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Report

TESTS OF BENTONITES

FROM EGYPT

Qasy Elsaga (Fayoum)
Cairo - Alex. Road
Koum Oshim (Fayoum)

UNIDO PROJECT UC/EGY/83/233
Contract No.84/41

Defined by :	CENTRAL METALLURGICAL RESEARCH AND DEVELOPMENT INSTITUTE NATIONAL RESEARCH CENTRE DOKKI - CAIRO - EGYPT
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C O N T E N T

A B S T R A C T :

Three samples of bentonites from Egyptian localities, i.e.

- Qasy Elsaga (Fayoum) - hand picked
- Cairo-Alex. Road
- Koum Oshim (Fayoum)

have been tested.

The research was aimed for find out their applicability in foundries, for oil decolourization, for bore holes flushing, and for liquidation of wastes from municipal waste water treatment plants.

It was found out through laboratory tests, that these raw materials contain about 50 % of montmorillonite; furthermore the presence of pseudo-monoclinic kaolinite, quartz and hydrated iron oxides was proved. Other minerals like feldspar, gypsum and carbonates are present only in a small quantity.

These bentonites can be applied in foundries only for low-duty castings. The decolourizing ability of mineral oils is low. The suspensions for bore hole flushing may be prepared from all the three types, nevertheless in adding a high percentage of some expensive components. All the three samples are usable in the quality of auxiliary flocculants for dewatering of sludge from municipal waste water treatment plants, as well as of the agent for the treatment of waste waters contaminated by oil matters and by organic polymers dispersions. Also their application for the treatment of waste waters contaminated by food-processing industry and by agricultural waste products may be possible.

In view of the fact, that all samples are composed mostly of particles of a grain size below 1 µm, an improvement of their properties through grain-size up-grading, i.e. through separation of coarse non-clayey fraction, cannot be supposed.

I. INTRODUCTION

Through the Foreign Trade Corporation POLYTECHNA, Prague, the Research Institute for Ceramics, Refractories and Non-metallic Raw Materials in Pilsen received in the framework of UNIDO Project No.UC/EGY/83/233 entitled "TESTS OF BENTONITES", Contract No.84/41, three different samples of bentonites from Egypt to test them and to establish

- their mineralogical and chemical composition
- their physical-mechanical properties
- possibilities of their application in different industrial branches, in geological prospection and in environmental protection

The delivered three bentonite samples, each of them in a volume of 50 kg, were marked as follows :

Sample No.1 - Qasy Elsaga (Fayoum) hand picked bentonite
Sample No.2 - Cairo - Alex.Road bentonite
Sample No.3 - Koum Oshim (Fayoum) bentonite

The evaluation of all samples was carried out according to Czechoslovak State Standards in vigour.

II. CONCLUSIONS AND RECOMMENDATIONS

1) The sample of Qasy Elsaga (Fayoum) hand picked bentonite represents a raw material containing about 50 - 55 wt.% of montmorillonite, with a significant admixture of quartz (15 wt.%), of pseudo-monoclinic kaolinite and of feldspar. The concentration of iron hydroxides and calcium and magnesium carbonates is less significant. Furthermore the presence of siderite, gypsum, titanium minerals and dioctahedric micas can be supposed.

The kaolinite, quartz and other components admixtures are prejudical to the fact, that they reduce the montmorillonite quantity. Due to their specific properties they lower the quality of bentonite (e.g. thermal decomposition of carbonates and gypsum in moulding mixtures in foundries).

2) The Cairo-Alex.Road bentonite sample contains - in addition to montmorillonite - first of all the pseudo-monoclinic kaolinite and quartz. The presence of hydrated iron oxides, feldspars and titanium minerals is negligible. Gypsum and dioctahedric micas are present in trace concentrations only. Calcite and other carbonates were not identified in the sample.

3) The Koum Oshim (Fayoum) bentonite sample is very similar to the Qasy Elsaga (Fayoum) sample. The montmorillonite is polluted first of all by pseudo-monoclinic kaolinite and by quartz, furthermore by iron hydroxides, feldspars and carbonates, namely by calcite. Gypsum and titanium minerals are present in low concentrations only.

4) Granulometric analysis shows a prevailing share of submicron particles as for all the three samples. It is not possible therefore to consider an improvement of the raw material properties by commonly accessible methods of granulometric separation. The laboratory testing of these samples abstained therefore from such an up-grading method.

5) The methylene blue absorption being below 200 $mg.g^{-1}$ certifies usually an unsufficient quantity of montmorillonite in the sample. As for Egyptian bentonites the absorption value indicates e.g. their applicability array for bore hole flushing (the No.2 sample being the best, then No.1 sample and thereafter the No.3 sample follows.)

6) All the samples represent foundry bentonites of low-duty quality which can be used only for the sand moulds production of low - duty castings.

According to the Czechoslovak State Standard ČSN 72 1350 "Bentonite for foundry industry. Quality." a compression strength of 54 kPa at minimum of the activated bentonite's mixtures with a humidity of 3 ± 0,1 % is required. As for the mixtures with 10 ± 1 % humidity, the strength is not prescribed.

All the samples are conform to the lowest mark of non-activated bentonite,because the inferior strength limit is not given. Activated bentonites are not conform to the Standard, namely due to their low strength with 10 ± 1 % humidity.

7) Decolourizing capacity in oil refining is low and the addition of bentonites up-graded by activation (what is common for bentonites applied for decolourization) must be higher if compared with the most Czechoslovak bentonites.

8) During bentonites tests of application in bore hole flushing, best results were achieved in using the sample No.2. As for the other samples,it is necessary to add a higher quantity of additives to achieve desired rheological properties. In this way the expenses for flushing suspension preparation are being increased. Nevertheless it is possible - if some conditions are respected - to prepare a suitable flushing suspension at the base of all the three types of bentonite.

9) All the samples are usable in a quality of auxiliary flocculant (heavy medium) in dewatering digested sludges in municipal waste water treatment plants,adding in the same time $Al_2(SO_4)_3$ and an anion-active flocculant as well. The mixture of the thickened digested municipal sludge after flocculation and dewatering on a sieve-belt press or another appropriate filtering equipment represents a suitable fertilizer with a high content of organic components. It is suitable namely for compostation together with other substances of an organic origin.

   The bentonite influences positively nutrients retaining which otherwise could be washed away soon into inferior soil layers where the plants roots don't reach up. The fertilizing components (nitrates,phosphates) washed away in this way descend into ground waters and then they come again into rivers. Also drinking water can be contaminated.

10) All the samples can be used after their activation in a ferrous cycle for the treatment of waste waters contaminated by oil matters and after activation in a aluminum

cycle for waste waters contaminated by dispersions of organic polymers. It is real to suppose the application of bentonites activated in this way for waste water treatment in food processing industry and in agricultural production.

The sludges leaving the purifying process can be utilized for sandy soils reclaiming or as an additive to composts excluding only sludges contaminated by organic polymers which must be burnt after being dewatered.

