Hence, graphs were plotted of the dependence of the specific burning rate of peat and coke particles on the velocity of flow over the particle (Fig.). They show that as the flow velocity increases the burning rate of the peat and coke particles increases. For peat particles, the burning rate at flow velocities above 1.0 m/sec grows considerably faster than at flow velocities below 1.0 m/sec. This is evidence that as flow velocity increases, there is increased blowing away of the burning layer of volatile material from the front surface of the particle (this is also observed visually), which accelerates burning, since part of the front reaction surface of the particle, where active burn-up of coke residue begins, is still accessible to oxygen up to the end of the phase of visible burning of volatiles [2]. Moreover, as the flow velocity increases, the inhibiting action of diffusion on the heterogeneous reaction is lessened, which also accelerates burning.

The dependence of the specific burning rate on flow velocity is stronger for peat particles than for coke particles.

The burning rate of peat particles is considerably greater than that of coke particles of corresponding size, although the mass of the former averages twice that of the latter. The specific burning rate of 8 mm peat particles is thus 2.5 to 3.0 times that of coke of the same diameter within the range of flow velocities used in the tests. Therefore, on the whole, the volatiles serve to intensify the burning of peat particles (although at the time of emission they inhibit the burning of coke [2]).

Examination of the graphs also shows that as particle size decreases, the specific burning rate increases. This agrees with the fact that mass transfer increases with reduction of particle diameter, while specific burning rate also increases.

NOTATION

w – initial weight of fuel particle; w_r – weight of residue after burning; Δw – weight of fuel particle burned in time τ_b; S_p – external surface area of spherical particle; d – particle diameter.

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THE INFLUENCE OF RE NUMBER ON THE POSITION OF THE SEPARATION POINT OF A BOUNDARY LAYER

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The equation of motion of a liquid written in dimensionless form contains the small parameter 1/Re. If the quantities in the equation are expanded in terms of this parameter, the zero-order approximation, not containing the parameter, leads formally to the equation of the boundary layer. Thus, the concept of the boundary layer presupposes that the Reynolds number is sufficiently large, so that in the expansion for velocity, for example,

$$u = u_0 + \frac{1}{\sqrt{\mathrm{Re}}} u_1 + \frac{1}{\mathrm{Re}} u_2 + \ldots$$

all terms after the first may be neglected. Using this concept, it may be shown [1] that, up to a critical Re number, the dimensionless velocity distribution in the boundary layer, and also the location of the point of separation of the boundary layer, do not depend on the Re number.

The position of the separation point of a laminar boundary layer on the surface of a cylinder was first measured by Hiemenz [2]; according to the data of [3], the position of this point is 82° from the front stagnation point, at $\mathrm{Re} = 1.2 \cdot 10^4$, while according to [1] it is 81° at $\mathrm{Re} = 1.85 \cdot 10^4$.

The term "sufficiently large Reynolds number" is somewhat indefinite, it being difficult to point to a range where the concept of the boundary layer starts to be valid, and the position of separation point to be "steady."

At small Re numbers the terms with $1/\sqrt{\mathrm{Re}}$, 1/Re, and so on begin to be important in the expansion of the velocity in negative powers of Re, and so the position of the separation point of the boundary layer begins to depend on the Reynolds number (the concept "boundary layer" is then itself somewhat modified from that mentioned above).

Separation points for the region of low Re numbers (40-180) were measured in [4], and for Re = 40 in [5, 6] (see Fig.).

However, the literature as yet contains no systematic measurements in the Reynolds number range $3 \cdot 10^2$ to 10^4, although such information is of interest as regards instrumentation, ore concentration technology, and a variety of physical and chemical processes.

The authors have measured the position of the separation point of a laminar boundary layer on the surface of a cylinder in the Reynolds number range $4.6 \cdot 10^2$ to $6 \cdot 10^3$.

The technique used in the experiments was as follows. Tin and lead cylinders from 0.1 to 0.5 cm in diameter and 5.5 cm long were inserted into a mercury-filled rotating annular channel of mean diameter 50 cm and rectangular annulus section 3×6 cm^2.

The speed of rotation of the channel was varied so as to produce flow velocities of mercury in the range 2.7-18.7 cm/sec. Prior to immersion the polished surfaces of the cylinders were carefully amalgamed. As a result of diffusion of mercury, a sharp boundary was formed on the cylinder surface between regions of laminar and vortex diffusion, corresponding to the line of separation of the boundary layer. The results of the measurements are presented to a semilogarithmic scale in the figure.

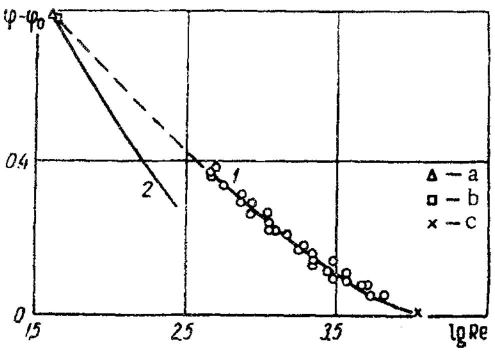

Fig. Position of separation point as a function of Re number: 1 – as measured by the authors; 2 – according to [4]; a – according to [5]; b – according to [6]; c – according to [2].

Because of certain discrepancies between our measurements and those of Homann [4], some comments should be made about the experimental conditions in both cases. In Homann's tests the end of the cylinder rested on the transparent wall of the channel, and what was photographed was, in fact, the flow in the region of contact of cylinder and wall. Moreover, Homann measured the separation point from photographs, as the intersection of the dividing line between vortex and external flow with the cylinder surface. As the Re number increased, this line approximated to a tangent to the cylinder surface, which introduced the possibility of considerable error in determining the point of intersection.

Our tests were free from this deficiency. The position of the separation point was measured immediately after the test in terms of two sharp lines on the cylinder surface. The end effects due to the finite length of the cylinder and the free mercury surface turned out to be approximately the same, and the region of their influence did not exceed 2-3 mm. Over the rest of the cylinder the separation line showed practically no distortion.

A known deficiency is that the tests were carried out in a rotating annular channel, which can lead to flow-distorting centrifugal effects. However, observation of the mercury surface did not reveal flow in the transverse direction. A simple calculation shows that the pressure drop in the mercury in the radial direction comprises only 6% of the velocity head at the largest Re number. Moreover, at Re = $6 \cdot 10^3$, when the centrifugal effect should appear most strongly, the measured separation angle is 84°, i.e., differs only slightly from the position of the separation line for a fully developed boundary layer. Note also that our curves of pressure distribution over the cylinder surface agree exactly with those in the literature (e.g., at Re = 2,800 and 5,000 with the data of [3]). We may therefore consider that at smaller Re numbers the centrifugal effect will be present to an even smaller degree, and will not in any case have an appreciable influence on the character of curve 1 (Fig.).

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