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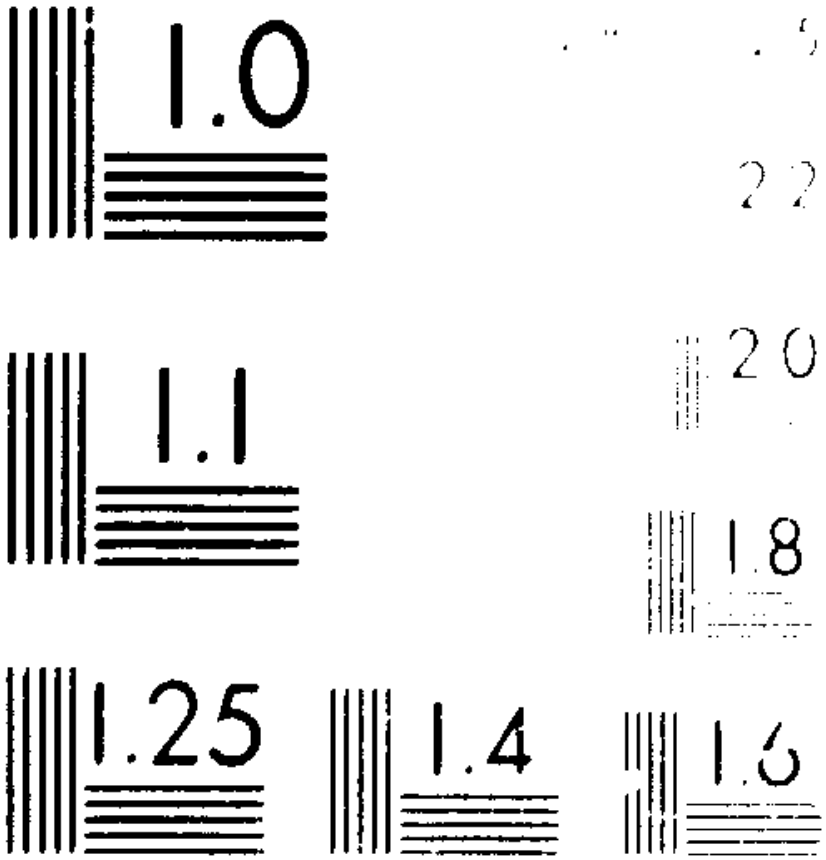
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April 1981

GENERAL ORGANIZATION FOR CEMENT & BUILDING MATERIALS INDUSTRY

PROJECT DP / SYR / 80 / 001 / 11-01 / 32.1.K

REPORT ON

ESTABLISHMENT OF A LIME INDUSTRY IN SYRIA, HAMA AND ADRA.

DP/SYR/80/001

Prepared for the Government of S.A.R.

by the United Nations Industrial Development Organization

executing agency for the United Nations Development Programme

Based on the work of M.V.Orel

lime adviser

United Nations Industrial Development Organization

Vienna

08:

I N D E X

100: GENERAL REMARKS

The pre-investment studies shall comprise the study of resources, material input, location, project engineering technologies and equipment and civil and building work, financial analyses and market studies.

110: GEOLOGICAL INVESTIGATION

In Syria there are many deposits of limestone of different purity, of dolomite, of bentonitic limestone, of magnesite etc.
The best solution is to begin to study the investigations made about the known location of deposits.
It is to speak about limestone from Raqqa, Meshaneh, Rastan and Hama.

Rastan limestone gives a hydraulic lime (in France it is produced) for building purposes.

Hama limestone is of a quality for all purposes.
It is to recommend the location of Hama, but there are needed further investigations with taking of superficial (100 samples each 10-20 m of length) and drilling samples (in 5 places around the deposits).

Usually it is much enough to have a investigated stock of 5,000.000 m^3 of limestone, that is enough for a 25 year consumption of the lime work.

120: LOCATION OF THE NEW LIME PLANT - SUBJECT OF INVESTMENT

The General Organization for Cement and Building Material declares a call for prequalification for a delivery of a lime and hydrated lime factory and intonts to set a factory for a production of lime and hydrated lime with a capacity of 400 t Lime per day.

The proposed locations for the factory Hama and Adra are suitable for this intention.
Because it is convenient to set in the first five year plan 1981-1985 one factory, it is recommended to choose Hama.
Hama is in the middle of the country between Damascus and Aleppo and also the industry in the surroundings occurs lime.
In the second stage of development of the lime industry in the years 1985-1990 is convenient to erect a lime factory also at Adra. In this time should the experience of Hama have influence on the development of the lime work Adra.

130: THE MATTER OF INVESTMENT

It is to suggest to the General Organization for Cement and Building Materials to erect in the Cement Factory Hama a new lime work beside the new Cement Plant location at Hama. The area gives the possibility to erect a lime work with 1-4 kilns. The same possibility has also the Cement Factory Adra.

For the first step it is convenient to erect before the lime factory Hama.
In the first step of building it will be stated lime plant with one lime kiln, fired with heavy oil of a capacity of 150 t/day lime and a new hydrated lime plant of a capacity of 10-12t/h hydrated lime with the storage and expedite device. In the second step it should be erected the other plant (in such 1-2 years).

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131: The Technical Conditions for the building of a Lime Work for a Capacity of 400 t/day are:

Production of 150 tons (metric) quick lime a day in one kiln.

Production of 300 tons quick lime a day

Input granulation of limestone of 8-15 cm (5-13 cm) for a capacity of 150 t/d and 300t/d lime.

The quality of limestone shall be determined by the chemical analysis in the elaborate of the resource reserves of the layer 4km from Hama:

Maximal Co_2 content in quick lime to 2%

The kiln is firing with heavy oil, so that is possible to change from heavy oil to other fuels. The consumption of technical fuel is 1150 kcal/kg or better 950kcal/kg lime, depending of the choice of the kiln.

For starting it is to use light oil

It is to project the measuring of input quantity of limestone, output of lime, consumption of fuel and electrical energy.

132: The Conditions for Building a Hydrated lime Plant are:

Total production of 20-30 t/h hydrated lime in two equipment of 10-20 t/h hydrated lime each.

The quality of hydrated lime have to accomplish the following conditions

remains on the sieve	0.09mm max. 3%
remains on the sieve	0.2 mm
content of free CaO	0 %

133: Situation of the Quarry of the Lime Work Hama

The quarry is at 4km from Hama and serves also for the Cement Plant.

The quarry contents the exploitation levels, device for grinding and classifying (separation).

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140: THE DEVELOPMENT OF LIME TECHNOLOGY IN EUROPE

It is intersting to compare the situation of lime production in Europe to Syria, then it would be able to say how much it shall take the same way of development.

