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Heated Needle Shut-off Nozzle

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The invention relates to a heated needle shut-off nozzle for injection moulding machines, for injection moulds or for hot runner systems.

There are known needle shut-off nozzles in which mechanical, pneumatic or hydraulic drive means are provided for moving the shut-off needle in the axial direction of opening or closing. With such nozzles, which have a melt-entry face connected to the injection-moulding machine and a melt-exit face at the mould nest, there is the problem of imparting to the gate needle the force required for the axial shut-off and opening movement. The gate needle can be connected to appropriate drive means on the melt-entry face as well as on the melt-exit face. For this reason, the state of the art provides for applying force in the central part of needle shut-off nozzles. But this necessitates a corresponding detour of the flow channel around the central part as has been illustrated and described in US Patent 5,387,099 and in EP 0 373 293.

Such detours are disadvantageous because the high injection pressures within the flow channel often result in difficulties with the sealing and in uncontrollable forces which are caused by the flowing melt and act upon the gate needle so that unilateral loads act on the needles. Thus implies considerable wear in the region of the needle guide means within the nozzle body as well as at the seat of the shut-off means, which seat is formed by the front end of the needle and the mating nozzle mouth.

Besides that, such needle shut-off nozzles can be manufactured only with great expenses for machinery and can be heated uniformly only by high energy consumption.

Furthermore, the known nozzles with the aforementioned detour imply increased pressure loss.

These are reasons for detrimental effects upon the quality of the injection moulded articles. An other disadvantage of the known nozzles results from their large size which considerably restricts their applications.

The problem underlying the invention is to configure a heated needle shut-off nozzle of the above-specified type so that unilateral load on the

needle by the flowing melt is eliminated and that the dimensions of the needle shut-off valve can be kept small.

It is the object of the present invention to substantially overcome or at least ameliorate one or more of the disadvantages of the prior art.

Accordingly, the present invention provides a heated needle shut-off nozzle for injection moulding machines, for injection moulds or for hot-runner systems, wherein the hot-runner section connecting a manifold or a nozzle of a machine with the mould nest is composed of two portions and wherein the first portion which faces a hot-runner manifold or a nozzle of a machine is formed at the end facing the portion by a basically cylindrical tubular body in which a flow channel is configured, wherein on the outer diameter of the tubular body there is movably and sealingly guided a sleeve which with its outer diameter is movably and sealingly guided in a second portion and wherein the sleeve is coupled to drive means at its free outwards pointing end and to a shut-off needle at its end pointing into the flow channel.

A preferred form of the present invention will now be described by way of example with reference to the accompanying drawings, wherein:

Figures 1a, 1b and 2 are partial cross-sectional views of the basic functional parts of the heatable needle shut-off valve;

Figure 3 is a partial cross-sectional view of the embodiment shown in Figure 2;

Figures 4 and 5 are another embodiment of the needle shut-off valve;

Figure 6 is an enlarged view of the detail A of Figure 4; and

Figure 7 is a cross-sectional view of the basic functional parts of another embodiment.

In Figures 1a, 1b and 2, a basic concept is illustrated in a greatly simplified form.

There is shown a hot-runner section 10 which is formed by portions 12 and 14, the one end 16 of which can be connected to a nozzle 18 of a machine or a hot-channel manifold (not shown), and the other end 20 of which forms the nozzle proper followed by the mould nest or the mould cavity of the injection mould.

For the sake of better understanding and greater clarity, the two portions 12, 14, which are illustrated in Figure 1a, are shown without heater elements integrated nozzle needle. However, it is obvious that a gap S1 is formed between the outer diameter 15 of the portion 12 and the inner diameter 19 of the portion 14. As shown clearly in Figure 2, in this gap S1 there is arranged the sleeve 22 of appropriate wall thickness, which is therefore supported for axial movement between the portions 12, 14. The sleeve 22 is provided on one end with means 21 suitable for cooperating with drive means (not shown) which are capable of moving the sleeve in the axial direction and will be described below. The opposite end of the sleeve 22 is joined with a shut-off needle 24.

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Figure 2 shows the sleeve 22 and the shut-off needle 24 in the opened position. Movement of the sleeve in the direction of arrow 26 transfers the shut-off needle 24 into the shut-off position.

In Figure 1a, the portion 12 extends over the length L2 into the portion 14.

Portion 12 is formed by a substantially cylindrical tube body 80 in which a flow channel 86 for the molten material is provided. As shown in Figure 2, the sleeve 22 is guided to move in sealing fashion on the outer diameter 15 of the tube body 80. Furthermore, the sleeve 22 is guided to move in sealing fashion with its outer diameter in the second portion 14. The sleeve is connected to drive means at its free outwardly pointing end 82 and to the shut-off needle 24 at its end 88 pointing into the flow channel.

The flow channel 86 of the hot-runner section 10 is almost over its entire length symmetric to the common axis 84 of portions 12, 14, of the shut-off needle 24, and of the sleeve 22.

