	980,--
2.1	3 fully hydraulic presses type HPP 750 Hydrorapid	DM	1.422.600,--	DM	57.750,--
2.1.1	3 granule distribution devices	DM	27.300,--	DM	1.950,--
2.2	3 complete 4-cav-dies 200 x 200 mm	DM	93.450,--	DM	4.650,--
2.3	1 hydraulic die handling unit	DM	11.680,--	DM	850,--
2.4	3 automatic fettling machines	DM	173.670,--	DM	12.300,--
2.4.1	1 tile transfer belt system	DM	53.460,--	DM	3.750,--
2.5	2 automatic tile compensators	DM	72.680,--	DM	5.080,--
2.6	2 rapid driers	DM	663.600,--	DM	49.800,--
3.1 - 3.14	2 glazing lines system Dorst/Omic	DM	390.200,--	DM	27.400,--
4.1 - 4.10	Preparation of silk screen printing stencils	DM	79.180,--	DM	5.540,--
5.1.1 - 5.2.3	1 storage plant	DM	1.393.200,--	DM	97.500,--
6.1	3 roller passage kilns	DM	5.646.000,--	DM	129.000,--

7.1.1 - 7.1.20	1 double sorting line	DM	281.000,--	DM	19.700,--
8.1 - 8.2	Works and Central laboratories	DM	386.000,--	DM	28.950,--
9.	Spare parts	DM	800.000,--	DM	72.000,--
	T o t a l p r i c e ex works, unpacked	DM	12.787.930,--		
	Costs for seaworthy packing and delivery f.o.b. EC seaport			DM	577.670,--
10.	Engineering	DM	200.000,--		
11.	Erection and Commissioning	DM	780.000,--		

The ceramic and technological know-how is not included in our offer and should be subject to a special agreement which your company has to make with our partners M/S Keraprogress - Hungary.
The project will be realized in straight collaboration with M/S Keraprogress.

Time of delivery

The time of delivery depends on when the technical and financial questions are fully clarified.

The deliveries will be in accordance with the progress of the project.

Beginning of the deliveries

Abt. 6 months after establishment of the letter of credit.

End of the deliveries

Abt. 12 months after establishment of the letter of credit, depending on the progress of the installation of the plant.

Payment

By an irrevocable, confirmed free of charge and divisible letter of credit, to be opened when placing the order with Bayerische Hypotheken- und Wechselbank, Munich, payable as follows:

30 % down payment immediately after receipt of the letter of credit
70 % pro rata delivery against presentation of the shipping documents resp. forwarding agent's certificate of receipt.

Corresponding details should still be discussed personally - including your proposals.

Validity

We hold ourselves bound to the quoted prices until end of March 1986 - under the precondition, that the deliveries can be effected until end of March 1987.

We hope to have submitted to you with our offer an useful contribution to your plannings and ask you kindly to consider our machines and equipment.

Should you need further information, we are always gladly at your disposal. In case we are favoured with your valued order, we shall give our best care and attention to it.

Yours faithfully,

Dorst-Maschinen- und Anlagenbau
Otto Dorst u. Dipl.-Ing. Walter Schlegel
GmbH & Co.

Enclosure

conditions for the supply
general terms for plant construction
folder of leaflets
informative layout
reference list complete plants

P.S. the enclosed lay-out is to be regarded merely as informative to give an idea how the equipment can be arranged.

DORST-MASCHINEN UND ANLAGENBAU
Otto Dorst und Dipl.-Ing. Walter Schlegel GmbH & Co
P.O.Box 109 + 129
D-8113 Kochel a. See
Telefon: 08851-19-1

General Conditions for the Supply of Plants and Machinery for Export

1. Quotations, Drawings and Descriptive Documents

1.1 Quotations are generally submitted free of charge. Services exceeding the presentation of quotations for the supply of plant and machinery, such as design work, planning services for complete projects, assistance in drawing up tenders and placing orders, supervision, acceptance tests etc. — here referred to as engineering services — are subject of juridically independent agreements.

1.2 Documents used, such as pictures and drawings, as well as weights, dimensions and capacities, together with statements regarding technology, performance ratings and other data included in quotations, catalogues, circulars etc. constitute an approximate guide only, except when they are expressly stipulated as being binding. Any drawings or technical documents intended for use in the construction of the plant or of part thereof and submitted to the purchaser prior or subsequent to the formation of the contract remain the exclusive property of the vendor. They may not, without the vendor's consent, be utilised by the purchaser or copied, reproduced, transmitted or communicated to a third party. However, the said plans and documents become the property of the purchaser:

1.2.1 if it is expressly so agreed, or

1.2.2 if they are based on a separate preliminary development contract relative to which no actual construction was to be performed and contain no reservation of ownership in favour of the vendor.

1.3 Any drawings or technical documents intended for use in the construction of the plant or of part thereof and submitted to the vendor by the purchaser prior or subsequent to the formation of the contract remain the exclusive property of the purchaser. They may not, without his consent, be utilised by the vendor or copied, reproduced, transmitted or communicated to a third party.

1.4 The vendor shall, if required by the purchaser, furnish free of charge to the purchaser within a specified period, information and drawings other than manufacturing drawings of the plant in sufficient detail to enable the purchaser to carry out the erection, commissioning, operation and maintenance including running repairs of all parts of the plant. Such information and drawings shall be the property of the purchaser and the restrictions on their use set out in paragraph 1.2 hereof shall not apply thereto. Nevertheless, if the vendor so stipulates, they shall remain confidential.

1.5 Quotations without a time limit terminate on the 45th day after the date of their issue. Any quotation may be withdrawn up to such time as the declaration of acceptance has been mailed by the purchaser. Quotations are valid only for the country specified therein. The purchaser shall be liable to the vendor for any prejudice and obligation which the vendor may suffer from disposal of the goods involved in a country other than that specified.

2. Formation of Contract and Scope of Supply

2.1 The authoritative statement of the scope of supply is the written acceptance of the order issued by the vendor. The contract shall be deemed to have been entered into when, upon receipt of an order, the vendor has sent an acceptance in writing within the time limit (if any) fixed by the purchaser. If the vendor, in drawing up his tender, has fixed a time limit for acceptance, the contract shall be deemed to have been entered into if the purchaser despatches an order in writing before the expiration of such time limit. However, this only applies if the order reaches the vendor no later than one week after the expiration of the time limit.

2.2 If the acceptance of the vendor contains supplements, limitations or other modifications of the order, the purchaser shall be deemed to consent, provided that he does not object in writing and without delay.