141: The beginning of the development of lime production in South Europe is based as in other Europe on shaft kilns, fired with coal of a output of 30t/24h lime. This kilns were build and after the second war until 1960. In this time were erected the first plants of hydrated lime Italian provenience with a output of 2.5 - 5t/h hydrated lime.
The capacity of both plants increased in the time to 50 t/d lime in kilns and 5-7t/h of hydrated lime.
In the followed years were erected over vertical kilns Hungarian with generator gas firing of 70t/day lime output.
Today are erect in all countries (also Yugoslavia) kilns of the capacity of 150t/day and 1150 kcal/kg fuel consumption and kiln of West Germany license but produced in the country of 150t/day or 300t/day with a 950-920 kcal/kg lime fuel consumption.
It is to remark that the Italian Forindus kilns of the same volume gives 100t/day lime and they need 1250kcal/kg fuel consumption.
The development of the lime industry press to choose such a equipment, that need less repairs and spare parts There are problems with lining, which is to import or to organize a fire bricks production in a muffle kiln by the applier.
Repairs of the kilns are to execute once a year at the end of the season in winter. The repairs have then a duration of 1-2 months. During the production it is possible to make also repairs of part of lining or machinery. It is recommended to use bricks of good quality, that are resistant for a long time. The life of bricks is 2-6 years, depending much of the manner of firing. In the more exposed part of the kiln (vaults) if the firing is not correct it should be need of local repairs in winter at the control of the kiln.
For the quality of lining it is better, that the kiln is throughout in operation, so there are not quick changes of temperature of the lining.

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142: The development of the hydrated lime plants begin in Europe after 1960. The first plants were in North Europe Sturterant, later Forindus in South Europe with capacity of 2.5-5 t/h hydrated lime.
Today are convenient capacities of 10-15 t/h and more.
The hydrator is composed from a hydrator (horizontal tube) and a homogensator.
The addition of hot lime milk in a twice quantity as theoretical required, with permanent classification of the product by specific weight and with escape of excess of water as steam from the hydrated lime are the main phases of the slaking process.
In the air separator after hydratation are separated the particles, that are more of 0.2 mm and would cause babbles in the plaster on the wall.
Hydrated lime is a dry white powder.

150: THE DEVELOMENT OF THE INDUSTRY OF LIME IN SYRIAN ARABIC REPUBLIC

In the five year plan 1980-1985 of Syria was estimated to a output of 1000tons lime per day after the meaning of the dirigent of the General Organization for Cement this quantity shall be lowered to 400 t/d lime. This gives a year production of 100.000 to quicklime or 125.000 t hydrated lime.

151: Lime Kilns in Syria

In the sugar industry there are 4 old kilns of 20t/d capacity at Homs, Adra, Jisr al Shaghur.
New plants of lime are; Tell Sabhat, Deisr El Zor Maskanch and Raqqa.
The production of lime with coke is very expensive for the purposes, that is a 1250 LS to 295 LS of lime cost using coke or heavy oil.
Also the kilns in the sugar industry may be prepared always for the new sugar production.
The only solution is to erect a new lime work in a new location: Hama and perhaps Adra later.

152: The Market for Lime in Syrian Arabic Republic

The application of lime was studying by the General Organization for Cement.

There are such requirements for lime a year:

1) For 2 factories of sandlime
440.000m^3 x 325 kg/m^3 = 14.300 t lime

2) For factories of cellular concrete
3.735.000 m^3 in 5 years x 97kg/m^3 lime = 72.000 t lime

3) For delivering in bags for plastering
36.000.000 m^2 plaster in 5 years a year = 28.600t lime

4) Lime for chemical industry 55.000 t lime

T o t a l = 169.900 t lime/year

This requirements should be satisfied with a production of 400 t/day quick lime and a production of 2 plants of 10-15 t/h hydrated lime rock.

160: PRODUCTION OF LIME

It is well known fact that the application of lime increases more slowly as the production.

The hydrated lime is a stable product that shall be transported in bags or in containers dry and is used mixed with sand and water immediately.

Fine lime is a quick lime with higher plasticity as hydrated lime, but of a limited stability. It is to pack in half empty bags with two of four sheets of bitumenisshed paper or in airproof bags of plastics.

Also the processing of lime and hydrated lime shall have the first 1-2 years some troubles and difficulties with the management. The rotary kilns have machinery and quality difficulties, the vertical processing difficulties when the personal are not trained as proposed.

In the shaft kiln the material falls with a continuous rhythm, the temperatures are to be controlled and corrected when is chosen one type of kiln, it is recommended to train personel on this kilns and hydrator for 6 months.

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The kiln is managed by an engineer and electrotechnicians control the kiln. Worker and technician must steady control and act when it is something incorrect with the kiln or hydrator.
Therefore, is to recommend to start before with one kiln and then with another in a half year interval.
With a trained personnel shall the production of lime start without troubles. When the personnel is not trained, the factory will start only when foreign workers are beside for a time.

170: APPLICATION OF LIME

It is very difficult to introduce lime application in the building industry at once. It occurs a few years of intense propoganda to improve lime application.
Lime is used in the chemical industry (fertilizer industry, titan dioxide industry), steel industry, building industry and other industries.
The sugar industry need lime, calcium carbid, paper, celulose industry and for industrial water softening. In the towns the building industry need 50% of lime, in the country it is to widen the use of lime. It is to appreciate the use of lime in the glass, plastics, ceramic, pesticide, industry, in the agricultural and in highway constructions.

Lime could be mixed in the building industry with cement, sand, gypsum and puzzolanic material.
Also others industries reduce the development of the lime industry so the gypsum board, concrete and celular concrete and volcanic (stone) wool isolation plates industry with applications in buildings and constructions.
In winter isolation of houses shall save a 30% of fuel consumption for heating.
Gypsumwallboards also have better isolation abilities as concrete walls or roofs. But gypsum as lime are better also for inner walls.

10/...

painting

Today it is very interesting the need of ~~whiting~~ emulsions on base of acrylate and painting on base of acrylic and plastic compounds for covering material also the additives for cement widen the use of cement for injections, less and more quick setting cement, such with airing and plastificated additives.

In Europe is the use of lime for big buildings in towns minimal, but is very important the use of lime in country houses (50% of buildings).

The cleaning of waste waters with hydrated lime is very significant.

In the production of phosphate fertilizers it is to recommend the use of limestone, when it is possible to go in an investment. So a need of 80t lime/day or 104t hydrated lime/day x 210.44 LS costs 21.885.8LS/day.

The equivalent need of limestone is 142.4 t/d x 10LS costs 1424 LS/day, what means a spare of ca 20.000LS/day.

To facilitate the neutralisation of calcium carbonate are used bigger reaction vessels and heating with steam.

For building purposes is to need only hydrated lime ($Ca(OH_2)$ that remains useful more months and eliminate the lasting slaking.

Hydrated lime is mixed to mortar in the same mixers as fresh concrete.

171: Lime Putty

Lime is mixed with water in 2 forms

171,1 as putty: mixing lime and water 1:1

Putty is of very different quality, may be fat or meagre. Fat putty has a great plasticity and is very dense, that is sign of good quality.

Good putty is obtained from soft burned lime with high percent of CaO. It is possible to test the quality with the plasticitimeter of Emley.

Good plastic lime has a plasticity factor of 500-700 Weak plasticity is about 200, hydrated lime has such lower plasticity of putty if is soon avalable, if is deposit for some days the plasticity increases.