Figure 2 also shows an electric heater element 28 arranged in central position in the portion 12 and a heater element 30 enclosing the portion 14. This makes evident the basic idea of the invention, namely to arrange a central heater element in one of the portions to obtain an outer diameter (e.g., 15) without heater elements and an inner diameter (e.g., 19) without heater elements in the other portion. In this way there are obtained appropriate cylindrical surfaces along which the sleeve 22 can be guided for sliding while sealing.

The peculiar feature of this arrangement is made obvious by this measure, namely to provide an inner heater at the portion 12 which is free of a shut-off needle and an outer heater in the region of the portion 14 the interior of which is occupied by the shut-off needle 24, whereby the indispensable cylindrical outer surfaces are formed and are available. The particular design of the various heater elements is not considered within the present description as they are not an object of the invention. One can resort to the known state of the art. Internal heater elements are known, for example, from German Patents 33 35 280 and 28 24 971. External heater elements have been described in DE-OS [German Application Laid Open for Public Inspection] 36 40 620.

At its end far from the shut-off needle 24, the sleeve 22 can be connected to hydraulic, pneumatic or mechanical drive means by which the sleeve 22 can be moved in the axial direction to render the closing and opening movements of the shut-off needle 24 coupled to the sleeve.

Figure 3 shows a modification of the design of Figure 2, wherein likewise the gap S1 resulting between the portions 12, 14 is used. In this embodiment, the gap is filled by a guide sleeve 32 having at least one bore 34 through which there extends a bolt 36 drivingly connecting the means 38 with the sleeve 40.

At its face far from shut-off needle 24, the sleeve 40 has a contour matching the front end of the portion 12 and/or the heater element 28.

In the embodiments according to Figures 2 and 3, the heater element 28 extends into the region influenced by the heater element 30.

Figure 4 shows the details of the hot-runner section 10. As far as thermal conditions are concerned, such a hot-runner section must generate heat to a substantially predetermined extent and discharge it to the melt. There must be no local overheating nor must thermal losses or solidification of the melt occur.

In the needle shut-off nozzle according to the invention it is also very important that the thermal expansion does not exceed a precalculated value in the region in which portions 12, 14 and the sleeve 22 and 44 interact, so that problems associated with sealing are precluded. Further, there must be no overheating in the region of the means 21, particularly if the same (as in the embodiment of Figures 4 and 5) are configured as a hydraulic/pneumatic piston comprising sealing elements.

The portions 12, 14 of the hot-runner section 10 are fixed inside a housing 42 and in mould plates 44, 46. In housing 42 there is a cylinder 48 cooperating with the means 21 in the form of a piston 50 and with the sleeve 22. Piston 50 is provided with seals 52. Piston 50 can be moved via hydraulic media into the positions of shut-off and opening of the shut-off needle. Only a small amount of heat passes to the outside through the inner heater element 28 in portion 12. In this way the enclosing or adjacent components, such as the piston and the cylinder, and particularly their seals, remain relatively cool. This has a particularly favourable effect on

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their service life. Portion 14 is surrounded by a sleeve 54; a heater element 30 is mounted between the portion and the sleeve 54. This heater element could be formed by a heater spiral or the like.

In the embodiment of Figures 4 and 5, the heater element 28 is configured in accordance with the state of the art, e.g., according to DE-OS [German Application Laid Open for Public Inspection] 33 35 280. A centrally located, electrically conducting heater rod is electrically insulated from, and enclosed by, a tubular body, with the heater rod and the tubular body electrically connected at their free end and forming an electric circuit. This assembly of a heater rod and a tube is usually termed a heater-conductor. The diameter of the heater-conductor is enlarged near its free forward end. When the shut-off needle is retracted, i.e., in the position in which the nozzle is open and melt can flow into the mould nest, the shape of the free end of the heater element 28 illustrated in Figures 4 and 5 has two important advantages. The front face 56 of the heater-conductor in the form of a segment of a sphere makes it possible that, upon retracting the shut-off needle (opening), the melt can readily deviate through ports 58 in an advantageous flow pattern, on the one hand, and, on the other hand, the surface is enlarged at the same time to transmit sufficient heat into the neighbouring face 56. The cone-like enlargement 62 between the segment of the sphere and the cylindrical part of the heater-conductor 28 guides the melt in an advantageous flow pattern through the ports 58 into the second portion 14.

Figure 6 shows the detail A of Figure 4 on an enlarged scale.

It is within the scope of the invention to provide a circumferential groove on the illustrated outer casing 64 of the portion's 12 outer surface, particularly near the end 43, 66 of portion 12, with the groove having a packing washer 70. Furthermore, near the upper end 72 of portion 14 a seal 74 may be arranged in a matching recess 68. But such seals are state of the art and, hence, they are not described here in detail.

