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Acid Decomposition of Bentonite Clay in Uzbekistan

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Abstract:
Objective. The article provides information on bentonite clay, its types and deposits. Physico-chemical parameters of bentonite clay and production of coagulant - aluminum sulfate from local aluminosilicates were investigated, as well as its use in the national economy.

Research on the acquisition and development of new types of high-efficiency coagulants is under way worldwide. In this regard, the development and improvement of aluminiumsulphate technology involving low-grade raw materials in industrial production is an important challenge.

Methods. The technology of producing coagulants aluminum sulfate from kaolin, bentonites and aluminium silicates is shown. Information on bentonites in Uzbekistan, Russia and abroad.

Results. In the treatment of bentonite clays to increase the yield of useful ingredients we carry out the preliminary roasting of raw materials. 100,000 tons of coagulant, aluminiumsulphate, are required per year for industrial plants and water treatment plants in the Republic. However, this is not the case. Meeting the needs of the Republic for aluminiumsulphate through the introduction of technology for the production of aluminium from local raw materials will make it possible to reduce its cost by a factor of three compared with the price of coagulant imported so far. This will also make it possible to preserve the reserves of the Republic's freely convertible currency.

Conclusion. Thus, the introduction of coagulant technology from local aluminosilicates and the integrated management of the resulting waste are both cost-effective and environmentallybeneficial

Keywords: bentoniteclay, types, physicochemical indicators, deposits, coagulant, aluminum sulfate, complex mineral, alkaline bentonites, montmorillonites, nanofiltration, aluminum silicate.

Introduction

The timely reforms carried out by the Government of Uzbekistan aimed at denationalizing and modernizing existing enterprises and developing and implementing strategic measures for the establishment and development of private business; The real conditions created for the broad attraction of foreign investment in the form of modern technological capacities have, in a relatively short period of time, contributed to the substantial restructuring and reorientation of Uzbek industry towards locally available raw materials.

According to data from the State mineral balance of the Republic of Uzbekistan (as of 01.01.2014), 1,764 deposits, including 648 building materials of various kinds, have been opened in the territory of Uzbekistan. Of these, 877 were opened, including 267 during the years of Independence. Among the minerals, clay is the most important, mainly kaolin, bentonite and bentonitelike clay, with a total of billions of tons. Until the beginning of our century, the mineral-raw base of bentonite and bentonite-like clay of Uzbekistan was known as a source of available raw material mainly for producing bentonite clay powders for drilling solutions, moulding mixtures in foundry production, in the production of ceramic plants, partially plasticizing additives into ceramic masses [1].

The production of aluminium sulphate, the most common coagulant in the world, is growing every year and is widely used in the industrial process for the treatment of industrial and waste water, water-processing, pulp and paper industry, as well as skin tanning and dyeing of tissues. The provision of effective coagulants to various industries is therefore a major challenge for the chemical industry. Coagulants improve the efficiency of treatment not only of wastewater, but are also widely used in water treatment for drinking water abstraction, CHP and industrial purposes. The provision of high-quality coagulants to enterprises is therefore a priority for the chemical industry in Uzbekistan.In the territory of Uzbekistan, geologists have discovered the wives of more than 200 manifestations of bentonite and bentonite-like clay, the exploration reserves of which, according to preliminary data, amount to an average of more than 2 billion cubic metres. tons. The mass formation of high-quality clay formations was carried out in the Jurassic, Cretaceous and Paleogenic Periode. To date, only the Nawbakhor, Azkamar, Kattakurgan, Lagon and Shorsu fields have been commercially exploited. The total quantity of bentonite clays mined and processed from these deposits is so far only 30-40 thousand tons per year. [2].

Bentonites are fine clay formations represented by aluminosilicates consisting of 80-90% of well-crystallized dioctahedralmontmorillonite with an impurity of mixed-layered clay minerals and selandonite-glauconite mica. Paragenetic minerals are characterized by agate, chalcedon, zeolites, cristobalite, mountain crystal, amethyst, sulphide minerals (galenite, chalcopyrite, sphalerite, pyrite).Bentonites are formed by hydrothermal metasomatosis of sub-intrusive, effusive and volcanic-sedimentary rocks, in particular andesite-basalt porphyries, liparite and tracheat-basalt shoes and ashes. The quality diversity of the resulting bentonites depends both on the composition of the parent rocks and on the composition and temperature of the thermal waters. The most favourable conditions for the conversion of volcanic glazing to montmorillonite were created at low (50-220^{o}C) and medium (200-300^{o}C) hydrothermal temperatures and their high alkalinity (pH = 9-10).Bentonites associated with the humid and arid metagenesis zones are divided into marine and continental freshwater lakes. They are structurally linked to platform areas. They were formed in an era of weakened tectonic activity.

The quality of these bentonites is inferior to that of the hydrothermal-metasomatic and volcanogenic-sedimentary types. They are, however, a conditioned moulding material in foundry production, used for the manufacture of drilling solutions, high-grade ceramic, and, when activated and modernized, can be successfully used as adsorbents, Catalysts in the petrochemical and food industries, agriculture, etc.Alkalinebentonites are characterised by high swelling, colloidality, plasticity and the maximum binding capacity possible for clay. These are mainly high-quality raw materials used in many industries.

