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(54) **METHOD FOR PREVENTING PACK-OUT IN PUMPING SYSTEM**

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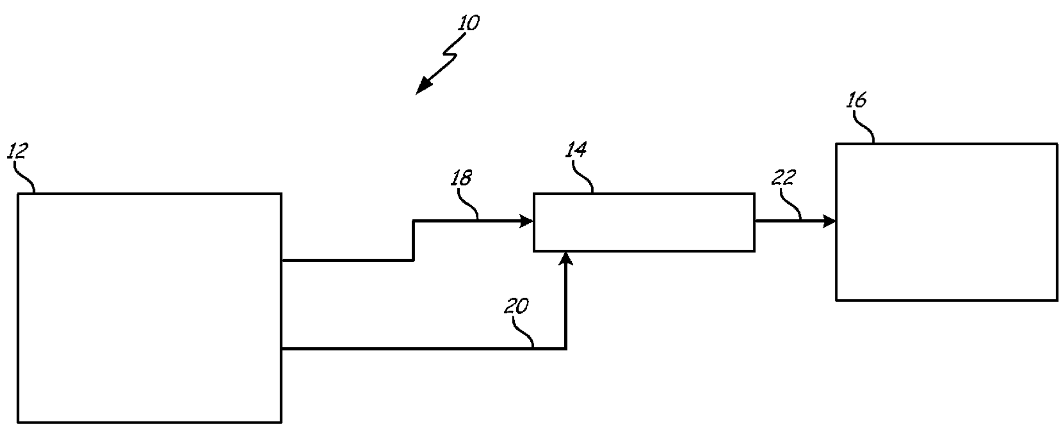
(57) **ABSTRACT**

A method for preventing pack-out in a system for pumping hybrid hot-melt material comprises monitoring activity of a pump that pumps hybrid hot-melt material, shutting off a heater that melts pumped hybrid hot-melt material at an inactivity threshold level, and relieving pump pressure.