In an other preferred embodiment of the invention, there are no special seals between the movable sleeve 22 and the fixed sections 12, 14. There one takes advantage of the fact that the melt solidifies at all times

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in more or less thick layers near the walls which confine the flow channel but are nevertheless cooler. These solidified layers in the area of the components which can move relative to each other form a natural seal which makes separate seals redundant. It proved to be particularly advantageous to provide the annular front face of the first portion 12 with a blade-like edge 90 in the area of the outer diameter. The same peels the still hot but already solidified portions of the plastic material from the wall of the sleeve 22 and returns the material into the core region of the melt. In this way a new solidified, sealing region is built up in each cycle but is returned again and again.

A similar situation prevails in the gap region formed between the portion 14 and the sleeve 22. The same action principle is used. Melt will enter into this gap and solidify. When the shut-off needle is urged into the shut-off position, the melt is forced back through the ports 58. The solidified layer, which is used for sealing, remains in the cooler areas of portion 14.

Figure 7 shows an embodiment without a gap between the portions 12, 14. There the diameter of the sleeve 22 is reduced at its end 78 facing the shut-off needle 24. In this way the diameter of the second portion 14 can be reduced, whereby it is possible to maintain small distances between the nests in the case of multiple moulds, i.e., when a number of hot-runner sections 10 receive material from a single manifold. There is no gap S1 in this embodiment but the sleeve's 22 diameters, which match sections 12, 14, facilitate sealing towards portions 12, 14. Apart from this differentiating feature, the design according to Figure 7 is at its functional points the same as in the previously described embodiments.

CLAIMS

1. A heated needle shut-off nozzle for injection moulding machines, for injection moulds or for hot-runner systems, wherein the hot-runner section connecting a manifold or a nozzle of a machine with the mould nest is composed of two portions and wherein the first portion which faces a hot-runner manifold or a nozzle of a machine is formed at the end facing the second portion by a basically cylindrical tubular body in which a flow channel is configured, wherein on the outer diameter of the tubular body there is movably and sealingly guided a sleeve which with its outer diameter is movably and sealingly guided in the second portion and wherein the sleeve is coupled to drive means at its free outwards pointing end and to a shut-off needle at its end pointing into the flow channel.

2. The heated needle shut-off nozzle according to Claim 1, wherein the facing ends of the first and the second portion have diameters such that there results an annular gap in which the sleeve is sealingly and axially movably arranged.

3. The heated needle shut-off nozzle according to Claim 1 or 2, wherein the outer diameter of the first portion is equal to, or larger than, the inner diameter of the second portion and wherein, between the point at which the shut-off needle is connected and the free end of the sleeve, the sleeve joining the two portions has a longitudinal section of reduced diameter such that the sleeve with the outer diameter of the longitudinal section is supported in the second portion for axial sliding and that the sleeve section of increased diameter encloses the first portion in axially sliding fashion.

4. The heated needle shut-off nozzle according to any one of the preceding claims, wherein the first portion is provided with central heater means so that an annulus-shaped flow channel is formed.

5. The heated needle shut-off nozzle according to any one of the preceding claims, wherein the second portion is surrounded by peripheral heater means enclosing the same from the outside.

6. The heated needle shut-off nozzle according to any one of the preceding claims, wherein the flow channel of the hot-runner section is over its entire length substantially symmetric to the common axis of the first and second portions and the shut-off needle and the sleeve.

7. The heated needle shut-off nozzle according to any one of the preceding claims, wherein at its end far from the shut-off needle, the sleeve is connected to hydraulic, pneumatic or mechanical drive means which act on the sleeve, move the sleeve axially, and in this way cause the shut-off and opening movement of the shut-off needle connected to the sleeve.

8. The heated needle shut-off nozzle according to any one of the preceding claims, wherein the first and second portions overlap.

9. The heated needle shut-off nozzle according to Claim 1, wherein at its face far from the shut-off needle, the sleeve has a contour which matches the front end of the first portion and/or of the central heater means.

10. The heated needle shut-off nozzle according to Claim 5, wherein the central heater means extends into the region influenced by the peripheral heater means.

11. The heated needle shut-off nozzle according to Claim 1, wherein the sleeve is integral with piston means and the piston is supported to move within a cylinder.

12. The heated needle shut-off nozzle according to Claim 10, wherein the front free end of the central heater means has a cone-like enlargement.

13. The heated needle shut-off nozzle according to Claim 12, wherein the front face of the central heater means has a surface area larger than the cross section in its shaft-shaped part and wherein it has specifically the form of a segment of a sphere.

14. The heated needle shut-off nozzle according to any one of the preceding claims, wherein the first portion is provided with a blade-like edge in the region of the front face area of its outer casing.

15. The heated needle shut-off nozzle according to any one of the preceding claims, wherein in the outer casing of the first portion near its end there is formed a circumferential groove which forms relatively elastic packing washers.

16. The heated needle shut-off nozzle according to Claim 15, wherein in the region of the second portion's end facing the first portion, there is arranged a seal which is configured in accordance with Claim 15 but cooperates with the outer diameter of the sleeve.

17. The heated needle shut-off nozzle according to Claim 1, wherein the annular gap is filled by the sleeve having at least one bore through which a bolt extends, with the bolt drivingly connecting piston means with the sleeve.