2.3 The supplies of the vendor are designed in accordance with the provisions of the Law concerning "Technische Arbeitsmittel", in force in the Federal Republic of Germany since 24th June 1968. The cost of supplementary protective devices, insofar as these are required in accordance with local statutory rules and official safety and accident prevention regulations in the country of destination, must be borne by the purchaser. Devices providing protection against the danger resulting from the use of the plant will be supplied at the purchaser's expense, if this has been agreed. Over and beyond this obligation, the plant shall not be deemed defective when they are lacking.

2.4 The vendor does not carry out any soil analyses for the foundation of buildings and machinery. All statements regarding foundations and prices eventually related thereto are only approximate unless specifically stated to be binding. The cost of any static calculations required and the preparation of reinforcement plans, etc. shall be borne by the purchaser.

2.5 As a result of continual technical progress the vendor reserves the right to carry out alterations and improvements regarding design and materials, provided that these alterations do not impair the conformity with promised properties and technical data. Should any alterations cause price increases the purchaser's consent will be sought.

2.6 If the vendor undertakes to erect the plant and machinery, his General Terms for Installation Projects shall apply together with these General Conditions for the Supply of Plants and Machinery for Export.

3. Payment

3.1 Payment shall be made in the manner and at the time or times agreed by the parties. Any advance payments made by the purchaser are payments on account and do not constitute a deposit, the abandonment of which would entitle either party to terminate the contract.

3.2 If the purchaser delays in making any payment, the vendor may postpone the fulfillment of his own obligations until such payment is made, unless the failure of the purchaser is due to an act or omission of the vendor. A payment conditional on the fulfillment of an obligation by the vendor shall not be due until such obligation has been fulfilled, unless the failure of the vendor is due to an act or omission of the purchaser. The vendor is entitled to refuse performance if, due to a circumstance occurring after the conclusion of the contract, he should have reason to fear that he may not receive the counter-consideration of the purchaser completely and in time.

3.3 If delay by the purchaser in making any payment is due to one of the circumstances mentioned in clause 10, the vendor shall not be entitled to any interest on the sum due. In all other cases, if the purchaser delays in making any payment, the vendor can, on giving the purchaser notice in writing within a reasonable time, claim payment of interest on the sum due at the rate prevailing in the country of the vendor for overdrawn current accounts. Payment shall be deemed as having been effected on the date on which the vendor can actually dispose of the corresponding amount.

3.4 Payments may not be withheld on account of any counterclaims not recognized by the vendor, nor may these be taken into account when paying.

4. Prices

4.1 Unless otherwise specified, all prices are quoted ex works and shall be deemed to apply to unpacked equipment. Only if expressly agreed do prices quoted in tenders and in the contract

include the cost of packing or protection required under normal transport conditions to prevent damage to or deterioration of the plant before it reaches its destination stated in the contract.

4.2 C.I.F.-deliveries do not include landing, port and dock charges. Import duties, consular fees or any other fees imposed in the country of destination are only included in the price if this has been expressly agreed.

4.3 In the event of C.I.F.-deliveries or in case of customs duties and similar charges being included in the price, the latter will be based on current rates applicable at the time. Only actual costs will be charged. The vendor will undertake to comply with foreign regulations regarding packing and weights and customs duties only in the event of accurate specifications having been received from the purchaser.

5. Delivery

5.1 Unless otherwise agreed the delivery period shall run from the latest of the following dates:

5.1.1 the date of the formation of the contract as defined in clause 2;

5.1.2 the date on which the vendor receives notice of the issue of a valid import licence where such is necessary for the execution of the contract;

5.1.3 the date of the receipt by the vendor of such payment in advance of manufacture as is stipulated in the contract.

It is a further prerequisite for the beginning of the delivery period that agreement must be reached with respect to all technical questions, clarification of which had been postponed for further discussion by the parties on concluding the contract and that any official authorization which may be required for fulfillment of the obligations of the vendor has been issued. It shall be understood to have been duly fulfilled if the goods are declared ready for despatch ex works within the period specified as the delivery time and the purchaser has been notified accordingly.

5.2 Occurrences such as labour disputes, in particular strikes and lock-outs, as well as unforeseen circumstances beyond the control of the vendor shall give rise to a reasonable extension of the delivery period. Such circumstances may be factory breakdowns, defective parts, late arrival of essential raw and building materials etc. unless it can be reasonably concluded from the circumstances that they did not prevent the vendor from delivering on the due date. This provision is also attributable to sub-contractors. Should delay in delivery be caused by any of the circumstances mentioned in clause 10 or by an act or omission of the purchaser, there shall be granted such an extension of the delivery period as is reasonable having regard to all the circumstances of the case.

5.3 If a fixed time for delivery is stipulated in the contract and the vendor fails to deliver within such time or any extension thereof granted under paragraph 5.2 hereof, the purchaser shall be entitled, on giving the vendor notice in writing within a reasonable time, to claim a reduction of the price payable under the contract, unless it can be reasonably concluded from the circumstances of the particular case that the purchaser has suffered no loss. Any possible reduction shall equal a percentage of 0.5 % of that part of the price which is properly attributable to such portion of the supply as cannot in consequence of the said failure be put to the use intended for each complete week of delay commencing 4 weeks after the due date of delivery, but shall not exceed the maximum percentage of 5 %. Such reduction shall be to the exclusion of any other claims of any type by the purchaser.

5.4 If the purchaser fails to accept delivery on the due date, he shall nevertheless make any payment conditional on delivery as if the plant had been delivered. The vendor shall arrange for the storage of the plant at the risk and cost of the purchaser. If required by the purchaser, the vendor shall insure the plant at the cost of the purchaser. However, if the delay in accepting delivery is due to one of the circumstances mentioned in clause 10 and the vendor is in a position to store it in his premises without prejudice to his business, the cost of storing the plant shall not be borne by the purchaser.

5.5 Adherence to the delivery date implies that all the purchaser's obligations under the contract in question have been met in full.

6. Passing of Risk

6.1 Except as provided in paragraph 5.4, the time at which the risk shall pass shall be fixed in accordance with the International Rules for the Interpretation of Trade Terms (Incoterms) of the International Chamber of Commerce in force at the date of the formation of the contract. Where no indication is given in the contract of the form of sale, the plant shall be deemed to be sold "ex works".