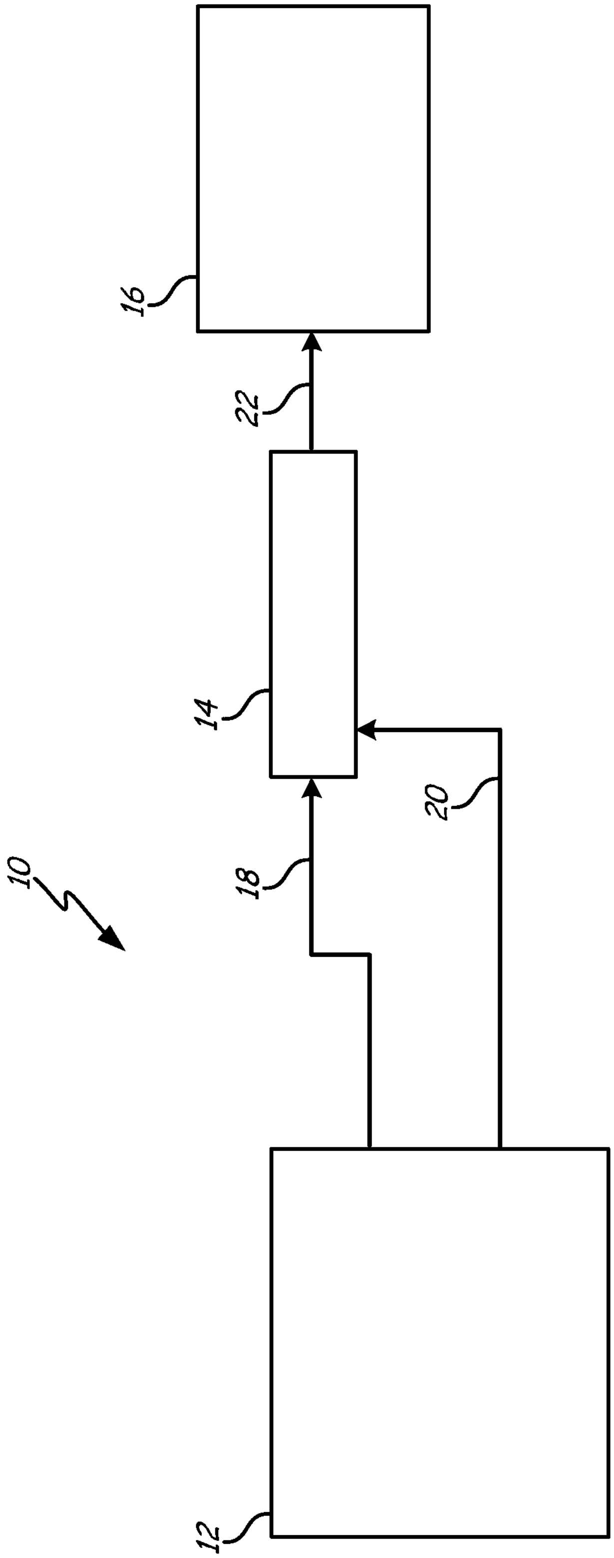


Fig. 1

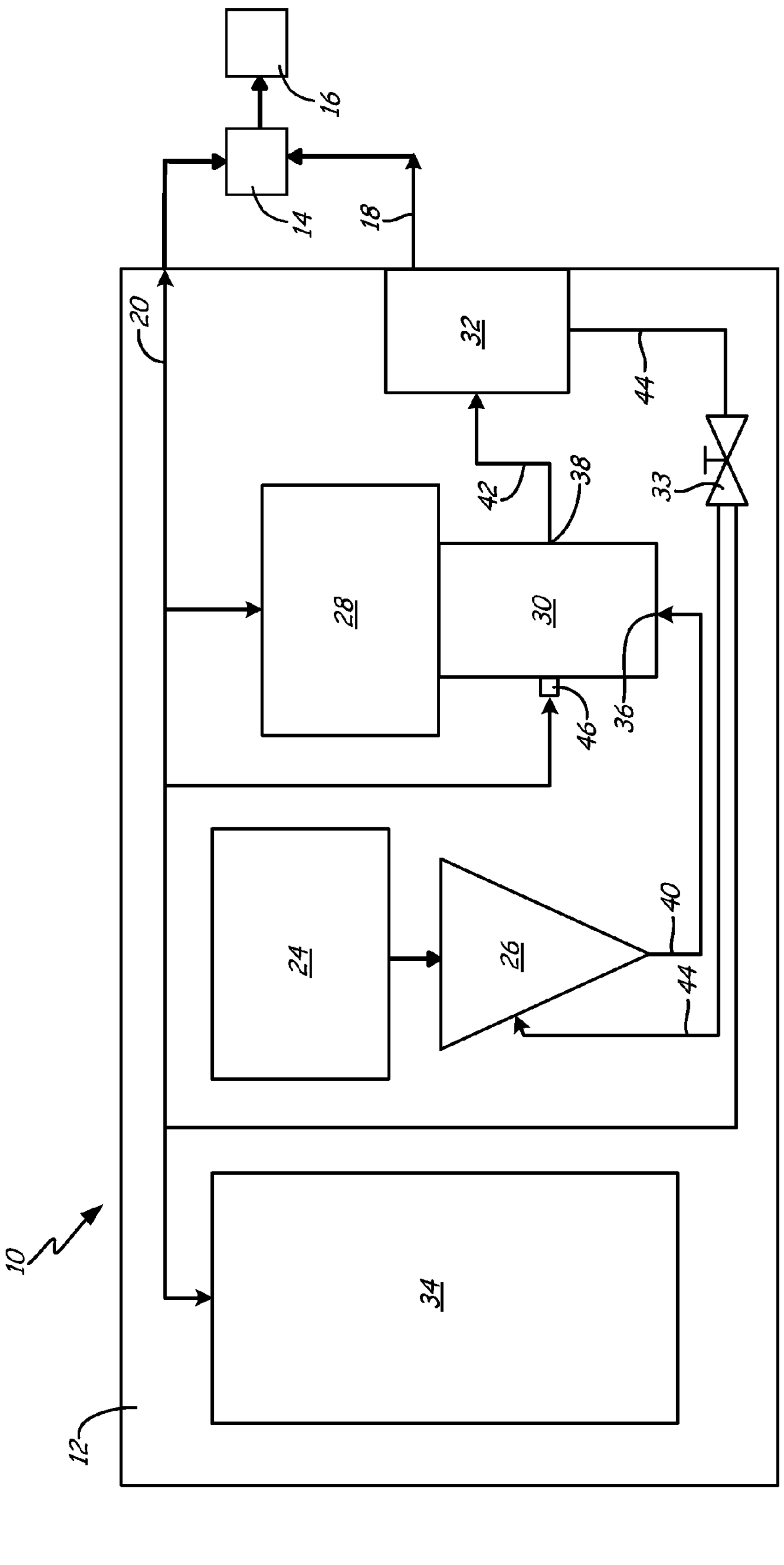


Fig. 2

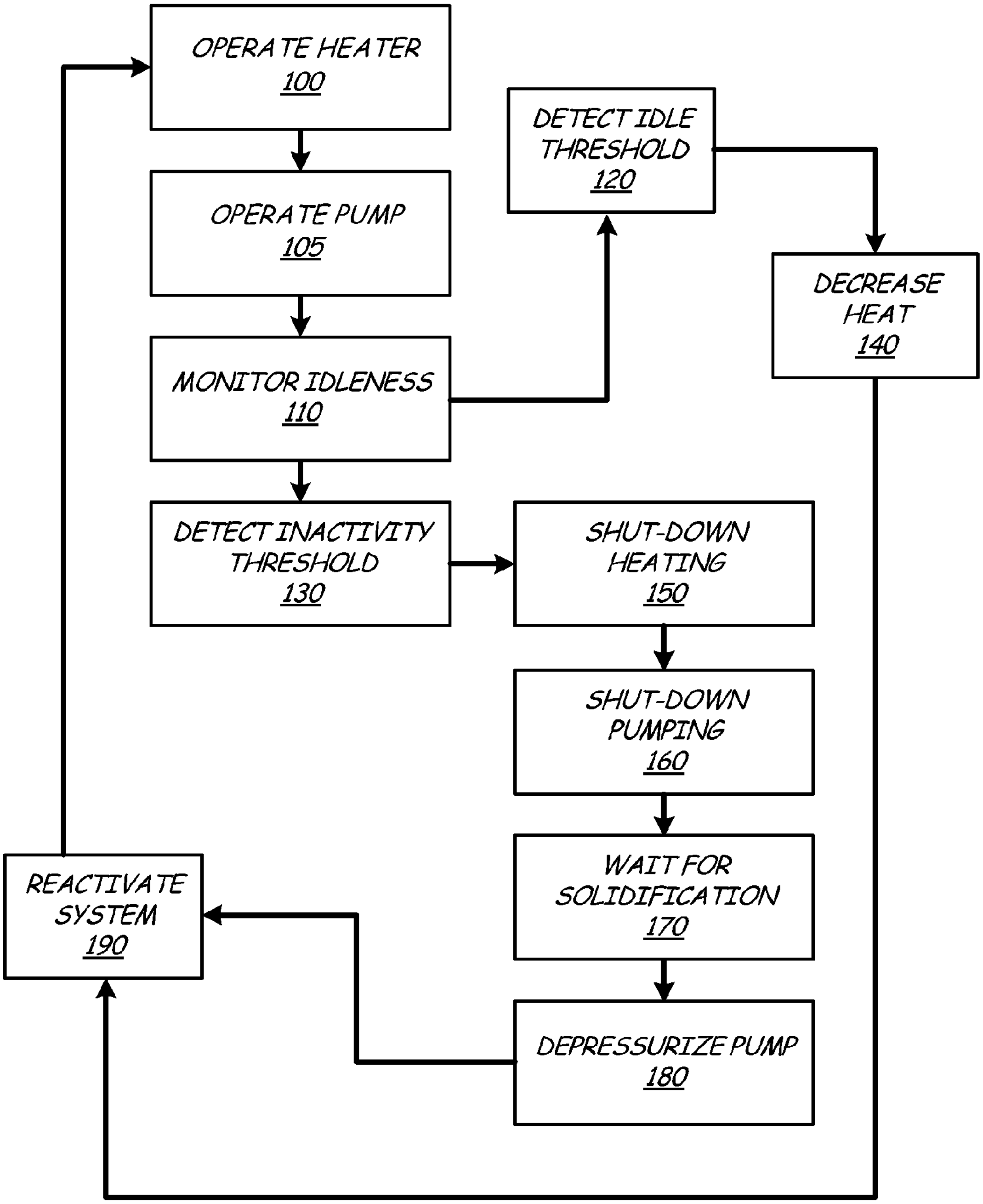

OPERATE HEATER
100
OPERATE PUMP
105
MONITOR IDLENESS
110
DETECT IDLE THRESHOLD
120
DECREASE HEAT
140
DETECT INACTIVITY THRESHOLD
130
SHUT-DOWN HEATING
150
SHUT-DOWN PUMPING
160
WAIT FOR SOLIDIFICATION
170
DEPRESSURIZE PUMP
180
REACTIVATE SYSTEM
190

