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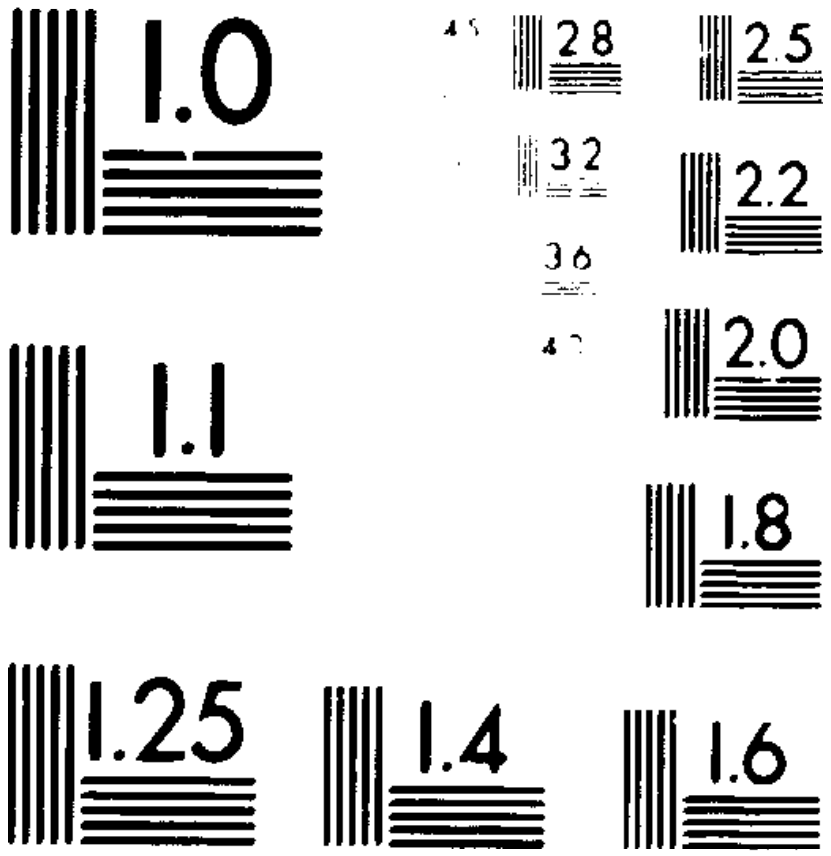

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EQUIPMENT FOR LABORATORY TESTING OF KAOLIN, CLAYS AND SANDS

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ABSTRACT

Two variants of laboratories are presented - regional laboratory for testing kaolin, clays and sands, and kaolin washing plant laboratory for testing kaolin.

The regional laboratory is supposed to comprise 5 departments (laboratory for preparation and beneficiation of samples, analytical laboratory, physical and mineralogical laboratory, technological laboratory and pilot workshop). The arrangement of laboratory equipment takes into account modern methods of kaolin, clay and sand evaluation with the view to assess precisely the process of winning, beneficiation and final production.

The second variant - a kaolin washing plant laboratory consists of chemical laboratory and technological laboratory.

The proposals are supplemented by informative prices of equipment and by useful information on accessories.

CONTENTS

INTRODUCTION

The delegates from developing countries participating in the In-plant Training Workshop on "The Exploitation and Beneficiation of Non-metallic Minerals" held in Czechoslovakia in April 1980 recommended in the Conclusions and Recommendations technical assistance for establishment of laboratories through the UNIDO-Czechoslovakia Joint Programme to be extended to their countries.

In this volume the proposals of equipment for a regional laboratory for testing kaolin, clays and sands as well as for a kaolin washing plant laboratory are presented.

In the next stage preliminary projects should be elaborated.

REGIONAL LABORATORY FOR TESTING

KAOLIN, CLAYS AND SANDS

STRUCTURE AND ASSIGNMENTS OF THE REGIONAL TESTING LABORATORY

The regional testing laboratory is subdivided as follows:

- Laboratory for preparation and beneficiation of samples
- Laboratory for analytical chemistry
- Laboratory for physical chemistry and mineralogy
- Technological laboratory
- Pilot workshop

The laboratory for preparation and beneficiation of samples receives, registers and designates samples of won raw materials, semiproducts and final products and prepares specification of tests to be carried out. Besides, preparation and beneficiation of samples take place here.

