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Composite Pigment-Filler on the Basis of Sludge of Heat Power Plant and Tails of Enrichment of Ferruterous Quartzites

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Abstract: The study presents the results of a study to obtain pigments-filler from Ferruginous Quartzite Tailings (FQT) and chemical Belgorod thermal power station water treatment sludge. Phase and mineral composition of these wastes has shown. Indicated equations of probable reactions occurring during thermal treatment FQT. The results of tests of oil paint prepared on composite pigment-filler based on FQT and thermal power station water treatment sludge are presented.

Key words: Wastes, slimes of chemical water cleaning of electrical heat station, tails of enrichment of ferruginous quartzites, processing, pigment-fillers

INTRODUCTION

In the group of pigments fillers includes a number of natural and synthetic inorganic powdery substances (Belen'kii and Riskin, 1974). Pigments fillers are used in many industries, especially in a combination with polymeric composites. Besides using in paint-and-lacquer materials (base coat, crack filler, paint, porcelain enamel), fillers are used in production of plastic, rubbers, dough as components of many finishing structures, in construction, in paper and ceramic industry, etc. Depending on appointment specific requirements for dispersion, thermal stability, the content of impurity and other indicators are imposed to fillers.

The fillers applied now (Belen'kii and Riskin, 1974) have index of refraction from 1.58-1.64, true density is from 2540 (kaolin) to 4500 (barium oxide); their oil absorption power in limits from 6-60 units; pH a aqueous extract from 5-10. Pigments fillers have to have high dispersion that is necessary for their uniform distribution in film-forming substances. At combined use of high-disperse pigments and fillers for grinding it isn't required the special fraying equipment.

From natural materials fillers are received dry or wet crushing in mills of various designs, with the subsequent classification of a product and extraction of fraction of the demanded dispersion. Dry fractionation is carried out by means of the mechanical sit or air separation. Wet ways usually include a cleaning of the crushed mineral from impurity and classification in pond (at the expense of various speed of subsidence of large and small particles and also the main product and impurity).

Fillers of a natural origin are completely involved in productions of receiving paints and varnishes therefore use as fillers of production waste is the perspective direction in development of production of composite pigments fillers.

We for receiving a composite pigment filler offer to use the Tails of Enrichment of Ferruterous Quartzites (TEFQ) and slime of chemical water purification of heat power plant.

TEFQ are waste of mining and processing works and mining and metals sector. In Russia mining and metals sector hold special position as their production makes important part of national economy and considerable part of export. In slurry pond of Russia over 20 million te of the tails occupying huge territories of fertile lands and causing irreparable ecological injury to environment as a result of annual carrying out of dust of heavy metals, near 300 te/year are annually stored (Petin, 2006).

The most serious toxic action of ions of metals arises at inhalation of dust (Petin, 2006; Nekrich, 2006, 2007), occurring in territories of the inhabited massifs adjacent to tailings dams. Particles with a diameter of 0.1-1 μ which are effectively adsorbed by lungs are especially dangerous. Lungs absorb the ions of metals arriving then on fluid medium of an organism is ten times more effective, than a digestive tract.

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On a mineral, petrographic structure are presented to structure of TEFQ by crystalline silicas, loadstones, red hematites, carbonates, micas, pyrites, ferrous titanate, silicates, feldspar, etc. The main mineral composing enrichment tails is [alpha]-quartz practically without inclusions of ore minerals also loadstone. The main ore mineral is presented by shot in the form in quartz grains, in silicates, more rare by separate thin layers in fragments of ferruterous quartzites. Thus in thin fractions concentration of high-disperse red hematite (Fe_2O_3) and loadstone (Petin, 2006) increases.

TEFQ: waste of concentrating factories, only the Stoylensky natural occurrence occupy the space equal to 493 ha. The part it is covered with water 253 ha and another is in the dehydrated state, so-called "dry beaches" which borrow to 255 areas of the tailings dam. Dust, coming to air, forms firm aerosols with a disperse phase in the form of quartz, iron, heavy metals.

Filling with tails of the taken-away territories is planned to make till 2015 and their quantity will make >100 million te.

In spite of the fact that >30 years development on practical application of tails of enrichment is conducted, the developed technologies are based only on their use as quartz filler in various construction materials: concrete, reinforced concrete, ceramic masses, cement, etc. (Lesovik, 2004; Yurina, 1980; Cherkashin *et al*., 2009; Shapovalov *et al*., 2013). At full implementation of the proposed technological solutions the volume of involvement of tails of enrichment in industrial production will make no >30% therefore, the problem of full utilization of tails won't be solved.

