

Description

This invention relates to cooling of plastics moulding machines, and more particularly to an apparatus, according to claim 6, and method, according to claim 1, for liquid overfeed refrigerant cooling of the moulds of moulding machines for the manufacture of plastics articles.

It is known that to improve the efficiency, throughput, and product quality of plastics moulding machines, it is desirable to provide a means for cooling the mould. Such mould cooling brings about a more rapid solidification of the hot liquid plastics, shortening the time that must be waited before the freshly moulded article develops sufficient strength to be removed from the mould. Furthermore, coolant flow passages in the mould may be selectively arranged to cause evenly distributed cooling according to the shape of the moulded article to achieve a product of uniform physical properties. Consequently, the development of methods and apparatus for achieving effective and efficient mould cooling has been a concern of those skilled in the plastics moulding art.

As a basis for attempting to achieve improved plastics mould cooling, it is important to understand the factors involved in mould heat transfer. These factors include the thermal conductivity of the plastics itself, the specific heat of the plastics itself, the heat transfer characteristics of the boundary layer between the plastics and the inner surface of the mould, the thermal conductivity of the mould material, the variable linear distance between the inner surface of the mould and coolant flow passage, the total mass of the mould, the heat transfer characteristic of the boundary layer between the surface of the cooling channel and the cooling medium, the temperature of the cooling medium, the velocity of the cooling medium, the temperature of the hot plastics, and the radiation effect of the mould to objects within the space.

Conventional mould cooling systems presently in use employ water as the coolant medium, a liquid having relatively high boiling and freezing points. The temperature of the coolant is lowered by passing it through refrigerated coils, a process which is low in energy efficiency. To increase the rate of mould cooling, much emphasis has been placed in the past on the importance of temperature and velocity of the cooling medium. As a result, the coolant temperature has been lowered, and the coolant flow rate has been increased, or both. Lowering the coolant temperature results in a greater temperature difference between the coolant and the inner surface of the mould coolant passages. Increasing the coolant velocity tends to increase the rate at which heat is carried away from the mould.

In a typical water-cooled injection moulding situation, the hot plastics will be injected at a temperature of about 249°C (480°F). Water coolant is typically at

10°C (50°F). According to the basic heat transfer equation, the rate of heat transfer is equal to the overall coefficient of heat transfer times the product of temperature difference and the area of the cooling interface. By lowering the water temperature from 10°C (50°F) to 4°C (40°F), thus increasing temperature difference from 239°C (430°F) to 244°C (440°F), the rate of overall heat transfer is increased by only about two percent. This small gain is more than offset by the added cost of further cooling the water and the possible need to dehumidify the room.

Of course, the water temperature should not be below the freezing point. When water is cooled from 5.6 to 4.4°C (42° to 40°F) in a typical heat exchanger with refrigerant, the refrigerant must be at about -1°C (30°F). Therefore, to prevent icing, an antifreeze such as glycol must be added to the water. However, this changes the specific heat, viscosity and conductivity of the heat transfer fluid thereby reducing overall mould cooling efficiency.

The approach of increasing the water coolant flow rate is effective in reducing overall costs only up to an optimum point, after which, exponentially increasing costs of pumping more than offset the savings from the increased heat transfer rate.

One of the impediments to rapid and efficient heat transfer is the existence of a resistance to heat transfer known as the film coefficient. This is a laminar film of resistance to heat flow that exists on both sides of the heat transfer surface. Lower coolant temperature has a negligible effect on the film and increased fluid flow rates would incur serious operating cost penalties.

U.S. Patent 3,127,753 discloses a system in which a suitable refrigerant, such as Freon 12 (dichlorodifluoromethane) (Freon is a Trademark of E.I. DuPont de Nemours & Co.), is delivered in liquid state to a single expansion valve. When passing through the expansion valve, some of the liquid refrigerant changes to vapour. A mixture of liquid and vapour enters each mould die element through single feed lines. In the mould die elements, the refrigerant is changed to superheated vapour which then exits to a conventional compressor, condenser, and receiver arrangement for recirculation. A superheat control is provided to modulate the single expansion valve and ensure that all refrigerant exiting the mould dies is superheated. The patent also discloses a means for controlling the degree of mould cooling comprising thermocouples in the mould die elements associated with modulating valves in the single mould die feed lines.