6.2 If the International Rules for the Interpretation of Trade Terms (Incoterms) of the International Chamber of Commerce are not applicable in the country of the purchaser, the time at which the risk shall pass shall be fixed, unless otherwise agreed, except as provided in paragraph 5.4, as follows:

6.2.1 In case of a sale "ex works" the risk shall pass from the vendor to the purchaser, when the goods are put at the purchaser's disposal according to the stipulations of the contract. The vendor must give notice in writing to the purchaser of the date on which the purchaser must take delivery of the machinery. The vendor must give sufficient notice to allow the purchaser to take such measures as are normally necessary for the purpose of taking delivery. If in the case of a sale "ex works" the vendor, on demand of the purchaser, undertakes to send the plant to its destination, the risk will pass to the purchaser on delivery to the first carrier.

6.2.2 In case of a sale "f.o.b." or "c.i.f." the risk shall pass from the vendor to the purchaser, when the goods have actually passed over the rails of the vessel in the seaport stipulated in the contract.

6.2.3 In case of a sale "free border" the risk shall pass from the vendor to the purchaser, when all customs formalities of the authorities in the exporting country have been concluded.

6.2.4 In the cases 6.2.2 and 6.2.3 the vendor must give notice in writing of the despatch in sufficient time to allow the purchaser to take such measures as are normally necessary for the purpose of taking delivery.

In all other cases the time at which the risk shall pass, shall be fixed as agreed in the contract.

6.3 If the purchaser, due to one of the circumstances referred to in clause 10, fails to take delivery of the plant, the risk will pass to the purchaser no later than the date when this circumstance appeared.

7. Inspection and Tests

7.1 If expressly agreed in the contract, the purchaser shall be entitled to have the quality of the materials used and the manufactured parts inspected and checked by his authorized representatives, both during manufacture and when completed. Such inspection and checking shall be carried out at the place of manufacture during normal working hours after agreement with the vendor as to date and time.

7.2 If as a result of such inspection and checking the purchaser shall be of the opinion that any materials or parts are defective or not in accordance with the contract, he shall state in writing his objections and the reasons therefore.

7.3 Acceptance tests shall not be carried out except when expressly stipulated. Acceptance tests will be performed, unless otherwise agreed, at the vendor's works and during normal working hours. If the technical requirements of the tests are not specified in the contract, the tests will be carried out in accordance with the general practice obtaining in the appropriate branch of the industry in the country where the plant is manufactured.

7.4 The vendor shall give the purchaser sufficient notice of the tests to permit the purchaser's representatives to attend. If the purchaser is not represented at the tests, the test report shall be forwarded by the vendor to the purchaser and shall be accepted as accurate by the purchaser.

7.5 If during any test (other than a test on site, where tests on site are provided for in the contract) the plant shall be found to be defective or not in accordance with the contract, the vendor shall at his own expense with all speed make good the defect or ensure that the plant complies with the contract. Thereafter, if the purchaser so requires, the test shall be repeated.

7.6 Unless otherwise agreed, the vendor shall bear all the expenses of tests carried out in his works except the personal expenses of the purchaser's representatives and their accommodation.

7.7 If the contract provides for tests on site, the terms and conditions governing such tests shall be as specifically agreed between the parties.

8. Reservation of Ownership

8.1 If delivery has been completed before payment of the whole sum payable under the contract, the plant delivered shall, to the extent permitted by the law of the country where the plant is situated after delivery, remain the property of the vendor until such payment has been effected. If such law does not permit reservation of ownership, the vendor shall be entitled to the benefit of such other rights in respect thereof as such law permits him to retain. The purchaser shall give the vendor every assistance in taking measures required to protect the vendor's right of ownership or such other rights as aforesaid.

8.2 If the law of the country of destination permits the reservation of rights of ownership, this reservation shall also apply to any claims arising in connection with the goods supplied, in particular claims arising from repairs, supplies of spare parts and accessories, cost of storage or insurance and costs arising from granting credits, if any, in respect of deliveries when these have been contractually taken over by the purchaser.

8.3 During the period for which the reservation is in force, the goods supplied must not be sold, pawned, transferred by way of security, hired out or surrendered in any other way without the vendor's written consent. In the case of interference by third parties with the goods supplied, the purchaser shall notify the vendor accordingly without delay by registered letter.

8.4 During the period for which the reservation of ownership is in force the goods supplied are at the vendor's request to be insured by the purchaser against fire, theft and burglary, and the purchaser shall also take out a liability-insurance. The vendor is also entitled to arrange for such insurances to be taken out at the purchaser's expense, to advance the premiums and to charge the amount of such premiums to the purchaser when collecting the instalments. Expenses, insurance contributions and the like are considered as part of the price. Any claims arising from such insurances shall be surrendered by the purchaser to the vendor for as long as the vendor has any claims under the delivery contract.

8.5 The purchaser undertakes to keep the goods involved in a proper and satisfactory condition for such period of time as the reservation of property shall be in force and to have any necessary repairs carried out without delay.

8.6 In the event of the purchaser failing to meet his obligations in respect of payments and insurance and obligations arising from the vendor's reservation of ownership the entire balance shall fall due and the vendor shall be entitled to demand the immediate surrender of the goods supplied without any rights of retention on the part of the purchaser being entertained and to dispose of the said goods by private contract in any way the vendor may think expedient.

9. Guarantee

9.1 Subject as hereinafter set out, the vendor undertakes to remedy any defect resulting from faulty design, materials or workmanship.

9.2 This liability is limited to defects which appear during a period — hereinafter called "the Guarantee Period" — of six months, provided that no other Guarantee Period has expressly been agreed in the contract.

9.3 In respect of such parts (whether of the vendor's own manufacture or not) of the plant as are expressly mentioned in the contract different guarantee periods can be laid down.

9.4 The Guarantee Period shall start from the date on which the purchaser receives notification in writing from the vendor that the plant is ready for despatch from the works. If despatch is delayed, the Guarantee Period shall be extended by a period equivalent to the amount of the delay, so that the purchaser can utilize all the time given for testing the plant. However, if such delay is due to a cause outside the control of the vendor, such extension shall not exceed six months. The Guarantee Period shall start from the date of despatch, if this is guaranteed between the parties.

9.5 The parties can specify a shorter Guarantee Period in the contract, taking due account of eventual excessive loading of the machinery. The normal daily use of the machinery is fixed at eight hours. If the machinery is used more intensively, the Guarantee Period shall be reduced accordingly.