The basic assignment of the laboratory for analytical chemistry consists in following continuously chemical composition of raw materials, semiproducts and final products. This is made by abridged chemical analyses and complete chemical analyses. In supplementary programme some special analyses are carried out.

Laboratory for physical chemistry and mineralo[illegible] evaluates by suitable methods raw materials, semiproducts and final products. Kaolin samples are subjected to grain size distribution analysis, measuring of whiteness shade, pH value and further physical-chemical parameters. Samples of raw materials are evaluated from the mineralogical point of view. Results of thermal analyses are combined with data of chemical analyses and mineralogical analyses are determined.

Clays are subjected to granularity analysis. Specific properties as adsorption capacity, specific surface, etc. are determined by physical-chemical methods.

As far as sands are concerned, both sand fractions and clay fractions are assessed from the mineralogical viewpoint. Higher attention is paid to heavy portions of sands (mineralogical quantitative and qualitative analysis of contaminations).

Technological laboratory is engaged in routine tests of clays, kaolins and sands. For clays the basic parameters are determined: humidity, sieve residues after wet screening, drying and firing dilatation, water absorption, firing colour, bending strength after drying, binding power, refractoriness, fusibility, content of water of plasticity and number of plasticity. Tests of kaolins determine their humidity, sieve residues after wet screening, content of particles under 2 micron by sedimentation, rheological properties, bending strength after drying, refractoriness and abrasivity.

Pilot workshop

Samples of clays, kaolins and sands are processed by semi-industrial equipment to verify quality of products. Samples of minimum weight of 50 kg pass through processing lines where kaolin washing and sand sorting is simulated. The workshop passes samples of beneficiated semiproducts and final products to the other laboratories for evaluation.

ARRANGEMENT AND EQUIPMENT OF LABORATORIES

Laboratory for preparation and beneficiation of samples

	Pcs
Reception, registration and store of samples	
Furniture:	
Laboratory bench	1
Shelf	3
Preparation and sorting of samples	
Instruments:	
Electric hot air drier (200 l)	1
Centrifuge for separation of solid phases	1
Laboratory jaw crusher	1
Screening machine for wet and dry screening	1
Sorting machine for separation of grain fractions	1
Rotary vacuum pump	1
Bench for vacuum filtration (vacuum distribution, 6 sucking flasks 3000ml)	1
Furniture:	
Low laboratory bench	2
High laboratory bench	3
Acid cupboard	1
Beneficiation of analytical samples	
Instruments:	
Laboratory ball mill	1
Laboratory mixer	1
Digital quick balance (160 g, 1000 g)	2

Electric hot air drier (60 l)	1
Furniture:	
High laboratory bench	4
Laboratory cabinet	1

Analytical laboratory

Reception of samples, evaluation of results

	Pcs
Instruments:	
Table calculator	1
Furniture:	
Low laboratory table	2
Laboratory cabinet for deposition of samples	1
Laboratory cabinet with armoured box for deposition of precious metals and poisons	1

Balance room

Instruments:	
Analytical semi-automatic balance (100 g)	2
Digital quick balance (200 g)	1
Furniture:	
Low laboratory table	1
Desk imbedded in a wall	1

Fume cupboards

Instruments:	
Mecker burners	8
Sand bath	2
Water bath	1
Heater (for digestion flask 250,500 ml)	2
Furniture:	
Fume cupboard	2
Low laboratory table	2

Atomic absorption spectrometer

Instruments:	
Two-beam spectrophotometer with automatic control of inlet gases incl. hollow cathod lamps	1
Compressor (necessary accessory)	1
Pressure vessels for acetylene and dinitrogene monoxide	2

