SHUNGITE CARBON EFFECT ON HEAT DESTRUCTION OF POLYMERIC MATRIXES

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Introduction

Powder produced of shungite rock (shungite type III) containing inseparable shungite carbon (ShC), silicates, metal oxides and organic additives in every particle, was investigated as a filler in different polymeric matrixes [1]. The filler of such kind was thought to be helpful for designing composite materials with the required properties. The main role of ShC in the materials created was established. ShC metastable structure was reported to be realized in its flexibility and its possible modification under mild conditions. Thus giant fullerene-like particles were observed after mechanical grinding and heat treatment [2,3]. But the recent experimental data showed a specific feature of mineral part of shungite rocks also, namely the fractal structure [4]. It partly clarifies the reasons of difficulties in separating and preserving the main structural ShC units, «globules». Finally, new properties are expected from shungite-filled polymers.

Carbonaceous fillers are known to enhance thermal shock resistance and to lessen heat ablation of the composite materials. Composition made of phenolic resin with short carbon fibers and mineral additives (EPAN) was used for production of the sealing rings for drying cylinders of paper- and cardboard-making machines. The complex geometry and a variety of radii and wall thickness of the rings showed the advantages of the above mentioned composition before the ones made of bulk graphite. The rings are working in steam-vapor atmosphere under the pressure more than 0.5 MPa and temperature above 160 ^{0}C. Sometimes working temperature of the drying cylinders could reach 220 ^{0}C. That causes the destruction of the composition at the ring surface layer accompanied by mass removing with working atmosphere. The effect of ablation shorten the time of the rings' performance.

Experimental

The present work deals with the investigating of shungite filler influence on the properties of the conventional press-composite material EPAN. The main parameters of the filler were reported earlier [1]. Composition mixed with shungite filler was cured in metal mould while heating at 180 ^{0}C under the specific pressure of 45.0 MPa. Mechanical characteristics of the conventional composite material as well as of the shungite-filled were determined by standard methods.

Heat resistance was determined as the temperature of the samples under bending at which 10% deformation has been reached.

Thermal stability was estimated as a removing mass in isothermal regime keeping the samples at 200 ^{0}C 2 hours.

Comparative thermogravimetric analysis were performed using thermogravimetric analyzer Q-1500 D (MOM, Hungary) under air in the range over from 20 to 1000 ^{0}C. The samples under investigation were heated in the respect atmosphere at the programmed rate of 10 ^{0}C/ min.

Results and Discussion

Table 1. contains the results of the experiments that include comparative investigation of EPAN and shungite-filled EPAN with the concentration of the filler determined to be the optimum based on physical mechanical properties. Shungite filler does not diminish the values of mechanical parameters but improves thermal stability of filled EPAN. It could be supposed that shungite-filler influenced on rheological properties of the polymer blend also, that is why more filler could be added without changing of compressive strength value. Small differences can be observed between the flexural strength of the compositions.

Table 1. Properties of EPAN compositions under investigation

Properties	EPAN	EPAN with shungite filler
Bulk density, g/cm^3	1.47	1.52
Compression strength, MPa	136.2	140.0
Compression strength after heat treatment at 150 ^{0}C, MPa	150.6	151.3
Flexural strength, MPa	60.0	66.0
Heat resistance, ^{0}C	230	245
Thermal stability at 200 ^{0}C 2h., %	8	4.6

Shungite-filler influences on thermostability and on strength of links in the composition as follows from the increasing of temperature of destruction from 540 ^{0}C for EPAN to 575 ^{0}C for shungite-filled composition. DTA curves of the compared materials determined in air atmosphere are illustrated by Fig.1.

Surface properties of ShC could be characterised by acid reaction of aqueous slurry and existence of hydroxyl surface groups. Both factors could have an effect on process of phenolic resin curing.

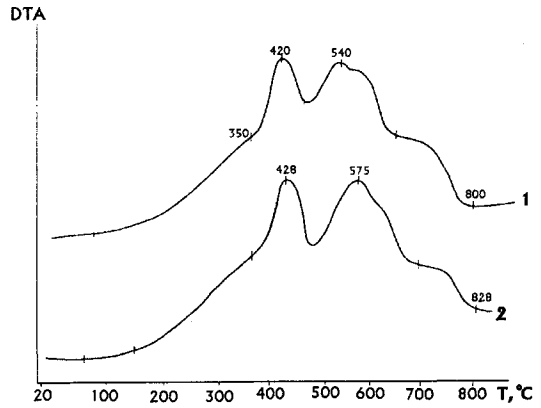

Figure 1. DTA curves of the composite materials: 1-EPAN, 2-EPAN with shungite-filler

Conclusion

The data obtained show improving of thermal stability and changing on heat destruction of EPAN by incorporating shungite filler. The observed effect was achieved, first of all, due to the structural peculiarities of ShC, namely its influence on rheological properties of different polymers. Secondly, thanks to the chemical activity of the surface groups of shungite filler that could react with the polymeric matrix.

Higher heat resistance of shungite-filled composite material under special conditions of paper making environment was achieved. That resulted in reduction of ablation of the composite material of the sealing rings.

References

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