Other type of waste deserving attention is slime of chemical water purification of heat power plant. Slime is a product of lime application and coagulation, represents steady mix of a certain structure. The chemical composition and a ratio of components of slime depend on a number of technological features of water treatment including also a chemical composition of the delivered raw water. Now slime of chemical water purification of the Belgorod heat power plant is utilized as withdrawal as researches on development of technical solutions of its use weren't made. According to official figures slurry waste collects in the superficial storages which aren't equipped with environment means of protection from filtration waters. This slime doesn't contain highly toxic substances it belongs to waste of the 5th class of danger, however problems with warehousing remain. As thus, there is an alienation of the big areas, threat of their salinization and a mineralization of underground waters, adjacent territories and also violation of the hydrochemical mode of nearby reservoirs is created.

Purpose of the research to investigate possibility of use of large-capacity industrial wastes TEFQ and sludge of chemical water purification of the Belgorod heat power plant for receiving a composite pigment filler and oil paint on its basis.

OBJECTS AND METHODS OF RESEARCH

Phase and chemical compositions of the used materials are presented in Fig. 1 and Table 1. According to X-ray PA the mineralogical structure is presented to SiO_2 to what existence of the corresponding peaks of d (Å) = 4.281; 3.357; 2.287; 2.241; 2.132; 1.983; 1.822; 1.674 Fe_2O_4 d (Å) = 2.95; 2.542; 2.092; 1.701; α-Fe_2O_3 d (Å) = 2.698; 2.542; 2.209; 1.857. Presence at quality of impurity of calcite is confirmed by existence of the corresponding peaks with sufficient intensity of d (Å) = 3.909; 3.074; 2.505; 2.341; 1.951; 1.882 (Fig. 1).

The mineralogical composition of sludge of heat power plant is presented by calcite ($CaCO_3$) (Å) = 3.036; 3.854; 2.493; 2.283; 2.094; 1.911; 1.874; 1.625; 1.603; 1.525; 1.440. Other minerals on the presented roentgenogram it isn't revealed that testifies to high degree of uniformity of slime.

Sludge of HPP and TEFQ in the dried-up state represent fine systems (Fig. 2) which amount of particles <60 μm.

And particles of sludge have higher dispersion in comparison with TEFQ particles. The sizes of particles of powdery materials are of great importance for many physical and chemical processes. In this case quality of the received oil paint and therefore, uniformity and smoothness of the painted surfaces will depend on the size of particles and their sedimentative stability.

MAIN PART

Results of research and their discussion. Earlier conducted researches showed (Tarasova, 2012) that as a result of heat treatment of TEFQ receiving a iron-oxide pigment filler of various color scale is possible. The variation of temperature condition promotes change of coloring from brick-orange to the intensive red-brown. At heat treatment, there is a stagewise oxidation of Fe_3O_4 and FeOOH loadstone to education α-Fe_2O_3, according to alleged reactions (Fig. 3):

$$Fe_3O_4 \xrightarrow{t^\circ} FeO + Fe_2O_3$$

$$2FeO + 0.5O_2 \xrightarrow{t^\circ} Fe_2O_3$$

$$2FeOOH + 0.5O_2 \xrightarrow{t^\circ} Fe_2O_3 + H_2O$$

$$Fe_2O_3 \times 1.2H_2O \xrightarrow[-1,2\,H_2O]{} \xrightarrow{t^\circ} Fe_2O_3$$

Table 1: Oxide structure of waste

Waste	CaO	MgO	SiO_2	Fe_2O_3	Al_2O_3	SO_3	P_2O_5	FeO	CO_2	MnO	SrO	Na_2O+K_2O
TEFQ	2.65	4.32	71.27	8.55	2.53	0.16	0.17	7.22	-	-	-	1.65
Sludge of HPP	49.06	3.81	2.52	0.95	0.45	0.15	0.11	-	42.74	0.02	0.14	0.05