171,2 As lime milk: if lime and water are mixed 1:10

Lime milk is used for whitening walls of rooms. It is a disifections agent. And also lime, if is applied in agriculture for vegetable cultivation serves as fertilizer and disinfectant. The same use is in whitening walls of stalls and soon.

11/...

172: Lime Mortar

Lime is very available to be mixed with sand as mortar. Mortar mixture is needed for building purposes, for erect walls with bricks and for plastering purposes.
There are two sheets of used plastering. At first it is used a spray of cement and fine sand 1:1 with enough water. If the wall is dry is to be wetted before.
The cement spray is to spray scarcely so that the wall is rough. When the wall is dry on each room side it shall be made two vertical ribbons of 1-2 cm thickness with rough plastering 1:3 lime to 6/7 mm sand and after accomplish the whole plastering of the wall the second plastering 2-5 mm thick is made with fine mortar 1:3 lime to sand 1-3mm. Each plastering is to dry 1-2 week. When the plastering is dry (perhaps in 2 weeks or 1 month) it is to put twice whitening with lime milk. The third whitening can be supplied with wall colours plastics emulsions or wall paper.
Lime can be mixed with plastics for mortars and emulsions. The development of plastics such as epoxy des and acrylic emulusions lowered the lime consumption in the building. Also gypsum plaster board walls, ceiling isolations, concrete piles with celular concrete lowered the use of lime for building walls and ceilings.

173: Quality of Mortars

To estimate For the quality of lime mortars, is very important to test the compressive and flexible strength, the water resistance and the volume stability. The Volume stability is done with cakes of lime gypsum putty put for several hours at 105°C.
The required strength of the samples 4x4x16 cm after 28 days of curing are 3-4kp/cm^2 flexible and 4-12kp/cm^2 (or 0.4-1.2 MPa) compression strength.
There are low values. If are required higher values it need to make mixed mortars of lime with cement, puzzolans etc. For example puzzolan or hydraulic limes have a compressive strength after 28 days of 25,50,75kp/cm^2 or 2,5; 5; 7,5 MPa and this material is hydraulic that means in water insoluble. Lime and gypsum are air binding material and are water soluble,

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therefore are to be applied for inner work in house or for facade with roof that is extended for 1-2m over the outer walls. In some regions of Europe there are facade walls covered with lime mortar/terra nova/ of very white agregate as marble or with artifical colours. This is a very resistant outer plastering that remains 20-50 years, without need of renewing, modern front walls are made with isolation plates, glass wool net and plastering with plastic emulusions.

174: Quality of Lime

Rheological lime putty is tyxotropic it means that under pressure get softener and liquid, in laying it get rigid. Agregates and sands in water are dilatant, it means that they flows, but at once they get to stop because of the resistance between the particles. This phenomena is possible to examine in tubes.

Lime putty is by drying after escape of water goes into calcium hydroxid and later into calcium carbonate or limestone. When added to the lime putty quartz sand it is formed calcium silicate (pozzolanic component) and the setting of plastering is quicker. Normally the first setting is ended in a few weeks and final in one or two years. In this phase the front wall is practical water insoluble for short time watering.

175: Application of Lime for Water Clearing

The addition of hydrated lime is used for softening water. The calcium carbonate falls from bounded CO_2 in water. Solved calcium bicarbonate falls also as calcium carbonate. In the first step of softening water for the steam power stations is used lime.

Today it is replaced with exchange ions.

In the paper and cellulose industry water is also softened before use.

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176: Stabilisation of Coherents (loamy) soils

In regions where loamy soils are difficult to fortifying for road purposes is to use a mixture of 5-8% lime or hydrated lime, depending of soil moisture. For dry soils is better to use hydrated lime. The soil should be relax in 15-20cm thickness or depth with a fra zing machine and then mixed with added lime. When the layer is homogeneous it should be compact with a vibrating roller (3-4 time courses).

The process of soil stabilisation lasts 3-4 weeks. When are preferable very freezing resistant stabilisation layors, it is recommended to use a addition of puzzolanc or fly ash to lime 2:1. Each soil mixture has a optimal moisture content of comprimation (between 15-25-35% water to dry soil) examinated with the Proctor device. In practice the required moisture content of soil is to be regulate with wetting or drying of soil surface.

177: Other Application of Lime

Lime is used in the chemical industry as a base for neutralisation by the production of fertilizers, titan dioxid, by the production of calcium carbid. Quick lime is a supplement in the steel and iron industry. Lime is needed in the Sugar industry there are special coke kilns to produce 35-40% CO_2 in flue gases. Lime is needed for neutralisation sand clearing of sweet waters. In the mining is also used lime. In the agriculture is hydrated lime a fertilizer and a disinfection agent added to acid soils. Calcium brings better quality of some vegetables and trees.

The building and other industries have need of lime, e.g. the glass, ceramic, silicate bricks, silice fire bricks, celular concrete and others industries.

14/...

180: QUALITY OF LIMESTONE

Chemical specifications

The investigated quality of Syrian limestones are as follows:

%	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	So_3	L.I.	K_2O	Na_2O	Cl
Plant Adra	0.8	0.4	0.1	54.6	0.5	0.1	42.6	0.1	0.1	0.01
Plant Hama	0.7-1.2	0.5-0.8	0.2	54.4-55.0	0.2	0.1	42.7-43.1	0.1	0.1	0.011
QuarryRastan	8.1	1.4	1.58	45.3	3.15		40.22			
QuarryRaqqa	0.95	0.09	0.13	53.93	0.6					

Physical Specifications

	Porosity	Spec. Weight	Hardness
Adra	2- 5%	2.63g/cm^3	Medium

Limestones from Plant Adra and Hama are of a good quality and are able to produce a lime of quality that should suit Syrian and other countries standards (British standard ASTM, DIN, AFNOR etc.).

The quality of limestone Rastan correspond to produce hydraulic lime of good quality. Hydraulic lime has specifical pozzolane properties, has better compressive strength (from 25-50 kp/cm^2) and can be used in wet conditions.
Before to start the construction of a new lime plant it is recommended to execute laboratory and industrial test of burning and slaking of lime. There are namely limestones who are changing the quality after burning to get soft or crumbling or to slake slowly etc.

190: THE PROBLEM OF FUEL

Today is to use heavy oil or earth gas for firing lime kilns The possibility of use petroleum coke is also given.

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191:

In lime kilns coke can be used as a mixed feed so that limestone and coke are put into the kiln together. Our Institute can take over such a study. It is to distinguish the study of lime and clinker (cement) burning with coke.

192:

A laboratory test of burning limestone with coke and the analysis of the burnt lime would give answer about the possibility of use coke for burning in kilns.

193

An analysis of petroleum coke should confirm the quality of coke for burning in kilns.

194:

It is to state that coke in general, as a short flame fuel could not be used in rotary kilns, but experiments in our pilot plant rotary kiln shall give answer if it is possible to burn milled coke with additifs in such kilns.