9.6 A further Guarantee Period of three months shall apply, under the same terms and conditions as those applicable to the original plant, to parts supplied in replacement of defective parts or to parts renewed in pursuance of this clause. This provision shall not apply to the remaining parts of the plant, the Guarantee Period of which shall be extended only by a period equal to the period during which the plant is out of action as a result of a fault covered by this clause.

9.7 In order to be able to avail himself of his rights under the liability of the vendor, the purchaser shall notify the vendor in writing without delay of any faults which have appeared and shall give him every opportunity of inspecting and eliminating them.

9.8 On receipt of such notification the vendor shall eliminate the fault forthwith and, except for the cases mentioned in paragraph 9.10 hereof, at his own expense. Except where the nature of the fault is such that repairs must be carried out on site, the purchaser shall return to the vendor any part in which a fault covered by this clause occurs, for repair or replacement by the vendor, and in such case the delivery to the purchaser of such part properly repaired or a part in replacement thereof shall be deemed to be a fulfilment by the vendor of his obligations under this paragraph in respect of such defective part.

9.9 Unless otherwise agreed, the purchaser shall bear the cost and risk of transport of defective parts and of repaired parts or parts supplied in replacement of such defective parts between the place where the plant is situated and one of the following points:

9.9.1 the vendor's works if the contract is "ex works" or "f.o.r.";

9.9.2 the port from which the vendor despatched the plant, if the contract is "f.o.b.", "f.a.s", "c.i.f." or "c & f";

9.9.3 in all other cases the frontier of the country from which the vendor despatched the plant.

9.10 Where, in pursuance of paragraph 9.8 hereof, repairs are required to be effected on site, the conditions covering the attendance of the vendor's representatives on site shall be such as may be specially agreed between the parties.

9.11 Defective parts replaced in accordance with the liability of the vendor shall be placed at his disposal.

9.12 If the vendor refuses to fulfill his obligations under this clause or fails to proceed with due diligence after being required to do so, the purchaser may proceed to do the necessary work at the vendor's risk and expense, provided that he does so with the necessary care.

9.13 The vendor's liability does not apply to defects due to materials provided, or a design stipulated by the purchaser. Likewise, the vendor shall not be liable with respect to manufactured goods provided by the purchaser.

9.14 The vendor's liability shall apply only to faults occurring under the operating conditions stipulated in the contract and in the case of correct use. It does not cover faults due to causes arising after the passing of risks to the vendor. In particular it does not cover faults arising from: faulty or careless handling, faulty erection or commissioning, alterations carried out by the purchaser or third parties, normal wear and deterioration, faulty or careless maintenance, excessive loading, unsuitable lubricants, unsuitable raw materials or materials not correctly prepared in accordance with appropriate technological requirements, repairs carried out improperly by the purchaser, incorrect masonry and foundation work, unsuitable ground for construction, chemical and electrochemical deterioration, etc. provided that such defects are not the vendor's responsibility.

9.15 Except as specified in this clause, the vendor shall not be liable for defects occurring after the passing of risks in accordance with clause 6, even if such defects are due to causes existing before the risk has been passed. It is expressly agreed that the purchaser shall have no claim in respect of personal injury or of damage to property not beeing subject matter of the contract nor of loss of profit.

9.16 If the rated performance data are not achieved or the rated consumption figures are exceeded for reasons within the vendor's responsibility and the vendor's attempts to eliminate these faults are ultimately unsuccessful, the purchaser has the right to claim a reduction. If the vendor and the purchaser cannot agree on the amount of reduction, the purchaser can take the legal measures expressly stipulated in the contract or, if no such provisions exist, make use of article 15.4 and have the amount of reduction fixed and enforced.

9.17 The purchaser can make no further claims and in particular no claim for damage which has not occurred to the actual equipment supplied.

9.18 All claims of the purchaser based on defects shall expire six months after assertion of the defectiveness, except where they have been recognized by the vendor or where the purchaser has brought an action prior to the termination of the time limit.

10. Reliefs

10.1 Any circumstances outside the control of the parties occurring after signing the contract and impeding its performance are considered to be cases of relief. Such circumstances are deemed to exist when they are not the fault of the party which invokes them. The following shall be considered as cases of relief if they intervene after the formation of the contract and impede its performance: industrial disputes and any other circumstances outside the control of the parties such as fire, mobilization, war, confiscation, embargo, natural catastrophes, currency restrictions, insurrection, shortage of transport, general shortage of materials and restrictions in the use of power.

10.2 The party wishing to claim relief by reason of any of the said circumstances shall notify the other party in writing without delay on the intervention and on the cessation thereof.

11. Purchaser's Right to Withdrawal

11.1 The purchaser can withdraw from the contract if, prior to the passing of risk, the vendor finds it impossible to make the complete delivery. The same applies if the vendor is incapable of so doing. The purchaser can also withdraw from the contract, if on ordering identical equipment it proves impossible to supply the whole order and he has a justified interest in refusing delivery of part of the order. If this is not the case, the purchaser can correspondingly reduce the counter-consideration.

11.2 If a delay in delivery occurs within the meaning of clause 5 hereof and if the purchaser gives the late vendor an appropriate period of grace with an express declaration to the effect that after this period the goods will be refused and, through his own fault, the vendor fails to meet the new deadline, then the purchaser is justified in withdrawing.

11.3 If the impossibility occurs during the acceptance period or due to the fault of the purchaser the latter must provide the counter-consideration.

11.4 The purchaser also has the right to withdraw if the vendor fails to comply with an appropriate period of grace given to perform repairs or replace goods, in connection with a deficiency on his part within the meaning of the General Conditions for the Supply of Plant and Machinery for Export. The purchaser's right to withdraw also exists when the vendor finds it impossible or is incapable of making the repair or providing a replacement.

11.5 The purchaser is not permitted to make any further claims, especially as regards conversion, giving notice or reduction, as well as making good damage of any type, particularly damage which has not occurred to the equipment supplied.

12. Vendor's Right to Withdrawal

12.1 The vendor can wholly or partly withdraw from the contract in the case of unforeseen events within the meaning of clause 5.2 and 10 of the General Conditions for the Supply of Plants and Machinery for Export, if they significantly change the economic importance or content of the delivery, or if they can have a significant effect on the vendor's business and for the case that subsequently the vendor finds it impossible to make the delivery. The purchaser cannot claim damages on the basis of such a withdrawal. If the vendor wishes to avail himself of his right, on becoming aware of the significance and impact of the events, he must immediately inform the purchaser, even if initially an extension to the delivery date had been agreed with the purchaser.