Thus, U.S. Patent 3, 127,753 addresses itself to increasing system efficiency by eliminating a separate heat exchanger and by lowering the coolant temperature. The apparatus disclosed therein is intended to make the mould as cold as possible. This means that the room must be dehumidified and capital equip-

ment must be added to obtain the lower temperatures. Coolant compression costs are much greater for colder vapour since larger compression equipment is needed to remove a given amount of heat at a lower refrigerant temperature.

FR-A-2329011, upon which the preambles of claim 1 and claim 6 are based, discloses a mould-cooling system in which regulation of the flow of cooling water to a condenser effectively controls the amount of refrigerant vapour in the system and thus the vapour pressure and, in consequence, the boiling point of the refrigerant in the cooling channels of the mould.

FR-A-2005835 discloses a mould-cooling system in which the boiling point of a coolant passing through the cooling passages of the mould is controlled by controlling the vapour pressure by using a vacuum pump equipped with a regulator arranged within the cooling circuit. Thus, adjustment of the boiling point of the coolant supplied to the mould is effected by control of the vacuum. In the system of FR-A-2005835, the coolant is pumped at high speed through all the cooling channels of the mould.

It is among the objects of the invention to provide an improved method of, and apparatus for cooling the mould of a plastics moulding machine.

These objects are attained, in accordance with the invention by the features set out severally in the appended claims 1 and 6.

Thus, the invention utilises liquid overfeed refrigeration cooling of plastics moulds. Liquid overfeed is a method of refrigeration wherein refrigerant is forced through an evaporator such that refrigerant exiting the evaporator is partially in the liquid state. Separate independently and selectively adjustable flows of boiling refrigerant are preferably provided through each mould cooling fluid passageway. The term "mould" as used herein is intended to include any device for imparting form to heated plastics material, such as, but not limited to, the male and female parts of an injection mould or the die of an extruder.

In preferred embodiments of the invention, liquid refrigerant enters the mould's cooling passages via liquid refrigerant distributor tubes emanating from a liquid distributor. The quantity of liquid refrigerant is precisely controlled to each individual mould passage or circuit by fixed or manually or automatically adjustable metering devices such as distributors, valves, capillaries, or orifices, to satisfy the unique and distinctive characteristics of each mould passageway. As the liquid enters the mould it absorbs heat from the product being moulded. The absorption of heat results in a violent boiling of the refrigerant liquid which is controlled throughout the entire length of the mould passage. This boiling action disrupts and tends to destroy the laminar film on the heat transfer surface. This boiling action greatly increases the heat transfer coefficient and thereby substantially reduces the

required cooling cycle when contrasted with conventional chilled water cooling cycles and refrigerant cycles employing superheat. The approximate mixture of gas to liquid refrigerant is one part gas to three parts liquid as the refrigerant stream exits the mould.

The gas-liquid mixture leaves the mould and returns via a return line to the low pressure accumulator. The primary function of the latter is to separate the mixture into two distinct components, gaseous and liquid. The gaseous component is evacuated via the compressor itself wherein it is compressed to a high pressure, high temperature gas. Leaving the compressor the gas is routed to a refrigerant condenser which converts the refrigerant back to liquid state. The liquid refrigerant then passes through a throttling device from whence it is returned to the low pressure accumulator. A liquid recirculating pump draws the low pressure refrigerant from the accumulator and discharges it into the refrigerant line to the plastics moulding machine. The pumped liquid is elevated in pressure. At the plastics moulding machines, the liquid refrigerant is reintroduced to the mould passages as described above for a continuous process.