III. MINERALOGICAL, CHEMICAL AND TECHNOLOGICAL EVALUATION

1.0. Mineralogical Evaluation

1.1. Methods Applied in Laboratory Research

- macroscopical description of samples
- X-ray goniometry
- differential thermal analysis DTA
- gravimetric thermal analysis GTA
- methylene blue absorption test

1.2. Laboratory Equipment Applied

- X-ray goniometry : MIKROMETA 2 apparatus
  producer : CHIRANA, Czechoslovakia
- DTA, GTA : DERIVATOGRAPH apparatus
  producer : MOM, Hungary

1.3. Qasy Elsaga (Fayoum) Bentonite - Hand Picked

The sample represents a grey-yellow, diagenetically rather solidified and irregularly friable bentonite with a rather high content of pelitic component. The fracture surfaces are slightly granular or almost smooth. The fragments with a smooth surface have generally a gentle fatty feel, a granular surface indicating elevated concentration of a sand-powder admixture. Under microscope minute shells of different faunae types, imprint pictures of animals' shells, minute silica grains as well as fine flakes of light mica have been observed. Calcareous animals' shells correspond first of all to Foraminifera species from the Cambrian to Ordovician Era till recent remnants. Substantial share of greater crystalline aggregates of gypsum with minute calcite grains appear in the most coarse fractions.

Montmorillonite in an approximate concentration of 50-55 % in the sample prevails the silica content of 15 %. Also the pseudo-monoclinic kaolinite and feldspar, both components representing 5 - 10 %, are present. Further on calcium and magnesium carbonates, hydrated iron oxides and siderite reach up to the limit of roughly 5 % of concentration. The presence of titanium minerals and gypsum has approximately the level of 1 %, dioctahedric micas are represented only in a trace concentration.

As for the granulometry, the sample is composed first of all from submicron particles with an admixture of about 30 % of coarser shares. Wet or dry separation process is not suitable therefore, because the product composition will not be too different with regard to the original raw material.

1.4. Cairo - Alex.Road Bentonite

The sample represents grey bentonite with green tint and with frequent rosty-brown spots. It is rather strongly diagenetically solidified and irregularly friable. The fracture surfaces are mostly flat and smooth. A conchoidal fracture has been frequently observed. Through microscope only solitary quartz grains and minute flakes of light mica are percetible. The presence of glauconite indicates the marine origin, but the rock contains neither faunae relicts nor free calcite. This fact can be explained by a greater depth of origin, where already the dissolving of calcium carbonate occurs.

Following respective shares can be estimated : the montmorillonite by 45 - 50 %,the pseudomonoclinic kaolinite by 20 - 25 %, the quartz by 20 % and the hydrated iron oxides by 5 - 10 %. Also feldspars.in a concentration near 5 % occur, the titanium minerals content being approximately of 2 %,the gypsum content about 1 % and dioctahedric micas only in a trace amount.

Also in this sample prevail expressively submicron particles the coarser shares being only by 15 - 20 %. For this reason an effective enrichment of usable components by means of wet or dry separation cannot be supposed.

1.5. Koum Oshim (Fayoum) Bentonite

From the point of view of its macroscopy,the sample is very similar to the hand-picked raw material from Qasy Elsaga locality. Flat and smooth surface prevails on fracture surfaces giving to evidence the absence of a higher quantity of coarser shares. Also the presence of pure gypsum in the form of free grains without calcite admixture represents a certain diversity

The montmorillonite in an approximate concentration of 50 % prevails in the sample the pseudomonoclinic kaolinite with 15 -20 % content and the quartz which can be estimated by 10 - 15 %. In comparison with the Qasy Elsaga bentonite,the sample has a higher content of kaolinite. The iron hydroxides appear in a concentration of 5 - 10 %, the feldspars being on a 5 % limit, the carbonates (above all calcite) on the 3 % level and gypsum in a concentration of about 2 %. The titanium minerals are represented in a share of about 1 %.

Analogically to the raw materials tested before,also this sample is characterized from the point of view of granulometry by a predominant share of submicron particles (about 75 %). It is not possible therefore to look for a more expressive effect in granulometric classification of this raw material.

1.6. Summarization of the Results of Mineralogical Evaluation

The X-ray goniometry results regarding all the three bentonite samples are summarized in the Table No.1. The Table No.2 shows most important data regarding differential thermal analysis and gravimetric thermal analysis. The Table No.3,4 and 5 bring out mineralogical descriptions of the screen oversizes. The table No.6 shows the results of determination of methylene blue absorption. Table No.7 presents the results of granulometric analysis,the particle content above 0,063 mm being determined by wet screening,bellow 0,063 mm by sedimentation method (applied apparatus : SEDIGRAPH 5000-D,producer: Micromeritics,USA).

2.0. Chemical Analysis

For the chemical analysis a combination of classical methodology of silicates chemical analysis,colorimetric methods and atomic absorption spectrophotometry (analyser Perkin-Elmer 403,USA) have been applied.

The chemical analysis results of all the three bentonite samples are summarized in the Table No.8.

3.0. Technological Tests

In the framework of technological tests following availability of all the three bentonite samples has been verified :

- for application in foundries
- for preparation of flushing suspensions
- for decolourization of mineral oils
- for environmental protection

3.1. Applicability in Foundries

3.1.1. Generalities

Bentonite is used as the most frequently applied binding agent in sand moulds and cores preparation for the production of castings from ferrous and non-ferrous metals and from their alloys.

The moulding mixture consists usually of 5 - 7 % bentonite and of 93 - 95 % of sand. In addition to it, the bentonite is being added to the mould and core coatings to prevent sedimentation of different admixtures (corundum, graphite, magnesite etc.). The mixture bentonite/carbonaceous additives is being used for sand moulding mixtures for grey iron castings to improve the surface quality of castings.

The mixtures bentonite/sand have totally pushed back in the practice natural foundry sands containing a clayey component only in a fluctuating quality. An increasing attention is there focussed to the research of bentonites and their application in foundry industry, namely in the context with up-to-date new foundry technologies.

The metal casting into bentonite bound green sand mixtures is proved to be effective as regards steel casting of 150 kg per piece, further on in casting of grey-iron and non-ferrous metals and of their alloys. As far as the bentonite is concerned, its heat stability during its contact with the melted metal is required. The presence of some minerals, e.g. of feldspar, gypsum, limestone a.o. is prejudical in this case.

3.1.2. Experimental

All the samples were evaluated from the point of view of their applicability in moulding sand mixtures used for the castings production according to the Czechoslovak Standard ČSN 72 1350 "Bentonite for foundry industry. Quality". Ground and non-activated bentonites as well as bentonites activated by 4 wt.% of sodium carbonate were tested.

As for non-activated bentonite the Standard mentioned above assesses as the lowest moulding mixture strength (7 % of bentonite and 93 % of sand with a medium grain size d_{50}=0.27 mm) the value of 54 kPa for humidity content of 3 ± 0,1 % and the value of 44 kPa for a humidity content of 10 ± 1 % at minimum.

The test results shown in Tables No.9,10 and 11 indicate that the quality of non-activated bentonites corresponds to the lowest quality class (type Normal 550). The activated bentonites are not suitable at all due to their low strength with a humidity content of 10 ± 1 %.

The addition of 4 wt.% of natrium carbonate prescribed by the Czechoslovak Standard ČSN 72 1350 is optimum only as for the sample No.3, 1 % as for the sample No.1 and 3 % as for the sample No.2. The optimum dosis of Na_2CO_3 addition is determined by the measurement of the sediment volume of bentonite suspension after adding 1 % up to 8 % of Na_2CO_3 in relation to the dry matter. Due to a very low strength of moulding sand mixtures it is not possible to consider an improvement of their properties,neither with an optimum addition of Na_2CO_3 as activating agent.

