

TITLE OF INVENTION**A SELF-HEAT REGULATING MOULD ASSEMBLY AND A METHOD OF INJECTING RUBBER MATERIAL TO THE SAME****TECHNICAL ART**

- 5 The present invention relates to a self-heat regulating system, and in particular, a self-heat regulating system in maintaining a consistent temperature range of between 60-80 °C.

BACKGROUND OF THE PRESENT INVENTION

Compression moulding is a manufacturing process used to fabricate a large variety of articles. In compression moulding, raw material is typically placed into an open cavity in a first portion
10 of a mould. The raw material, which may be rubber or some other type of thermosetting material, is typically in solid form. The raw material may be a single piece, may be in multiple pieces, or may even be in liquid form. A second portion of the mould is then attached to (or otherwise placed into contact with) the first portion. As heat and pressure are applied, the raw material in the mould cavity is formed into the desired shape.

15 Injection moulding apparatuses usually include an injecting device, a platform, and a mould. The injecting device and the mould are mounted on the platform. In operation, the injecting device heats and melts plastic particles and injects the molten plastic into the mould. The mould is also heated and maintained at a high temperature to obtain a high quality of products.

In liquid injection molding of liquid silicone rubber, liquid silicone rubbers are supplied in
20 barrels. Because of their low viscosity, these rubbers can be pumped through pipelines and tubes to the vulcanization equipment. Two components are pumped through a static mixer by a metering pump. One of the components contains the catalyst, typically platinum based. A coloring paste as well as other additives can also be added before the material enters the static mixer section. In the static mixer the components are well mixed and are transferred to
25 the cooled metering section of the injection molding machine. The static mixer renders a very homogeneous material that results in products that are not only very consistent throughout the part, but also from part to part. This is in contrast to solid silicone rubber materials that are purchased pre-mixed and partially vulcanized. In contrast, hard silicone rubbers are processed by transfer molding and result in less material consistency and control, leading to higher part
30 variability. Additionally, solid silicone rubber materials are processed at higher temperatures and require longer vulcanization times.

US Patent No. 8, 692,163 discloses an electrical sleeve heater for heating an elongated part, the sleeve heater, for an injection moulding nozzle, comprising: a metallic and tubular casing extending coaxially along an axis with the part and surrounding the part, the casing having a front end and being formed there with a radially inwardly open cut-out; an electrical heating
 5 element set in the casing and energizable to heat the casing and the part surrounded by the casing; a thermocouple having a sensing tip in the cut-out; and a body of lower thermal conductivity than the casing fitted in the cut-out, having an inner surface conforming to a shape of an outer face of the part, holding the tip, and urging the tip radially inward into direct engagement with an outer surface of the part, the cut-out having angularly confronting edges
 10 formed with grooves receiving ends of the body and opening on the edges only angularly into the cut-out.

US Patent No. 8,657,600 discloses plastic material injection moulding system, comprising: a feeding nozzle for feeding liquid plastic material; and a forming mould device comprising: a forming mould having a forming cavity therein; and a material-passing mould disposed
 15 between the feeding nozzle and the forming mould, and having a material-feeding runner therein in communication with both the feeding nozzle and the forming cavity, the material-feeding runner comprising: an inlet section directly in communication with the feeding nozzle; a buffer section, the inlet section being arranged between the buffer section and the feeding nozzle, and being directly in communication with the buffer section; a first bending section, the
 20 buffer section being arranged between the inlet section and the first bending section, and being directly in communication with the first bending section, a width of the buffer section being larger than a width of the first bending section and a width of the inlet section; and a second bending section, the first bending section being arranged between the buffer section and the second bending section, and being in communication with the second bending section;
 25 a U-turn section, the second bending section being arranged between the first bending section and the U-turn section, and being in communication with the first bending section and the U-turn section; and an outlet section arranged between the U-turn section and the forming cavity, and being in communication with the U-turn section and the forming cavity, wherein both of the second bending section and the outlet are connected to a same side of the U-turn section,
 30 and a calibre of the U-turn section shrinks gradually from the same side of the U-turn section towards an opposite side of the U-turn section, which is away from the second bending section.