Preparative chemistry

Instruments:	
Single-beam spectrophotometer for photocclorimetry, turbidity measurements, photometric and fluorimetric titration	1
pH meter	1
Electromagnetic mixer	1
Electric hot air drier (60 l)	1
Electric kiln (1200°C, 20 cu.dm)	1
Glass distillation apparatus (12 l/hour)	1
Furniture:	
High laboratory bench	3
Laboratory sink	2
Low laboratory bench	2
Laboratory cabinet for chemicals and glass	4

Store room

Furniture:	
Shelf	4

Laboratory for physical chemistry and mineralogy

Measurements of grain size distribution and whiteness

Instruments:	Pcs
Analytical balance (100 g)	1
X-ray analyzer of grain size distribution (0.1 to 100 microns) with direct record of cumulative grainage curve	1
Two-beam photometer (400 - 700 nm) for measuring whiteness and colours of powdered materials	1
Furniture:	
Low laboratory bench	2
Desk inbedded in a wall	1
Laboratory cabinet	2

Workroom of mineralogy

Instruments:	
Polarizing microscope for identification of minerals and determination of their optical properties (enlargement 20 to 540 times)	1
Stereoscopic microscope (enlargement 1.7 to 40 times)	1
Thermoanalytical equipment for differential thermal and gravimetric analyses and derivation of the gravimetric curve up to 1500°C	1
Digital quick balance (200 g)	1
Furniture:	
Low laboratory bench	4
Laboratory cabinet	1

Physico-chemical measurements

Instruments:	
pH meter	1
Apparatus for measuring conductivity of solutions and suspensions (0-500 mS)	1

Electromagnetic mixer	1
Electric hot air drier (60 l)	1
Furniture:	
Low laboratory bench	6

Technological laboratory

Technological testing

Instruments:	Pcs
Apparatus for determination of abrasivity (used for testing kaolin for paper industry)	1
Equipment for wet sorting by sedimentation (it serves for determination of kaolin content in washed suspensions)	1
Experimental equipment for sorting by screens	1
Synchronous electric rotary viscometer	1
Through-flow viscometer	1
Equipment for determination of water and number of plasticity by Pfefferkorn	1
Digital quick balance (1000 g)	1
Equipment for preparation of testing corpuscles	1
Electric hot air drier (200 l)	2
Breaking machine - for determination of bending strength of ceramic products	1
Laboratory Superkanthal kiln (1600°C)	1
Laboratory mixer	1
Furniture:	
High laboratory bench	8
Low laboratory bench	4
Laboratory sink	2
Laboratory cabinet	3

Store room

Furniture:	
Shelf	4

Pilot workshop

Production line for kaolin beneficiation by kaolin washing

Blunger with sand lifter
Vibrating screen
Hydrocyclones
Sedimentation tank
Filter press
Drier

Production line for sand beneficiation by sand sorting

Blunger
Vibrating screen
Thickener
Dewatering equipment
Counterflow separator
Checking sieve
Dewatering equipment
Drier

APPENDIX:

Summary of laboratory furniture

The furniture referred to in the lists of laboratory equipment is wood-metal combined modular furniture of increased loading capacity. The furniture assortment represents a modular system enabling combination completion and extension.

Summary of the above described furniture:

	Pcs
Low laboratory bench on which the operator can only operate the instrument and carry out measurements	20
High laboratory bench on which the worker stands and performs all of preparative character	23
Laboratory sink placed next to a high laboratory bench	4
Laboratory fume cupboard with installed exhaust of detrimental gases	3
Laboratory cabinets for chemicals, glass accessories and spare parts	14
Table desks imbedded in main walls as supports for analytical balances and other sensitive instruments	2

Equipment of laboratories with precious metals

In chemical analyses of silicates it is necessary to decompose samples (by fusing or dissolving) in platinum ovenware. The following set of platinum crucibles and dishes is recommended:

	Pcs
Middle-sized platinum crucible with lid	16
Platinum finger shaped crucibles with lid	8
Platinum dish ø 80 mm	16
Thermocouple Pt-PtRh 10	1

Laboratory chemicals

The analytical laboratory should have an adequate stock of chemicals. Below the consumption of chemicals for 100 analyses (Al_2O_3, Fe_2O_3, TiO_2, CaO) is listed.