3.1.3. Evaluation of the Tests

All the bentonite samples under tests display only low-level properties and their application could come into consideration only for simple castings of grey-iron or non-ferrous metals and of their alloys. Low mechanical strength of moulding mixtures based on non-activated and activated bentonites exclude their application in steel casting technology.

3.2. Application in Geological Survey and Geological Engineering

3.2.1. Generalities

Colloidal and rheolog :al properties of bentonite suspensions are asserted very efficiently in geological survey and geological engineering as flushing suspensions for bore holes or as sealing and plugging materials. The preparation of drilling fluid has its biggest importance in prospecting of petroleum,natural gas or minerals deposits.

The bentonite based drilling fluid has to present following properties :

- low viscosity for its easy pumping by the circulating system into the bore hole
- sufficiently high thixotropy enabling buoyancy of the rock drilled out of the hole and precluding the sedimentation of rock fragments if the flushing circulation be interrupted
- high degree of bentonite particles dispersion and the abilit to bind on their surface a maximum quantity of water,which tends to infiltrate into the hole walls
- the bentonite suspension has to form on the bore hole wall impervious,elastic and thin layer preventing the penetration of water into the surrounding rock
- the suspension has to have a pH-value higher then 7 to prevent corrosion effect of the suspension on drilling tools, pumps and tubes

The bentonite concentrates all the properties required just by relatively low concentration of the suspension being mostly by 6 - 8 % of bentonite.

It is well known that mineral salts e.g. $NaCl$,$CaCl_2$,$CaSO_4$ are intensive coagulating agents of bentonite suspensions, because they increase their viscosity and flow limit and worsen at the same time the pumping ability of the suspension. A high temperature in the bore hole has a similar unfavourable effect being the cause of coagulation of bentonite particles. It is necessary therefore to stabilize thermally the suspensions by adding anorganic and organic plastifiers or so called protective colloids. Lignin compounds, complex phosphates, oxylates and others are being used as plastifiers, cellulose compounds (karboxymethylcellulose), polysacharides (starch, dextrin), polyacrylate compounds (polyacrylamide, natrium methyl-metacrylate) a.o. as protective colloids. The function of plastifiers and protective colloids is verified by tests, most frequently according to the API (American Petroleum Institute) methodology.

3.2.2. Experimental

The samples delivered to be tested have been up-graded by crushing by means of a jaw crusher. Following dry matter content were determined :

sample No.1	92,29 %
sample No.2	90,64 %
sample No.3	93,60 %

Technological process of the tests :

1) Influence of bentonite concentration to rheological and colloidal suspension properties

The influence of bentonite concentration to rheological and colloidal suspension properties have been observed as for the suspensions with a concentration of 4 - 6 - 7 - 8 - - 10 % of bentonite. The apparent suspension viscosity of the bentonite samples raises by the concentration increase. As for the sample No. 1 and 3, very low values have been achieved, the sample No.2 shows a value corresponding to the 1.a class of bentonite (as well as to the API specification). The values of filtering ability are high, especially as for the sample No.3. The test results are shown in Table No.12, 13 and 14.

2) Determination of an optimum quantity of Na_2CO_3 as natrification agent

The determination of an optimum Na_2CO_3 quantity for the natrification of bentonite has been carried out by adding 2 - 3 - 4 - 5 - 6 - 7 %, eventually also - if need be - 12 wt.% of soda ash (in relation to the bentonite mass) into a 6 % bentonite suspension. After 24 hours of maturing rheological and colloidal suspension properties have been measured. The results are shown in Tables No.15, 16 and 17.

In increasing the soda ash concentration, the sample No.1 shows an anomalous behaviour. The apparent viscosity value increases up to 4 wt.% of soda concentration, meanwhile a higher soda quantity does not influence this value. In the same way the filtering ability value decreases up to a concentration of 4 wt.% of soda, but furtheron it does not change practically. As for the sample No.2 the apparent viscosity value achieves its optimum by adding 3 - 4 wt.% of soda. Higher soda concentration originates already the suspension coagulation which results also in an increase of filtering ability values. As for the sample No.3, only an imperceptible and non-satisfactory increase of apparent viscosity values takes place after natrification. The optimum value of filtering ability has been achieved with 6 wt.% of soda ash.

3) Modification possibilities of rheological and colloidal properties of a 6 % bentonite suspension natrified by an optimum soda quantity by means of drilling fluid additives

To modify rheological and colloidal properties of natrified 6 % bentonite suspension, the following drilling fluid additives have been chosen, which are being applied in practice most frequently :

- SOKRAT 44 acrylate dispersion and KMC TS-20 polymers (carboxymethylcellulose) for modifying the filteringability and suspension stability
- HUMITAN (natrium huminate) and natrium pyrophosphate for the improvement of rheological properties of the liquefying agent

The test results are shown in the Table No.18,19 and 20.

Due to low values of suspension apparent viscosity of the sample No.1 it is more useful for the modification of rheological properties to utilize high-molecular polymers as e.g. KMC TS-20 mentioned above. Although the SOKRAT 44 influence to the filtering ability value is almost identic in comparison with the KMC TS-20 influence,it would be useful to increase its dosing to achieve satisfactory values of apparent viscosity. HUMITAN and pyrophosphate have a good liquefying effect.

As for the sample No.2,it is more advantageous to use the polymers with medium molecular mass,e.g. SOKRAT 44,in the function of anti-filtering agent and stabilizer. KMC TS-20 deteriorates rheological properties. The pyrophosphate seems to be an effective liquefying agent.

As for the sample No.3 showing very low rheological values of the natrified suspension,it is necessary to use higher polymers concentration to achieve satisfying values of apparent viscosity.

3.2.3. Evaluation of the Tests Carried Out

According to the evaluation results of laboratory testing of samples No.1,2 and 3,the sample No.2 can be estimated as the best one. To modify namely the rheological properties of flushing suspensions,the samples No.1 and No.3 need a higher concentration of polymers or of special high-mollecular polymers or copolymers. The modification of such suspensions is therefore also an economical problem. In principle it can be said nevertheless,that a convenient flushing suspension can be prepared on the base of all the three respective samples. The difference consists in the intricacy of the modification of its properties.

3.3. Oil Decolourization

3.3.1. Generalities

As for the decolourization of edible and mineral oils, not only an improvement of the colour,but also the retaining of non-desired components of mostly colloidal character is the matter,because they can - namely as for the edible oil - influence disfavourably its flavour properties.

Formerly the activated carbon was used for oil bleaching and refining,but it is too expensive and binds in itself a high oil quantity - mostly 100 - 140 % of its own mass - causing product losses in this way.

The disadvantage in using activated carbon for oil decolourization were successfully removed by application of so called bleaching clays produced mostly on the base of bentonite. The mineralogical character of some bentonites enables their application in the natural state,only after having crushed,dried and ground them.Nevertheless the majority of bentonites need to be upgraded,i.e.activated by acids.

The bentonite is blunged in water to get a thick suspension,a calculated quantity of HCl or H_2SO_4 is added,the content is heated up to the boiling point and let to stand for 24 hours. Then it is dewatered in filter-presses,the acid being washed out by means of water. The filter cakes are dried to a final humidity of 5 - 8 % and ground to the desired grain size.