An oil receiver/still complete with oil piping and transfer pump is installed on the low-pressure accumulator to return the lost compressor oil back to the refrigeration compressor. Refrigeration compressor lubricating oil is cooled by process cooling water.

In a preferred embodiment of the apparatus of the invention, a first sight glass is provided in the supply line at the mould site. A metering device is provided in each of the feed lines. A second sight glass is provided in each of the effluent lines.

In operation, the metering devices are manually or automatically adjusted while observing the refrigerant in the sight glasses. The metering devices are independently and selectively adjusted to obtain an all-liquid refrigerant supply in the first sight glass and an optimum liquid/vapour refrigerant mixture in the second sight glasses. By attaining this mixture, it is ensured that the refrigerant temperature throughout each of the mould cooling passageways is no greater than the boiling point and that the refrigerant throughout each of the mould cooling passageways is in a turbulent, boiling state.

The two results of low-temperature and boiling action made possible by the invention bring about the heretofore unobtained advantages in refrigerant cooled plastics moulding of preventing the refrigerant from reaching a superheated vapour state, thus avoiding a reduction in temperature difference, and of breaking down the film coefficient in the mould cooling passageways. Thus, mould cooling rates are significantly increased without unproductive and ineffective resort to unnecessarily low coolant temperatures and unduly high coolant flow rates. The invention takes advantage of the superior heat transfer properties of

a boiling refrigerant mixture over a superheated refrigerant vapour.

Since each mould cooling passageway is likely to present a different resistance to refrigerant flow, the provision of individual, independently and selectively metered refrigerant flows to each cooling passageway allows for optimal, uniform mould cooling. Furthermore, the invention may be used with moulds having but a single cooling passageway, in which case a single feed flow would be provided through the passageway. Alternatively, when the mould cooling passageways are sufficiently similar in flow characteristics, a single metering device may be provided for controlling the flow through all of the mould cooling passageways.

Preferred embodiments of the invention have an additional advantage in that a fluorocarbon refrigerant used acts as a cleaning agent to maintain the cooling passageways free of contaminants and obstructions.

The superior performance and efficiency of an embodiment of the invention has been determined on an experimental installation. Twenty-nine moulds for products of varying size and shape were tested. On forty-eight percent of the items tested, a thirty-five percent cycle time reduction as compared to chilled water was attained. This equates to a fifty-four percent productivity gain. On eighty-six percent of the items tested, a twenty-seven percent cycle time reduction was attained, equating to thirty-seven percent productivity gain. On the entire population tested, the average cycle time reduction was twenty-five percent, which is a thirty-three percent productivity gain. This increase in productivity was accomplished with both improved product quality, fewer produced rejects, and reduced energy input per unit of production.

Embodiments of the invention are described below by way of example, with reference to the accompanying drawings, in which :-

FIGURES 1A and 1B taken together are a diagrammatic illustration of apparatus embodying the principles of the invention as used in a plastics moulding process ;

FIGURE 2 is an enlarged diagrammatic illustration of the plastics moulding machine shown in Figure 1B ;

FIGURE 3 is similar to Figure 2 but shows an alternative embodiment of the apparatus of the invention.

By way of disclosing a preferred embodiment of the invention, and not by way of limitation, Figures 1A and 1B taken together diagrammatically show an apparatus embodying the invention for cooling the mould of a plastics injection moulding machine A having first mould element 1 and second mould element 2. It should be understood that the moulding machine A will usually be at a distance from the liquid recirculating system of the apparatus which may be suitably housed in an equipment room, and that the

apparatus may be used to cool a plurality of moulding machines.

In the liquid recirculating system illustrated, refrigerant hot gas line 101 runs from compressor 102 to water cooled condenser receiver 103. High-side liquid line 104 runs from condenser receiver 103 through filter drier 105, or bypasses filter drier 105 if inlet valve 106 is closed to drier 105 and bypass valve 107 is open, to pilot float valve 108 and pilot operated valve 109. Highside liquid line 104 also runs through normally closed shut-off valve 111 to liquid receiver 112 for refrigerant storage. Stored liquid phase refrigerant is then passed from receiver 112 through line 110 to the lower region of the low pressure accumulator 114.