Fig. 3

METHOD FOR PREVENTING PACK-OUT IN PUMPING SYSTEM

BACKGROUND

[0001] The present disclosure relates generally to pumping systems for hot-melt material, such as those used for dispensing adhesives used in packaging. More specifically, the present disclosure relates to control methods for operating pumping systems for dispensing hybrid hot-melt material.

[0002] Hot-melt systems conventionally operate to melt solid polymer pellets before passing the melted liquid pellets into a pump system for routing to a dispenser. These systems require the melted liquid to be heated along the entire route from a hopper for the un-heated pellets to the dispenser. This requires the use of multiple heaters in the system. For example, a hopper, a pump and a manifold are configured in a single unit that is provided with heating, and a heated hose connects the manifold to a dispenser. Heaters increase the power consumption of such systems, thereby increasing the cost of operation. Recent advancements in hot-melt technology have involved the use of hybrid compositions wherein a heterogeneously dispersed polymeric particulate is suspended in an adsorbed liquid component, such as is described in U.S. Pat. No. 7,285,583 to Stumphauzer et al., which is assigned to H.B. Fuller Company. In dispensing systems for such hybrid compositions, heat is not applied to the composition until the point of dispensing, typically right before entry into a dispenser, as is described in U.S. Pat. No. 7,221,859 to Stumphauzer et al., which is assigned to H.B. Fuller Company.

[0003] Hybrid composition dispensing units experience a phenomenon called "pack-out" wherein the liquid component is depleted from the pumping unit and the solid polymeric particulates are left in the pump. When the pumping systems are put into a standby mode where the pump is pressurized, but melted material is not being pumped, the pressure within the pump can cause the liquid component to backflow through seals to the low pressure region of the pump and leak out. With only solid particulate remaining, the pump mechanism has a tendency to lock-up. Maintenance is therefore required to remove the jammed particulates, which causes delays in production lines. Prior art systems that have been developed to address pack-out have involved continuously re-circulating material through the pump in a feedback loop to prevent backflow of the liquid component, even when melted material is not being dispensed. Typically, an orifice is provided in the re-circulation loop to maintain backpressure for dispensing, but that permits some flow to recalculate. Such systems increase the complexity of the overall system and have increased power demands, thereby eliminating some of the benefit of the hybrid composition hot-melt system in the first place. There is, therefore, a need for improved hot-melt dispensing systems.

SUMMARY

[0004] The present invention is directed to a method for preventing pack-out in a system for pumping hybrid hot-melt material. The method comprises monitoring activity of a pump that pumps hybrid hot-melt material, shutting off a heater that melts pumped hybrid hot-melt material at an inactivity threshold level, and relieving pump pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. **1** is a schematic of a hot-melt dispensing system including a pump assembly, heater and dispense gun for use with a hybrid hot-melt composition.

[0006] FIG. **2** is a schematic of the pump assembly of FIG. **1** showing interconnection of a hybrid material container, a hopper, an air motor, a pump, a fluid outlet block, a relief valve and electronics that execute the control over the hot-melt dispensing system.

[0007] FIG. **3** is a block diagram outlining a method that the electronics of FIG. **2** execute to prevent pack-out in the pump assembly.

DETAILED DESCRIPTION

[0008] FIG. **1** is a schematic of hot-melt dispensing system **10** including pump assembly **12**, heater **14** and dispenser **16** for use with a hybrid hot-melt composition. Pump assembly **12** is fluidly connected to heater **14** by fluid line **18**. Pump assembly **12** is electronically connected to heater **14** by communication line **20**. Heater **14** is connected to dispenser **16** at coupling **22**.