The principle of the bentonite activation by acids is not deffinitely cleared up till now. It is supposed that hydrogen from mineral acids substitutes in the surface layers of clay minerals the Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} cations, which become then active centres of sorption or of catalysis.

It is requested that the bleaching agents have only the adsorption effect and that they don't change chemical and physical properties of oils and fats. These requirements are fulfilled almost completely by the recently applied bleaching clays. As for edible oils it can happen sometimes, that the oil acquires the characteristic "earth-like" flavour, but it can be easily removed by deodorization.

High-quality adsorption agents ought to have the highest decolourizing effect. In practice 0,3 - 2,0 % of bleaching clay in relation to the total mass of oil is being added. The decolourizing agent has to remove not only some colourizing substances, but it has to remove if possible all of them. Any agent doesn't correspond generally to this requirement. Therefore the bleaching clays for oil and fat bleaching are being combined with activated carbon in a quantity of about 10-20 % to the applied quantity of bleaching clay.

The degree of decolourization can be stated by ocular evaluation only or by means of a photocolorimetric method comparing a certain layer of the original oil with a thickness of the decolourized oil layer, if its colour be equal to that of non-decolourized oil. If e.g. a layer of non-decolourized oil 2 cm thick can be compared with a layer of decolourized oil 10 cm thick, the oil has been decolourized by 80 %.

For evaluation of bleaching clays it is necessary to take into consideration also the oil and fat retention in the bleaching clay. Some clays even after having been blown-through by steam or air retain about 30 - 60 % of oil. It can be regenerated e.g. by petrol extraction but still oil quantity and quality losses occur. In many cases the bleaching clay doesn't recycle, its sorption capacity being always lower compared with the original material.

3.3.2. Experimental

All the three samples have been activated by acid in the Research Institute for Ceramics, Refractories and Non-metallic Raw Materials in Pilsen. The bentonites were treated with boiling hydrochloric acid for 2 hours. The samples were washed out by distilled water up to 6,7 pH value through decantation in a centrifuge and thereafter on a paper filter. The end of washing-out was controlled according to the reaction of Cl^- by means of $AgNO_3$ solution in the filtrate. Thereafter the samples were dried and crushed to a grain size below 0,063 mm.

The evaluation of decolourizing ability was realized by ocular estimate, because the differences in colour shade were minimal and not perceptible by using the measuring method according to the ISO scale (Czechoslovak State Standard ČSN 65 6076 "Determination of colour to ISO").

Decolourizing tests were carried out with following three types of mineral oils :

OHL oil - gained by de-paraffining hydrogenated light oil fraction after crude-oil distillation

OHS 90 oil - gained after de-paraffining hydrogenated middle oil fraction after crude-oil distillation

R 774 W oil - gained after de-paraffining the distillation residue after crude-oil distillation selectively refined by the mixture of phenol-cresol solvents

For comparison a sample of Czechoslovak-make bleaching clay has been used.

The decolourizing test was carried out with all the three samples as follows :

100 g of the respective mineral oil was heated up to the temperature of 90 °C, thereafter a chosen quantity of bleaching clay was added (0,1 ÷ 2,0 %); after 0,5 hour of stirring by means of a mechanical mixer this oil/clay mixture was filtered by means of filtering paper and the colour of the filtrate gained in this way was evaluated.

As for the OHL oil,following doses of decolourizing agents were tested : 0,1 %, 0,25 %, 1,0 %; as for OHS 90 oil : 0,1 %, 0,35 %, 1,0 %; as for the R 774 W oil : 0,6 %, 1,0 %, 2,0 %.

As far as the OHL and OHS 90 oils is concerned,best results have been achieved in all cases using Czechoslovak bleaching clay and thereafter the Egyptian bentonite sample No.2. As for the R 774 W oil,the decolourizing ability of the bentonite sample No.2 can be compared to the Czechoslovak bleaching clay; if adding 2,0 %, the Egyptian bentonite No.2 showed even better results.

3.3.3. Evaluation of the Tests Carried Out

The decolourizing ability of Egyptian bleaching clays doesn't achieve the decolourizing ability level of the Czechoslovak bleaching clay. Nevertheless,this level may be almost achieved by using the bleaching clay based on the bentonite sample No.2.

3.4. Application of Bentonites in Environmental Protection

3.4.1. Generalities

The high sorption capacity of bentonites comes to be utilized even more frequently to solve the problems of environmental protection. Recently the attention is focussed to waste waters from industry,agriculture and households which are frequently discharged into water flows without being purified appropriately. In this way also toxic substances come into rivers,causing in emergency cases ecological disasters,e.g. fish perishing,vegetetion annihilation,impossibility of water recycling for industrial purposes,or - first-of-all - of drinking water treatment.

It has been established,that the addition of bentonite can remove oil products from water,i.e. not only those which are emulsified in the water and influence in this way namely the flavour properties of drinking water. In the same way it is possible to remove by means of bentonite high-mollecular substances from the water,e.g. latices or other water soluble surface activ matters. It has been proved,that bentonite is able to retain also heavy metals which are toxic for living organisms.

3.4.2. Experimental

The samples of Egyptian bentonites were used for dewatering of sludges from the municipal waste water treatment plants. The bentonite is used in a mixture of 75 wt.% of bentonite + 25 wt.% of $Al_2(SO_4)_3.18\ H_2O$ as an auxiliary flocculant and heavy medium into the thickened digested sludge. Another advantage of this mixture consists in the possibility of utilizing a less expensive anionic flocculant (in this case the PRAESTOL 2935 anionic flocculant in a quantity of 0,5 - 1,0 g per 1 kg of the dry matter of the digested sludge) in comparison to the cationic flocculant used without bentonite addition (PRAESTOL 543 K in a quantity of more then 3 g per 1 kg of the dry matter of digested sludge).

The municipal sludge with bentonite and flocculant addition can be easily dewatered on a sieve belt press,so that the dry matter content increases from the original 5 wt.% to about 30 wt.%. In laboratory conditions the dewatering process by means of the sieve belt press is modelled by means of a static sieve mesh 0,3 x 0,2 mm which corresponds to the mesh size of a sieve belt press. It has been proved that all the three samples are usable as auxiliary flocculant (heavy medium).

The sludge dewatered in this way present a high-quality organo-mineral fertilizer usable immediately to fertilize the plants or to compost it together with other organic wastes. The dewatered sludge can be loaded and transported by current manipulation equipment and conveyances.

The practical importance of such a fertilizer consists in its nutrients retaining capacity, which could be - namely in sandy soils-quickly washed by water away and without use into inferior soil layers whereto the plants roots don´t rea These dissolved fertilizing substances (nitrates, phosphates, potassium, trace elements) can come in this way in the natura hydrologic cycle into ground water flows, wherefrom water is pumped to be treated for drinking water. This imperceptible water contamination, its "salination" becomes to be an ever more serious problem. Just the bentonite application for waste water treatment could contribute very significantely to solve this problem.

Furthermore the bentonite application for the treatment of waters contaminated by oil and organic polymers dispersions (latices etc.) has been tested under laboratory conditions.