Alkaline terrestrial bentonites are less hydrophilic and have less connectivity. They tend to be inferior in quality to the alkaline bentonites, and in their natural state they are of little use in some industries.Bentonites have high connectivity, adsorption and catalytic activity. Clays with a smaller but dominant Montmorillonite content are called Bentonite-like [3].

The salts of iron and aluminium used for purifying water as goulants are capable of hydrating to form a cotton-like sludge, which carries with it suspended substances and bacteria.

Aluminium-containing coagulants are the most common in our country and abroad. The aluminiumsulphate used for this purpose is produced primarily from aluminium hydroxide, which is a doro-state agent. In the physical-chemical treatment of water, coagulants based on iron and aluminium salts are the most common. Because the disruption leads to the penetration of iron ions into the purified water. These deficiencies can be largely remedied by adding aluminium salts. The use of a mixed coagulant significantly reduces the risk of overdose of iron salts resulting in a significant reduction of iron residue in purified water [4].

It is therefore necessary to improve the methods and the means of purifying water from iron. You can use efficient but costly methods: reverse osmosis, nano-filtration, electrocoagulation, etc. However, the economic situation of many of the economic entities of the Russian Federation limits the resources available to implement environmental protection activities. In this regard, efficient wastewater treatment (WT) techniques are being introduced that do not require large financial investments and do not have a negative impact on the home environment. Therefore, the waste from industrial and agricultural plants, in particular from petrochemical plants [5] is promising to be used as reagents for cleaning up iron ions contaminated by the WT.

Methods.

Aluminosilicates are widely distributed in various regions and have a fairly high content of aluminium and silicon oxides and relatively small content of other impurities. Given that silicon dioxide has virtually no interaction with sulfuric acid, As soon as the first technological transformation - sulphation - it is relatively easy to separate aluminium from silicon selectively and efficiently process aluminosilicates to aluminiumsulphate and other products.The use of sulphuric acid makes it possible to process practically any raw material with a high degree of aluminium extraction into a solution. Compared to other mineral acids, it is less aggressive towards technological equipment and does not require special alloys for lining.

In the patentable method [6] the ground-ground non-feline-containing raw material is treated with a 20-35% solution H_2SO_4 at a flow rate of 70-100% of the stoichiometric required quantity for 5-120 seconds at a temperature of 70-100°C. The resultant suspension, which consists of an aluminium belt containing a solution (ABC) and insoluble mineral particles, is diluted with water and the insoluble mineral particles are separated from the ABC coagulant-flocculant.The results of the study of the process of isolating amorphous silicon dioxide with a minimum content of impurities (~0.1%) from silica-containing solutions from products of the sulphuric acid decomposition of the nepheline concentrate are given [7]. The optimum technological parameters of the system have been defined, which ensure the production of well-filtered suspensions and the achievement of the highest filtration rate and the lowest humidity of the precipitation at the maximum extraction of SiO_2 from the solution.

A method for producing aluminiumsulphate from shelled kaolin clays [8] is patented, said method comprising the interaction thereof with sulphuric acid taken in a quantity of 93-95% from stoichiometry, which is characterized in that the interaction is carried out in a reactor, 2-particle ratio, with a diameter ratio of 0.4-0.5 and an upper ratio with a diameter ratio of 2.3-2.5, and a propeller mixing pulp with a turnover of 40-80 per minute and a hot steam at a pressure of 1.5-3.5 atm temperature of 110-125°C for 30-45 min.Various modifications of this method were aimed at improving the processes of decomposition of kaolin by sulphuric acid and crystallization of the finished product.

In the People’s Republic of Poland, a method has been developed for producing a coagulant from clay, according to which uninhabited clay is treated with H_2SO_4 solution in autoclaves at 170-190°C [9]. The excess acid in the pulp is neutralized by the burned clay and then the reaction mass is poured onto the crystallization table. The product contains 7% Al_2O_3 and 0.5% Fe_2O_3sulphate, 2% free H_2SO_4 and 37% insoluble residue.