[0009] Pump assembly **12**, which is described in greater detail with reference to FIG. **2**, comprises a mechanical pump that provides a motive flow of a liquid material to heater **14**. In the described embodiment, the liquid material comprises a hybrid hot-melt adhesive composition ("hybrid composition") comprising a heterogeneously dispersed polymeric particulate that is suspended in an adsorbed liquid component, such as is described in U.S. Pat. No. 7,285,583 to Stumphauzer et al. The present invention may, however, be used with pumping systems that dispense any type of hybrid composition in which solid particles are mixed in a liquid material. Electronics within pump assembly **12** operate the pump to provide a desired amount of flow of the hybrid material to heater **14**. The electronics also operate heater **14** to provide the requisite amount of thermal output to melt the dispersed polymeric particulate within the hot melt adhesive composition, thereby activating an adhesive material. In one embodiment, heater **14** comprises an in-line heater wherein coupling **22** uninterruptedly joins fluid line **18** to the outlet valve of dispenser **16**. For example, heater **14** may comprise an in-line heater as is described in U.S. Pat. No. 7,221,859 to Stumphauzer et al. The melted mixture of hot melt adhesive flows into dispenser **16** that is capable of applying the adhesive in a controlled manner. Dispenser **16** may comprise a hand-held gun that is directly manually operated, or a module that is operated by a controller as part of an automated process. Thus, in a particular application, hot glue can be applied to surfaces such as those of packaging, boxes and the like.

[0010] At ambient, room temperature, the liquid material is sufficiently viscous to flow from pump system **12** to heater **14** under pump pressure. Fluid line **18** is, therefore, neither heated nor insulated. Heater **14** provides all the thermal input necessary to activate the hybrid composition into a homogeneous, viscous hot glue. The hot glue also flows from heater **14** to dispenser **16** through coupling **22** under pressure from pump system **12**. Heater **14** provides sufficient thermal output and is appropriately connected to dispenser **16** such that heat from heater **14** maintains the hybrid composition in a melted state within dispenser **16**. However, in other embodiments, dispenser **16** is provided with separate heating elements. Further, in some configurations, coupling **22** may includes hoses or the like that are heated. Any in-line heating systems as is known in the art may be used, such as resistive heating elements. In such embodiments, those heaters are controlled with respect to the present invention in a similar manner as heater **14**. Thus, dispenser **16** receives the hybrid composition in a condition ready for application. Such a system is advantageous over prior art solid-pellet systems due to the elimination of the need to heat the hybrid composition all the way through the pump system and out the dispenser, as is know in the art.

[0011] Hot-melt dispensing system **10** can thus be continuously or intermittently operated to dispense hot glue while only requiring a small amount of hybrid composition to be activated between heater **14** and dispenser **16**. Activated (heated) hybrid composition turns into a homogeneous solid material upon cooling to room temperature. The solid material can be re-melted into hot glue, but cannot be returned to the hybrid composition as originally provided. Thus, it is undesirable for any heated and activated hybrid composition to flow backwards into fluid line **18** or pump system **12**. In a conventional, prior art system, such an occurrence would require the heating of any component of the system into which activated hybrid composition entered in order to dislodge the solidified glue. As long as the prior art system is continuously used or intermittently used in short intervals, this typically will not occur. If however, the prior art system is left idle for a period of time, activated hybrid composition from the heater can migrate backward into a fluid line where it can solidify and plug the system. Further, such systems may separately suffer a pack-out condition. The present invention provides a control method for system **10** that prevents the occurrence of pack-out conditions, thereby preventing activated hybrid composition from heater **14** from migrating backwards through system **10**.

[0012] FIG. **2** is a schematic of pump assembly **12** of FIG. **1** showing interconnection of hybrid material container **24**, hopper **26**, motor **28**, pump **30**, fluid outlet block **32**, relief valve **33** and electronics **34**, which execute control over hot-melt dispensing system **10**. Pump **30** includes inlet **36**, outlet **38** and fluid lines **40** and **42**. Relief valve **33** is positioned within return line **44**, which connects fluid outlet block **32** with hopper **26**. Electronics **34** include communication line **20**, which connects to position sensor **46**, relief valve **33** and motor **28**.

[0013] Pump **30** comprises a pump for pressurizing liquid material from hopper **26**. Pump **30** may comprise any conventional pump as is known in the art. For example, in one embodiment, pump **30** may comprise a positive displacement pump, such as a diaphragm pump or a linear displacement piston pump. Pump **30** is driven by motor **28**, which may comprise any conventional motor as is known in the art. For example, motor **26** may comprise an air motor or an electric motor that rotates a shaft for powering pump **30**. Electronics **34** selectively operate motor **28** to drive pump **30** based on either an operator input or a programmed schedule.