All the three bentonite samples were activated in a ferrou and aluminium cycle. To verify the sorption capacity of oil matters the bentonites activated in a ferrous cycle were test

It was proved, that for the treatment of waste water contam ned by 50 mg per liter of Diesel oil emulsified by anion-acti ve surfactant it is possible by adding 5 g of bentonite activated in a ferrous cycle and by pH value modification to achi eve deemulsification of oil matters and their sorption to ben tonite with an effeciency of 99,5 %. The oil matter content in outlet water was 0,13 mg per liter at maximum or it was not identified at all.

The sludge saturated by oil matters settles down very well.

The oil matters retaining capacity of the bentonite activated in aluminium cycle was not tested, because experience of the Research Institute for Ceramics sh a higher efficiency of the ferrous bentonite in this field.

To verify the treatment of waste waters contaminated by organic polymers dispersions, water polluted by dispersion of the styrene copolymer, of butylacrylate and by n-butoximethylacrylamide in a quantity of 10 g/l was tested. All the three samples of bentonite activated in a ferrous or aluminium cycle were used as sorbents.

After having added the bentonite to the waste water and after the pH-value modification,the deemulsification of impurities and their sorption to bentonite occurred. The sludge sediments very well and forms great flakes which can be easily dewatered. An effective dose of aluminium activated bentonite is about 5 - 8 g/l, of ferrous activated bentonite about 12 g/l of waste water. From the point of view of the oxygen chemical consumption the efficiency of the purifying process was higher then 98,5 %.

The test results are shown in the Table No.21.

3.4.3. Evaluation of the Tests Carried Out

In laboratory conditions the applicacion of Egyptian bentonites was tested using them as auxiliary flocculants for dewatering of digested thickened municipal sludges on a sieve belt press. In all the three cases the bentonites proved to be well usable for this purpose. The mixture of the digested sludge with the bentonite shows to be a good type of fertilizer namely for sandy soils.

In the field of waste water treatment it was proved by laboratory tests,that all the three samples of bentonite are very efficient for the treatment of waste waters contaminated by oil hydrocarbons and by organic polymers dispersions.

As for the oil matters,the activation of bentonite in a ferrous cycle is suitable. The best efficiency was proved as for the Qasy Elsaga bentonite.

As far as the organic polymers dispersions is concerned, the activation of bentonite in aluminium cycle is more suitable,a slightly lower efficiency was proved as for the Qasy Elsaga bentonite.

Basing on analogical experiences in application of bentonites for waste water treatment it is possible to suppose a good efficiency of bentonites after their activation in the aluminium or ferrous cycle for the treatment of waste waters in food-processing or in agricultural production.

IV. FINAL NOTE

Through a complex of mineralogical, chemical and technological tests a laboratory evaluation of three different Egyptian bentonite samples marked as

Sample No.1 - Qasy Elsaga (Fayoum) bentonite hand picked
Sample No.2 - Cairo - Alex.Road bentonite
Sample No.3 - Koum Oshim (Fayoum) bentonite

were carried out.

Laboratory tests proved, that the average montmorillonite content in these samples be 50 %, so that all bentonites show an mediocre quality.

These bentonites, namely that of sample No.2, could be applied in practice for bore hole flushing suspensions, but only in increasing the addition of expensive additives. All types are suitable for the production of organic-mineral fertilizer with a thickened digested sludge originated in municipal waste water treatment plants, and - after having been activated in the aluminium or ferrous cycle - also for the purifying of waste waters polluted by oil matters, by organic polymers dispersions, by food processing and agricultural products. With certain reservations it is possible to recommend them also for the mineral oil decolourization. For foundry purposes the tested bentonites have only a limited applicability (grey iron, non-ferrous metals and their alloys).

V. REFERENCES

- Records of laboratory tests carried out in the Research Institute for Ceramics, Refractories and Non-metallic Raw Materials in Pilsen - Research Division at Karlovy Vary
- Records of laboratory tests carried out in the Research Institute for Geological Engineering in Brno
- Records of laboratory tests carried out in the Institute for Non-metallic Raw Materials at Kutná Hora
- Czechoslovak State Standards :

  ČSN 72 1350 - Bentonite for foundry industry.Quality.

  ČSN 72 1083 - Thermal analysis of ceramic raw material

  ČSN 65 6076 - Colour determination according to the ISO scale

LIST OF TABLES

Table No. 20

Modification of Rheological and Colloidial Properties of the 6 % Activated Bentonite Suspension - Sample No. 3

Table No. 21

Purifying Tests of Waste Waters Contaminated by Oil Matters and by Organic Polymers Dispersions by Means of Bentonite

Table No.1 - X-Ray Goniometry of the Egyptian Bentonites (most important relative intensities are tabulated)

Position of the diffraction (nm)	Interpretation	Relative Intensity		
		Qasy Elsaga (Fayoum) -hand picked	Cairo-Alex.Road	Koum Oshim (Fayoum)
1,310	montmorillonite	7	7	8
0,728	kaolinite	8	9	10
0,447	montmorillonite kaolinite	6	7	7
0,429	quartz	8	8	8
0,360	kaolinite	8	9	9
0,336	quartz	10	10	10
0,326	feldspar	9	8	7
0,321	feldspar	9	8	8
0,306	calcite	7	-	7
0,290	dolomite	7	6	-
0,246	quartz	6	7	7
0,228	quartz	6	6	6

Table No. 2 - Thermal Analyses of Egyptian Bentonites

Temperature Interval (°C)	Maximum Temperature of Process (°C)	Interpretation	Weight loss in %		
			Qasy Elsaga (Fayoum) hand picked	Cairo - Alex. Road	Koum Oshim (Fayoum)
up to 190	110	humidity and molecular water loss	6,62	9,83	6,31
190-420	-	dehydroxylation of hydrated iron oxides etc.	1,32	1,17	1,16
420-600	535	dehydroxylation of phylosilicates	3,48	5,00	5,32
600-1000	710	carbonates dissociation	1,82	0,67	1,50
--	915	structural changes	-	-	-

Table No. 3 - Mineralogical Composition of Screen Residue (Oversize) of the Qasy Elsaga (Fayoum) Hand Picked Bentonite in %

Mineral	Oversize on Screen (mm)				
	1,0	0,5	0,315	0,125	0,063
Iron hydroxides	50	70	40	5	5
Quartz	--	5	5	10	90
Muscovite	--	--	acc.	5	acc.
Sea fauna	--	5	15	20	acc.
Glauconite	--	acc.	30	60	5
Calcite	5	5	5	acc.	acc.
Gypsum with calcite	45	15	5	acc.	-

acc. = accessories

Table No. 4 - Mineralogical Composition of Screen Residue (Oversize) of the Cairo-Alex.Road Bentonite in %

Mineral	Oversize on screen (mm)				
	1,0	0,5	0,315	0,125	0,063
Iron hydroxides	--	30	20	5	1
Quartz	--	65	80	90	98
Muscovite	--	--	--	5	1
Glauconite	--	--	--	acc.	acc.
Gypsum	--	--	--	acc.	--
White gypsum without calcite	--	5	--	--	--

acc. = accessories

Table No.5 - Mineralogical Composition of Screen Residue (Oversize) of the Koum Oshim (Fayoum) Bentonite in %

