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SIMULATION OF AIR FLOW RATE AT POINT OF CONTACT WITH A STREAM OF MELTED POLYMERIC MATERIAL

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Abstract: This paper presents the research of interaction of air flow and melted material in production of fibrous materials. Correlations for calculation of air flow rate in different cross sections of a stream are acquired. The developed method of calculation of air flow rate at point of contact with stream of the melted polymeric material can be used in construction of blow heads models with a slot nozzle in production of fibrous products from different polymeric materials.

1 Introduction

In the technological chart of producing the thermo bonded products from polymeric fibrous materials by extrusive blowing method the most important is determination of air flow rate from slot nozzle of blow head at point of its contact with stream of the melted polymeric material flowing from exit nozzle of the melting unit.

2 Methods and materials used for research

Quality of the received fiber significantly depends on air flow rate at the contact point with stream of the melted material [1]. In equipment for implementation of the vertical blowing method, calculating of this rate does not present essential difficulties. For this purpose it is enough to know air outlet rate from annular nozzle of blow head and the current rate of the melted material. Required rate is defined as difference of marked rates as the directions of the considered flows match. Researches [1], [2] have proved that the average diameter of elementary fibers in production of basalt fiber by the duplex way decreases with increase of the considered rate. For one of three possible concept versions of fiber production process [1], where from single stream of the melted material of diameter d_c, the single fiber thread of diameter d_b is produced, after drawing up the equation of continuity of air flow and the melted material moving in one direction as it has been proved in research [1], formula for determination of average diameter of elementary fiber received:

$$d_b = d_c (V_c/V_{bc})^{0,5} \quad (1)$$

where V_c - the rate of flow of the melted material stream, m/s; V_{bc}-the contact rate of melted material stream with air flow from a blow head, m/s, which for the case above is defined as a difference:

$$V_{bc} = V_b - V_c \cos \gamma \quad (2)$$

where V_b - air flow rate in the merger coordinate of the melted material stream and air flow, m/s; γ - angle between the directions of the air flow movement and melted material stream at the merger coordinate, deg.

When producing the thermo bonded products from polymeric fibrous materials by extrusive blowing method, the directions of the air flow movement from a blow head nozzle and the melted polymeric material stream flowing from extruder exit nozzle do not match. Possible options of the given streams arrangement are presented in figure 1. All six presented options can be produced but have their special features, significant during the design process for the manufacturing of the thermo bonded products using the above method. Options (c) and (e), where air flow and the melted material stream contact under a right or acute angle, assume a vertical arrangement of extruder for melting and feed of the melted material.

Thus there is an opportunity to significantly reduce the space, occupied by the equipment, while increasing the dimensional height yielding the convenience of equipment operation.Options (a), (b), (d) and (f) assume a horizontal arrangement of extruder, where the melted material stream horizontally flows from a form-building extruder head and changes its movement direction to the vertical by gravity. The advantage of each option is in