Low-side liquid line 113 runs from pilot operated valve 109 to low pressure accumulator 114. Pump suction low-side liquid line 115 runs from accumulator 114 to liquid refrigerant pumps 116, one of which is a stand-by. Pump discharge low-side liquid line 10 runs from pump 116 to the cooling load, the mould of injection moulding machine A. Refrigerant two phase mixture return line 23 runs from the suction manifold 22 to the accumulator 114. Refrigerant vapour compressor suction line 118 runs from the accumulator 114 to the screw compressor 102. First compressor oil return line 121 runs from accumulator 114 to heated oil receiver 122. Second oil return line 123 runs from receiver 122 to oil pump 124. Third oil return line 125 runs from oil pump 124 to compressor suction line 118.

Condenser receiver cooling water supply piping 126, 127 runs from a plant cooling water supply through pump 152 to condenser receiver 103 to the cooling water return piping 128, 129. Oil cooling water supply piping 131 runs from a plant cooling water supply to compressor oil cooler 132 and then from the compressor oil cooler to the cooling water return piping 133.

Throughout the apparatus there are provided shut-off valves 141, control valves 142, check valves 144, relief valves 145, ball valves 146, solenoid valves 147, level indicators 148, and bleed-off lines 151 for purposes of control, venting, and maintenance.

In the accumulator 114, liquid phase refrigerant 31 falls to the bottom, while vapour phase refrigerant 32 rises to the top. Vapour phase refrigerant is taken from the upper region of the accumulator 114 through line 118 to compressor 102. Compressed refrigerant exits the compressor through line 101 to condenser 103 where heat is removed from the refrigerant and the refrigerant is converted to liquid phase and returned through line 104 to pilot operated valve 109 and line 113 to accumulator 114.

Liquid phase refrigerant is drawn from the lower region of the accumulator 114 by one of the pumps 116. The pump delivers a flow of refrigerant to supply line 10 and thereafter to the plastics mould site.

The purpose of the liquid recirculating system as

described thus far is to deliver a supply of all liquid phase refrigerant to moulding machine A through liquid line 10, to return liquid/vapour phase refrigerant from the moulding machine A through return line 23, and to compress, remove heat, and condense vapour phase refrigerant to liquid, then to be recycled to the moulding machine as liquid refrigerant. The sizes and capacities of the components of the apparatus should be chosen according to the cooling requirements of the moulding machine or machines A.

Referring now to Figure 2, at the plastics mould machine site there is provided a supply of liquid phase refrigerant through supply line 10. It is contemplated in the preferred embodiment of the invention that the refrigerant is a fluorocarbon such as Freon R-12. The refrigerant passes from the supply line 10 through a first sight glass 11. From the sight glass 11, the refrigerant flow is divided into a number of feeder lines 12 corresponding to the number of mould parts, which in this illustration is two. Each feeder line leads to a distributor 13.

The distributors 13 further divide the refrigerant flows into a plurality of individual flows corresponding to the number of cooling passageways 3 in the mould parts 1 and 2. These individual flows are conducted through distributor tubes or feed lines 14. In each feed line 14, there is disposed a metering device, which, in this embodiment, is a manual needle valve 16. Downstream of the needle valves 16, the feed lines communicate directly and individually with the mould cooling passageways 3.

The individual refrigerant flows each exit the cooling passageways to a plurality of effluent lines 17. In each of the effluent lines, there is disposed a second sight glass 18. The sight glasses 18 should be placed as near as practicable to the mould so that the refrigerant state observable through the sight glasses 18 is accurately representative of the refrigerant state in the cooling passageways 3.