Mineral	Oversize on screen (mm)				
	1,0	0,5	0,315	0,125	0,063
Iron hydroxides	10	40	45	5	5
Quartz	acc.	2	10	40	85
Muscovite	--	--	--	5	2
Sea fauna	--	--	15	20	3
Glauconite	--	--	--	acc.	acc.
Gypsum in free grains	--	3	10	20	5
Calcite	--	5	5	5	acc.
White gypsum with calcite	90	50	15	5	acc.

acc. = accessories

Table No. 6 - Results of Determination of Methylene Blue Absorption Level in the Respective Egyptian Bentonites

Sample No.	Methylene Blue Quantity in mg/g
1	186,86
2	221,89
3	141,26

Table No. 7 - Granulometric Distribution in Egyptian Bentonites

Fraction (mm)	Share in wt. %		
	Sample No.1 Qasy Elsaga	Sample No.2 Cairo-Alex.R.	Sample No.3 Koum Oshim
over 1,0	0,15	0,00	0,33
1,0 - 0,5	0,03	0,06	0,05
0,5 - 0,315	0,04	0,10	0,03
0,315 - 0,125	0,40	0,53	0,15
0,125 - 0,063	5,76	3,05	1,60
0,063 - 0,020	3,74	0,00	1,00
0,020 - 0,010	3,74	0,00	4,89
0,010 - 0,005	3,74	2,89	1,96
0,005 - 0,002	7,49	4,81	6,85
0,002 - 0,001	2,81	2,89	6,85
below 0,001	72,10	85,67	76,29

Table No. 8 - Chemical Analyses of Egyptian Bentonites (in wt. %)

	Sample No.1 Qasy Elsaga	Sample No.2 Cairo-Alex.R.	Sample No.3 Koum Oshim
l.o.i.	9,20	10,53	10,09
SiO_2	55,65	54,90	54,45
TiO_2	1,06	1,66	1,12
Al_2O_3	17,36	21,47	21,03
Fe_2O_3	8,40	6,0[illegible]	6,41
MgO	2,04	1,61	1,32
CaO	2,72	0,39	2,03
K_2O	1,44	2,15	1,62
Na_2O	1,45	0,75	1,26
Total	99,32	99,53	99,23

Table No. 9 - Properties for Foundry Application - Sample No. 1

	Unit	Non- activated bentonite				Bentonite activated by 4 % of Na_2CO_3	
Mixture humidity	%	2,85	3,20	3,65	10,5	3,20	10,25
Mass of the test specimen	g	148	151	152	168	150	169
Permeability	NU	153	124	120	38	137	47
Compression strength	kPa	61,6	51,6	46,3	27,3	60,6	25
Shear strength	kPa	12	10,6	9,6	5	12	5
Tensile strength in the condensation zone	kPa	1,75	1,6	1,5	--	1,33	--
Compresion strength after drying 200 °C/2h.	MPa	0,27	0,58	0,58	1,21	0,24	0,94
Compressibility	%	61	61	60	53,3	62	55

NU = normal units

Table No. 10 - Properties for Foundry Application -
- Sample No. 2

	Unit	Non-activated bentonite		Bentonite activated by 4 % of Na_2CO_3	
Mixture humidity	%	3,2	10,4	3,3	10,6
Mass of the test specimen	g	150	169	149	169
Permeability	NU	129,6	43	138,3	39
Compression strength	kPa	65	23,6	78,6	25,3
Shear strength	kPa	12	4,6	14,6	5
Tensile strength in the condensation zone	kPa	0,88	-	0,95	-
Compression strength after drying 200 °C/2h	MPa	0,52	1,25	0,48	1,26
Compresibility	%	62	55	62	54,6

NU = normal units

Table No. 11 - Properties for Foundry Application -
- Sample No. 3

	Unit	Non-activated bentonite		Bentonite activated by 4 % of Na_2CO_3	
Mixture humidity	%	2,75	10,1	3,25	10,65
Mass of the test specimen	g	149	169	150	169
Permeability	NU	142,6	48	129,3	50,3
Compression strength	kPa	63	20	60,3	19,3
Shear strength	kPa	11,6	3,6	12	4,3
Tensile strength in the condensation zone	kPa	1,55	--	0,95	--
Compression strength after drying 200°C/2h	MPa	0,24	0,85	0,25	0,68
Compressibility	%	60,3	50,3	62	53

NU = normal units

Table No. 12 - Influence of Concentration of Egyptian Bentonite Suspension to its Rheological Properties - Sample No.1 - Qasy Elsaga

Measurement	Units	Sample No.				
		1	2	3	4	5
FANN viscosimeter						
600 r.p.m.	Pa	1,91	4,79	8,14	11,01	18,19
300 r.p.m.	Pa	1,44	3,35	6,22	8,61	16,28
200 r.p.m.	Pa	1,19	2,87	5,74	8,14	15,32
100 r.p.m.	Pa	0,96	2,39	4,79	7,18	14,36
6 r.p.m.	Pa	0,48	0,96	3,83	6,22	13,89
3 r.p.m.	Pa	0,00	0,48	3,35	5,74	13,41
Plastic viscosity	mPa.s	1	3	4	5	4
Bingham flux limit	Pa	0,96	1,91	4,31	6,22	14,36
Apparent viscosity	mPa.s	2	5	8,5	11,5	19
Flux limit after 10''	Pa	0,48	0,96	2,39	4,79	15,80
Flux limit after 10'	Pa	0,96	3,83	8,14	14,36	29,69
Filtering capacity API	ml/30'	40,0	32,0	32,0	26,0	25,0
Filtering crust	mm	0,90	1,31	1,64	1,68	1,95
Specific mass	$kg.m^{-3}$	1 020,2	1 030,7	1 040,4	1 054,7	1 070,8

Sample No.1 = 4 % bentonite suspension
" 2 = 6 % " "
" 3 = 7 % " "
" 4 = 8 % " "
" 5 = 10 % " "

Table No. 13 - Influence of Concentration of Egyptian Bentonite Suspension to its Rheological Properties - Sample No.2 - Cairo - Alex.Road

Measurement	Units	Sample No.				
		1	2	3	4	5
FANN viscosimeter						
600 r.p.m.	Pa	8,14	17,24	21,07	28,25	48,84
300 r.p.m.	Pa	7,18	15,80	19,63	26,81	47,88
200 r.p.m.	Pa	6,22	14,36	18,19	25,38	46,92
100 r.p.m.	Pa	5,27	13,89	17,24	24,90	45,97
6 r.p.m.	Pa	2,87	12,45	16,28	23,94	44,05
3 r.p.m.	Pa	1,44	11,97	15,32	23,46	43,09
Plastic viscosity	mPa.s	2	3	3	3	2
Bingham flux limit	Pa	6,22	14,36	18,19	25,38	46,92
Apparent viscosity	mPa.s	8,5	18,0	22,0	29,5	51,0
Flux limit after 10''	Pa	3,83	9,58	10,05	14,36	24,66
Flux limit after 10'	Pa	5,74	11,49	14,36	17,24	27,77
Filtering capacity API	ml/30'	38,0	33,0	31,0	29,0	25,0
Filtering crust	mm	1,25	1,63	1,58	2,06	2,22
Specific mass	$kg.m^{-3}$	1 009,5	1 036,6	1 049,2	1 049,6	1 110,2

Sample No. 1 = 4 % bentonite suspension
" 2 = 6 % " "
" 3 = 7 % " "
" 4 = 8 % " "
" 5 = 10 % " "