US Patent Publication No. 20116305790 discloses a sprue bushing comprising: a head; and a main body connected to the head and defining at least one lateral channel, the at least one
 35 lateral channel extending through a sidewall of the main body; wherein the sprue bushing defines a sprue and at least two longitudinal channels, the sprue extends through the head

and the main body along a center axis of the sprue bushing, the at least two longitudinal channels extend through the head into the main body, one of the at least one lateral channel communicates two of the at least two longitudinal channels.

5 US Patent No. 8,632,335 discloses an injection moulding apparatus, comprising: a mould; an injecting device for melting plastic and injecting molten plastic into the mould; a platform for loading and controlling the mould and the injecting device; and two heat insulation assemblies, each of the heat insulation assemblies comprising: a metallic plate; and a pipe member mounted in the metallic plate for receiving hot liquid to heat the metallic plate; wherein the mould is sandwiched between and mounted to the two metallic plates of the two heat insulation
10 assemblies, one of the metallic plates is mounted to and sandwiched between the mould and the injecting device, the other metallic plate is mounted to and sandwiched between the mould and the platform, and the metallic plates are heated by the hot liquid to a predetermined temperature lower than a preset temperature of the mould to prevent the mould from transferring heat to the injecting device and the platform.

15 US Patent No. 4,436,496 discloses a mold apparatus for liquid injection molding compositions comprising: a frame having a forward and a rear end; support plate means mounted on said frame and supporting a support post means, said plate means having a forward end and a rear end; a mold frame means mounted on said support post means; a conduit for liquid molding composition slidably mounted on the forward end of said frame and on the forward
20 end of said mold frame means; a first plate means having passage means therein for the passage of liquid molding composition and fixedly mounted on the forward end of said conduit and adapted to slide within said support post means and within said mold frame means and located adjacent said forward end of said frame; nozzle means at the end of said passage means in said first plate means adjacent the rear end of said mold frame means away from
25 said conduit means, said nozzle means including pin means slidably mounted in said mold frame means and adapted to open and close a nozzle opening means in said nozzle means; and mold cavity means slidably mounted on said support post means and adapted to move toward and away from said nozzle means.

Accordingly, it is desirable to provide a self-heat regulating mould assembly configured for
30 maintaining a consistent temperature range at a material inlet which overcome the exiting problems of the material cured before the rubber material enters into the rubber mould cavities, thus it solve the problem of raw rubber material cured before it is enters the mould cavity.

SUMMARY OF THE INVENTION

This summary introduces, in a simplified form, concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, and is not intended to be used as an aid in determining the scope of the claims.

- 5 An object of the present invention is to provide a self-heat regulating mould assembly configured for maintaining a consistent temperature range at a material inlet thereof comprising (a) a top back plate and a top plate which encloses a piston surrounded by a cooling channel, (b) a runner plate, adapted for a nozzle bushing and a valve pin assembly, being connected to the top plate, (c) a bush plate and an insulation plate to hold a runner
10 bushing, and (d) a cold nozzle plate used to hold the nozzle bushing, characterized in that cooling air passes through the cooling channel at the top plate and out of the top plate so as to cool a piston shaft and the bushing plate is cooled by way of cooling air such that material for moulding entering the mould assembly is maintained at predetermined temperature range.

- Still a further object of the present invention is to provide a self-heat regulating mould
15 assembly, wherein the cooling channel is a spiral cooling channel having an air inlet and an air outlet is mounted at the top plate of the mould assembly.

Yet a further object of the present invention is to provide a self-heat regulating mould assembly, wherein a runner plate is positioned in between the top plate and the bush plate of the self-heat regulating mould assembly.

- 20 Yet still an object of the present invention is to provide a self-heat regulating mould assembly, wherein a pneumatic valve is used to push down a shut-off valve pin positioned at the middle of the self-heat regulating mould assembly.

A further object of the present invention is to provide a self-heat regulating mould assembly, wherein an insulation plate is positioned above the cold nozzle plate.

- 25 Another object of the present invention is to provide a method of injection rubber material to the self-heat regulating mould assembly set forth in Claim 1, comprising the steps of (i) charging rubber material in roll type into the mould assembly; (ii) barrelling the charged material into the machine to the self heating regulating assembly; (iii) rotating the screw of the self regulating machine to charge the rubber material from step (i); and (iv) injecting the
30 material by screwing of the self regulation device.