13. Delivery on Trial Basis

13.1 If machines or other equipment are delivered on trial, the purchaser has the right, within the agreed trial period, to return them, if they do not have the promised properties. Other reasons are not valid.

13.2 After the trial period has elapsed the machines, etc. delivered are deemed to be taken over, if the vendor has by then received no other written statement from the purchaser.

13.3 The purchaser shall always bear the cost of transport to, and, if goods are returned, from his works, as well as possible customs duties, repair costs, eventually necessary overhauling costs, etc.

14. Patent Rights

In the event of the vendor supplying goods which are not listed in his production schedule but are manufactured according to drawings or models or to the purchaser's specifications the vendor cannot be held responsible for infringement of foreign patents; responsibility for such claims by third parties shall be solely the purchaser's.

15. Termination, Supplementary Terms, Applicable Law

15.1 Termination of the contract, from whatever cause, shall be without prejudice to the rights of the parties accrued under the contract up to the time of termination.

15.2 In the event of individual clauses within these General Conditions for the Supply of Plants and Machinery for Export being invalid, specifically in consequence of contrary obligatory statutory regulations in force at the place where the purchaser is situated, the contractual relationship shall remain unaffected provided the object and intent of the contractual relationship is unimpaired. Otherwise the contractual parties undertake in such cases to execute appropriate supplementary terms of agreement in accordance with the law valid in the Federal Republic of Germany and taking due account of obligatory foreign legal regulations which correspond to the object of the agreed contractual terms.

15.3 Amendments and supplements to the contractual terms agreed between the vendor and the purchaser must be made in writing. Oral ancillary agreements have no validity until such time as they have been acknowledged in writing and confirmed. Unilateral written confirmation is not deemed adequate to comply with the requirements for the written form.

15.4 All disputes between the parties arising out of, or in connection with this contract shall be settled by an arbitral tribunal being constituted as follows:

The arbitral tribunal shall be composed of two arbitrators, one nominated by each party, and the presiding arbitrator. The party making a request for arbitration (the claimant) shall notify the other (the respondent) by registered letter, and indicate therein the name, first name and residence of the arbitrator nominated as well as the substance of the dispute. The respondent shall, within 30 days of the receipt of the aforementioned registered letter, communicate to the claimant by registered letter the name, first name and residence of the arbitrator nominated by him. Where one party fails to nominate an arbitrator, the latter shall be nominated by the President of the Chamber of Commerce in Zurich. Within 20 days of their nomination, the arbitrators shall appoint the presiding arbitrator. Where the arbitrators cannot agree on the appointment of the presiding arbitrator within the aforementioned period, the latter shall be appointed by the President of the Chamber of Commerce in Zurich. The arbitral tribunal shall determine its own meeting place. The rules of the arbitral procedure as well as the allocation of the costs connected with the activity of the arbitral tribunal, shall be determined by the arbitral tribunal. The award of the arbitral tribunal shall be final and binding on both parties.

15.5 The vendor shall be entitled to bring an action before the ordinary court of his residence, or his principal place of business, or before the ordinary court having jurisdiction over the purchaser instead of before the arbitral tribunal of paragraph 15.4 hereof, unless and until the dispute has been referred to arbitration by one of the parties.

Edition, January 1982

DORST-MASCHINEN UND ANLAGENBAU
Otto Dorst und Dipl.-Ing. Walter Schlegel GmbH & Co
P.O.Box 109 + 129
D-8113 Kochel a. See
Telephon: 08851/188-1

General Terms for Plant Construction and Large Scale Installation Projects

1. Preamble

These installation terms are designed to establish a clear arrangement of the contractual terms between the buyer and our company – hereinafter called "Installing Firm". They apply to the execution of all installing work carried out by personnel of the installing firm outside its own premises.

2. Scope

2.1 The installing work relates to the delivery contract stipulated in Schedule 1. The value of delivery contracts never includes installing work outside the premises of the Installing Firm unless this has been agreed specifically in writing.

2.2 Installing work is undertaken by the Installing Firm only on demand. The installation contract is deemed to have attained legally binding force on receipt by the Installing Firm of the written or telephoned request for personnel, unless Buyer issues a contradiction in writing immediately, but not later than within ten days after receipt of these Terms.

2.3 Personnel of the Installing Firm are available in principle only for work on equipment supplied by the Installing Firm itself or which the Buyer has manufactured complementary thereto under its own control in accordance with drawings and documents supplied by the Installing Firm. In the latter case the Installing Firm is prepared to issue warranty only for the accuracy of drawings and documents which it has complied itself but not for correct technical manufacture.

2.4 If the personnel of the Installing Firm are to be employed on equipment furnished by the Buyer it is first necessary to obtain written permission from the Installing Firm. Under no circumstances is any liability undertaken for the execution of such work.

3. Calculation Bases

3.1 Dispatch of personnel from the Installing Firm is computed in principle on a time basis. Only in exceptional cases can a global price be agreed upon explicitly in writing.

3.2 Invoice shall be levied for the working time during which the personnel are absent from the factory of the Installing Firm. The time expended shall include the journey to and from as well as any waiting time which may arise at the installation site. The agreed sums are to be understood whithout Value Added Tax which shall be debited additionally where applicable.

3.3 The working time for personnel dispatched for installation work shall be debited on the basis of the relevant collective wage agreements laid down for normal working hours in the Federal Republic of Germany. Normal working hours are the time corresponding to the normal working time on the factory premises of the Installing Firm. The normal hours per week laid down by collective wage agreement and the relevant wage agreements are listed in Schedule 1. All working hours completed in addition are deemed overtime hours. This also includes working hours on those days which are statutory holidays in the Federal Republic of Germany or days which are workfree for other reasons.

3.4 The personnel of the Installing Firm are required to perform overtime work only at the explicit request of the Buyer.

3.5 If, in special cases, it has been agreed that the work of personnel of the Installing Firm shall be debited on a global basis, the agreed global price shall apply only for the periods of time stipulated explicitly in Schedule 3 and for the fitters, technicians, engineers, etc. designated there in detail.

3.6 A globally agreed period of stay shall relate always only to normal hours in accordance with the customary working time in the works of the Installing Firm.

3.7 If overtime work is carried out on Buyer's request within the framework of a flat-rate installation project, such work shall be invoiced according to the overtime tariff as shown in Schedule 1. In principle travelling costs are not included in global prices.

