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POSSIBILITIES TO USE VERMICULITES FOR SORPTION CLEANING OF PHOSPHORUS-CONTAINING SLUDGE

Abstract. The sludge reuse problem, despite significant move in this question at Novodzhambul phosphorous plant, remains actual. This enterprise carries out phosphorus-containing sludge reuse as follows: the sludge from burning department is steamed, pumped into capacity, where it is settled for phosphorus separation, which further is used as finished product. The sludge, remained after the separation, with sufficiently high content of phosphorus, is vapored under vacuum and in a free-flowing form is delivered to the burning department for return into the furnace. It is found that the principal mineral for vermiculites of studied fields is montmorillonite. Except the principal mineral, there are kaolinite, hydrargillite, hydromica with insufficient impurities of minerals of pyrophyllite, amphibole, etc.

Key words: phosphoric sludge, sorption cleaning, vermiculites, sorbents.

Introduction. The main reason for formation of phosphoric sludge is high difference of polarities, composing a two-phase system: water (ε=81) – phosphorus (ε=3,8). At that, matters with intermediate value ε are adsorbed on the phase boundary, adjusting by their presence difference of the phases' polarities [1-2]. The more difference of the polarities, the higher value of the adsorption forces on the phase boundary. Phosphoric sludge formation and stabilization occurs on the phosphorus condensation stage, at the moment of occurrence of the phosphorus – water phase boundary, having with free energy [3]. The phosphorus condensable drop growth is broken by adsorption layers, formed by emulsion stabilizers. The furnace gas solid mineral impurities, untrapped in electrofilters and organic substances from the phosphorus phase are considered as the emulsion stabilizers, able to be adsorbed on the phosphorus drop surface and cause its lyophilizing [4].

Experimental part. The sludge reuse problem, despite significant move in this question at Novodzhambul phosphorous plant, remains actual. This enterprise carries out phosphorus-containing sludge reuse as follows: the sludge from the burning department is steamed, pumped into capacity, where it is settled for the phosphorus separation, which further is used as finished product. The sludge, remained after the separation, with sufficiently high content of the phosphorus, is vapored under vacuum and in a free-flowing form is delivered to the burning department for return into the furnace [5-7].

Despite significant volume of studies on the phosphorus-containing sludge reuse, there is currently no definite study of the sludge-formation mechanism and process solution of its reuse [8].

To modern scientists, the sludge-formation mechanism appears as a process of high-temperature adsorption and capillary condensation of the phosphorus vapors by flour particles in a gas circuit, which begins on the phosphorus distillation stage [9-11].

Further, the untrapped dust in the electrofilter, passing through the gas conduit continues to interact with the condensable phosphorus and dispersed water and forms the phosphoric sludge. In a result, technogenic conglomerate – the phosphorus-containing sludge, being hardly destroyable phosphorus

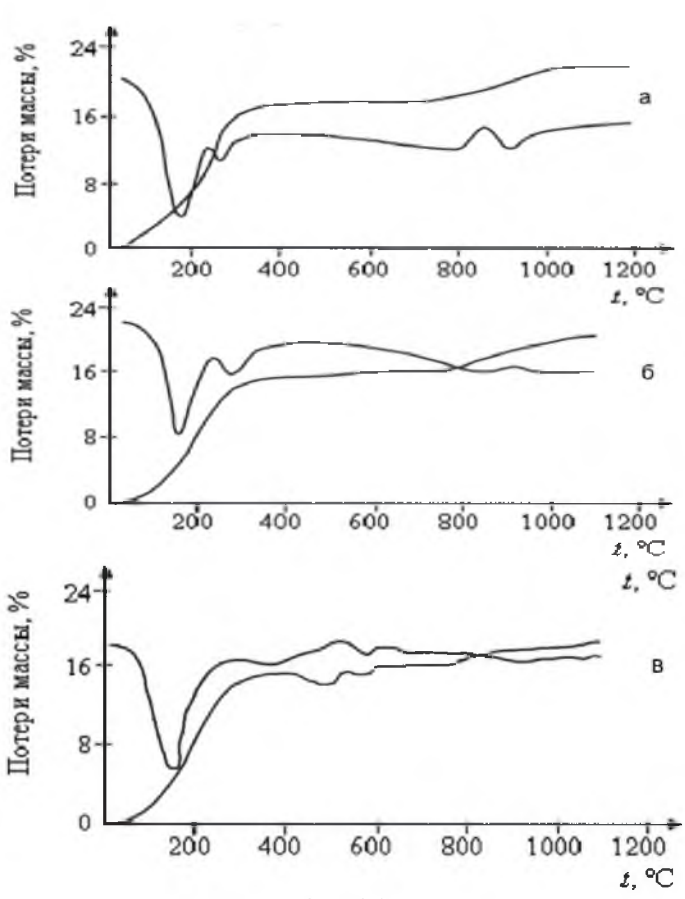
emulsion in water, stabilized by finely dispersed mechanical particles, appears. The phosphoric sludge consists of:

- Phosphorus (up to 30% by the volume)
- Mineral particles of gas carbon, quartzite, phosphorite (up to 30% by the volume)
- Water (up to 80% by the volume) [12].

Result and its discussion. The phosphorus-containing sludge, containing elemental phosphorus, cannot be disposed to dumps by both economic and ecological reasons. To this end, it is necessary to select such technology of processing, which will meet all requirements of the operating procedure. One of such ways to our opinion is sorption method of cleaning of the phosphorus-containing sludge from mechanical and organic impurities with separation of clear finished phosphorus [13]. Objective of the work is to study physical-chemical properties and prepare sorbents from local aluminosilicate minerals, appropriate for cleaning of the phosphorus-containing sludge from the impurities. Vermiculites of Karatas-Altyntas field of West Kazakhstan and Kulantau field of South Kazakhstan were used for the study. Vermiculite, related to the group of hydromica, has valuable property – capability to increase its volume in 15 times during the furnacing.

Chemical composition of Kulantau field vermiculites

Content of components, %									
CaO	FeO	MgO	SiO_2	Al_2O_3	TiO_2	$Na_2O + K_2O$	Fe_2O_3	MnO	H_2O
2,05-3,22	2,0	24,7-26	34-36	11,1-11,9	0,4-0,47	0,7-0,87	10,6-11,0	5,3-6,07	4,1-5,2



Loss in weight, %

Results of the vermiculates DTA and DTG:
a – Karatas vermiculite; b – Altyntas pholidolite; c – Kulantau vermiculite

The swollen vermiculite after cooling maintains its gained volume with very fine air interlayers between the mica flakes. Table 1 presents chemical composition of South Kazakhstan oblast Kulantau field vermiculite. The vermiculite raw material is a loose mixture, consisting of feldspars, amphiboles and mica, which is covered by recent sediments. Figure presents curves of the vermiculites' DTA and DTG. Karatas field vermiculite DTA curve (Figure, a) is characterized by endothermic effect at 180-230°C, that characterizes fractional dehydration and formation of hydrargillite-bellite of polymorphic form, and soft exothermic effect at 800°C, that characterizes burnout of trace impurities of sulfur-containing and volatile compounds. Altyntas and Kulantau fields DTA curves (Figure, b, c) by analogy with the first sample are characterized by endothermic effects at 170-240°C, specifying processes of dehydrations, separation of constitution water with destruction of the crystal lattice. Further increase of temperature does not result in essential appearances characteristic for the burnout of volatile and carbonaceous compounds.

Results of radiography analysis of different fields' vermiculites showed that diffraction maximums of radiograms of three vermiculite samples are characterized by total kaolinite, hydrargillite and montmorillonite content. This is evidenced by the presence of diffraction values of maximums of montmorillonite – 6,30; 4,47; 2,60; kaolinite – 7,14; 2,62; 2,33; 2,55; hydrargillite – 2,37; 2,02; 1,79.

Results of elementwise composition and electronic image of the microstructure [4] of the vermiculites showed that Kulantau field vermiculite studied sample contains minerals of groups of montmorillonite, hydromica, kaolinite. These minerals are characterized by high ductility, ability to cation exchange and sorption properties. Analysis of the vermiculites' elementwise and weight composition is characterized by high concentration in %: oxygen – 56,88, silicon – 24,79, aluminum – 6,56, calcium – 6,15, etc.