Still yet another object of the present invention is to provide a method of injection rubber material, wherein the inflow of rubber is maintained at 60-80 °C.

A further object of the present invention is to provide a method of injection rubber material, wherein the temperature of coolant flowing through the self-regulation mould is maintained at 80 °C.

5 Yet still a further object of the present invention is to provide a self-heat regulating mould assembly, wherein the insulation plate has an insulation material created by injection that formed in the inner wall of the bushing to deter heat transmission into the inner wall of the bush of the mould.

10 Another object of the present invention is to provide a self-heat regulating mould assembly, wherein a stream of cool air is used to deter direct heat migration from the outer mod onto the raw rubber material.

Further object of the present invention is to provide a self-heat regulating mould assembly, wherein the rubber material includes natural rubber, isoprene rubber, EPDM, Chloroprene, SBR, Silicone, Liquid silicone, Butyl, Nitrile, etc.

15 Still yet another object of the present invention is to provide a method of injection rubber material into a mould assembly, wherein cool air in comes in one end and the hot air exists at two directions.

20 In at least some embodiments, heating elements are located near a mould and between platens used to press a mould and a mating mould together. Multiple molds and heating elements may be placed in a carrier tray to form a mould assembly. In some embodiments, mould assemblies may include a conductor plate which contacts the heating elements and the mould. The conductor plate, which may have a higher thermal conductivity value than the mould, spreads the heat from the heating elements. A layer of insulating material may also be placed between the conductor plate and the carrier tray.

BRIEF DESCRIPTION OF THE DRAWINGS

25 The foregoing summary, as well as the following detailed description of the preferred embodiments, is better understood when read in conjunction with the accompanying drawings, which are included by way of example, and not by way of limitation with regard to the claimed invention.

30 FIG. 1 is an exploded view showing the components of the self-heat regulating mould assembly in accordance with the present invention.

FIG. 2 is another exploded view showing the various components of the self-heat regulating mould assembly in accordance with the present invention.

FIG. 3 is a section view of the self-heat regulating mould assembly in accordance with the present invention.

FIG. 4 is a section view of the self-heat regulating mould assembly together with the plates adapted to contain the assembly in accordance with the present invention.

- 5 FIG. 5 is a perspective view showing the mounting of a valve pin into a valve pin guide in accordance with the present invention.

FIG. 6 is a perspective view showing the mounting of the valve pin assembly with the nozzle bushing in accordance with the present invention.

- 10 FIG. 7 is a perspective view showing the formation of the cool runner assembly in accordance with the present invention.

FIG. 8 is a perspective view showing the mounting of the runner bushing with the bushing plate in accordance with the present invention.

FIG. 9 is a perspective view showing the mounting of insulation plate with the cold nozzle plate together with the bushing plate in accordance with the present invention.

- 15 FIG. 10 is a perspective view of the runner plate onto the bushing plate in accordance with the present invention.

FIG. 11 is a perspective view of the top plate being mounted to the rubber plate in accordance with the present invention.

- 20 FIG. 12 is a perspective view showing the mounting of a piston shaft to the valve pin within the valve pin guide in accordance with the present invention.

FIG. 13 is a perspective view showing the mounting of the top back plate onto the piston shaft in accordance with the present invention.

FIG. 14 is a schematic view showing the air push the piston to open and/or to close the gate in accordance with the present invention.

- 25 FIG. 15 is a schematic perspective view indicating the nozzle cooling system in accordance with the present invention.

FIG. 16 shows a sectional view of injection rubber material feed into an injection machine in accordance with the present invention.

FIG. 17 is a perspective view showing the feeding of rubber material by injection to a mould in accordance with the present invention.

FIG. 18 is a perspective schematic view showing the feeding of rubber material by injection to a self-heat regulating mould assembly in accordance with the present invention.

5 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

So as to provide a convenient example, embodiments of the invention are described by reference to a self-heat regulating mould system. However, the invention is not limited to systems or method for injection rubber material to the self-heat regulating mould assembly. The rubber material of the present invention includes natural rubber, isoprene rubber, EPDM,
 10 Chloroprene, SBR, Silicone, Liquid silicone, Butyl, Nitrile, etc.