3.7 If overtime work is carried out on Buyer's request within the framework of a flat-rate installation project, such work shall be invoiced according to the overtime tariff as shown in Schedule 1. In principle travelling costs are not included in global prices.

3.8 If the services of some of the installation personnel are invoiced on a time basis and the remaining personnel on a global basis the remaining terms of this agreement shall apply accordingly. The definite demarcation shall be the responsibility of the Installing Firm.

4. Accommodations and Reimsbursement of Expenditure

4.1 The personnel of the Installing Firm are entitled to orderly and appropriate accomodations and maintenance in accordance with Central European conditions, particularly in countries where different climatic conditions apply.

4.2 Hotel accommodations, maintenance and reimbursement of expenditure shall be debited for each day of absence from the Installing Firm's works at the relevant valid rates as specified in Schedule 1.

4.3 Should it be found that these sums are not adequate for appropriate maintenance, higher rates can be debited.

4.4 If, in exceptional cases, it is agreed explicitly in writing that the Buyer grants free accomodation, free maintenance or both, the compensation for expenditure as specified in Schedule 1 shall be reduced as follows:

4.4.1 **With free accommodation only**
Reduction in allowance by 30%

4.4.2 **For free maintenance only**
Reduction in allowance 40%

4.4.3 **With free maintenance and free accommodation**
Reduction in allowance by 70%

4.5 The reimbursement of expenditure shall also be debited for the period of incapacity to work as a result of illness or accident. In the event of hospital confinement 50% of the full allowances shall be debited.

5. Travelling and Transportation Costs

5.1 The travelling costs of personnel from the Installing Firm's works to destination and return – including baggage – and/or tool transportation, transport insurances, etc., shall be debited in accordance with substantiating vouchers from the Installing Firm. The travelling costs include also traveling on company business in Buyer's country, costs for visas, delivery charges, for baggage and tools, telegram and telephone charges arising in connection with the installation work, costs of medical examinations, inoculations, vaccinations, etc.

5.2 For travelling in tropical countries an appropriate global sum shall be debited for procurement of tropical kit and additional insurance per person.

5.3 For travelling by aircraft charges shall be based on the tourist class rates and railway travel shall be subject to first class rates. Where it is necessary to use other forms of transport, e.g. company vehicles or private vehicles owned by personnel the equivalent value of the corresponding tourist class air fare shall be levied, in the case of journeys to locations having no airline connections the rate to the airport in closest proximity and from there the first class rail fare or taxi fare shall be levied.

5.4 Airline tickets for the return flight are to be made available promptly in each case by Buyer after arrengement with the Installing Firm. This shall include family visiting trips as laid down in tariff agreements. Time expended in travelling between building site and accommodation in excess of thirty minutes shall be debited as regular working time.

5.5 The Installing Firm is entitled to provide personnel with important special purpose tools after consultation with the Buyer can acquire these tools by purchase after installation work has been completed. In such cases return freight shall not apply.

6. Changes in Collective Wage Tariff Agreements

6.1 The tariffs for normal working time, overtime, holiday work, allowances etc., of which Buyer is notified in Schedule 1, can be increased by the Installing Firm to the same extent as general wage and salary increases occur in the Federal Republic of Germany. Invoices shall always be submitted in DM currency.

7. Pocket Money

7.1 On installation projects in foreign countries a sum of pocket money shall be paid to each person in local currency on the installation site, in each case fourteen days in advance throughout the entire period of stay, in accordance with Schedule 1.

8. Joint Cooperation Responsibility of Buyer

8.1 Buyer must, at his own expense, put into effect all precautions to ensure that the personnel of the Installing Firm commence immediately and carry out relevant work without interruption or obstruction. This relates in particular to prompt availablitily, suitable storage and orderly securing of all equipment supplied and provided by the customer on the construction site, also to a serviceable access road to the installation site, to earth moving, masonry and foundation work which must always be carried out by Buyer, to the procurement and making available of necessary building materials, structural steel etc., and to wiring and service lines for electricity, water, compressed air, fuels and operating materials and installation thereof to the individual points of use. Buyer must also make available promptly and free of charge all necessary miscellaneous materials, for example, screws, bolts, gaskets and seals, electrodes and/or gas for welding equipment, together with cleaning materials and lubricants. This also includes prompt delivery free of charge by the Buyer of power, water, fuel and operating materials, lighting, transporting aids and raw materials necessary for trial operation or commissioning in a form correctly prepared in accordance with appropriate technological requirements.

8.2 Lining of wet drum mills, combustion chambers, air heaters, etc., is deemed always to be a service to be rendered by Buyer, also where the appropriate lining materials are supplied by the Installing Firm. The presence of a site manager from the Installing Firm does not imply any warranty obligation for such works carried out on site. Where necessary capable specialist masons must be requested explicitly by Buyer.

8.3 Buyer is responsible for furnishing free of charge protective devices, protective clothing etc., insofar as these are necessary in accordance with safety and accident prevention regulations in force locally on the installation site and in the Federal Republic of Germany.

8.4 Buyer shall furnish the necessary installation tools, lifting tackle, welding equipment, scaffolding, thread cutters compressors, etc. at his expense and to the extent stated by the Installing Firm prior to the start of installation works or which may be requested during installation work by personnel of the installing firm. The same applies to skilled and unskilled workers to be provided by the Buyer at his own expense.

8.5 Appropriate working and rest room premises and sanitary facilities must be made available for the personnel of the Installing Firm.

8.6 Buyer assures that the work must not be carried out on unhealthy or dangerous terrain.

8.7 Buyer shall arrange for free of charge transportation of personnel between accommodation and installation site and also for free of charge transportation for customary private requirements of personnel, specifically for the purchase of medical supplies, foodstuffs, beverages, etc., where the installation site and/or the accommodation cannot be reached by public transport. Payment for the use of public transport for such purposes shall be borne by Buyer. Where necessary, interpreters are to be kept available by Buyer.

8.8 In the event of non-fulfillment or unsatisfactory fulfillment of cooperation obligations all supplementary costs thus incurred shall be borne by Buyer, also if a global sum shall have been agreed upon.

9. Estimated Installation Period and Anticipated Costs

9.1 The installation period depends primarily upon fulfillment by Buyer of section 8 of these installation terms. Meteorological influences can also have a significant effect. The approximate installation period specified in Schedule 2, the number of personnel from the installing firm listed therein and the number of auxiliary personnel to be furnished by Buyer as well as the approximate installation costs shown therein are – also where laid down in writing always to be regarded as merely estimates and of no binding force upon the Installing Firm. Buyer is always responsible for settling those costs determined by the Installing Firm after completion of works on the basis of the period of time involved in installation.

