MANUFACTURING AND EQUIPMENT

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A ROTARY FINE FILTER FOR HIGH-EFFICIENT DRY DUST COLLECTING IN THE PRODUCTION OF REFRACTORIES

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A fine filter for treatment of dust-laden gases in the production of refractories is developed. Its testing in a pilot filtering unit using a model quartz dust has shown a high-efficient on-line recovery of 75 – 85%. The aerodynamics of the filter equipped with rotary impellers is discussed. The engineering solution proposed expands the application of fine filters and allows the treatment of dust-laden gases to be carried out without preliminary separation of large-sized particles using other facilities.

Filtering of aerosols through porous cross-linked beds (such as metallic filter grids, ceramic and metal-ceramic membranes) has two major inconveniences: it requires a high pressure drop, and the filtering facilities employed are difficult to recover [1]. A way of improving operation of the filter bed is to collect the coagulating dust with a low pore depth penetration and to remove it. Furthermore, the recovery technique should allow some dust to be retained on the bed surface to ensure efficiency of the new filtering cycle.

It has been noted earlier [2, 3] that rotary cylindrical or conical filter cells provide a steady-state aerodynamic filtering regime and a continuous recovery, which operate under constant centrifugal field conditions and do not require the use of special accessories or additional energy expenditure. It was suggested in [4] that that the creation of an adequate driving force in the centripetal gas-and-dust flow may prevent formation of a deposit on the flat filter membrane.

To improve efficiency, throughput, applicability and recovery of porous filter membranes, a fine gas-and-dust filter for special application in the refractory technology has been developed.[2] The newly designed dust collector uses the combined effect of a centrifugal force and filtration.

The filter (Fig. 1) is a box-shaped apparatus composed of a casing *1*, an inlet header *2*, an outlet pipe *3*, a chamber for dust-laden *4* and treated gas *5*, and a dust bin *6*. The filter is fitted with filter cells of porous metal *7*. A rotary shaft *8* with impellers *9* passing between filter cell sections is housed inside the casing.

With the shaft in rotation, the particles impinging on the filter are subjected to the centrifugal force that drives them away from the filter surface. Rotation speed of the medium

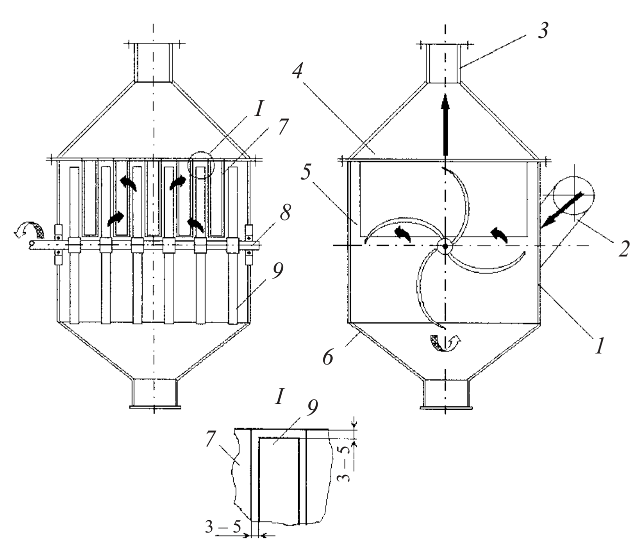

Fig. 1. Aerodynamic recovery filter: *1*) casing; *2*) inlet header; *3*) outlet pipe; *4*) treated gas chamber; *5*) dust-laden gas chamber; *6*) dust bin; *7*) filter cells; *8*) shaft with impellers; *9*) impeller blade.

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[2] RF Patent No. 2156642.

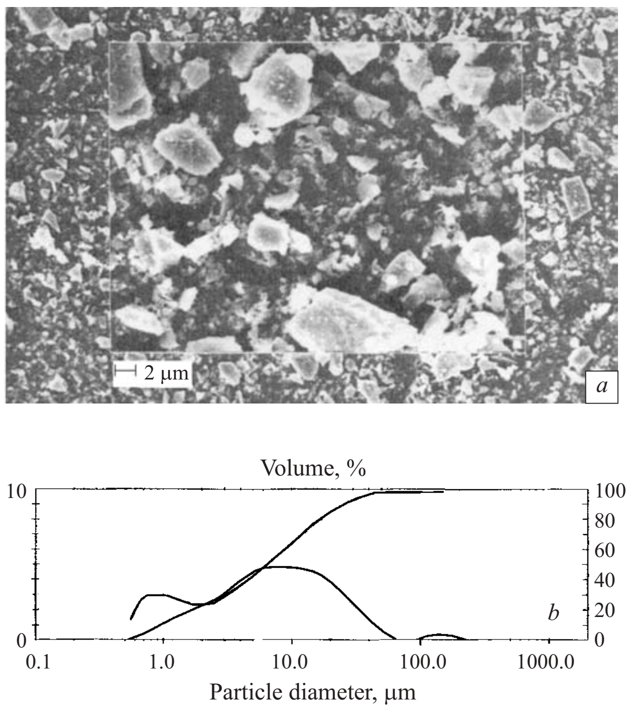

Fig. 2. Electron photomicrograph (*a*) and particle size distribution (*b*) of the model quartz dust.

