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EFFECT OF RED MUD PARTICLE SIZE DISTRIBUTION ON ELONGATION AT BREAK OF COMPOSITES BASED ON ACRYLIC DISPERSION

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Abstract. The aim of this work is to determine the effect of red mud particle size distribution on the elongation at break of composites based on Policril 590 acrylic dispersion. A series of compositions with the same filler content, namely 50 wt. % of the dry residue of the dispersion, was studied for different red mud fractions. In addition, a sample without fraction separation and a control sample of the unfilled dispersion were investigated for comparison. It was found that the pure dispersion is characterized by the maximum elongation at break of 728.6 %, whereas for the filled composites this value is 150.0–500.0 %. The obtained results can be used to select the optimal red mud particle size distribution for filled latex composites.

Keywords: red mud, particle size distribution, acrylic dispersion, Policril 590, elongation at break.

Red mud is a large tonnage technogenic waste of alumina production that can be considered not only an environmental problem but also a promising mineral filler for polymer composites. Previous studies have demonstrated the possibility of its use in composites and coatings based on various polymer binders, particularly at high filler content, which confirms the technological feasibility of this approach [1, 2]. At the same time, the performance properties of filled systems are determined not only by the concentration of red mud but also by its particle size distribution, since particle size affects the uniformity of filler distribution in the matrix, packing density, interfacial interaction area, and the nature of stress concentration in the material. For water-dispersed acrylic compositions based on Policril 590, this issue is particularly important because changes in filler dispersity can significantly affect deformation characteristics, in particular elongation at break. Therefore, the development of this topic is relevant from both scientific and practical points of view.

To determine the effect of red mud particle size distribution on the elongation at break of composites based on Policril 590 acrylic dispersion.

The object of the study was composites based on Policril 590 acrylic dispersion filled with red mud. For all filled systems, the red mud content was 50 wt. % of the dry residue of the dispersion. Compositions containing red mud fractions of 50, 63, 100, 200, 400, and >50 μm, as well as a composition with a mixture of fractions without sieving and the initial pure dispersion without filler, were studied. The experiments were carried out using a laboratory mechanical tensile testing machine. Based on the experimental data, elongation at break and tensile stress at break were calculated.

The calculated values of elongation at break and tensile stress at break for the studied samples are shown in Fig. 1. It was established that the control pure dispersion has the highest elongation at break, amounting to 728.6 %. For the filled composites, this value decreases to 150–500 % depending on the particle size distribution of red mud.

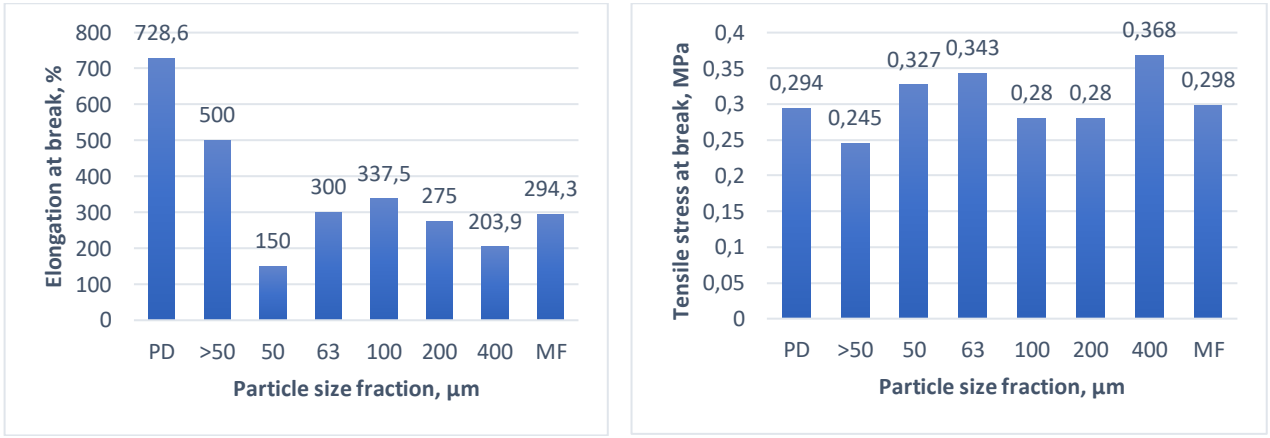

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Figure 1 – Effect of red mud particle size distribution on elongation at break (a) and tensile stress at break (b) of composites based on Policril 590 acrylic dispersion, where PD is pure dispersion and MF is a mixture of fractions

The introduction of 50 wt. % red mud into Policril 590 acrylic dispersion leads to a decrease in elongation at break compared with the pure matrix, which is typical of filled polymer systems. However, the magnitude of this decrease strongly depends on the particle size distribution of the filler. The lowest elongation at break is characteristic of the composite containing the 50 µm fraction, whereas the highest value among the filled samples is observed for the >50 µm fraction. An intermediate value of 294.3 % was obtained for the mixture of fractions. The non-monotonic nature of the dependence indicates that deformability is influenced not only by particle size but also by particle packing, agglomeration, and interfacial interaction in the acrylic matrix–red mud system.

The obtained results can be used to select the optimal red mud particle size distribution in filled water-dispersed compositions based on acrylic latices. This opens up the possibility of purposeful control of the deformation properties of coatings and film-forming materials.

CONCLUSIONS

1. The effect of red mud particle size distribution on the elongation at break of composites based on Policril 590 acrylic dispersion at a constant filler content of 50 wt. % of the dry residue was studied.
2. It was established that the particle size distribution of red mud significantly affects the deformation properties of the studied composites.
3. It was shown that the pure acrylic dispersion is characterized by the maximum elongation at break of 728.6 %, whereas for the filled composites this value varies within 150.0–500.0 %.
4. It was established that among the filled samples the highest elongation at break is observed for the composite containing the >50 µm red mud fraction, while the lowest value is characteristic of the composite containing the 50 µm fraction.

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