sults of these calculations, carried out by the Monte Carlo method. Analysis of the data obtained revealed that the character of the dependence of the effective albedo on the distance R is preserved for substances with different Z, but the range over which f(R) varies decreases as Z grows.

In the region $\mu(E_0)R \leqslant 10$ the function $f(R, \theta, \varphi, \theta_0, E_0)$ can be represented as an empirical formula

$$f(R, \theta, \varphi, \theta_0, E_0) = \frac{\left[b_0 + b_1\mu^3(E_0) + b_2\frac{\mu^2(E_0)}{\cos\theta} + b_3\frac{\cos\theta_0}{\cos\theta}\right]R}{1 + [d_1\mu^3(E_0) + d_2\cos\theta_0]R^{\left(c_1 + \frac{c_2}{\cos\theta}\right)}}, \quad (4)$$

where b_0, b_1, b_2, b_3, c_1, c_2, d_1, and d_2 are empirical constants whose values are given in Table 1 for $\mu(E_0)R > 10$ we can assume that $f(R) \approx 1$ with an error not exceeding 20% in most cases.

The results of the calculations from Eq. (4) differ from those obtained by the Monte Carlo method by no more than 20-25%, the maximum divergence being 60%. The statistical error of Monte Carlo calculations is 5-20%.

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LITERATURE CITED

1. N. G. Gusev et al., Physical Foundations of Radiation Protection [in Russian], Atomizdat, Moscow (1980).
2. V. I. Bulatov et al., Gamma-Ray Albedo [in Russian], Atomizdat, Moscow (1968).
3. V. I. Kulikov et al., At. Energ., 44, No. 1, 85 (1978).
4. V. I. Kulikov et al., At. Energ., 51, No. 1, 59 (1981).

CREEP IN A CARBON–CARBON MATERIAL

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There is now an extensive discussion of the scope for using materials of carbon–carbon type with high-tensile fibers (KUP-VM) as constructional materials for high-temperature systems [1-3] including high-temperature gas-cooled reactors [4, 5]. The high strength performance of such materials is particularly pronounced for compressive loads.

The creep is considerably dependent on the structure [3, 6], so it is of interest to determine the creep kinetics for material of KUP-VM type at high temperature under compressive axial loads.

We tested cylindrical sleeve specimens made of KUP-VMSKM material* with a coke matrix of diameter 60 mm, height ∿100 mm, and wall thickness 5 mm. The density of the material was ∿1.3 g/cm^3. The specimens were placed in a rigid graphite holder and loaded with a graphite plunger. The tests were performed for 1 h at 1800, 2200, and 2300°K at loads of 5 and 8 MPa. A specimen was heated to the required temperature under vacuum, after which an excess pressure of argon was set up in the apparatus (0.02 MPa). After the set temperature had been

*This material was developed by G. I. Babayants, V. I. Artem'ev, and O. V. Bokov; it is a material of carbon–carbon type based on a coke matrix.

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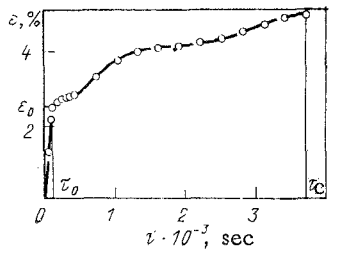

Fig. 1

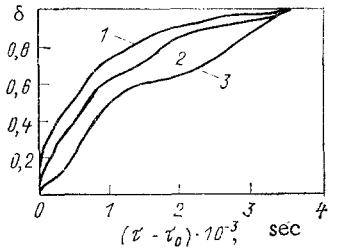

Fig. 2

Fig. 1. Axial deformation as a function of time for T = 2300°K and σ = 8 MPa.

Fig. 2. Dependence of the axial strain on time for T = 1800°K and σ = 8 MPa (1); 2200°K and 5 MPa (2); 2300°K and 8 MPa (3).

attained, the specimen was loaded by an axial force with a rate of ∿50 N/sec. The time recorder was started at the instant of application of the load and the axial strain was measured. The limiting errors in determining the parameters were not more than ±0.4% for temperature, ±5% for force, and ±2% for axial strain.

Figure 1 shows a typical strain–time relationship, where $\varepsilon = \Delta H/H_0$ is the relative axial deformation (H_0 is the initial height of the specimen, while ΔH is the measured axial deformation), while τ is time. These creep curves show the elastic-strain part clearly together with a transitional stage, after which the creep does not vary linearly, as for most constructional materials, but with characteristic fluctuations.

This feature is clearly illustrated if the strain is represented in relative coordinates (Fig. 2), where $\delta = (\varepsilon - \varepsilon_0)/(\varepsilon_c - \varepsilon_0)$ and ε_0 is the strain at the end of the elastic-strain zone τ_0, with ε_c the strain throughout the test time τ_c.

Each curve in Fig. 2 has been constructed from the results for several (two or three) specimens, and the spread in ε for the individual specimens at a given τ was not more than ±6% of the mean value. A similar picture was observed under all test conditions, which indicates that the KUP-VMSKM material does not have a stage of steady-state creep. This feature must be borne in mind in developing designs to work at high temperature under compressive load.

LITERATURE CITED

1. D. M. Karpinos, L. I. Tuchinskii, and L. R. Vishnyakov, New Composite Materials [in Russian], Vysshaya Shkola, Kiev (1977).
2. C. Chamis (ed.), Composite Materials [Russian translation], Vol. 8, Mashinostroenie, Moscow (1978).
3. Handbook on the Properties of Constructional Materials Based on Carbon [in Russian], Metallurgiya, Moscow (1975).
4. K. A. Andrianov et al., At. Energ., 46, No. 6, 406 (1979).
5. T. B. Ashrapov et al., Atomic Science and Engineering, Physics of Radiation Damage and Radiation Materials Science [in Russian], Issue 2(13) (1980), p. 26.
6. L. Brantman (ed.)., Composite Materials [Russian translation], Vol. 5, Mir, Moscow (1978).