At the injection mould site, an operator will adjust the individual refrigerant flows to the cooling passageways 3 to obtain a liquid and vapour phase refrigerant mixture throughout the cooling passageways. This is achieved by carefully adjusting each of the needle valves 16 so that the flow observable through sight glass 11 is all liquid phase and the flow observable in each of the sight glasses 18 is a boiling liquid and vapour mixture, preferably one part vapour to three parts liquid.

As shown by phantom lines 50 and 51, it is possible to extend supply line 10 and return line 23 to connect additional plastics moulding machines to the system in parallel fashion.

The embodiment of the invention shown in the drawings uses a gravity return of liquid/vapour refrigerant from the mould machines to the recirculating system. Thus, the return line is situated below the mould parts and slopes downwardly towards the

accumulator 114. The accumulator and pumps 116 are placed in a pit. However, it is within the scope of this invention to provide other means of return feed such as by lifting liquid/vapour refrigerant to overhead return lines.

It is possible with some moulds that individual control of refrigerant flow through each cooling passageway 3 is not necessary. The passageways 3 may be similar in length, diameter, exposure to heat, and other characteristics such that a single control over all feed lines is sufficient. Thus, in Figure 3 there is shown an alternative embodiment of the invention where the plurality of needle valves 16 is replaced by a single needle valve 40 located upstream of the distributors 13 and in fluid communication with the feed lines. The operator adjusts valve 40 to obtain a liquid/vapour mixture in sight glasses 18.

Also, a fixed metering device such as an orifice or capillary selected for the characteristics of a particular mould may be employed instead of the valves 16 or 40.

It is further within the scope of the invention to provide automatic control of the metering devices. In Figure 2 there is shown a feedback control 41 which comprises a means for automatically detecting the quality of the refrigerant downstream of the mould and automatic means associated with valves 16 responsive to the refrigerant quality to adjust the valves 16 so that there is attained a prescribed optimum quality of the refrigerant. By "quality" is meant characteristics such as densities, temperature, or optical properties from which the liquid/vapour ratio may be derived. Similarly, in Figure 3, feedback control 42 is shown.

Claims

1. A method for cooling the mould (A) of a plastics moulding machine, the mould being of the type having one or more cooling fluid passageways (3) formed therethrough, said method comprising the steps of :
 providing a supply flow of liquid phase refrigerant to the site of the moulding machine, and
 distributing the supply flow into feed flows through the cooling fluid passageways (3) ;
 characterised by the further step of adjusting the liquid phase feed flow rate so as to cause the refrigerant flowing throughout each of the cooling fluid passageways (3) to be maintained as a boiling mixture of the liquid phase and the vapour phase.
2. The method of claim 1 wherein said step of adjusting includes providing metering means disposed in fluid communication with said feed flows.
3. The method of claim 2 wherein said step of providing metering means comprises providing a plurality of individually adjustable metering means each in fluid communication with an individual feed flow, and said step of adjusting comprises selectively and inde-

described thus far is to deliver a supply of all liquid phase refrigerant to moulding machine A through liquid line 10, to return liquid/vapour phase refrigerant from the moulding machine A through return line 23, and to compress, remove heat, and condense vapour phase refrigerant to liquid, then to be recycled to the moulding machine as liquid refrigerant. The sizes and capacities of the components of the apparatus should be chosen according to the cooling requirements of the moulding machine or machines A.

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The distributors 13 further divide the refrigerant flows into a plurality of individual flows corresponding to the number of cooling passageways 3 in the mould parts 1 and 2. These individual flows are conducted through distributor tubes or feed lines 14. In each feed line 14, there is disposed a metering device, which, in this embodiment, is a manual needle valve 16. Downstream of the needle valves 16, the feed lines communicate directly and individually with the mould cooling passageways 3.

The individual refrigerant flows each exit the cooling passageways to a plurality of effluent lines 17. In each of the effluent lines, there is disposed a second sight glass 18. The sight glasses 18 should be placed as near as practicable to the mould so that the refrigerant state observable through the sight glasses 18 is accurately representative of the refrigerant state in the cooling passageways 3.