Required purity: p.a.

chemicals	g
potassium chloride	250
sodium fluoride	500
sodium nitrate	50
ammonium sulphate	100
sodium carbonate	1500
disodium tetraborate	100
chelaton 3	500
ammonium acetate	4000
sodium acetate	500
zinc acetate	500
ammonium chloride	100

urotropine	500
ethanol	100
hydrochloric acid	5000
sulphuric acid	500
hydrofluoric acid	2000
nitric acid	3000
glacial acetic acid	2500
ascorbic acid	50
ammonium hydroxide	1500
potassium hydroxide	500
xylene orange	10
fluorexon	5
2.2 - dipyridyl	5
tiron	5
iron of pure spectrum	3
titanium oxide of pure spectrum	10
silicagel coloured	1000
set of buffer solutions	1

Chemicals for technological laboratory

Approximately the following quantities of chemicals should be on stock:

chemicals	g
sodium carbonate	250
ammonium hydroxide	1000
glacial acetic acid	1000
barium sulphate	250
coloured silicagel	2000

Aids for analytical laboratory

The laboratory should be equipped by chemical glass and laboratory porcelain as follows:

Aid	Pcs
platinum crucible (30 ml) with a lid	4
weighing bottle (ø 40 mm) low shape	24
desiccator (ø 300 mm)	1
desiccator (ø 150 mm)	1
fast filtering funnel (ø 60 mm)	112
volumetric flask (50 ml)	12
volumetric flask (100 ml)	12
volumetric flask (500 ml)	6
volumetric flask (1000 ml)	6
beaker (250 ml) low shape	12
beaker (500 ml) low shape	12
beaker (800 ml) high shape	12
pipette (1 ml)	3
pipette (5 ml)	6
pipette (10 ml)	6
pipette (20 ml)	3
pipette (50 ml)	3
automatic burette (20 ml)	2
automatic burette (50 ml)	2
reagent bottle (1000 ml)	6
bottle for indicators	6
porcelain dish (ø 150 mm)	12
filter paper blue band (100 pcs)	2
filter paper white band (100 pcs)	4

Aids for technological laboratory

The list of necessary aids for technological laboratory is shown below:

Aid	Pcs
sedimentation cylinder by Andreasen	6
sucking flask (5000 ml)	6
desiccator (ø 350 mm)	2
desiccator (ø 250 mm)	2
pipette (5 ml) calibrated	2
weighing bottle (ø 60 mm) low shape	24
weighing bottle (ø 50 mm) low shape	24
beaker (250 ml) low shape	12
beaker (600 ml) high shape	12
beaker (1000 ml) low shape	12
reagent bottle (5000 ml) wide neck	12
Büchner funnel (ø 250 mm)	6
porcelain dish (ø 50 mm) medium shape	24
porcelain dish (ø 100 mm) low shape	24
porcelain dish (ø 150 mm) medium shape	24
polyethylene flask (500-ml) wide neck	24
polyethylene flask (1000 ml) wide neck	24
plastic dish (ø 400 mm)	3
plastic bucket (5 l)	6
porcelain crucible (50 ml) high shape	40
laboratory thermometer (0 - 50°C)	2
slide gauge	1
filter paper blue band (100 pcs)	3
filter paper black band (100 pcs)	3

Estimate of prices of main deliveries

	US $
Laboratory instruments	206 000
Manufacturing equipment of pilot workshop	86 000
Laboratory furniture (incl. gas distribution etc. inside laboratory benches)	22 000
Platinum crucibles and dishes	47 000
Laboratory aids (laboratory glass and porcelain)	4 000
	365 000

Estimated prices are calculated FOB European ports.

Useful data for investor regarding land development and civil engineering work

Built-up area	405 sq.m
Built-up space	1620 cu.m
Required height of laboratories	4 m

Required electric power input (KW)

	3x380/220 V	220 V
Laboratory for preparation and beneficiation	6	10
Laboratory for analytical chemistry	20	15
Laboratory for physical chemistry and mineralogy	-	15
Technological laboratory	10	10
Pilot workshop	50	15

KAOLIN WASHING PLANT LABORATORY

STRUCTURE AND ASSIGNMENTS OF KAOLIN
WASHING PLANT LABORATORY

The kaolin washing plant laboratory consists of chemical laboratory and technological laboratory.