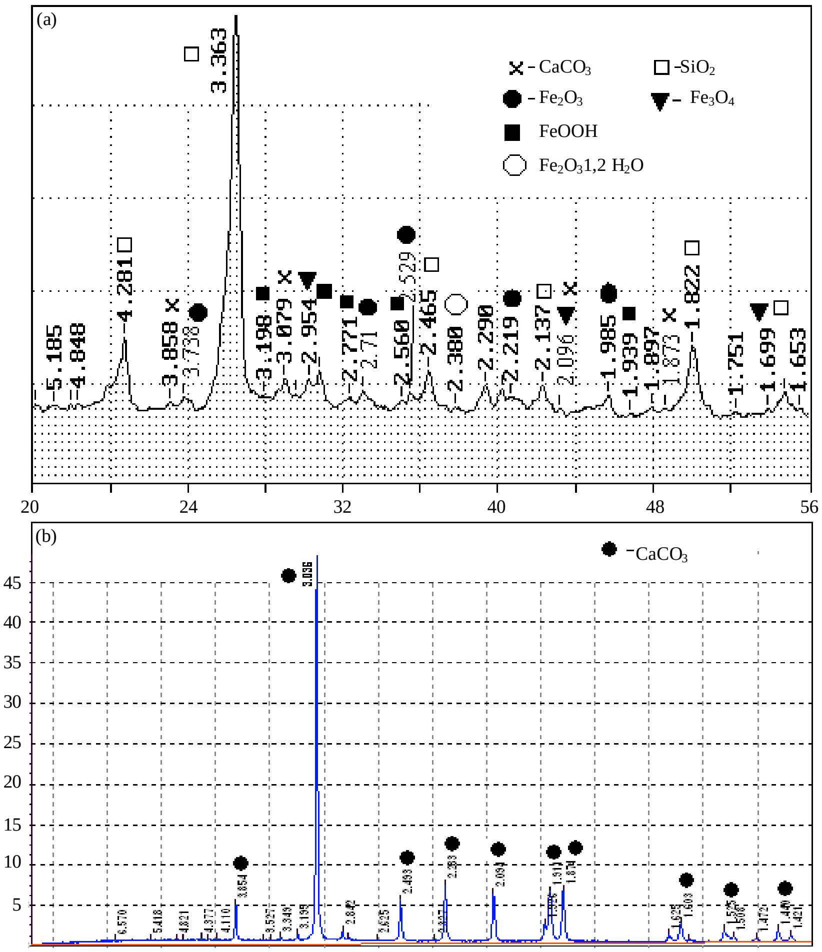

Fig. 1: a) Roentgenograms of TEFQ LMPC and b) sludge of Belgorod Heat Power Plant (HPP)

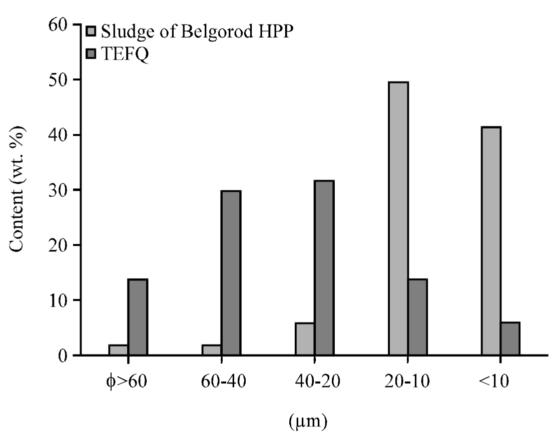

Fig 2: Particle distribution sludge of HPP and TEFQ on fractions

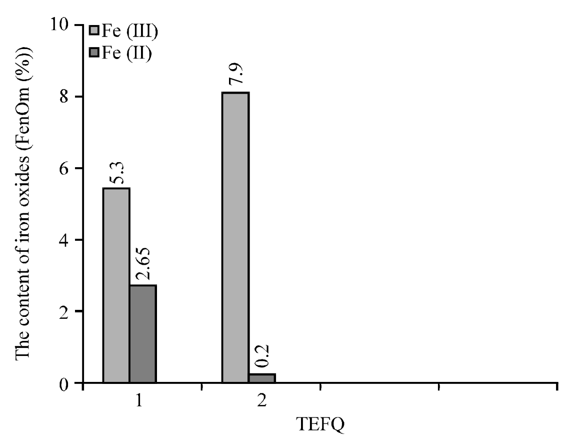

Fig. 3: Content of Fe^{+3}u Fe^{+2} un waste of TEFQ: 1: initial TEFQ; 2: TEFQ after heat treatment