195:

In the meantime it is possible in Syria after this mentioned investigation to prepare an industrial firing with coke in a lime kiln of the sugar industry at the time of the sugar season.

196:

Also it is convenient to study the possibility of desulphurisation of the gases before the coke process.

It is to prepare a purpose to install a desulphurisation device with reasonable costs.

200: COMPARISON OF DIFFERENT LIME KILNS

The General Organization for Cement and Building Materials has received the following offers:

1) A 400 t/d rotary kiln and hydrated lime plant of the Fuller Company, Pa.
2) A 400 t/d Calcimatic rotary horizontal kiln and a rotary Kiln of 400t/d of Calcimpienti, Italy.

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3) A 400 t/d rotary kiln and a 2x230t/d or 450t/d vertical kiln , Maerz of Plimex Cekop, Poland
4) A 400 t/d rotary kiln of VEB Dessau
5) A 400 t/d rotary kiln of KHD, West Germany

and other 30 offers less importance.

In Europe the rotary kilns are not economically convenient for lime production in capacities smaller as 1000t/d of lime. Such kilns are using for steel industry pruposes. Rotary kilns have this disadvantages:

1) They use too much heat (1300 Kcal/kg lime noted by Fuller and others)
2) The investment costs are higher
3) The consumption of electrical energy is also higher, but not so much as the first two costs.

The Calcimatic kiln has a heat consumption of 1150 Kcal/kg There is a little high and the hanging ceiling on the whole surface of the kiln is also a problem.

All this kilns can operate economical with fuel and electrical consumption costs at full capacity.

Vertical kilns are of different capacities, with low heat consumption and soft burned lime, so they are convenient for masonry purposes.

The lime production for building purposes is a season production. Therefore it is very convenient to have two kilns, when one is in repair or is no need of lime is stopping, the other kiln works with full production.

The same is with production of hydrated lime. When the kilns work continually the hydrated lime plant must reproduce the required quantity of lime. This plant is to be simple and of easy construction.

The Maerz kiln is composed of two kilns twins. It is better to have two kilns of 230t/d but is to waite with the experiences of the plant in Hungary. In Yugoslavia there are a home constructed kiln of 150t/d with 1150Kcal/kg required heat consumption and 5-7 erected and in production home constructed lime kilns with West Germany licence Beckenbach and lower heat consumption of 950-920Kcal/kg lime and also Maerz kilns. In connection with the use of petroleum coke it is to see if it is possible to modify the the kiln for the use of both fuels (coke and heavy oil).

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The combination of a kiln of 150t/d and of 300t/d capacity is much convenient for the seasonal require of lime. When it is to calculate that a lime plant works in the average with 70% of kilns capacity the choice of kilns of different capacity is enable to vary the capacity of the lime work from 150t/d to 400t/d of lime.

210; The Problem is to Select a Rotary or a Vertical Kiln

The rotary kiln is a kiln adapt for cement production. For burning lime the kiln need a preheater device and a cooling shaft. With this improvements the heat consumption is between 1200-1300 Kcal/kg lime (as it is to see in the offers of different firms).

Also the rotary horizontal kiln calcimatic need 1150-1200 Kcal/kg lime.

Some vertical kilns need 1150 Kcal/kg such Italian, Yugoslave. The kiln of Poland offer with Swiss licence (Maerz) or Yugoslave (with Germany licence Wibmestalle) have a lower heat consumption of 900 or 920-950 Kcal/kg.

The Maerzkiln is a twin, that means the process is executed in two kilns. The top of the first kiln is for 4 min. cooled, of the second kiln is preheated and after 4 minutes the situation is opposite the first kiln is preheated and the second cooled.
The lime is drawed from both kilns. The Maerz should start this year in Hungary and it is to waite a time for results.

The Beckenbach kilns with Germany licence work much years with great success.
In Europ the rotary kilns are not usually used for burning lime. There are some older 1000t/d in West Germany for the use in the steel industry and smaller in the East countries and North America.
Smaller capacities of 1000t/d are not convenient in Europe. In West Europe are in use vertical kilns.

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The Economical Estimation of Vertical And Rotary Kilns gives this results:

	Rotary Kiln	Vertical Kiln
Heat consumption of (heavy oil) Kcal.kg lime	1300	950
Required for firing t, oil/day	54.7	40
t/oil/year	15.873	11.600
Costs of fuel LS/day	45.400	33.200
LS/year	13.474.590	9.628.000

Spare of Fuel Cost by Vertical Kilns 3.845.590 LS/year

	Rotary Kiln	Vertical Kiln
Costs of equipment	4,696,000 $	
Total investment	25,000.000 D M	
Costs of machinery	2,947.000 $	
Weight of machinery	4,043,5 t	2,985 t/2kilns
	3,939 t	
Total	4,316 t	3,362 t
Weight of electrical equipment	377 t	377 t
Use of electrical energy Kwh/t	20.6	16.4

Cost of equipment for hydrated lime plant : 1,500,000.- D.M.

211: Conclusion about comparison of Kilns

It is very difficult to establish the costs of different offers, but if it is to compare the weight of a rotary kiln (4.3166) and two vertical kilns (3.362 t) it is to check also a difference in the costs for 1000 t of also less of machinery.

19/...

The used electrical energy is also something lower by the vertical kilns. A very studious comparison of the costs for all kilns it shall be troublesome, but it is to state that in generaly the vertical kilns are more economical for lime burning and also it is to remark about lime quality. In a table it is to resume all this facts:

SHAFT KILN	ROTARY KILN
Advantages	Advantages
Low investment costs	Possiblity of burning hard, middle, soft burned lime
Lower heat consumption(950Kcal/kg)	Possibility to use all grain size available
Little space requirement	Limestone of 0-0.1 mm does not need further preparation and can be used for soil stabilization, fillers and agriculture.

SHAFT KILN	ROTARY KILN
Disadvantages	Disadvantages
Possibility of burn only soft and middle burned lime, not hard burned lime	Higher investment costs compared to shaft kilns
Limitation of grain size of the new material	Heat consumption of 1200-1300 Kcal/kg of lime compared to 950Kcal/kg of vertical kilns
	Space requirement

To this comparison is to remark that in Hama and Adra is no need of hard burned lime and it is no reason to mill fine limestone, if it is to use limestone for burning lime. The smaller pieces of limestone are prepared for the cement plant.
The production of lime in vertical kilns is cheaper while it is not need of high milling energy.
It is cheaper to grind lime as harder limestone.

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220: DESCRIPTION OF THE PROCESS OF LIME PRODUCTION

221: Quarry

The acquiring of limestone will be at the same location as for the cement industry with a difference of [illegible] classifying.

With deep drilling obtained limestone until a 1500x 1200 mm size is crushed in a jaw crusher and screened on a sieve to obtain limestone of a size 50--150 mm.

222: The limestone is transported with a belt conveyor to the 6000 t storage for a 11 day production reserve near the planned lime work. From the storage the limestone is transported with a underground conveyor, by screening separated the under grain and delivered to the bin before the kiln, weighed and transported to the top of the kiln.