Chemical laboratory determines Al_2O_3, Fe_2O_3 and TiO_2 contents in kaolin samples of the laboratory washed kaolin, identical oxides and CaO content in leach in the samples of final product. Prepared analytical samples are decomposed by fusing with sodium carbonate, separated SiO_2 is removed by filtration and Al_2O_3 content is determined by titrimetry and Fe_2O_3 and TiO_2 contents by photometry from the filtrate. CaO content is determined by complexometric titration in the leach prepared from separately weighed sample.

Technological laboratory determines the content of particles under 20 microns in the washed kaolin. Semiproducts are tested to deliver data on sieve residues and bulk density. As for final products, the following parameters are tested: humidity, sieve residues, content of particles under 2 microns, apparent dynamic viscosity, bending strength and abrasivity.

ARRANGEMENT AND EQUIPMENT OF LABORATORIES

Chemical laboratory

Instruments:	Pcs
Analytical semi-automatic balance (100 g)	1
Electric hot air drier (60 l)	1
Equipment for decomposition of samples by fusing (4 Mecker burners, 4 stands, 4 triangles)	1
Sand bath	1
Water bath	1
Electric heater	1
Electric muffle kiln (1200°C, 6 dm^3)	1
Electromagnetic mixer	1
Transportable pH meter	1
Single-beam spectrophotometer for photocolorimetry, turbidity measurements, photometric and fluorimetric titration	1
Glass distillation apparatus (4.5 l distilled water per hour)	1
Two-beam photometer (400 - 700 nm) for measuring whiteness of kaolin samples	1

Technological laboratory

Instruments:	Pcs
Screening machine for wet and dry screening applicable as vibrating mill for preparation of samples to chemical analyses	1
Laboratory mixer	1
Electric hot air drier (200 l)	1
Digital quick balance (1000 g)	1
Laboratory mixer	1

Equipment for wet sorting by sedimentation for determination of kaolin content in washed suspensions	1
Stop watch for measuring times of sedimentation	1
Rotary vacuum pump	1
Bench for vacuum filtration (vacuum distribution, 4 sucking flasks 5000 ml)	1
Equipment for determination of particle content under 2 microns (4 Andreasen cylinders in tempering bath)	1
Through-flow viscometer	1
Equipment for preparation of testing corpuscles	1
Breaking machine- for determination of bonding strength of testing corpuscles	1
Apparatus for determination of abrasivity (used for testing kaolin for paper industry)	1

SUPPLEMENT

Summary of laboratory furniture

	Pcs
High laboratory bench	8
Laboratory sink	4
Low laboratory bench	12
Table for analytical balance	1
Fume cupboard with installed exhaust of detrimental gases	1
Laboratory cabinet	5

Equipment of chemical laboratory with precious metals

Middle sized platinum crucible with lid	16
Platinum finger-shaped crucible with lid	8
Platinum dish ø 80 mm	16
Thermocouple PtRh 10	1

Laboratory chemicals

The consumption of chemicals for 100 analyses is approximately the same as in the Regional Laboratory (analytical laboratory). This applied also to the stock of chemicals for technological laboratory.

Aids for chemical laboratory

Aids for chemical laboratory are estimated in this proposal to be of the same extent as aids of the Regional Laboratory (analytical laboratory - glass and porcelain aids).

Estimate of prices of main deliveries

	US $
Laboratory instruments	34 700
Laboratory furniture	9 200
Platinum crucibles and dishes	47 000
Laboratory aids (laboratory glass and porcelain)	4 000
	94 900

Useful data for investor regarding land development and civil engineering work

Built-up area	126 m^2
Built-up space	504 m^3

FINAL NOTE

It should be emphasized that the submitted proposals were prepared without the knowledge of quality and quantity of raw materials to be tested. Information on actual conditions might considerably change the extent of such a project and consequently the price estimates as well.