Table No. 14 - Influence of Concentration of Egyptian Bentonite Suspension to its Rheological Properties - Sample No.3 - Koum Oshim

Measurement	Units	Sample No.				
		1	2	3	4	5
FANN viscosimeter						
600 r.p.m.	Pa	1,91	3,35	5,27	7,66	10,05
300 r.p.m.	Pa	1,44	2,39	3,83	5,74	8,61
200 r.p.m.	Pa	0,96	1,91	3,35	5,27	8,14
100 r.p.m.	Pa	0,48	1,44	2,87	4,79	7,66
6 r.p.m.	Pa	0,48	0,96	2,39	4,31	7,18
3 r.p.m.	Pa	0,48	0,48	1,91	3,83	6,22
Plastic viscosity	mPa.s	1	2	3	4	3
Bingham flux limit	Pa	0,96	1,44	2,39	3,83	7,18
Apparent viscosity	mPa.s	2,0	3,5	5,5	8,0	10,5
Flux limit after 10''	Pa	0,48	0,96	2,87	4,31	8,61
Flux limit after 10'	Pa	0,48	1,91	5,74	9,10	15,32
Filtering capacity API	ml/30'	60	45	43	42	38
Filtering crust	mm	0,95	1,15	1,25	1,27	1,27
Specific mass	$kg.m^{-3}$	1 046	1 047	1 048	1 049	1 050

Sample No. 1 = 4 % bentonite suspension
" 2 = 6 % " "
" 3 = 7 % " "
" 4 = 8 % " "
" 5 = 10 % " "

Table No. 15 - Determination of Optimum Quantity of Na_2CO_3 Added as Natrification Agent to the Egyptian Bentonite - Sample No.1 - Qasy Elsaga

Measurement	Units	Sample No.					
		1	2	3	4	5	6
FANN viscosimeter							
600 r.p.m.	Pa	7,18	9,10	9,10	9,10	9,10	7,18
300 r.p.m.	Pa	6,22	6,70	7,18	7,18	7,18	5,27
200 r.p.m.	Pa	5,27	5,74	6,22	6,70	5,74	4,31
100 r.p.m.	Pa	4,79	4,79	5,74	6,22	5,27	3,83
6 r.p.m.	Pa	4,31	4,31	5,27	5,27	4,79	3,83
3 r.p.m.	Pa	3,83	3,83	4,79	4,79	4,31	3,35
Plastic viskosity	mPa.s	2	5	4	4	4	4
Bingham flux limit	Pa	5,27	4,31	5,27	5,27	5,27	3,35
Apparent viscosity	mPa.s	7,5	9,5	9,5	9,5	9,5	7,5
Flux limit after 10''	Pa	3,35	3,35	3,83	4,31	4,31	3,35
Flux limit after 10'	Pa	12,93	14,36	11,49	13,41	13,41	12,93
Filtering capacity API	ml/30'	30,0	28,0	28,0	28,0	29,0	33,0
Filtering crust	mm	1,58	1,50	1,62	1,54	1,55	1,43
Specific mass	$kg.m^{-3}$	1 030,6	1 036,5	1 030,0	1 040,5	1 025,8	1 039,1

Sample No. 1 = 6 % bentonite suspension + 3 % Na_2CO_3
2 = 6 % " " + 4 % "
3 = 6 % " " + 5 % "
4 = 6 % " " + 6 % "
5 = 6 % " " + 7 % "
6 = 6 % " " + 12 % "

Table No. 16 - Determination of Optimum Quantity of Na_2CO_3 Added as Natrification Agent to the Egyptian Bentonite - Sample No.2 - Cairo-Alex.Road

Measurement	Units	Sample No.						
		0	1	2	3	4	5	6
FANN viscosimeter								
600 r.p.m.	Pa	18,67	24,90	23,94	20,59	20,11	19,15	16,28
300 r.p.m.	Pa	16,76	22,50	21,54	19,15	19,15	18,19	14,36
200 r.p.m.	Pa	16,28	22,03	21,54	19,15	19,15	16,76	13,89
100 r.p.m.	Pa	14,36	21,54	21,07	18,19	18,67	16,28	13,41
6 r.p.m.	Pa	13,41	21,07	20,59	17,72	18,19	15,80	12,93
3 r.p.m.	Pa	11,49	19,15	20,59	17,24	17,73	15,32	12,45
Plastic viscosity	mPa.s	4	5	5	3	2	2	4
Bingham flux limit	Pa	14,84	20,11	19,15	17,72	18,19	17,24	12,45
Apparent viscosity	mPa.s	19,5	26,0	25,0	21,5	21,0	20,0	17,0
Flux limit after 10''	Pa	11,49	20,11	22,98	21,07	20,59	20,11	14,36
Flux limit after 10'	Pa	15,32	34,95	33,52	32,56	28,73	30,64	23,94
Filtering capacity API	ml/30'	38,0	31,0	30,0	30,0	32,0	33,0	38,0
Filtering crust	mm	2,44	2,35	2,31	2,05	2,13	1,87	2,10
Specific mass	$kg.m^{-3}$	1 046,0	1 057,1	1 046,6	1 048,5	1 028,0	1 054,0	1 025,2

Sample No. 0 = 6 % bentonite suspension + 2 % Na_2CO_3
1 = 6 % " " + 3 % "
2 = 6 % " " + 4 % "
3 = 6 % " " + 5 % "
4 = 6 % " " + 6 % "
5 = 6 % " " + 7 % "
6 = 6 % " " + 12 % "

Table No. 17 - Determination of Optimum Quantity of Na_2CO_3 Added as Natrification Agent to the Egyptian Bentonite - Sample No.3 - Koum Oshim

Measurement	Units	Sample No.					
		1	2	3	4	5	6
FANN viscosimeter							
600 r.p.m.	Pa	3,35	3,83	4,31	3,83	4,31	6,22
300 r.p.m.	Pa	2,39	2,87	2,87	2,87	2,87	4,31
200 r.p.m.	Pa	1,91	1,91	2,39	1,91	2,39	3,83
100 r.p.m.	Pa	1,44	1,44	1,91	1,44	1,91	2,87
6 r.p.m.	Pa	0,96	0,96	1,44	0,96	1,44	2,39
3 r.p.m.	Pa	0,48	0,48	0,96	0,48	0,96	1,44
Plastic viscosity	mPa.s	2	2	3	2	3	4
Bingham flux limit	Pa	1,44	1,91	1,44	1,91	1,44	2,39
Apparent viscosity	mPa.s	3,5	4,0	4,5	4,0	4,5	6,5
Flux limit after 10''	Pa	0,48	0,96	1,44	0,96	0,96	2,87
Flux limit after 10'	Pa	4,31	4,31	4,31	4,31	4,31	7,18
Filtering capacity API	ml/30'	42,0	42,0	42,0	35,0	41,5	48,0
Filtering crust	mm	1,49	1,45	1,45	1,46	1,45	1,43
Specific mass	$kg.m^{-3}$	1 049,0	1 039,0	1 038,0	1 048,0	1 046,0	1 048,0

Sample No. 1 - 6 % bentonite suspension + 3 % Na_2CO_3
2 = 6 % " " + 4 % "
3 = 6 % " " + 5 % "
4 = 6 % " " + 6 % "
5 = 6 % " " + 7 % "
6 = 6 % " " + 12 % "

