MIGRATION OF PLASTICIZER FROM COMPOSITE ENERGETIC MATERIAL INTO POLYMER COATING

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Abstract: The migration of plasticizers from composite energetic materials (CEM) into the external environment leads to the degradation of their performance characteristics. The paper presents the results of modeling the process of migration of a plasticizer – transformer oil from CEM with HTPB binder into an ethylene–propylene rubber used as insulating coating. Diffusion coefficients (D) of oil in CEM have been determined by desorption into a gaseous medium on a thermogravimetric apparatus in the temperature range of 80–160 °C and an empirical dependence of D on temperature and oil concentration has been obtained. Diffusion coefficients in the coating have been found by sorption from a large volume of oil at temperatures of 20 and 60 °C. The errors in the experimental determination of the diffusion coefficients are analized. An analytical solution of the diffusion equations is obtained for the case of oil migration from a large volume of energetic material into a thin layer coating. The calculation of model variants of the dependence of oil concentration on time in the energetic material and coating is discussed. It is shown that over a period of several years, the oil content in the coating can reach tens of percent of its initial mass. A relatively high concentration of plasticizer in the coating can be achieved already in the process of vulcanization of the energetic material carried out at elevated temperatures.

Keywords: composite energetic material; insulating coating; transformer oil; migration; diffusion

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Figure Captions

Figure 1 Time dependence of the relative weight loss of K-2 samples at temperatures of 90 (*1*), 115 (*2*), and 130 °C (*3*): solid curves — experiments; and dotted curves — calculation using Eq. (6). The sample thicknesses (L) are 0.87, 0.95, and 0.51 mm, respectively

Figure 2 Distribution of the transformer oil concentration in the K-2 material (*a*) and in the coating (*b*) at $T = 20$ °C (variant 1 in Table 2) at time moments 10^5 (*1*), 10^6 (*2*), 10^7 (*3*), 10^8 (*4*), and 10^9 s (*5*). The K-2 material is in the region $x < 0$, and the coating is in the region $0 < x \leq 0.005$ m. The concentration of oil in the coating region for the indicated time moments increases from bottom to top

Figure 3 Dependence of the average concentration of transformer oil on time in the K-2 material C_1^* and in the coating C_2^* (curves 1 and 2). Curve numbers correspond to the calculation variants in Table 2

Figure 4 Dependence of the average concentration of transformer oil in the coating on time. Curve numbers correspond to the calculation variants in Table 2. The characteristics of the variants are given in the text

Figure 5 Temperature dependence of the weight loss (as a percentage of the initial one) of the coating (*1* — initial sample of coating and *2* — coating sample after contact with energetic material containing oil) and transformer oil samples (*3*) at a heating rate of 5 °C/min

Table Captions

Table 1 Diffusion coefficients of transformer oil (D, m^2/s) in K-2 material at different concentrations and temperatures

Table 2 Calculated variants of transformer oil migration

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