In accordance with the present invention, there is shown a self-heat regulating mould assembly. FIG 1 is a perspective exploded view of the self-regulating mould assembly, which comprises a shaft piston 9, a runner bushing 8, a valve pin 10, a valve pin guide 12, and a nozzle bushing 11. FIG. 2 is an exploded view showing the similar components shown in FIG. 1, except the piston shaft and the runner bushing shown in FIG. 1. All these components are adapted to be contained within a number of plates, such as top back plate 7, top plate 3, a runner plate 5, a bushing plate 4, an insulation plate 2, and a cold nozzle plate 1. FIG. 3 is a section view of the self-heat regulating mould assembly in accordance with the present invention. The piston shaft 9 is inserted into the center of the runner bushing 8 so as to engage
 15 with the head of the valve pin 10. The valve pin 10 passes through the valve pin guide 12, which is enclosed by an insulator 111 enclosed by a nozzle bushing 11. In accordance with the present invention, the insulator 111 is made from material of high temperature resistance, and is selected from, for examples, MYLAR or ULTEM resin, etc. The insulator 111 has a high temperature resistant of 350 -400 degree C. The inflow of rubber to the mould is shown
 20 by arrow 110. The coolant to the bushing plate 4 is indicated by arrow 42 and the coolant flows out from the bushing plate 4 is indicated by arrow 44. The out flow of rubber into the mould cavity is shown by reference number 46. A plastic enclosure 48 is formed within the nozzle bushing 11. A stainless steel flow channel 50 with spiral cooling fins is formed adjacent to the plastic enclosure 48.

FIG. 4 is a schematic view of the self-heat regulating mould system of a preferred embodiment in accordance with the present invention. Viewing from the top, there is the top back plate 7, which is adapted for the seating of the top of the piston shaft 9. Next to the top back plate 7 is a top plate 3, which holds the entire body of the piston shaft 9, and encloses the piston shaft 9 to rotate therein. The runner plate 5 is beneath the top plate 3, which holds the lower part
 30

of the piston shaft 9 and the piston shaft 9 is connected to the valve pin 10, and the valve pin 10 is rotatable within the valve pin guide 12. As shown in the figure, the bushing plate 4 is below the runner plate 5 and holds the runner bushing 8. There is an insulation plate 2 beneath the bushing plate 4, and the cold nozzle plate 1 hold the nozzle bushing 11. As shown, on the top plate 3, two cooling channels 32, 33, are provided to cool down the temperature of the piston shaft 9. There are air stream channel with gates, 142, 144 (shown in FIG. 14) on the top plate 3. Air stream via the air stream channel with gate 142 acts on the piston shaft to push the shaft 9 to move downward and air stream through the gate 144 forces the piston shaft 9 to move upward.

In the preferred embodiment of the present invention, there is provided a self-heat regulating mould assembly configured for maintaining a consistent temperature range at a material inlet thereof comprising (a) a top back plate 7 and a top plate 3 which enclose a piston shaft 9 surrounded by a first air stream channel with gate 142, to push down the piston shaft and a second air stream channel with gate 144 to push up the piston shaft 9 (shown in FIG. 4), (b) a runner plate 3, adapted for a nozzle bushing 11 and a valve pin assembly 10, 12, being connected to the top plate 3, (c) a bush plate 4 and an insulation plate 5 to hold a runner bushing 8, and (d) a cold nozzle plate 1 used to hold the nozzle bushing 11. The material for moulding is maintained at a temperature of the nozzle bushing before the material is injected into the mould and the air stream passes through the air stream channel at the top plate to push down the piston shaft to squeeze out the moulding material, and the air stream via the second air stream channel to push out the piston shaft and the bushing plate is cooled by way of cooling air such that material for moulding entering the mould assembly is maintained at predetermined temperature range.

