

Influence of calcite and quartz on phase transformations in natural phosphorites during high energy milling

Влияние на калцит и кварц върху фазовите трансформации в природни фосфорити при интензивна енергетична активация

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Conventional technologies for phosphorous fertilizers cause environmental pollution. Therefore, new rational and non-traditional methods are necessary for the processing of raw phosphate materials. Recently, the high energy milling (HEM) activation finds increasing application in the treatment of sedimentary phosphorite ores with low concentration of P_2O_5 ($P_2O_5^{total}$) and high content of admixtures (Elliot, 1994; Chaikina, 2002). The impact of mechanical forces on samples is mostly related to an increase in quantity of assimilable form of P_2O_5 ($P_2O_5^{ass}$) for plants.

Materials and methods. We investigated untreated and HEM activated (for 5, 10, 30, 120, 150, 240, and 300 min) natural phosphorites from Tunisia (samples TF – from TF0 to TF300) and Syria (samples SF – from SF0 to SF300) using chemical analysis, BET method for measurement of specific surface area (SSA), powder X-ray diffraction (Bruker D8, Germany, with Cu $K\alpha$ radiation), Fourier Transform Infrared spectroscopy (Nicolet 6700, transmission spectra, KBr pellets) as well as thermal analyses (SETSYS2400, SETARAM, France) in the temperature range from room temperature to 1300 K, heating rate of 10 K.min⁻¹, gas – air. The HEM activation was carried out for 20 g samples in a planetary mill (Pulverisette-5, Fritsch Co, Germany) with Cr-Ni milling bodies with diameter 20 mm.

Results and discussion. Figure 1 presents the exponential growth dependences: $P_2O_5^{ass}/P_2O_5^{total}$ versus HEM activation time for the activated samples with initial samples characteristics: $P_2O_5^{ass}/P_2O_5^{total} = 21.50\%$ – for TF0 and 23.50% – for SF0. The rings and triangles show experimentally measured values, while the solid lines are their best fits: $y = -29.31 \cdot \exp(x/-70.38) + 53.61$ (R^2 0.984, sample SF) and $y = -26.7 \cdot \exp(x/-116.42) + 62.77$ (R^2 0.997, sample TF). The exponential growth constants display the more rapid increase of $P_2O_5^{ass}/P_2O_5^{total}$ with increas-

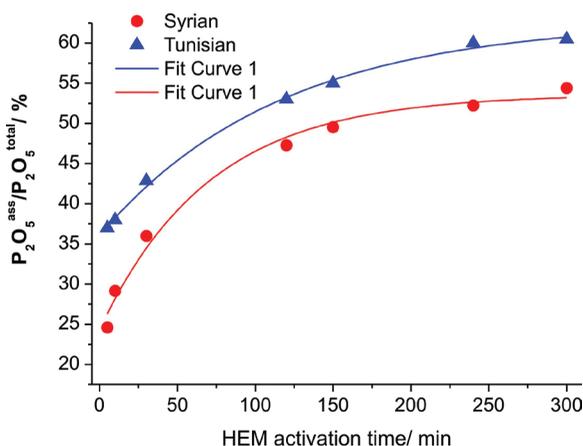


Fig. 1. $P_2O_5^{ass}/P_2O_5^{total}$, % versus HEM activation time, min

ing HEM activation time for sample TF that contains lower amount of quartz.

Figure 2 shows the SSA changes with HEM activation time. Samples SF and TF show increase of SSA to 10 min of activation. After reaching the maximum values of SSA, the activated samples show the SSA values which can be described by functional dependencies. The SSA values of samples SF and TF decay exponentially ($y = 17.24 \cdot (-x/93.11) + 3.85$, R^2 0.981 and $y = 17.67 \cdot \exp(-x/76.29) + 5.57$, R^2 0.980, respectively).

One can see the inverse relationship between the $P_2O_5^{ass}$ and SSA with HEM-activation (Figs. 1, 2). The quantity of $P_2O_5^{ass}$ increases rapidly to 120 min of HEM activation. The obtained maximal values for SSA are at 10 min of HEM activation (TF sample) and at 30 min (SF sample). For more prolonged activation times, the SSA decrease significantly. These results are in agreement with decreasing size of particles (for