9.2 Personnel of the Installing Firm are required to compile hourly records of work on a daily basis. Buyer is required to arrange for a responsible representative to confirm the hourly records daily. In the event of failure to provide such confirmation the hourly reports recorded by the responsible superior of the crew dispatched by the Installing Firm shall be binding for the final account.

10. Interruption in Work

10.1 If work on the installation site is interrupted for some reason beyond the control of the Installing Firm,

10.1.1 Buyer may send back the personnel of the Installing Firm but must then bear any additional costs thus arising.

10.1.2 The Installing Firm may recall its personnel at Buyer's expense.

10.2 Recall or sending back of the Installing Firm's personnel does not terminate the contractual relationship between the Installing Firm and Buyer but merely entails postponement of fulfilment until such time as Buyer requests the Installing Firm once again to withdraw the personnel. This request must be lodged in sufficient time for the Installing Firm to make prompt alternative arrangements taking due account of its other obligations. In the event of interruption of work the Installing Firm undertakes no warranty whatsoever that, after the cause of interruption has been rectified, the personnel in question can again be made immediately available, but it shall endeavour to make arrangements accordingly.

11. Accounting

Accounting for costs incurred in installation shall be conducted as follows:

11.1 In the case of global or mixed invoicing the global sum or the global proportion shall, as far as is possible, be included in the delivery value of the equipment. Otherwise the payment terms agreed in writing in Schedule 4 apply.

11.2 Costs incurred as a result of time expended are to be reimbursed by Buyer in accordance with the written terms agreed in Schedule 4.

12. Acceptance

12.1 Buyer is required to accept the installation works as soon as he has been notified of completion thereof and any contractually stipulated trial of the installed object of delivery has been completed. If installation or management of installation works should fail to comply with the terms of contract for reasons attributable to the Installing Firm, the Installing Firm shall be required to remedy any shortcoming at its own expense. If the fault in question is only insignificant nature the Buyer cannot decline acceptance if the Installing Firm expressly acknowledges its obligation to remedy the shortcoming.

12.2 If acceptance is delayed through no fault of the Installing Firm the acceptance shall be deemed effected after expiration of fourteen days from the completion date of the installed plant, provided personnel of the Installing Firm have notified Buyer of the time of acceptance within three days from completion of the installing works.

12.3 On acceptance the liability of the Installing Firm ceases for all faults of shortcomings recognizable through careful and expert examination unless Buyer has reserved the right to assert such faults or shortcomings. Otherwise Buyer is required to furnish proof that he was unable to ascertain on acceptance concealed defects arising subsequently.

13. Warranty

13.1 The Installing Firm guarantees orderly execution of the agreed works and accepts liability for faults in installation or installation management becoming apparent within six months from acceptance, however subject to the terms of Fig. 12.3 The Installing Firm undertakes liability, subject to exclusion of all other claims on the part of Buyer, exclusively by way of remedying defects. Buyer is required to notify the Installing Firm of any defect immediately in writing. Failure to submit written notification shall cancel any form of warranty entitlement.

13.2 Under no circumstances will the Installing Firm accept liability for consequential loss arising out of a fault, specifically for any disadvantages which might arise for Buyer in consequence of interruption in production.

13.3 The period of warranty shall be extended by the period during which production has to be suspended for repair works but does not recommence anew on completion of the repair work.

13.4 The Installing Firm does not accept liability for the quality and suitability of objects, equipment and materials furnished by Buyer. In particular the Installing Firm undertakes no warranty whatsoever for faulty workmanship on the part of personnel furnished by Buyer unless Buyer can substantiate that fault instructions have been given by the Installing Firm or that the supervisory obligations have been breached. Moreover any liability on the part of the Installing Firm is excluded for losses of damage attributable to wear and tear, unsuitable handling of the plant or which are attributable to the Buyer for some other reason.

13.5 If acceptance is deemed effected owing to the fact that within 14 days of completion of installation and despite prompt notification in accordance with Fig. 12.2 no representative of Buyer authorized to carry out necessary acceptance formalities appears on the installation site, the period of warranty shall run with effect from the fourteenth day from completion of installation work. If special statutory regulations stipulate an official inspection and testing of the installation such inspection shall have no influence upon the period of warranty, irrespective of whether the inspection is carried out by the official inspecting body.

13.6 The liability of the Installing Firm does not apply if Buyer has, without approval of the Installing Firm, carried out any modifications to the plant during the period of warranty.

13.7 Buyer cannot offset, file action for reduction or assert any retention rights, irrespective of legal basis, against the claims of the Installing Firm for payment of all services carried out in connection with the installation works or installation supervisory work, including all ancillary costs.

14. Safety Regulations

14.1 Buyer must notify the Installing Firm immediately concerning the safety regulations which it has issued for its own personnel or which are to be complied with on the basis of statutory regulations or official regulations in force in the area of the installation site. The Installing Firm shall ensure that these regulations are complied with by its personnel.

14.2 If Buyer ascertains any breaches against the safety regulations by personnel of the Installing Firm, Buyer is required to notify the Installing Firm accordingly immediately in writing.

15. Taxes and Insurance

15.1 In cases of installation outside the territory of the Federal Republic of Germany, Buyer untertakes to pay all taxes, social security levies and other levies incurred insofar as such payments are levied in the counry in question.

16. Illness and Accident

16.1 In the event of illness or accident resulting in an incapacity to work or a restriction in the working capacity of the personnel of Installing Firm, Buyer shall bear all costs for medical treatment, hospitalization, medication, food and similar maintenance. The Installing Firm shall reimburse these costs based on vouchers submitted to the extent to which the insurers of the Installing Firm accept liability therefore.

16.2 If personnel of the Installing Firm are obliged to return prematurely owing to illness the Installing Firm shall ensure earliest possible replacement with payment of traveling costs being borne by Buyer.

17. Non-fulfilment by Buyer

17.1 If Buyer fails to comply with his obligations arising out of these contractual terms the Installing Firm shall be entitled, after failure to reach an amicable arrangement, to postpone commencement of installing work or to suspend installing work which has already been commenced until such time as the said breach of contract has been remedied. The obligation of Buyer to ensure prompt payment for installing works and for all ancillary services shall remain unimpaired. Buyer also has no right in such a case to otherwise refuse to perform the services for which he is responsible.