[0014] Inlet **36** of pump **30** is fluidly coupled, such as by fluid line **40**, to hopper **26**. Hopper **26** comprises a container or receptacle that holds hot-melt material container **24** and directs the material to inlet **36** of pump **30**. For example, hopper **26** may have a funnel shape or may have a separate pump to prime pump **30**. As mentioned above, hot-melt material container **24** comprises a hybrid composition comprising a heterogeneously dispersed polymeric particulate that is suspended in an adsorbed liquid component. In one embodiment, material container **24** comprises a bag-in-box package that can be placed into or on top of hopper **26**. Outlet **38** of pump **30** is fluidly coupled to fluid outlet block **32** by fluid line **42**. Fluid outlet block **32** comprises a fluid manifold that receives pressurized fluid from pump **30** and directs the pressurized fluid to fluid line **18** and return line **44**. Fluid line **18** extends to a heater and dispenser, such as heater **14** and dispenser **16** (FIG. **1**). Return line **44** extends to material hopper **26**. Flow through return line **44** is controlled by relief valve **33**, which can be selectively operated by electronics **34**.

[0015] Electronics **34** operates hot-melt dispensing system **10**, typically in an automated fashion. As such, electronics **34** comprises a computer system including a processor, memory, graphical display, user interfaces, memory and the like, as are known in the art. Under normal or typical operating conditions, electronics **34** maintains system **10** in a state such that activated (heated) hybrid composition can be dispensed at the dispenser. Under such conditions, motor **28** is active to maintain pump **30** in a pressurized, operating state. As such, pump **30** receives unpressurized fluid from hopper **26** and maintains pressurized fluid downstream of outlet **38**. Furthermore, electronics **34** activate heater **14** such that heat or thermal output is generated. Thus, hybrid composition that is pushed to dispenser **16** by pump **30** first passes through heater **14**. The thermal output of heater **14** causes the suspended polymeric particulate within the liquid component to melt, thereby forming hot glue. Thus, pressurized and unheated hybrid composition is provided up to heater **14**, and pressurized and heated hybrid composition is provided to heater **14** and dispenser **16**. Dispenser **16** can thus be operated, either manually or automatically, to distribute activated hybrid composition.

[0016] Sometimes system **10** is left in condition for normal operation, such as with motor **28** and heater **14** operating, but when activated hybrid composition is not being dispensed. If system **10** is not anticipated to be used for an extended period of time, such as at the end of the day or a manufacturing shift, it is generally desirable to shut-down the entire system. Short periods of inactivity, such as in between dispensing operations, do not have an impact on the operation of system **10**. However, if system **10** is left powered-up without dispensing any fluid for an extended period of time, system **10** may experience a phenomenon called “pack-out” in which pump **30** becomes jammed with un-melted polymeric particulate in the hybrid composition. Such a phenomena occurs when pump **30** is maintained in a state where there is a pressure differential between inlet **36** and outlet **38**. The pressure differential can cause the liquid component of the hybrid composition to back-flow through the system, particularly through seals of pump **30**.

[0017] In prior art systems, the pump can become seized-up, and heated hybrid composition can back flow from the heater into a fluid line. Once the heated hybrid composition is moved away from the heater it solidifies after a period of time, thus plugging the fluid line. This causes the system to be un-operable, thereby losing production time. Maintenance of the system is required to remove solidified hybrid composition in from the fluid line upstream of the heater. Solidified hybrid composition can be re-melted with heat, but once it has migrated far enough away from the heater within the fluid line an external source of heat must be brought in to remove the solidified hybrid composition from the prior art system. In the present invention, electronics **34** execute an operating algorithm to prevent pump **30** from operating under pressure for an extended period of time without dispensing fluid.

[0018] FIG. 3 is a block diagram outlining a method that electronics 34 of FIG. 2 execute to prevent pack-out in pump 30. At step 100, hot-melt dispensing system 10 is activated to begin the process of dispensing activated hybrid composition or hot glue. In particular, electronics 34 sends a signal to heater 14 over communication line 20. Heater 14 then activates the hybrid composition within dispenser 16. In one embodiment, heater 14 is coupled directly to an outlet valve in dispenser 16 such that heater 14 activates only the hybrid composition that is immediately ready to be dispensed. As mentioned, electronics 34 also sends a signal to any other heaters used in system 10. Hybrid composition within line 18 upstream of heater 14 remains un-melted. At step 105, pump 30 is activated, such as by electronics 34 sending a signal to motor 28 over communication line 20. Thus, pump 30 is operated to send pressurized hybrid composition out to fluid outlet block 32 and dispenser 16. As such, system 10 is ready to dispense activated hybrid material.