Conclusion. Modern analysis methods defined physical-chemical characteristics of Karatas – Altyntas and Kulantau fields' vermiculites. Basic compounds and minerals, consisting raw feed stocks, were identified by XRF, DTA, REM methods and chemical analyses.

It is found that the principal mineral for the studied fields' vermiculites is montmorillonite. Except the principal mineral, there are kaolinite, hydrargillite, hydromica with insufficient impurities of minerals of pyrophyllite, amphibole, etc. Further studies plan to use the above mentioned materials for preparation of sorbents at the cleaning of the phosphorus-containing sludge.

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ФОСФОРҚҰРАМДАС ШЛАМДАРДЫҢ СОРБЦИЯЛЫҚ ТАЗАЛАУ ҮШІН ВЕРМИКУЛИТЕРДЫ ПАЙДАЛАНУ МҮМКІНДІГІ

Аннотация. Химиялық фосфор өндірісі кең көлемде техногенді қалдықтардың пайда болуымен тығыз байланысты. Фосфор шламдарын зерттеу кең көлемде жүргізіліп, зерттелгенмен, оны жан-жақты технологиялық тұрғыда қайта өңдеу процесі жеткілікті қарастырылмаған. Өте қауіпті және қиын өңделетін қалдықтар - фосфор шламдары болып табылады. Техногенді қалдықтар қоршаған ортаға экологиялық және техногендік кері әсерін тигізеді. Сол себепті, қалдықтарды қайта өңдеу қазіргі уақытта ең өзекті мәселе болып тұр.

Сонда, фосфор шламдарын қайта өңдеуге бағытталған зерттеу жұмыстары қазіргі таңда өзекті тақырып болып табылады. Осы гылыми зерттеу жұмысымызда ұсынылып отырган әдісіміз - сіңіру арқылы фосфорқұрамдас шламдарды механикалық және органикалық қоспалардан тазартып, құрамынан таза фосфорды бөліп алу.

Сол себепті, алюмосиликатты шикізаттардан түйіршікті сорбенттер дайындап, сол арқылы фосфор шламынан таза фосфорды бөліп алу әдісі зерттеледі. Аталған сорбенттерді дайындау үшін, Оңтүстік Қазақстан облысының жергілікті Құлантау кен орнынан және Батыс Қазақстан облысының Қаратас – Алтынтас кен орындарынан вермикулиттер алынды.

Зерттеулер нәтижесі бойынша, вермикулиттер құрамында монтмориллонит, каолинит, гидраргилит, роговоя обманка және т.б. минералдар бар екені белгілі болды.

Түйін сөздер: фосфор шламы, сорбция әдісімен тазалау, вермикулиттер, сорбенттер.

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ВОЗМОЖНОСТИ ИСПОЛЬЗОВАНИЯ ВЕРМИКУЛИТОВ ДЛЯ СОРБЦИОННОЙ ОЧИСТКИ ФОСФОРСОДЕРЖАЩИХ ШЛАМОВ

Аннотация. Проблема утилизации шламов, несмотря на сушественный сдвиг в этом вопросе, на действующих предприятиях все еще остается очень актуальной. Отходы фосфорного производства очень токсичны и являются причиной многих экологических проблем окружающей среды. В данной работе утилизация фосфорсодержащих шламов осуществляется следующим образом: полученный из печного цеха шлам, подвергается обработке паром, перекачивается в емкость, где отстаивается для выделения фосфора, который в дальнейшим используется как готовый продукт. Оставшийся после разделения шлам, с достаточно высоким содержанием фосфора, выпаривается под вакуумом и в жидкотекучем виде направляется в печной цех для возврата в печь. Установлено, что основным минералом для вермикулитов рассматриваемых месторождений является монтмориллонит. Кроме основного минерала присутствуют каолинит, гидраргилит, гидрослюды с незначительными включениями минералов пирофиллита, роговой обманки и др.

Ключевые слова: фосфорные шламы, сорбционная очистка, вермикулиты, сорбенты.