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Also, a fixed metering device such as an orifice or capillary selected for the characteristics of a particular mould may be employed instead of the valves 16 or 40.

It is further within the scope of the invention to provide automatic control of the metering devices. In Figure 2 there is shown a feedback control 41 which comprises a means for automatically detecting the quality of the refrigerant downstream of the mould and automatic means associated with valves 16 responsive to the refrigerant quality to adjust the valves 16 so that there is attained a prescribed optimum quality of the refrigerant. By "quality" is meant characteristics such as densities, temperature, or optical properties from which the liquid/vapour ratio may be derived. Similarly, in Figure 3, feedback control 42 is shown.

Claims

1. A method for cooling the mould (A) of a plastics moulding machine, the mould being of the type having one or more cooling fluid passageways (3) formed therethrough, said method comprising the steps of :
providing a supply flow of liquid phase refrigerant to the site of the moulding machine, and
distributing the supply flow into feed flows through the cooling fluid passageways (3) ;
characterised by the further step of adjusting the liquid phase feed flow rate so as to cause the refrigerant flowing throughout each of the cooling fluid passageways (3) to be maintained as a boiling mixture of the liquid phase and the vapour phase.

2. The method of claim 1 wherein said step of adjusting includes providing metering means disposed in fluid communication with said feed flows.

3. The method of claim 2 wherein said step of providing metering means comprises providing a plurality of individually adjustable metering means each in fluid communication with an individual feed flow, and said step of adjusting comprises selectively and inde-



pendently adjusting each of said individually adjustable metering means.

4. The method of claim 2 or claim 3 further comprising the steps of :

providing sight glasses (18) in fluid communication with each of said feed flows downstream of its mould (A), and

observing the refrigerant through said sight glasses (18).

5. The method of any of claims 2 to 4 wherein said step of adjusting is performed by automatic control means responsive to the refrigerant quality downstream of the mould.

6. Apparatus for refrigerant cooling of the mould (A) of a plastics moulding machine, the mould having one or more cooling fluid passageways (3) formed therethrough, said apparatus comprising :

means (116, 10) for providing a supply flow of liquid phase refrigerant at the site of the plastics moulding machine ;

means (12, 13) for dividing the refrigerant supply flow into a number of individual feed flows corresponding in number to the number of cooling fluid passageways (3) ;

means (14) for separately conducting each of the feed flows through one of the cooling fluid passageways (3) ; characterised by means (16, 40) to adjust the feed flows to obtain a liquid phase and vapour phase refrigerant mixture throughout each of the cooling fluid passageways (3).

7. The apparatus of claim 6 wherein said means (16, 40) for adjustment comprises a plurality of metering devices (16), a respective one of said devices being disposed in fluid communication with each of said feed flows.

8. The apparatus of claims 6 and 7 further comprising automatic control means (41, 42) operatively associated with said means (16, 40) for adjustment, said automatic control means comprising means for sensing the quality of at least one of said feed flows downstream of said mould and means responsive to the means for sensing for activating said means for sensing for activating said means for adjustment.

9. The apparatus of claim 7, 8 or 9 further comprising :

means (102, 103) for converting said vapour phase refrigerant to liquid phase ; and

means (112, 114, 116) for recycling the converted refrigerant to the plastics moulding machine.