The filling of the kiln as the passage through it are automatically. /System Wärmestelle, Azbe etc/.

The firing of the chambers at two levels (8 or 10 chambers) depend of the capacity of the kiln (1500 or 300 t/d).

The fuel heavy oil is stored in a 800 t tank for a 20 day production of lime of 400 t/d and is heated with heat carrying oil.

This manner of heating is very cheap and there are no troubles with the cooling and stirring of fuel. The preheated and burned lime in the burning zone after cooling in the cooling zone falls in the silo at the bottom of the kiln. A system of recirculation of flue gases in the lower level chambers give the possibility at lower temperature (between 1150°-1250°C) to burn lime without overburning.

A part of combustion gases are passing lime down the kiln to the inner vertical cylinder of the kiln and are needed as recirculation gases in the chambers.

A further cooling of flue gases is done in a recuperator, where the blast is heated air, what enable the low heat consumption of the kiln.

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223: The quicklime is transported with a belt conveyor and expedited on lorries or directly to the bins in the hydrated lime department.
From the bins the lime is passed to the equipment of hydration. There are two hydrated plant. The lime is transported from quick lime bin to a hammer crusher and is elevated to a bin for milled lime is fallen in the screw conveyor above the hydrator, where is supplied hot lime milk from the wet chamber above the hydrator, is passed to the hydrator where takes the process of dry slaking with the twice theoretical use of water.
The slaking, homogenisation and cooling of hydrate is finished in the homogenizator (a horizontal tube with mixing showels). The hydrated lime is transported with a screw belt, elevator on the top of the air separator, where is separated commercial hydrated lime from the rough particles there are falling in a roller mill, in which are milled to undergrain 0.09mm and returned to the air separator. The hydrated lime is transported to a 1200 t silo for the hydrated lime and filled reinfuse in containers or in the packing department in 33kg bags and loaded in lorries.

224: The other lot of quick lime could be crushed in the third step of erection of the lime work, when it will be need of fine lime for the building industry in the same crusher or for hydrated lime and then milled in a roll mill with air separator and packed in half empty bags with 4 sheets, of them two bituminised.
The capacity of such a fine lime department is to be enough for a capacity of 10t/h or 46.000t fine lime production a year in two shifts.

22/...

230: DESCRIPTION OF THE BURNING PROCESS IN VERTICAL KILNS

231: Burning of Lime in a Kiln With Two Levels and Recirculation of Flue Gases

The kiln has more firing places or gasification chambers In princip the chambers are a gas generator in which heavy oil combuste in the atmosphere of recirculations gases that are coming from the fan of for extract flue gases on the top of the kiln.

This gases content CO_2 and in connection with a part of air created carbonmonoxid after the formule

$$C + CO_2 \longrightarrow 2CO - 38.8 \text{ Kcal}$$

The gases content CO, which burns in the shaft and leaves the chamber at 300°C. In this manner it results a triple prologation of the height of the burning zone (with temperatures over 1000°C).

By the older coal burned kilns the height was 0.5-1m above the firing place.

By a direct burning of heavy oil in kilns chambers are developing too high temperature and begin a dangerous smelting of the lining.

232: With recirculation of the flue gases from the top of the kiln or from the inner tube by others kilns it is possible to lower the high temperature that are developed by the burning of heavy oil. The theoretical temperature of burning oil is 2220°C, what happens when fine sprayed oil mixed with fresh air burns in a few time by a theoretical air factor $\lambda = 1,0$.

When the temperature is lowered to 1300°C the air factor is $\lambda = 2$. At this condition the consumption of oil is high, the losses of heat are high and the gases shall be smoky or sooty.

When the air factor is choosed between $\lambda = 0.4-0.6$ and there are used 40-70% recirculated gases in the chambers, reach the temperature in the shaft 1200°C - 1300°C, what is a good condition to burn lime in kilns.

233: The present carbon dioxid from the recirculated gases creates a reduction atmosphere and lowers the possibility of total burning of heavy oil. The creation of CO by the gasification lowers the temperature in the chambers and enables a further combustion of CO in the shaft kiln.

23/...

234: The recirculation gases from the top of the burning zone and the air for the burning process procure a stable temperature in the chambers (800°÷1000°C) what is a condition for a right gasification of heavy oil into generator gas. Thereby also fall all troubles by the combustion and gasification of oil because of the cooling of the chambers.
If the chamber is cooler the process develops by this equation.

$$2Co \rightarrow C + Co_2 + 136.0 \text{ Kcal}$$

particulary if the temperature falls in the chamber below 800°C, what it occurs, if are conducted too much cooled flue gases or air. In this case it occurs a partial direct burning in the reduction atmosphere. For the burning of oil in the lower chambers it is necessary to use beside air the recirculations gases from the top of the kiln or top of the burning zone. In the top of the kiln is a temperature of 350°-400°C, on the top of the burning zone it is 800°-850°C. Higher temperatures on the top of the kiln means more heat losses.

235: The percent of recirculated gases in the burning chambers may vary from 5-70% (average 20%) depending of the air factor λ and of the pressure of gases and air from the burners, at lower pressure it must be the procent lower, by higher pressure higher. The addition of 5% recirculated gases needs a pressure of 100mm WC, the addition of 40% needs a pressure of 500mm WC.

236: By the other manner of burning without recirculation oil burns in the (upper) chambers of two level kilns insufficiently with an air factor λ =0.4-0.6 and temperature of 800°C. Air for combustion of gas mixture of CO would be conducted in 3 heights of the burning zone so that the temperature not exceeds 1200°C-1300°C, This kilns are made with capacity of 100t/d lime. To get greater capacities the kilns must have two levels of chambers. Such kilns reached a capacity of 150t-300t/d lime or more.

24/...

237: In the MaerzKilns the process is operated so that the burning of lime in twin shafts is based on recuperation of heat.

This heat exchange as by the Siemens steel furnaces known need one chamber to emit and the other to receive heat from the hot combustion gases. The Maerzkiln is so constructed that the upper part of the first kiln is cooled, the upper part of the second kiln is heated for 4 minutes, the other 4 minutes is the first kiln heated, the second cooled and so on.

The burners for heating are in the upper part of the kilns. There is a direct burning of lime but at 4 min. intervals of cooling. The air is coming from the bottom of both kilns and from the top of the processing kiln. Therefore the gases leaves the kiln with a lower temperature.

240: THE PROCESS OF GASIFICATION

The gasification is taken in chambers. The burning is incomplete. The primary air for burning is given in 60-70% of the theoretical needed for a burning. From the bottom of the shaft comes the air needed for the complete burning.

The temperature in the chambers by the incomplete burning is 800°C. The complete burning is done with the equation

$$C + O_2 \rightarrow CO_2 + 97 \text{ Kcal}$$

The air contains 21% (vol.) of oxygen and 79% of azote. Azote is gone in the flue gases and also the excess of oxygen is not utilised.