18. Applicable Law and Place of Jurisdiction

18.1 The law applicable in the Federal Republic of Germany applies exclusively for all legal transactions arising out of the contractual relationship between Buyer and the Installing Firm.

18.2 For all disputes arising out of the contractual relationship the court sitting at the registered head office of the Installing Firm is competent, specifically the Munich District Court II.

18.3 However, the Installing Firm may also call upon the Court competent for a branch establishment or licensee to whom installation has been entrusted or upon the court competent for the area in which Buyer's registered offices are situated.

19. Supplementary Terms of Agreement

19.1 In the event of individual clauses within these installation conditions being invalid, specifically in consequence of contrary obligatory statutory regulations in force at the place where the installation management is situated, the contractual relationship shall remain unaffected provided the object and intent of the contractual relationship is unimpaired. Otherwise the contractual parties undertake in such cases to execute appropriate supplementary terms of agreement in accordance with the law valid in the Federal Republic of Germany and taking due account of obligatory foreign legal regulations which correspond to the object of the agreed contractual terms.

19.2 Amendments and amplifications of the contractual terms agreed between the Installing Firm and the Buyer must be made in writing and are recorded in Schedule 4. Oral ancillary agreements have no validity until such time as they have been acknowledged in writing and confirmed. Unilateral written confirmation is not deemed adequate to comply with the requirements for written form.

Schedule 1

Shandong Aluminium Works
Shandong / China

These installation conditions are based on the following supply contract of Buyer:

a) written order from Buyer :

b) order confirmation from the Installing Firm :

c) supply contract between the parties :

Based on the collective wage agreements currently in force in the Federal Republic of Germany the following rates are applicable for the dispatch of installing personnel. With reference to Fig. 3.3 in the foregoing General Installation Terms one working day and one working week are deemed to consist of normal working hours completed from Monday to Friday between 7.00 hours and 17.00 hours. All working time outside these times and extending beyond a 38,5 -hour week are invoiced at the statutory overtime surcharge rates – also in the case of flat-rate or global agreements.

Qualification	Price per normal working, travelling and waiting hour or per 8 hour day	Daily Allowance	Equivalent value of pocket money per day in local currency	Overtime surcharges Up to 6 hours	Over 6 hours and on Sundays	On statutory holidays in the Federal Republic of Germany
Commissioning eng.	DM 95,--	DM 280,-- /day	DM 30,-- /day	25%	50%	100%
Installation engineer	DM "	DM " /day	DM " /day	25%	50%	100%
Burner specialist	DM "	DM " /day	DM " /day	25%	50%	100%
Installation foreman	DM "	DM " /day	DM " /day	25%	50%	100%
Foreman fitter	DM "	DM " /day	DM " /day	25%	50%	100%
Fitter	DM "	DM " /day	DM " /day	25%	50%	100%
Foreman electrician	DM "	DM " /day	DM " /day	25%	50%	100%
Electrician	DM "	DM " /day	DM " /day	25%	50%	100%
Specialist welder	DM "	DM " /day	DM " /day	25%	50%	100%
Specialist mason	DM "	DM " /day	DM " /day	25%	50%	100%
Machine fitter	DM "	DM " /day	DM " /day	25%	50%	100%
Structural steel work fitter	DM "	DM " /day	DM " /day	25%	50%	100%
Installation fitter	DM "	DM " /day	DM " /day	25%	50%	100%
Insulation fitter	DM "	DM " /day	DM " /day	25%	50%	100%
Skilled labourer	DM "	DM " /day	DM " /day	25%	50%	100%
Unskilled labourer	DM "	DM " /day	DM " /day	25%	50%	100%

Validity: March 31, 1986

Schedule 2

Subject to the reservation of Fig. 9 in the preceding General Installation Terms it is estimated that the following personnel from the Installing Firm will be required for the time indicated below:

Number	Qualification	Normal hours or normal 8 hour days per person	total
	Commissioning engineer		
	Installation engineer		
	Burner specialist		
	Installation foreman		
	Foreman fitter		
	Fitter		
	Foreman electrician		
	Electrician		
	Specialist welder		
	Specialist mason		
	Machine fitter		
	Structural steel work fitter		
	Installation fitter		
	Insulation fitter		
	Skilled labourer		
	Unskilled labourer		

From this an installation period is estimated at approximately _____

Without travel costs, without possible overtime surcharges and without the pocket money payable in the local currency the approximate maintenance costs for personnel of the installing firm are anticipated at

DM _____

It is emphasized once again that these figures respresent an estimate which is not binding upon the installing firm. With reference to Fig. 8.4 in the foregoing General Installation Terms the following additional estimated number of personnel is to be made available by Buyer at his own expense:

Number	Qualification	Working days	
		per person	total
	Commissioning engineer		
	Installation engineer		
	Burner specialist		
	Installation foreman		
	Foreman fitter		
	Fitter		
	Foreman electrician		
	Electrician		
	Specialist welder		
	Specialist mason		
	Machine fitter		
	Structural steel work fitter		
	Installation fitter		
	Insulation fitter		
	Skilled labourer		
	Unskilled labourer		

Schedule 3

If under application of Fig. 3.5 in foregoing General Installation Terms a partial or complete lump sum is agreed as a charge for personnel of the Installing Firm this applies only for the following persons and for the following normal working time without overtime.

Number	Qualification	Normal hours or normal 8 hour days	
		per person	total
	Commissioning engineer		
	Installation engineer		
	Burner specialist		
	Installation foreman		
	Foreman fitter		
	Fitter		
	Foreman electrician		
	Electrician		
	Specialist welder		
	Specialist mason		
	Machine fitter		
	Structural steel work fitter		
	Installation fitter		
	Insulation fitter		
	Skilled labourer		
	Unskilled labourer		

For additional working time incurred, the tariff rates shown in Schedule 1 are applied. Unless it is already included in the delivery value of the equipment, the agreed global sum amounts to

DM _____

Schedule 2 applies accordingly in respect of ancillary personnel to be provided by Buyer at his own expense.

Schedule 4

Complementary to Fig. 11 in the foregoing General Installation Terms the following payment terms are agreed:

DORST-MASCHINEN UND ANLAGENBAU

OTTO DORST U. IND.
DIPL.-ING. WALTER SCHLEGEL
GMBH & CO.
D-8113 KOCHEL A. SEE
FED. REP. OF GERMANY
TEL. 08851-188-1 · TELEX 59842 dorst d
TELEFAX 08851-188-310