Table No. 18 - Modification of Rheological and Colloidal Properties of the 6 % Activated Bentonite Suspension -Sample No.1 - Qasy Elsaga

Measurement	Units	Sample No.					
		1	2	3	4	5	6
FANN viscosimeter							
600 r.p.m.	Pa	14,84	22,03	8,61	12,45	3,35	2,39
300 r.p.m.	Pa	8,61	13,89	4,79	6,70	1,91	1,91
200 r.p.m.	Pa	7,18	10,53	3,83	5,27	1,44	0,96
100 r.p.m.	Pa	4,79	6,70	1,91	3,35	0,96	0,48
6 r.p.m.	Pa	0,96	1,44	0,48	0,48	0,48	0,0
3 r.p.m.	Pa	0,48	0,96	0,0	0,0	0,0	0,0
Plastic viscosity	mPa.s	13	17	8	12	3	1
Bingham flux limit	Pa	2,39	5,74	0,96	5,74	0,48	1,44
Apparent viscosity	mPa.s	15,5	23,0	9,0	13,0	3,5	2,5
Flux limit after 10''	Pa	0,96	0,96	0,48	0,96	0,96	0,48
Flux limit after 10'	Pa	3,35	3,35	0,96	0,96	0,96	0,48
Filtering capacity	ml/30'	11,5	9,0	10,0	13,5	13,0	22,0
Filtering crust	mm	0,43	0,45	0,48	0,38	0,06	0,80
Specific mass	$kg.m^{-3}$	1 029,8	1 027,8	1 030,0	1 030,4	990,5	1 039,1

Sample No. 1 = 6 % bentonite suspension + 4 % Na_2CO_3 + 0,5 % KMC TS - 20
2 = 6 % " " + 4 % " + 1,0 % KMC TS - 20
3 = 6 % " " + 4 % " + 0,25 % Sokrat 44
4 = 6 % " " + 4 % " + 0,5 % Sokrat 44
5 = 6 % " " + 4 % " + 0,5 % HUMITAN
6 = 6 % " " + 4 % " + 0,1 % pyrophosphate

Table No. 19 - Modification of Rheological and Colloidal Properties of the 6 % Activated Bentonite Suspension - Sample No.2 - Cairo-Alex.R.

Measurement	Units	Sample No.					
		1	2	3	4	5	6
FANN viscosimeter							
600 r.p.m.	Pa	18,67	32,56	18,19	25,38	7,66	4,31
300 r.p.m.	Pa	16,28	22,50	10,53	14,84	4,31	2,87
200 r.p.m.	Pa	13,89	17,72	8,14	11,01	3,35	1,91
100 r.p.m.	Pa	10,53	12,45	4,79	6,70	1,91	1,44
6 r.p.m.	Pa	5,27	3,35	0,96	0,96	0,96	0,48
3 r.p.m.	Pa	4,31	2,39	0,48	0,48	0,48	0,0
Plastic viscosity	mPa.s	15	21	16	22	7	3
Bingham flux limit	Pa	9,10	12,45	2,87	4,31	0,96	1,44
Apparent viscosity	mPa.s	24,5	34,0	19,0	26,5	8,0	4,5
Flux limit after 10''	Pa	5,74	2,39	0,96	0,96	0,96	0,96
Flux limit after 10'	Pa	26,81	17,24	1,91	1,44	3,35	1,44
Filtering capacity	ml/30'	10,5	10,0	11,0	10,0	10,0	20,0
Filtering crust	mm	0,74	0,65	0,79	0,60	0,52	0,82
Specific mass	$kg.m^{-3}$	1 042,0	1 025,0	1 045,2	1 043,4	996,7	1 042,1

Sample No. 1 = 6 % bentonite suspension + 4 % Na_2CO_3 + 0,5 % KMC TS - 20
2 = 6 % " " + 4 % " + 1,0 % KMC TS - 20
3 = 6 % " " + 4 % " + 0,25 % SOKRAT 44
4 = 6 % " " + 4 % " + 0,5 % SOKRAT 44
5 = 6 % " " + 4 % " + 0,5 % HUMITAN
6 = 6 % " " + 4 % " + 0,1 % pyrophosphate

Table No. 20 - Modification of Rheological and Colloidal Properties of the 6 % Activated Bentonite Suspension - Sample No.3 - Koum Oshim

Measurement	Units	Sample No.					
		1	2	3	4	5	6
FANN viscosimeter							
600 r.p.m.	Pa	8,14	16,28	5,74	9,10	3,35	2,39
300 r.p.m.	Pa	4,79	10,05	3,35	5,27	1,44	1,44
200 r.p.m.	Pa	3,35	7,66	2,39	3,83	0,96	0,96
100 r.p.m.	Pa	1,91	4,31	1,44	1,91	0,48	0,48
6 r.p.m.	Pa	0,96	1,44	0,96	0,96	0,48	0,48
3 r.p.m.	Pa	0,48	0,96	0,48	0,48	0,48	0,48
Plastic viscosity	mPa.s	7	13	5	8	4	2
Bingham flux limit	Pa	1,44	3,83	0,96	1,44	0,0	0,48
Apparent viscosity	mPa.s	8,5	17,0	6,0	9,5	3,5	2,5
Flux limit after 10''	Pa	0,48	1,91	0,48	0,48	0,48	0,48
Flux limit after 10'	Pa	0,48	1,91	0,48	0,48	0,48	0,48
Filtering capacity	ml/30'	11,0	9,5	10,0	9,0	38,0	32,0
Filtering crust	mm	0,59	0,29	0,30	0,30	0,30	0,35
Specific mass	$kg.m^{-3}$	1 042,0	1 053,0	1 044,0	1 048,0	1 043,0	1 045,0

Sample No. 1 = 6 % bentonite suspension + 4 % Na_2CO_3 + 0,5 % KMC TS - 20
2 = 6 % " " + 4 % " + 1,0 % KMC TS - 20
3 = 6 % " " + 4 % " + 0,25 % SOKRAT 44
4 = 6 % " " + 4 % " + 0,5 % SOKRAT 44
5 = 6 % " " + 4 % " + 0,5 % HUMITAN
6 = 6 % " " + 4 % " + 0,1 % pyrophosphate

Table No. 21 - Purifying Tests of Waste Waters Contaminated by Oil Matters and by Organic Polymers Dispersions by Means of Bentonite

Type of bentonite	Activation	Water contaminated by oil matters				Water contaminated by oil dispersions			
		bentonite dose g/1	initial OM cont. mg/1	final OM con. mg/1	efficiency %	optimum dose of bentonite g/1	initial OCC mg/1	final OCC mg/1	efficiency %
Qasy Elsaga	Al^{3+}	--	--	--	--	8	22 500	170	[illegible]
	Fe^{2+}	5	50	0	100	12	22 500	255	[illegible]
Cairo-Alex.R	Al^{3+}	--	--	--	--	6	22 500	255	[illegible]
	Fe^{2+}	5	50	0,13	99,7	12	22 500	255	[illegible]
Koum Oshim	Al^{3+}	--	--	--	--	6	22 500	235	99,0
	Fe^{2+}	5	50	0,13	99,7	12	22 500	274	[illegible]

OM - oil matters

OCC - oxygen chemical consumption