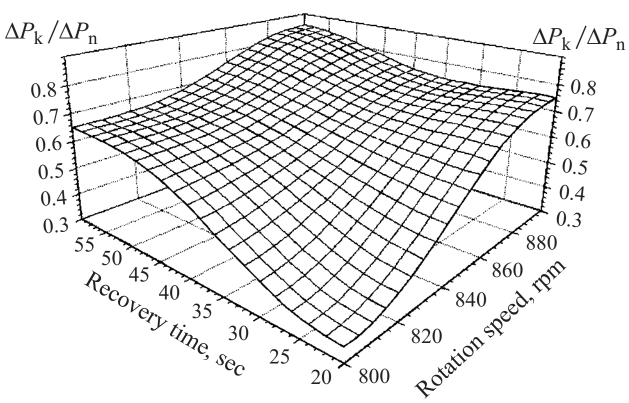

Fig. 3. Relationship $\Delta P_k/\Delta P_n = f(n, t)$.

(that is, particulate matter) near the filter surface is close to the impeller rotation speed. The tangential streams at the surface of the filter cell overcome the force of friction and thus work in shear of the dust deposit; the uppermost layer of dust deposited on the filter loosens up and the dust particles are carried away, impinge on the inner wall of the casing, and fall down in the dust bin. Such is the mechanism of continuous filter recovery [5, 6].

To test this theoretical concept, a pilot filtering unit fitted with a filter cell was designed; the filter bed was made of spherical powder (stainless steel Kh18N15), size fraction smaller than 0.1 mm. The filter cell area was 0.125 m^2. The

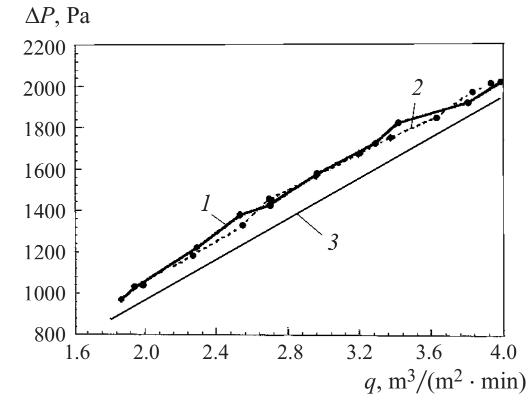

Fig. 4. Filter resistance ΔP plotted as a function of the specific gas load q: *1*) no impeller rotated; *2*) with impeller rotated; *3*) calculated by Ergan formula.

model dust was a quartz dust with the following parameters: $\rho = 2600$ kg/m^3, $d_m = 6.3$ μm, and $\log \sigma = 1.385$. A photomicrograph of the quartz dust and its granulometric distribution are shown in Fig. 2 (a Mastersizer S laser spectrometer was used).

Relevant data on the filter recovery tests are given in Fig. 3. The efficiency of this recovery technique is 75 – 85%, which should be recognized as a quite satisfactory result.

Experimental data properly processed by a statistical method (Fig. 3) are described by the equation $\Delta P_k/\Delta P_n = -3.85 + 0.005n + 0.0475t - 0.00005nt$, where n is the shaft rotation speed, min^{-1}, and t is the recovery time, sec.

In practice, to recover a filter, the filter's sections are relieved of the gas load, which results in a decrease in rupture strength of the dust-laden layer. Therefore we have considered the effect of shaft speed on the pressure during continuous recovery of the filter cell (under gas load); relevant data are given in Fig. 4.

The data in Fig. 4 show that the impeller rotation produces little change in the aerodynamic conditions. The filter recovery may be carried out either in a continuous regime (the dust layer thickness, that is, the filter efficiency can be controlled by changing the shaft rotation speed) or in a periodic regime (at a definite pressure drop). By changing the aerodynamic regime, one can control the pressure drop across the filter membrane.

The engineering solution proposed here expands the application of fine filters and allows the treatment of dust-laden gases to be carried out without preliminary separation of large-sized particles using other facilities (cyclones, etc.).

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