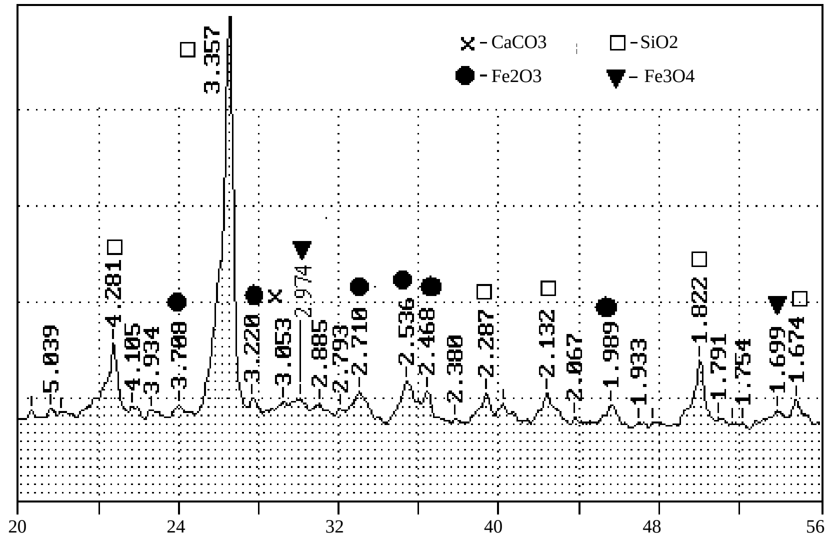

Fig. 4: The roentgenogram of the heat-treated TEFQ of LMPC

Table 2: Characteristics of samples of oil paint with use of CPF

Results	Specifications TU 2317-015-15822449-99	The composite pigment filler (wt. %) TEFQ-100 sludge-0	TEFQ-75 sludge-25	TEFQ-50 sludge-50	TEFQ-25 sludge-75	TEFQ-0 sludge-100
Colour	Red-brown	Red-brown	Brown	Light brown	Dark beige	Beige
External appearance of coating	Once dry-an even coating	Check	Check	Check	Check	Check
Mf (%) no more that	21	21	20	20	19	19
Cv (sec) not less that	65-120	80	79	75	73	70
Mn (%)	58-93	76	64	66	68	70
Dg (μm) no more that	70	70	63	55	42	39
Dt, hour at 20°C, no more that	24	2	2	1.7	1.5	1.25
Hardness index, y.e., not less that	0.05	0.2	0.23	0.24	0.25	0.27
C (g/m^2) no more that	100	50	54	62	65	70
Rc, hour, not less that	1	1	1 h 20 min	1 h 20 min	1 h 10 h	1
Cr, hour, not less that	2	2	2 h 10 min	2 h 10 min	2 h 30 min	2 h 40 min
Ml (%) no more that	25	25	25	24	24	24

As a result, the general quantity of Fe_2O_3 increases (Fig. 3) that is confirmed by results of X-rayPA there is an increase in intensity of the corresponding peaks of d (Å) = 2.71; 2.954 (Fig. 4). At heat treatment, there is also a calcite decomposition, on what specifies decrease in intensity of peaks $CaCO_3$ d (Å) = 3.074; 2.505; 2.341; 1.951; 1.882 (Fig. 1 and 4).

In this research when receiving oil paint as a pigment filler used composite material the powder received at mixture of TEFQ heat-treated at a temperature 1000°C and initial slime of heat power plant in various ratios. Oil paint was prepared in factory laboratory OJSC "the factory of paints KVIL" (Belgorod) with full replacement traditional using pigment filler on the Composite Pigment Filler (CPF) offered by us on factory technology according to TU 2317-015-15822449-99. Quality of the received samples of oil paint investigated on compliance to the following indicators:

- Mass fraction of nonvolatile components, Mn, percentage
- Degree of a grinding (Dg, μm)
- Drying time at 105°C (Dt, hour)
- Conditional viscosity (Cv, sec)
- Resistance of a covering to static influence of water (Rc, hour)
- Impact strength (Is, Sm)
- Covering ability of an undried film (C, g/m^2)
- Conditional light resistance of a covering (Cr, hour)
- Dispersive ability (D μm)
- Mass fraction of film-forming substance (Mf, percentage)
- Mass fraction of volatile (Ml, percentage)
- Elasticity of a film at a bend (El, mm)
- Dilution ratio (Dr, percentage)

Results of research are presented in Table 2.

CONCLUSION

Thus, on all studied indicators experimental samples of oil paint with use of the composite pigment filler representing mix the heat-treated of TEFQ and sludge of heat power plant in various ratios conform to requirements of TU 2317-015-15822449-99.

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