By the incomplete burning is developping a part of heat

$$C + \tfrac{1}{2}O2 \rightarrow CO + 29 \text{ Kcal}$$

It means that a part of the fuel burns completely and the present CO_2 with a further fuel gives Co-gas, so

$$C + CO_2 \rightarrow 2CO - 38.8 \text{ Kcal}$$

and it is spend a part of heat to create Co and the temperature is lowered (below 1000°C)

25/...

250: THE SHAFT OF A KILN

The kiln has 3 zones: preheating, burning and cooling

251: The Preheating Zone

The limestone falls through the shaft down. The flue gases are coming from the upper burning zone at 850°C and they heat the stone and leave the kiln with 150°C-300°C through the fan and chimney. The stone in the preheating zone is heated to 850°C, so in the burning zone begins the process of dissociation or the burning of lime.

252: The Cooling Zone

The contrary process as in the preheating zone is taken in the cooling zone.
The lime is cooled from 1000°C to 50°C-100°C and with this temperature leaves the kiln.
The cool air occured for the combustion in the burning zone is heated in the cooling zone to 350°C.
The lime is in hard pieces, so can the air pass the void between it.

253: The Burning Zone

The zone has 3 sheets: from 850°C-950°C, from 950°C-1050°C and from 1050°C-1150°C. The burning of lime is done in the lower sheet, where the temperature is higher and enable to expell CO_2 from lime. This sheet has 0.5-1.5 m height.
The burning process is a transfer of heat from the flue gases to the middle of the stone. This heat have to be upper as 850°C to burn lime practical must be 1150°C - 1250°C.
When it occurs to accelerate the burning of lime the difference of temperature between gases and stone is to be higher. The small pieces of material have a higher transfer of heat as the larger. For example the time of burning of a 100 mm piece is 11h, for a 200mm/27.5 h. The same difference is in the time of preheating or cooling: 4.3h for 100 mm pieces and 11.5h for 200mm pieces.

26/...

260: HYDRATISATION OF LIME

The process of lime slaking depends upon:

a) the size of lime particles

b) the porosity of lime or the speed of penetration of water in the sheet of calcium oxide.

If the particles are small the lime slaking is easier, so for example particles of 0.3 μ diameter are slaking 120 time quicker as particles of 10 μ.

If it is the volumic weight of quicklime lower, greater is its porosity and shorter the time of slaking.

The process of hydratation of lime is the boundery of water to calcium oxide after the equation.

$$CaO + H_2O \longrightarrow Ca(OH)_2 + 15{,}2 \text{ Kcal}$$

In this process it develops 205 Kcal/kg $Ca(OH)_2$ and the water is heated to the boil point. At higher temperatures of slaking lime bounds 2 molecules of water, after expelling one molecule with developing of heat. One molecule of water is then evaporated.

In the air separator are separated particles greater of 0.6mm, they go to the milling. This particles could be cause bubbles in the plaster on walls The particles greater of 0.6mm are milled and returned to the air separator, so that are not wastes.

300: THE PLAN OF PRODUCTION OF LIME ECONOMICAL VIEW

Building and construction purposes of limes use required a season work. In the summer months April-September it is 100% need of lime. In Autumn and Winter it is 50-70% need of lime for building purposes.

The same is in Europe. There are industries that are working with half capacity. That means that in Winter season is a 1/3 of the production of lime to be lowered or stopped.

27/...

It is known that with lowering of kiln capacity the consumption of fuel rises and also maintainance costs are greater. In Europe the problem is solved in such a way that for example by a production of 400t/d lime with two kilns of 150t/d or 300t/d lime production is the 150t/d kiln stopped. In this time occurs repairs of the kiln.
When is the consumption of lime lower can work only the 150t/d kiln. When occurs troubles and it is only one 400t/d kiln, it is no production of lime, when there are two kilns is less occasion to stop both kilns. And also it is need of less storage capacities, the equipment is also cheaper. It is not economical to have 2 rotary kilns of 200t/d each. The e are to small capacity for rotary kilns.

Vertical kilns need a smaller area as the rotary. In Europe are in use vertical kilns for mass production of the steel industry(6x3 kilns etc.). An economical planning of lime production and consumption is favourable to the vertical kilns.

It is known that by starting a new kiln the consumption of fuel is higher and the production is lower. For vertical kilns it occurs 2-3 week for the full production of lime for a 300 t/d capacity
The burning of kilns occurs a tempering of 10 days, each day must the temperature arise for 150°C. That is very important for maintainance of lining. The same is also with the rotary kilns. They are empty and it is not desirous when occurs falls of temperature.

The training of the personnel occurs for a 6 months on the same type of kiln or hydrated plant. It is need to send for a kiln:

- 2 engineers,
- 3 electrotechnicians
- 2 workers,
-

for hydrated plant:

- 2 workers, the engineers are the same as for the kiln.

28/...

310: Factory Costs

311: Production of Quick Lime

The production of 400t/d lime is to execute in one kiln of a capacity of 150t/d and one of a capacity of 300t/d lime.

312: Consumption of Limestone

For this 400t/d production it is necessary to use:

Production of Lime Time	T	Used Limestone 50-150mmd T	m^3(1,6)	Non Classified limestone m^3
An hour	17			
A day	400	712	445	636
A month (30 days)	12000	21360	13350	19070
A year (290 days)	116000	206480	129000	184285
A year (330 days)	132000	234960	146850	209790

When the kilns produced with nominal capacity they use:

Time /	For a Kiln of 150t/d capacity: Production of Lime / t	Used Limestone t	m3	For a Kiln of 300t/d capacity: Production of Lime/t	Used Limestone t	m3
hour	6.25	11.2	7	12.5	22.4	14
day	150	267	167	300	534	334
month (30days)	4500	8070	5400	9000	16020	10010
year (290days)	43500	77430	48390	87000	154860	96790
year (330days)	49500	88770	55440	99000	176220	110140

In the practice it is always to calculate a 70% production of the full capacity.

The undergrain of the classified limestone is to be used for cement production.

313: Consumption of Electric Energy

	For t product Kwh/t	Installed Power Kw
Kilns	16	150
Hydrated Plant	12.5	190
Pack and Silo	2.5	40

314: Consumption of Heavy Oil

It is recommend to start a kiln with light oil and to to continue after to burn with heavy oil.

Heat Consumption: 950Kcal/kg Lime 1300Kcal/kg Lime

Time	For400t/d t oil	For150t/d t oil	For300t/d t oil	For400t/dProduction t oil
Hour	1.7	0.63	1.25	2.3
24 Hrs	40	15	30	54.7
Month	1200	450	900	1642
Year (290days)	11600	4350	8700	15870

320: Production of Hydrated Lime

It needs 0.80 - 0.85 t lime/t hydrated lime.

Production of	Hydrated Lime / t	Need of Quick Lime / t	Need of Water m^3
Time	1	0,8	0.486
h	24	19.2	11.7
16h-day	384	307.2	186.6
20.8h-day	500	400	243 for a total consumption of quick lime
Month (30days)	11.520	9.216	5.600
Year (290days)	111360	89.090	54.090

330: Production of Fine Lime

Production Time	Fine Lime / t
Hour	10
16h-day	160
Month (30days)	4800
Year (290days)	46400

All this quantity of lime can be also used as wet slaked lime for building purposes.