Ansprüche

1. Verfahren zum Kühlen der Form (A) einer Maschine zum Formen von plastischen Artikeln, wobei die Form von der Art ist, daß sie eine oder mehrere durch sie hindurch ausgebildete Kühlfluid-Kanäle (3) aufweist, wobei besagtes Verfahren die

folgenden Schritte umfaßt :

Zur-Verfügung-Stellen eines Versorgungsstroms von flüssigem Kältemittel zum Ort der Formmaschine, und

Verteilen des Versorgungsstroms in Zuführströme durch die Kühlfluid-Kanäle (3) ;

gekennzeichnet durch den weiteren Schritt des Einstellens der Durchflußmenge des flüssigen Zuführstroms, um zu bewirken, daß das Kältemittel, daß durch jeden der Kühlfluid-Kanäle (3) strömt, als ein siedendes Gemisch der flüssigen Phase und der Dampfphase gehalten wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß besagter Schritt des Einstellens das Zur-Verfügung-Stellen von Meßeinrichtungen einschließt, die in Fließverbindung mit besagten Zuführströmen angeordnet sind.

3. Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß besagter Schritt des Zur-Verfügung-Stellens von Meßeinrichtungen das Zur-Verfügung-Stellen von einzeln einstellbaren Meßeinrichtungen umfaßt, die jede in Fließverbindung mit einem einzelnen Zuführstrom stehen, und daß besagter Schritt des Einstellens das selektive und unabhängige Einstellen jeder der besagten einzeln einstellbaren Meßeinrichtungen umfaßt.

4. Verfahren nach Anspruch 2 oder 3, weiter gekennzeichnet durch die folgenden Schritte :

Zur-Verfügung-Stellen von Schaugläsern (18) in Fließverbindung mit jedem besagter Zuführströme stromabwärts von seiner Form (A), und

Beobachten des Kältemittels durch besagte Schaugläser (18).

5. Verfahren nach einem der Ansprüche 2 bis 4, dadurch gekennzeichnet, daß besagter Schritt des Einstellens durch automatische Steuereinrichtungen durchgeführt wird, die auf die Kältemittelqualität stromabwärts der Form ansprechen.

6. Vorrichtung zum Kühlen der Form (A) einer Maschine zum Formen plastischer Artikel mit Kältemittel, wobei die Form eine oder mehrere durch sie hindurch ausgebildete Kühlfluidkanäle (3) aufweist, wobei besagte Vorrichtung folgendes umfaßt :

Mittel (116, 10) zum Zur-Verfügung-Stellen eines Versorgungsstroms von flüssigem Kältemittel am Ort der Maschine zum Formen plastischer Artikel ;

Mittel (12, 13) zum Aufteilen des Versorgungsstroms des Kältemittels in eine Anzahl einzelner Zuführströme, die in ihrer Anzahl der Anzahl von Kühlfluid-Kanäle (3) entsprechen ;

Mittel (14) zum separaten Führen jedes Zuführstroms durch einen der Kühlfluid-Kanäle (3) ;

gekennzeichnet durch Mittel (16, 40) zum Einstellen der Zuführströme, um ein Kältemittelgemisch in flüssiger Phase und dampfförmiger Phase durch jeden der Kühlfluid-Kanäle (3) hindurch zu erhalten.

7. Vorrichtung nach Anspruch 6, dadurch gekennzeichnet, daß besagte Mittel (16, 40) zum Ein-



stellen mehrere Meßeinrichtungen (16) umfassen, wobei jeweils eine der besagten Einrichtungen in Fließverbindung mit jedem der besagten Zuführströme angeordnet ist.

8. Vorrichtung nach den Ansprüchen 6 und 7, weiter gekennzeichnet durch automatische Steuereinrichtungen (41, 42), die funktionsmäßig mit besagten Mitteln (16, 40) zum Einstellen verbunden sind, wobei besagte automatische Steuereinrichtungen Mittel zum Bestimmen der Qualität von wenigstens einem der besagten Zuführströme stromabwärts besagter Form und Mittel, die auf die Mittel zum Bestimmen ansprechen, zum Aktivieren besagter Mittel zum Bestimmen um besagte Mittel zum Einstellen zu aktivieren, umfassen.