A method for producing a coagulant from clay [10] containing 40% Al_2O_3 is proposed in France by sintering said coagulant with concentrated sulphuric acid in a rotating furnace at 400oC. Sintering produces anhydrous aluminiumsulphate, which significantly increases the water-soluble aluminium oxide content of the product. With 22% Al_2o_3 sulfate containing Sio_2 is a product that can be transported in bulk in wagons.The staff of the Institute of the Academy of Sciences of the Republic of Ukraine have developed a method for producing an uncleaned granulated coagulant from kaolins [11]. When the mixers of kaolin, sulphuric acid and an acid suspension are mixed, after the granulator, a caolin pulp with a humidity of 45-50% is prepared. Sulphuric acid is dosed in 90-95% of stoichiometry. Kaolin content in pulp is 23-24% and sulphuric acid 25.8%. The pulse in the correction collectors is stirred with compressed air at a continuous circulation thereof and is then pumped into pneumatic nozzles via an annular pipe.The Polish People's Republic has developed a method for producing purified aluminiumsulphate [12]. This method involves the use of clay containing 25% Al_2O_3 and 4% Fe_2O_3. The unburned clay is mixed with a negotiable uterine solution and is degraded by an excess of H_2SO_4 in autoclaves at 170-190°C. Extraction of aluminium oxide in solution is about 90%. The aluminiumsulphate solution is filtered away from the insoluble silica sludge and is inflated in devices with submersible burners.The NIOCHEM Institute has developed a method for producing aluminiumsulphate from enriched kaolin [13] which is used on an industrial scale. The kaolin was crushed and the fraction, measuring 3-7 mm, was directed towards the roast, and the smaller fraction was ground, dried in the drum furnace and granulated in a plate granulator. Granules measuring 3-7 mm, together with the cereal, were burned in a rotary furnace at 750-800ºC. The burned kaolin was cooled by the absorption of large amounts of air and fed for acid decomposition at a temperature of 105-110ºC into a flow-type reactor with recycling, where the washing water after the third flushing and concentrated sulphuric acid were also finished.

In recent years, under the guidance of I.O. Zapolsky, a continuous method of producing aluminiumsulphate from kaolins has been developed [14]. Kaolin from the open wagons is unloaded by a grappler crane to the warehouse, from where it is fed into the bunker and ground in the clay-resistant machine to a fraction of 30-50 mm. The crushed kaolin and aluminium sulfate solution are delivered to the wet grinding mill for the preparation of a pulp with a humidity of 50-55%. The pulp is pumped into the pneumatic injectors of the boiling layer. Dehydration and granulation of pulp is carried out at 190-230°C using small granules as a retour.The inventive method for producing aluminium sulfate [15] consists in treating aluminium-containing raw material - kaolin 95% sulphuric acid and in thermally treating the resultant reaction mass, wherein said method is characterised in that a kaolin with a mass of aluminium oxide is used, 20-27% which is wetted before mixing with sulphuric acid, the reaction mass is heat-treated at 320-350°C for 3 hours thereafter, the sulphate product is leached with water at a ratio of T:G of 1:3 and a temperature of 80-90°C to a final value of pH; 3.5-4.0. The resultant pulp is filtered, the filter is characterised to a density of 1.45 g/cm3 and the aluminium sulfate is crystallized.The Institute of Chemistry of the Academy of Sciences of the Republic of Uzbekistan [16] has developed a method for producing aluminium sulfate from Angren clay. The kaolin from the bunker, the sulphuric acid in a quantity of 90% of the stoichiometric quantity from the pressure tank, and the washing water are mixed in a double-rolled mixer. The pulp is baked at 280-300ºC for 1.5 h in the drum furnace. A sinter containing up to 16% water-soluble aluminium oxide and meeting the specifications for a raw coagulant can be used for the treatment of drinking and wastewater.The chemistry and kinetics of the process of producing a mixed coagulant" from bentonite clay are studied by the acid method. Bentonite clay leaching processes were mathematically processed and an integrated process was developedDiagram of saline-sulfuric acid-acid degradation of bentoniteclay[17].

Results.

The technology[18-20] for the production of coagulant - aluminium sulfate from bentonite is as follows: the raw material containing bentonite is incinerated; the volatile fraction is separated and the crystalline structure of bentonite is altered during the incineration process; the sinter is fed into the reactor after incineration, where the mixture is degraded by a 60% sulphuric acid solution at 80-90°C for 1 hour; the mixture is heated by the heat of the reaction; in order to maintain the specified temperature, the mixture is mixed and the superheated vapour with a temperature of 110°C is sent there; The resulting hot pulp is fed to the second stage of the process of the reactor-neutralizer; the water and steam with a temperature of 110°C are fed to the solution to dilute the solution; the excess amount of sulphuric acid is neutralized by the supply of the chalk-$CaCO_3$ and carbon dioxide; During the process of neutralization, the iron compound is precipitated, which improves the quality of the product; the pulp is filtered after neutralization, the residue is washed at a temperature of 60°C with water; the filter and the solution are fed into the evaporator after the first washing; The filtrate, after the second refilling of the sediment, acts as a recycled solution to maintain the relationship between the liquid and the solid phase at a given level; by cooling the solution crystallizer after evaporation, the finished product, the aluminium sulfate salt, is produced; It is recommended that sludge generated after smelting be used in the production of building materials.

Discussion.

The process of producing coagulants from kaolin clay differs little from the process of producing products from bentonite clay. In the treatment of bentonite clays to increase the yield of useful ingredients we carry out the preliminary roasting of raw materials. 100,000 tons of coagulant, aluminiumsulphate, are required per year for industrial plants and water treatment plants in the Republic. However, this is not the case. Meeting the needs of the Republic for aluminiumsulphate through the introduction of technology for the production of aluminium from local raw materials will make it possible to reduce its cost by a factor of three compared with the price of coagulant imported so far. This will also make it possible to preserve the reserves of the Republic’s freely convertible currency.

Conclusion. Thus, the introduction of coagulant technology from local aluminosilicates and the integrated management of the resulting waste are both cost-effective and environmentally beneficial.

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