FIG. 5 is a perspective schematic view showing the formation of a valve pin assembly that is the combination of the valve pin 10 and the valve pin guide 12. The valve pin has a head portion 110 which has a slot 120 with a narrow neck portion to be in engagement with the tip of the piston shaft 9. A plurality of dowel pins are used to prevent the valve pin mechanism from rotation during the point of engagement of the piston shaft 9 with the valve pin 10. The valve pin 10 is inserted into the valve pin guide 12 via the center hole 121 thereof. As shown in FIG. 6, the valve in assembly 10, 12 is rotatably positioned within the nozzle bushing 11, which includes an insulator 111 enclosed by the nozzle bushing 11. FIG. 7 is a perspective schematic view showing the mounting of the cool runner assembly 11 into the cold nozzle plate 1.

As shown in FIG. 8, there is shown a perspective view showing the mounting of the runner bushing 8 with the bushing plate 4 in accordance with the present invention. The insulation

plate 2 is mounted onto the top of the cold nozzle plate 1 and the bushing plate 4 is then followed. The cool runner assembly consists of the cold nozzle plate 1 as the base, followed with the insulation plate 2, then with the bushing plate 4. This is shown in FIG. 9. FIG. 10 is a perspective view showing the runner plate 5 is mounted to the bushing plate 4 in accordance with the present invention. The top plate 3 containing the piston shaft 9 being inserted to the center thereof is then mounted onto the runner plate 5.

As shown in FIG. 12, the piston shaft 9 is then inserted to the top plate 3 through the center thereof, such that the tip of the piston shaft 9 is in engagement with the slot 129 of the valve pin 10. The piston shaft 9 is pushed downward and is rotated to lock the tip of the piston shaft 9 to the valve pin 10. The top back plate 7 is then covered from top to the top plate 3 to form the self-heat regulating device, which has been shown in FIG. 13.

FIG. 14 is a schematic view of the self-heat regulating moulding system in accordance with the present invention. On the top plate 3, there is air inlet cooling channel 36 which is used to cool the piston shaft 33. Similarly, for the bushing plate 4, cool air 41 enters the bushing plate 4, goes around the runner bushing 4 to cool down the nozzle bushing 11 such that rubber material passing through will be kept at a predetermined temperature range. Hot air is dissipated via another exit tube on the bushing plate 4; this is shown in FIG. 15.

FIG. 16 shows a sectional view of injection rubber material feed into an injection machine in accordance with the present invention. In accordance with the preferred embodiment, it is a method of injection rubber material to the self-heat regulating mould assembly described above, comprising the steps of (i) preparing rubber material in roll type into a barrel; (ii) charging the material in roll type into an injection machine; (iii) rotating the screw shaft of the injection machine so as to charge the rubber material into the self-heat regulating mould assembly, and (iv) injecting the rubber material by continuous screwing of the injection machine into a mould.

FIG. 17 is a perspective view showing the feeding of rubber material by injection to a mould in accordance with the present invention. As shown in FIG. 18, rubber material flows into the rubber to the runner bushing 8 and then into the nozzle bushing 11, the rubber material is then squeezed out to the cavity of a mould.

In accordance with preferred embodiment of the present invention, the mould is set at a temperature of 180 degree C, and a stream of cool air of 20 degree C passes through the cooling channel on bushing plate, the temperature is stable after 2.5 minutes. In practice, the injection moulding process is lasted for about less than 1 minute. The records of the temperature are as follows:

Duration	AirTempIn (°C)	AirTemp Out (°C)
30 Sec	20°C	46°C
1 Min	20°C	56°C
1Min 30 Sec	20°C	61°C
2 Min	20°C	65°C
2Min 30 Sec	20°C	68°C
3 Min	20°C	68°C

In another example, where cooling water of 20 degree C is provided to the nozzle bush, and the mould is set at a temperature of 180 degree C, , and a stream of cool air of 20 degree C passes through the cooling channel on the bushing plate, the temperature is stable after 2.5 minutes. The records of the temperature are as follows:

Duration	Water Temp (°C)
1 st 30Sec (reach 180 °C Mould temp)	56°C
1 Min	71°C
1Min 30 Sec	73°C
2 Min	74°C
2Min 30 Sec	78°C
3 Min	80°C

In view of the preferred embodiment, the self-heat regulating mould system is able to maintain a temperature of 60 to 80 degree C, and therefore rubber material for moulding is kept at a constant temperature before it is injected into the high temperature mould.

