Effect of carbon black content to heat conductionin rubber compounds

This work deals with the influence of commercially commonly used carbon black filler type on heat conduction of prepared rubber compounds. Heat conduction during vulcanization of rubber compounds is important not only from the point of the process duration but also formation of optimal sulphur crosslink network. Heat conduction was recorded using an IoT-based sensing platform designed for monitoring of heat conduction in rubber compounds. Prepared rubber compounds contain carbon black in the interval from 20 to 80 phr with step of 20 phr.

The prepared compounds were subjected to a study of rheological properties and vulcanization characteristics (Tab. 2). Heat conduction significantly affects mainly the vulcanization characteristics, namely scorch time and optimum vulcanization time, due to faster activation of the vulcanization system. The next step was testing heat conduction using a special mold for monitoring heat transfer during vulcanization with evenly distributed sensors (Fig. 2) in the amount of 5 pcs. Heat was supplied to the elastomer compound using the upper and lower closure only to the contact surfaces of the elastomer compound - mold closure. The mold was monitored during the test using a thermal camera to verify the heat transfer only from the mold closure (Fig. 1). The measured test results (test time 1800 s) were graphically processed. It can be observed that with increasing filler content, the temperature value achieved on individual sensors also increases, which confirms the thermal conductivity of the filler used (Fig. 3).

The results of the study show that with increasing carbon black N339 content, the heat transfer ability of the elastomer compound also increases. The carbon black content supports the transfer of heat from the heating plates to the volume of the elastomer compound. It is known from professional scientific publications that carbon black is a good thermal conductor, which also affects the values of vulcanization characteristics. From the above results of the scorch time (t_{s02}) of the compound and the optimal vulcanization time, with increasing carbon black content in the elastomer compound, the scorch time value of the compound decreases, which also indicates the speed of overheating of the elastomer compound and activation of the vulcanization system. From the point of view of the optimum vulcanization time, the trend is similar, but only up to a content of 60 phr. A content higher than 60 phr (80 phr) causes an increase in the value of the optimum vulcanization time, which may be caused by the filler itself and its content, which forms a barrier to the vulcanization process (availability of the vulcanizing agent and accelerator). Rheological properties show an increase in the value of the minimum torque as well as the maximum torque with increasing filler content in the compound.

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