DESIGN AND CALCULATIONS

DEVELOPMENT AND STUDY OF A SCREW PLASTICIZER FOR ASBESTOS-FILLED MATERIALS

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Analysis of the existing methods and equipment for processing thermoreactive materials shows that use of screw plasticizers is one of the most promising lines. In this respect, vertical-type screw plasticizer with a conical screw is highly efficient for asbestos-filled materials [1]. However, the specific properties of asbestos-filled materials (high adhesion to metals, tendency to cake, poor friability, etc.) make it necessary to study the behavior of asbestos-filled materials in the process of plasticization by a screw.

For rational designing of a screw-type plasticizer, we investigated different variants of charging of asbestos-filled materials into a plasticizing cylinder (or into a material cylinder), determined the dependence of the productivity on the screw rotation speed and on the plasticization pressure, and studied the mechanism of material movement in the screw channel and its effect on the temperature of the dose accumulated.

The experiments were performed on a vertical-type screw plasticizer with screw diameters \( D = 6.3 \times 10^{-2} \) and \( 5 \times 10^{-2} \) m, lengths respectively of 10D and 8D, channel depths \( n = (8-12) \times 10^{-3} \), and a compression ratio \( i = 1 \). The material cylinder was heated by two electric heaters. The temperature of the plasticized tablet was measured by a needle thermocouple. The screw was set into rotation by a hydraulic motor which permits smooth variation of its rotation speed within 0-1 sec\(^{-1}\). Asbestos-filled materials containing 143-63L and 328-303 rubber binders and FS-301-41 and F5-385-66 resin binders were chosen as the test materials. The cylindrical screw of the plasticizer [2] has only a rotary motion while the material charge accumulates in the feed chamber where a constant head (counter pressure) is maintained by means of a hydraulic cylinder. Such a design permits one to avoid nonuniformity of temperature of the charge due to variation in the effective length of the cylindrical screw in the process of the charge collection and to prevent disintegration of the fibrous filler which occurs in the area of material entry into the plasticizing cylinder through to-and-fro movement of the cylindrical screw. The requisite amount of the material is segmented by shifting the batching chamber in a plane perpendicular to the screw axis and is extruded by the piston of the hydraulic cylinder.

Reliable operation of the screw plasticizer depends a great deal on the design of the charging area. Of special importance is correct batching of the material from the bin for processing poorly friable materials with a fibrous filler. In investigating the performance of the screw plasticizer we examined two design variants of the area of charging of the asbestos-filled materials into the material cylinder. In one variant the bin is provided with a stirrer made in the form of a blade whose lower edge represents a curve formed by truncation of the cone by a semicylinder [3]. In this case conditions are created for movement, in the operation process, of the poorly friable asbestos-filled materials on the inner surface of the blade from the walls of the bin to its center where the material is captured by the whorls of the cylindrical screw. The axes of symmetry of the screw and the blade being parallel, charging of the poorly friable asbestos-filled materials into the screw occurs without notable compaction of the material.

In the other variant the charging bin was provided with a conical screw [1] having a helix angle \( \alpha = 17^\circ 42' \) and a generatrix angle \( \beta = 30^\circ \). In order to select the optimum length of the conical screw its dimensions were altered by attaching additional sections of whorls. To prevent churning of the material in the peripheral direction, the lower part of the bin was provided with grooves whose shape and dimensions were selected in accordance with the recommendations of [4].

Fig. 1. Material temperature $T_m$ versus plasticization pressure $p$ for different designs: — conical screw; --- blade stirrer.

Fig. 2. Productivity $Q$ versus screw rotation speed $n$ and plasticization pressure $p$ during processing of different asbestos-filled materials: a) $Q = f(n)$; b) $Q = f(p)$; ---) conical screw; ---) blade stirrer; 1) 328-303, 2) 143-63L, 3) F-301-41, and 4) F5-385-66.

The experimental data obtained show that the calculation and selection of the geometric dimensions of the conical screw should be made with due consideration for the particle size of the material and the compression characteristics of the asbestos-filled materials being processed. Use of a conical screw having its conical part $9 \times 10^{-2}$ m in length ensured the most favorable conditions for capture and transport of the asbestos-filled materials 143-63L and 328-303.

Investigations of the pattern of movement and compaction of the materials showed that the asbestos-filled material can be compacted in the charging area 3-5-fold by a conical screw. Owing to high density of the asbestos-filled material and its pluglike movement in the channel of the cylindrical screw, the whole length of the material cylinder is used