340: Man Power

Quarry	2 x 2 men
Cars	2 men
Kilns	2 x 4 =8men (4 shifts)
Hydrator	3 x 2 =6men (2 shifts)
Electr. + Mech. need	3 men
Chief	1 man
Bureau	2 men
	23 personnel

30/...

350: Calculation of Everage Costs of Quicklime, Hydrated Lime and Fine Lime

For a vertical kiln it shall be a different calculation as for a rotary kiln.

351: Quicklime

352: Calculation of Lime Costs per 1t lime for a vertical kiln:

Consumption	LS
Limestone	10.68
Fuel 100kg x 830 LS	83.00
Electrical energy	2.28
Man power	4.60
	100.56 LS x 2 = 201.00 LS of productions costs for 1 t lime

353: Calculation of Lime Costs per 1 t Lime for a Rotary Kiln

Consumption value	LS
Limestone	10.68
Fuel 136.84kgoilx830LS	113.60
Electrical energy (given the same as vertival kiln)	2.28
Man power	4.60
	131.16LSx2=262,32LS of production costs for 1ton lime.

The multiplier factor 2 involves all other costs: repairs, utilities, sales, loan an overhead costs for a normal production.

354: Hydrated Lime

Calculation of costs per 1 ton of hydrated Lime

Consumption	LS
0,8 t limex200.5 LS	160.44
Other costs:water, man power	20.00
	180.44
Repairs,overhead costs	30.00
	210.44 LS of production costs for 1t hydrated lime

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355: Fine Lime

The costs for fine lime are evaluated to 250.00 LS for 1 ton of fine lime.

360: Calculation of Loan Amortizations Costs per ton of Lime

For the calculation it was used the higher investment costs for a rotary kiln of Fuller Co., 4.696.000 US$ with 6% interest is 281.760 US$ interest a year.

For 20 years loan conditions:

281.760x20=5.635.200 - US$ interest

4.696.000 - US$ loan

10.331.200 $: 20 = 516.560 US$ /year of loan x 7.5 (currency + 30% duty) = 3.872.000 LS:

81200t=47.7LS/t LIME

loan amortizations costs

For 6 years loan conditions:

281.760 x 6 = 1.690.560 US$ interest

4.696.000 US$

6.386.560 US$: 6=1.064.427$/year x 7.5 (currency + 30% duty) = 7.983.202.5 LS:

81.200 t = 98.3 LS/t lime

Loan amortizations costs

In the calculated price of lime is with factor 2 provided 100 LS/t lime for overhead costs, between this also for loan amortizations costs, In this way the return of costs begin with the starting of the lime work in production.

The 20 years term of payments of loan amortizations costs of 47.7 LS/t lime is just right. The short term loan calculated for 6 years means 98.3 LS/T lime of amortizations costs are too rigid conditions of payment.

364: ~~Cost of Running a New Lime Kiln into Production~~

32/...

361: Costs of Running a New Lime Kiln Into Production

If it is to calculate a 20 day running of the kiln it means for a 400t/d capacity 8000 t lime production x 200 LS/t = 1.600.000 LS of running costs.
By a 81.200t production of lime is 19.7 LS/t lime.
For a kiln of 150t/d capacity it is 7.4LS costs/t lime. When it is need of a twice running of the kiln are for the first year of production the same costs as for loan amortization.
This a fact that speak of the convenience of training personnel.
In the working capital is to calculate the costs for a 10 day reserve of fuel and limestone (ca. 380.000 LS).

400: SPECIFICATION OF THE EQUIPMENT FOR A LIME WORK

The equipments specifications for the lime work Hama or Adra should be divided in following factory departments or devices:

1.- Quarry: addition of a(crusher and)screening device
2.- Two kilns
3.- Basin and tank for fuel (550t weight) of the device for oil)
4.- Hydrated lime department - two units
5.- Silo for hydrated lime, packing and storage
6.- Fine lime department

410: Equipment of the Quarry

In the quarry it is to change in the crushing department:
For crushing limestone it is need of a jaw crusher with the exit 130-150 mm and a screen device for screening the undergrain of 50mm, which can be delivered for the use of the existing cement plant.
The limestone for cement can also pass the existent double hammer crusher and can be transported to the cement work by belt conveyor or lorries.
By the same way is to transport separately the lime stone for the lime work.

33/...

411: Limestone Storage at the Lime Work

Limestone of granulation 50-150mm is supplied by conveyor to the limestone storage of a capacity of 8000 T.

The limestone is recovered from the storage by means of vibrating feeders on the underground belt conveyor and to a vibrating screen to separate undergrain before the kiln charge. The limestone, is fed to the kiln bin, weighed and transported to the top of the kiln by conveyors. All the shafts kiln are fed in a exact time programm.

412: Specification of the Changed Quarry Equipment

1.- Slat belt conveyor: B=2500mm, L=15.36m, angle 20 Q=200-1000 t/h

2.- Vibrating screen, sieve mesh 150x150m, Q=600t/h, B=2000m, L=5500m.

3.- Jaw crusher inlet 1200x1500mm, outlet slot 180x280mm, Q=200-400t/h

4.- Belt conveyor B=1200mm, for receipt of material from the vibrating screen

5.- Belt conveyor B=1200 mm , L=6m for receipt of waste from vibrating screen

6.- Other equipment for the transport of limestone from the quarry to the kiln department.

420: Specification of the Equipment of the Shaft Kiln

421: Silo for Limestone 750m^3 (7.5x7.5x3.5m) for the supply of the Limestone.

422: Vibrating Groove for Stone for Conveying from the Silo to the Conveyor.

It is made of plates of electrowelded, bound with amortizers at the steel construction.

The construction of the groot is bound with screens at the frame of the output opening. As motor device serves a electromagentical vibrator with regulation.

34/...

423: System of Conveyors and Groots for Stone from Silo to the top of the Kilns.
There are provided two kiln, one of 150t/d and the other of 300t/d capacity.

424: Automatic Weights
Serves for weighing stones befor slaking in the kiln. It is composed of a housing, measurement of flow at the belt, system of levers and a supporting construction. The weights are bound with the electrical numerator to control the number of weighings and in the same moment to record the weighings in a hour and a day.
The number of weights is arranged corresponding to the capacity of the output of lime from the kiln.

425: Passing Funnel or Conveyor Serves to the Supply of Stone from the Weights to the Top of the Kiln

426: Shaft Kiln
It is composed of the following parts.

426.1- Mantle of kiln

426.2- Lining of kiln

426.3- Platforms with the device for the opening of the clock of the kiln

426.4- Device for the control of the filling of the lime Kiln

426.5- Device for the drawing of lime

To 426.1:
The mantle of the kiln is cylindric, depending of the type of the choosed vertical kiln of a useful volume of $150m^3$. The mantle is from steel plates, electro-welded, from the inner side fastened with rings and ribs of profilated steel and with plates. At the outer side of the mantle are the control steps, which enable the access to the openings and to the plate-forms.

35/...

