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A MODELING OF FORMING PROCESS FOR SYSTEM TRANSPORT PORES IN STRUCTURE OF CARBONIZED COAL-PLASTIC

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There are considered conformities to forming of the system of transport pores in the structure of carbonized coal-plastics composites at their gasification in the volume of running reactor of isothermal type. There is decided the task of transfer of dioxide of carbon on length of pores for carbonized coal-plastics, providing profiling of their structure in the process of gasification. There are set kinetic parameters of gasification process for three types of carbon materials: pyrolytical carbon, glass carbon and technical carbon.

Keywords: carbonized coal-plastics, profiling of structure, system of transport pores, gasification, energy of activation

Carbon fibres, carbonized phenol-formaldehyde rosin and pyrolitical carbon are of part of the complement for carbon composites,. On the stage of making coal-plastic it is carried out the complete enveloping of carbon fibers by liquid connecting material. After consolidation of the noted material and completion of carbonization process of coal-plastic the surface of fiber is characterized by the presence of layer of glasscarbon, here a pyrolitic carbon fills the porous volume of carbonized connecting material partly. .

Presence of transport pores in a structure carbonized coal-plastic and them geometrical form provide at deposition of pyrolitical carbon from a gas phase high-quality compression of the noted material, both at the conditions of isothermal method and to the method of the radial moving for area of pyrolysis [1,2].

The task over of work is development of mathematical model of forming process for the transport pores system in a structure carbonized coal-plastic at its gasification.

Transfer of carbon dioxide by diffusion on length of pore is described by the system of equations

$$\frac{d^2C}{dx^2} = \frac{2k}{D\cdot r}\cdot f\ \ C \quad , \qquad (1)$$

$$\tilde{N}\big|_{x=0} = C_n \ ; \qquad (2)$$

$$\left.\frac{dC}{dx}\right|_{x=y} = 0 \ , \qquad (3)$$

where C – a concentration of carbon dioxide; x – a co-ordinate on length of pore; k – a constant for speed of carbon gasification; D – a coefficient of diffusion for carbon dioxide in mixture of gases; r – a radius of pore; $f(C)$ – a concentration function; C_n – a concentration of carbon dioxide on a surface carbonized coal-plastic; y – a half of thickness of wall for coal-plastic.

The decision of the noted system sets distribution for concentration of carbon dioxide on length of pore:

$$\tilde{N} = \frac{\tilde{N}_0 \cdot \left\langle \exp(-a\cdot x) + \exp\left[a\cdot(x-2y)\right]\right\rangle}{1+\exp(-2a\cdot y)} \,, \tag{4}$$

where a – a root of characteristic equation $a = (2\,k/r\cdot D)^{0,5}$.

Reaction for gasification process of in a structure carbonized coal-plastic looks like:

$$C + CO_2 \Leftrightarrow 2CO \;. \tag{5}$$

For the noted reaction for distribution of reactionary gases on length of reactor taking into account the measure of decomposition of carbon dioxide it is possible to write down as

$$C_{CO_2} = C_{CO_2}^{\text{âõ}}\cdot(1-\alpha)\;;\quad C_{CO} = C_{CO_2}^{\text{âõ}}\cdot(1+2\alpha)\;;\quad U = U_{\text{âõ}}\cdot(1+\alpha)\;, \tag{6}$$

where $C_{CO_2}^{\text{âõ}}$ – a concentration of dioxide of carbon on an entrance to the reactor; α – a measure of decomposition of carbon dioxide; $U_{вх}$ – speed of presentation for reactionary gas on an entrance to the reactor.

Equation (6) taking into account correlations (6) looks like:

$$\frac{3\alpha}{1-\alpha}\cdot\frac{d\alpha}{dx} + \frac{k\cdot\varepsilon\cdot\beta}{U_{\text{âõ}}} = 0 \;. \tag{7}$$

Decision of equation (7) in relation to the measure of decomposition of carbon dioxide α it is possible to write down as

$$\alpha(x) = (2\varepsilon\cdot x)^{0,5}. \tag{8}$$

From equation (8) the coefficient of mass conductivity β it is determined as

$$\beta = \frac{\alpha^2(L)\cdot U_{\text{âõ}}\cdot R\cdot\left[k\cdot(1-q_i) - \pi\cdot q_i\cdot\sum\Omega_{\text{i}}\right]}{2k\cdot L - \alpha^2(L)\cdot U_{\text{âõ}}\cdot R} \,, \tag{9}$$

where L – length of reactionary area.

Use of decisions (4), (8) and (9) assumes that are values known of constants of speed of gasification for carbon different forms in the environment of carbon dioxide.

Linear speed of gasification W of carbon different forms, which investigated, determine as

$$W = W_{\text{ïèò}}\cdot S \;, \tag{10}$$

where W_{num} – specific speed of gasification, $W_{\text{ïèò}} = k\cdot C/\rho$; ρ – a density to the component of coal-plastic; $k = k_0\cdot\exp(-E/B\cdot T)$; k_0 – pre-exponenta; E – energy of activating of gasification process; B – universal gas constant; T – a temperature of process; S – an area of powder surface.

Using correlation (15), and also experimental data, that it is got in work [3], calculated the parameters of constants of gasification speed for glass carbon (GC), pyrolitic carbon (PC) and technical carbon (TC)

The presence of difference of values of energy of activating is related to the structure of materials which study. So, glass carbon has a globular structure which consists of ribbon formations of carbon atoms. A technical carbon is micro powders the particles of which have an effective size from a few carbon atoms to a few hundred micrometers. On the surface of large particles of technical carbon look thin layer of pyrolitical carbon [6, 7]. Pyrolitical carbon which get on the heated surface of carbonized coal-plastic by deposition from a gas phase in the environment of natural gas is characterized by a well-organized crystalline structure, which consists of atomic planes, located in parallel surfaces of deposition lining, here the carbon atoms are placed in the tops of correct hexagons.

From the analysis of the got results it shows, that pores have a cone-shaped form with a radius the value of which grows from the middle of thickness carbonized coal-plastic to its surface.

There is worked out mathematical model of forming at gasification of the system of transport pores for cone-shaped form in the porous structure of carbonized coal-plastics. Final correlations are offered for the estimation of porosity of carbonized coal-plastics at their gasification in the environment of carbon dioxide.

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