Numerous other variations on the systems and operations described above will be apparent to persons skilled in the art in view of the description and drawings provided herein. As previously indicated, the invention is not limited to use in conjunction with moulds for a particular type of article. The invention is similarly not limited to moulds having geometries
5 such as are shown in the drawings. These and other variations and permutations of the above described devices and operations fall within the spirit and scope of the invention as set forth in the appended claims. It is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing
10 the invention as set forth in the claims.

CLAIMS:

1. A self-heat regulating mould assembly configured for maintaining a consistent temperature range at a material inlet thereof comprising

(a) a top back plate and a top plate which encloses a piston shaft surrounded by a first air stream channel with gates to push down the piston shaft and a second air stream channel to push up the piston shaft,

(b) a runner plate, adapted for a nozzle bushing and a valve pin assembly, being connected to the top plate,

(c) a bush plate and an insulation plate to hold a runner bushing, and

(d) a cold nozzle plate used to hold the nozzle bushing, wherein the material for moulding is maintained at a temperature of the nozzle bushing before the material is injected into the mould and the air stream passes through the air stream channel at the top plate to push down the piston shaft to squeeze out the moulding material, and the air stream via the second air stream channel to push out the piston shaft and the bushing plate is cooled by way of cooling air such that material for moulding entering the mould assembly is maintained at predetermined temperature range.

2. The self-heat regulating mould assembly set forth in Claim 1, wherein a runner plate is positioned in between the top plate and the bush plate of the self-heat regulating mould assembly.

3. The self-heat regulating mould assembly set forth in Claim 1, wherein a pneumatic valve is used to push down a shut-off valve pin positioned at the middle of the self-heat regulating mould assembly.

4. The self-heat regulating mould assembly set forth in Claim 1, wherein an insulation plate is positioned above the cold nozzle plate.

5. A method of injection rubber material to the self-heat regulating mould assembly set forth in Claim 1, comprising the steps of (i) charging rubber material in roll type into the mould assembly; (ii) barrelling the charged material into the machine to the self heating regulating assembly; (iii) rotating the screw of the self regulating machine to

charge the rubber material from step (i); and (iv) injecting the material by screwing of the self regulation device.

- 5 6. The method of injection rubber material set forth in Claim 5, wherein the inflow of rubber is maintained at 60-80 degree C.
7. The method of injection rubber material set forth in Claim 5, wherein the temperature of coolant flowing through the self-regulation mould is maintained at 80 degree C.
- 10 8. The self-heat regulating mould assembly as set forth in Claim 1, wherein the insulation plate has an insulation material created by injection that formed in the inner wall of the bushing to deter heat transmission into the inner wall of the bush of the mould.
- 15 9. The self-heat regulating mould assembly as set forth in Claim 1, wherein a stream of cool air is used to deter direct heat migration from the outer mould onto the raw rubber material.
- 20 10. The self-heat regulating mould assembly as set forth in Claim 1, wherein the rubber material is selected from the group consisting of natural rubber, isoprene rubber, EPDM, Chloroprene, SBR, Silicone, Liquid silicone, Butyl, Nitrile.
- 25 11. The method of injection rubber material as set forth in Claim 1, wherein cool air comes in at one end and the hot air exits in two directions.
- 30 12. The self-heat regulating mould assembly set forth in Claim 1, wherein the top plate is provided with an air inlet and air outlet at the lateral side thereof.
- 35 13. The self-heat regulating mould assembly set forth in Claim 1, wherein a valve pin is inserted into a valve pin guide, and then inserted into the nozzle bushing, wherein the nozzle bushing is enclosed by the bushing plate the insulation plate and the cold nozzle plate.
14. The self-heat regulating mould assembly set forth in Claim 1, wherein the cooling channel of the top plate is at temperature 20 degree C.
15. The self-heat regulating mould assembly set forth in Claim 1, wherein the nozzle bushing is about 68 degree C.

16. The self-heat regulating mould assembly set forth in Claim 1, wherein the material for moulding runs in the runner plate then to the runner bushing and to the nozzle bushing and out from the nozzle bushing to cavity of the mould.

5

17. The method of injection of rubber material set forth in Claim 1, wherein cool air is injected to the cool air inlet which carries away the generated heat by the mould.