To 426.2

The lining are executed for the conditions of firing with heavy oil. The shaft in the burning zone is lined with chrom magnesia bricks in the chambers are used bricks on base of magnesia and mortar of magnesia, iron and iron oxide, for the remained part of the shaft is used magnesia chromit and alumina bricks. Alumina mael water glass and special kinds of mortars. The lining of the shaft is finished at the bottom with a conic output and a 50m^3 concrete silo. Above the conic part are arranged round the mantle in two levels the firing places (chambers).

To 426.3

The platform on the top with the driving device for the openings of the clock. It serves for the access to the input to the gorge / or upper device/ of the kiln and to the driving device for the access of stone to the clock. The plateform is made from profiled steel, covered with ribs, plates and with a fence, that is following to the steps balustrade.
There are several plateforms at different levels of the kiln.

To 426.4 - 426.5

The device for the control of emptiness of the kiln.
It is realised with radioactive isotops, which detector is connected with the device for filling and empting of the kiln. On the top of the lining is a device for the measurement of the filling of the shaft.

430: The Specification of the Equipment for a Hydrated Lime Plant of 10-15 t/h Output

There are planned two paralel equipments.
The production of hydrated lime is foreseen for the total quantity of quick lime with the supposition that the industry should need a lot of quick lime and fine lime. Also in the village country it should be used more wet slaked lime.

36/...

The storage of hydrated lime is provided for a 1200m^3 in a silo of 12m ø.
The hydrated lime shall be transported in containers in 33kg bags. The hydrated lime has a long period of use (several months) Naturally hydrated lime must be stocked under roof.
The hydrated lime plant is to provided with this equipment.

431: Silo for quick lime bulk, capacity 370 m^3 (concrete)

432: Supplementary for quick lime from the silo

433: Hammer mill for crushing quick lime 10-12t/h

434: Bucket elevator for quick lime, capacity 20t/h, hei height 17.3m

435: Silo for grind lime, capacity 36m^3 of steel

436: Vibrating supplementary, capacity 12m^3/h

437: Screw conveyor to the hydrator

438: Hydrator for hydrating quick lime, capacity 10-12t/h hydrated lime 2.0 m ø, 6m length with conic cover

439: Water dedusting, coloumn 0.8 m high

440: Homogenisator 6m length, 12.1 m high, 0.5m bright for homogenisation of hydrated lime.

441: Bucket elevator 17.5 m of height with conveyor for conveying hydrated lime on the top of an air separator.

442: Air separator for classing the rough particles of 0.09m, 3.5 m ø

443: Tube mill, 4t/h capacity for milling hydrated grits

444: Filters for adduster system with device for cleaning and electronic automatisme.

445: Conveying from hydrating plant to silo
1 piece: Fuller pump
1 piece: Compressor = 18m^3/min

446: Silo hydrated lime 1200 m^3 capacity.

37/...

447: Equipment for silo hydrated lime with empting device, fan, device for loading and filtering.

448: Equipment for packing with pneumatic conveying, trough, pneumatic supplement, 4 tube pack machine with small trough with conveyor and elevator.

The weights of one equipment is 72 t, the quicklime silo silo 200t without weights of packing device.
The big silo has 1000 t.
In all it is 1272 to of material.

The surface of a hydrated lime plant is:
326m^2 hydrated lime building
72m^2 packing device building
250m^2 storage
150m^3 fine lime building

450: The Heavy Oil Device With the Installations Before the Kiln

Consists of receiving levels, pumps for heavy oil, tank for heav- oil, tank for light oil, command pannel, device for heating heavy oil with heat carrying oil.

460: The fine Lime Plant

It is proposed a 10t/h fine lime plant with a roll mill, air separator, that is f in the down part connected with a packing machine and the possibility of transport in containers.

500: CONCLUSION

There are given all elements , needed for a decision about a lime plant. The problem of the kilns is so resolved, that are proposed vertical kilns and for a today requirements a Beckenbach West Germany License type of kiln with a delivery of equipment partly constructed in less developed countries to lower the costs.
All the proposed specifications for equipment are based on strict economy of costs.

ANNEX TO THE REPORT ON LIME INDUSTRY

THE CHOICE OF CAPACITY OF A LIME PLANT IN S. A. R. AFTER DATA OF LIME REQUIREMENTS

Analysis of date of G.O.C.

An economical rule of the development of the lime industry is that this industry has to work at full capacity all a year or the most part of it (8-9 months)
This production would give a positive economic result and thereby the possibility to return all loans and financial aids of the investment .

SCHEDULE OF LIME REQUIREMENTS:

1) Requirement of lime for the TSP fertilizer plant Homs. From the paper of C. Babinski is to resume that 14.635 m^3 water daily need 60t lime. For a need of 30 days and 11 months it results 19.800t/y lime.
2) Planned requirement of hydrated lime for factories of prefabricate (that is a sand lime factory and a celular bricks factory) are after our data from the statics by us 14.700t/y For reserve it would all quantities of hydrated lime calculated as quick lime, after these statistics a celular concrete factory need only 2.000 t/y lime. There are problems of lower quality by the use of lime instead cement.
3) Planned requirement of hydrated lime in buildings. If it is to calculate the requirements of lime for 2.000.000 inhabitant in Europe to 26.500t/y hydrated lime , also calculated as quick lime are all requirements of lime exhausted. For other foreseen needs it is better for the first time to import and then after real requirements to erect a new perhaps 150t/Kime/day or 300t/d kiln near the first kiln. Also is enough a hydrated lime plant of 10-12t/h capacity. In S.A.R. is no production of clay bricks who are the greater consumer of lime.
Therefore are all need of lime in building to calculate as twice greater or for 4 millions of inhabitant a year.

2/...

4) Summary of the real requirements of lime with enough reserve:

1) Requirement of lime for TSP fertilizer (60t/d lime)	19.800t/y
2) Requirement of lime for prefabricates	14.700t/y
3) Requirement of lime in buildings	26.500t/y
4) Total requirements of lime in a year	61.000t/y

THE REQUIRED CAPACITY OF A LIME WORK

To realize this requirements of lime (61.000t/y) by in 11 months 30 days production it is needed a capacity of a kiln of 185t lime daily. It is noted that a kiln of a capacity of 150t lime daily has the possibility to produce also 180t/d it is to stated that for all requirements of a planned period 1981-1985 is enough to erect at first a lime factory with a vertical kiln of lower heat consumption (below 1000 Kcal/Kg lime) of a capacity of 150t lime daily.
Because of the great need of lime for the fertiliser factory is to propose to erect a lime factory near Homs.

ECONOMIC EVALUATION OF THE PRODUCTION COSTS FOR LIME

After the report of C. Babinki is to remark that in the year 1978 was the price of lime in the sugar industry 292 LS/t lime and in 1980 requested 370LS/t lime. Naturally it is a price of lime fired with coke, but also lime from a rotative kiln could have a production cost of 260LS/t and this price is near the price of cement.
In all cases lime must compete cement with the price, if it is to use it in the building, therefore it is to choose the most economical process of lime production.