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Viscosity prediction model of epoxy resin modified with waste quartz powders based on contact angle measurements

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Epoxy resin additives are common practice. Until now, researchers have usually focused on the properties of hardened epoxy resins with additives, while the properties of liquid epoxy resins have been neglected. The most important properties of liquid epoxy resin are viscosity and contact angle. It should be noted that after mixing the epoxy resin with the hardener, cross-linking begins immediately, and hardened epoxy can only be removed mechanically. This causes the risk of damage to the test equipment. Therefore, there is a need for an easy and safe method of measuring the contact angle and viscosity of epoxy resins.

Keywords (from 3 to 5 max): epoxy resin coating, viscosity, contact angle, waste quartz powders,

1. Introduction

Industrial floors are increasingly made of epoxy resins, however, these resins are very harmful to the environment. The addition of waste quartz powders would reduce the amount of epoxy resin and the accumulation of this waste. The amount, the chemical composition and the particle size of the additive may affect the properties of the epoxy resin. The epoxy resins are characterized by high viscosity, which is problematic when adding the additive, because they usually increase the viscosity of the epoxy resin. The very high viscosity causes problems when mixing and applying the epoxy resin. The contact angle has an effect on the work of adhesion, so it may affect the final pull-off strength of epoxy resin [1]. Measurements of the properties of liquid epoxy resin with a hardener pose the risk of hardening in the measuring apparatus, and thus its damage. These aspects of the epoxy resin had not to be omitted. Therefore, there is a need to find a solution that would easily and safely determine the viscosity of the epoxy resin with hardener and additives. One of it could be to find a correlation between the viscosity and the contact angle of the epoxy resin.

2. Methods

The tests were carried out for epoxy resin with a hardener and the addition of waste quartz powders in four fractions. Five mixtures were made for each additive (from 7 to 29% of the additive content). The kinematic viscosity measurements were made using a flow cup, and the contact angle measurements of the same mixtures were made using a simple test stand of its own design (Figure 1). Drop images were analyzed in our own program created in the MATLAB R2020a environment.

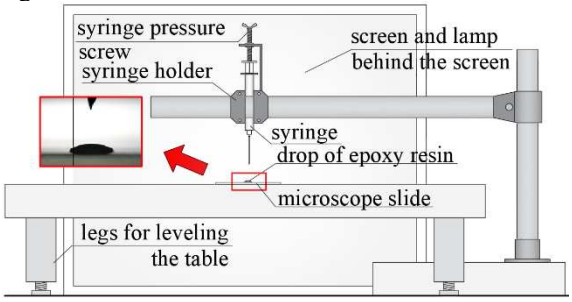

Figure 1: View of the contact angle test stand

3. Results

On the basis of the obtained results, graphs of the dependence of the kinematic viscosity on the contact angle of epoxy resin were created for each additive (Figure 2). As the contact angle increases, the kinematic viscosity of the epoxy resin increases approximately linearly. Based on the correlation of the obtained results, the viscosity prediction model of the epoxy resin modified with mineral powders was created based on the contact angle measurements.

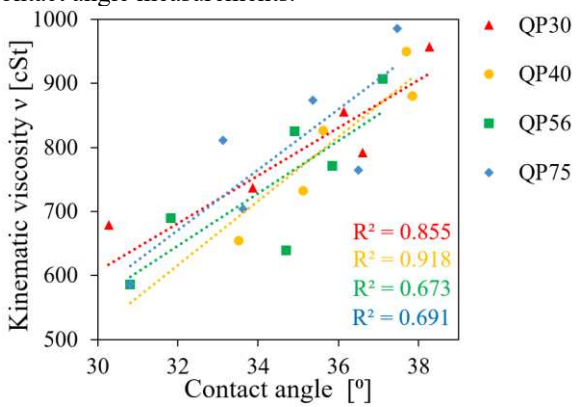

Figure 2: Graphs of the dependence of kinematic viscosity on the contact angle of epoxy resin with hardener modified with quartz waste powders.

4. Discussion

The topic of the properties of liquid epoxy resin modified with waste mineral powders still has not been fully discussed. There are many gaps in the literature about the viscosity and contact angle of epoxy resin that need to be filled. In further research, It would be beneficial to investigate the effect of other waste mineral powders in different granularities (feldspar-quartz and lime powders) on the viscosity and contact angle of epoxy resin. It would improve the accuracy of the viscosity prediction model.

5. References

[1] Barnat-Hunek D., Surface free energy as a factor influencing the effectiveness of hydrophobization in the protection of building structures (in Polish), Lublin University of Technology (2016), 23-38