9. Vorrichtung nach Anspruch 6, 7 oder 8, weiter gekennzeichnet durch

Mittel (102, 103) zum Überführen besagten dampfförmigen Kältemittels in die flüssige Phase ; und

Mittel (112, 114, 116) zum Zurückführen des umgewandelten Kältemittels zur Maschine zum Formen plastischer Artikel

Revendications

1. Procédé destiné à refroidir le moule (A) d'une machine à mouler des matières plastiques, le moule étant du type comportant un ou plusieurs passages de fluide de refroidissement (3) formés à travers celui-ci, le procédé comprenant les étapes consistant à :

– fournir un flux de distribution de réfrigérant au site de la machine à mouler, et

– répartir le flux de distribution en plusieurs flux d'alimentation à travers les passages de fluide de refroidissement (3) ;

caractérisé par l'étape supplémentaire consistant à ajuster le débit du flux d'alimentation en phase liquide de façon à faire en sorte que le réfrigérant s'écoulant à travers chacun des passages de fluide de refroidissement (3) soit maintenu sous forme d'un mélange en ébullition de la phase liquide et de la phase vapeur.

2. Procédé selon la revendication 1, dans lequel l'étape d'ajustement comprend la fourniture de moyens de dosage disposés en communication avec les flux d'alimentation.

3. Procédé selon la revendication 2, dans lequel l'étape de fourniture des moyens de dosage comprend la fourniture d'une pluralité de moyens de dosage réglables individuellement, chacun se trouvant en communication de fluide avec un flux d'alimentation individuel, et l'étape d'ajustement comprend l'ajustement sélectif et indépendant de chacun des moyens de dosage réglables individuellement.

4. Procédé selon la revendication 2 ou la reven-

dication 3, comprenant de plus les étapes consistant à :

– fournir des voyants ou hublots de regard (18) en communication de fluide avec chacun des flux d'alimentation en aval du moule (A), et

– observer le réfrigérant à travers les hublots de regard (18).

5. Procédé selon l'une quelconque des revendications 2 à 4, dans lequel l'étape d'ajustement est effectuée par des moyens de commande automatique sensibles à la qualité du réfrigérant en aval du moule.

6. Appareil de refroidissement par réfrigérant du moule (A) d'une machine à mouler des matières plastiques, le moule comportant un ou plusieurs passages de fluide de refroidissement (3) formés à travers celui-ci, l'appareil comprenant :

– des moyens (116, 10) destinés à fournir un flux de distribution de réfrigérant en phase liquide au site de la machine à mouler les matières plastiques ;

– des moyens (12, 13) destinés à diviser le flux de distribution de réfrigérant en un certain nombre de flux d'alimentation individuels correspondant en nombre au nombre de passages de fluide de refroidissement (3) ;

– des moyens (14) destinés à conduire séparément chacun des flux d'alimentation à travers un des passages de fluide de refroidissement (3) ;

caractérisé par des moyens (16, 40) pour ajuster les flux d'alimentation afin d'obtenir un mélange de réfrigérant en phase liquide et en phase vapeur à travers chacun des passages de fluide de refroidissement (3).

7. Appareil selon la revendication 6, dans lequel les moyens d'ajustement (16, 40) comprennent une pluralité de dispositifs de dosage (16), un dispositif respectif de ceux-ci étant disposé en communication de fluide avec chacun des flux d'alimentation.

8. Appareil selon les revendications 6 et 7, comprenant de plus des moyens de commande automatique (41, 42) associés fonctionnellement aux moyens d'ajustement (16, 40), ces moyens de commande automatique comprenant des moyens destinés à détecter la qualité d'au moins un des flux d'alimentation en aval du moule et des moyens sensibles aux moyens de détection pour actionner les moyens de détection et pour actionner les moyens d'ajustement.

9. Appareil selon la revendication 7, 8 ou 9, comprenant de plus :

– des moyens (102, 103) destinés à convertir le réfrigérant en phase vapeur en réfrigérant en phase liquide ; et

– des moyens (112, 114, 116) destinés à recycler le réfrigérant converti dans la machine à mouler les matières plastiques.