[0019] At step 110, electronics 34 monitor pump 30 for activity. Specifically, electronics 34 are in communication with position sensor 46 coupled to pump 30 through communication line 20. Position sensor 46 determines movement of a component of pump 30 that provides an indication if active pumping is occurring. For example, position sensor 46 may monitor the position of a piston shaft used to displace a linear displacement piston pump. Alternatively, activity of pump 30 can be monitored indirectly by monitoring activity of dispenser 16. Thus, a trigger, activation lever or nozzle of dispenser 16 can be provided with a motion sensor or position sensor. Thus, at step 110 electronics 34 continuously monitor pump 30 to detect activity. Electronics 34 maintain a counter or clock that is initiated when movement in pump 30 ceases. In the described embodiment, electronics 34 maintain a single clock that determines two threshold levels for inactivity of pump 30. In other embodiments, electronics 34 include two separate clocks that individually determine one threshold level each.

[0020] Electronics 34 put system 10 into a standby mode at step 120 after electronics 34 determine that pump 30 has been idle for a first threshold level, referred to as an "idle" threshold level. In the standby mode, electronics 34 send a signal to heater 14 over communication line 20 that commands heater 14 to reduce heat output. The heat output is turned down to a level that prevents hybrid material from being activated, thereby providing cost savings in reduced energy output. The heat output level is maintained sufficiently high to allow heater 14 to be brought back up to operating temperature quickly when operation of system 10 is again desired or required. Standby mode can be initiated at a first threshold level when it is known that system 10 will again be used in a short period of time, such as after the completion of a maintenance operation or a scheduled break. The time limit for the first threshold level can be set and adjusted at electronics 34 by an operator of system 10.

[0021] When in standby mode, electronics 34 continue to monitor inactivity of pump 30. If an additional amount of time passes beyond the first "idle" threshold such that a second threshold level, or "inactivity" threshold, is reached, electronics 34 begins shutting down components of system 10 at step 130. First, heater 14 is shut-down or powered off at step 150. At step 160, pump 30 is shut-down or powered off by electronics 34. Specifically, electronics 34 command motor 28 and heater 14 to cease operation. Inactivity of motor 28 causes pump 30 to no longer actively generate a pressure differential between inlet 36 and outlet 38, thereby eliminating the conditions under which pack-out can occur. Inactivity of heater 14 prevents melting of additional hybrid composition. After a sufficient length of time has passed in step 170, hybrid composition within heater 14 eventually cools down to a temperature where solidification occurs. As such, solidified hybrid composition within heater 14 can be re-melted upon activation of heater 14, but hybrid material short of heater 14 in fluid line 18 remains un-activated in a suspended-liquid state. Thus, activated hybrid composition is prevented from drifting backward or migrating into fluid line 18 or pump assembly 12. At step 180, pump 30 is depressurized to allow any residual pressurized hybrid composition remaining in system 10, such as lines 42 and 44, to be drained back to hopper 26. Specifically, electronics 34 send a signal to relief valve 33 commanding the valve to open. Relief valve 33 may comprise any suitable automated shut-off valve. Because all hybrid material that has been activated, will solidify within heater 14 upon cooling, only un-activated hybrid composition will flow from fluid line 18 back into fluid outlet block 32, line 42 and pump 38 when valve 33 opens. As such, system 10 is fully put into an inactive mode where no pumping and no heating occur and no dispensing is possible. In such a state, backward migration of the liquid component of the hybrid composition is prevented from occurring in pump 30 because no pressure differential is present across inlet 36 and outlet 38. As such, activated hybrid composition is prevented from entering system 10 where heat from heater 14 is unavailable. Furthermore, pack-out of pump 30 is prevented.

[0022] At step 190, electronics 34 reactivate system 10. In particular, power is restored to pump 30 and heater 14. Furthermore, relief valve 33 is returned to a closed state. In one embodiment, system 10 is reactivated after an operator provides an indication to electronics 34. In another embodiment, electronics 34 reactivate system 10 as part of a preprogrammed schedule. For example, electronics 34 may place system 10 into standby and then inactive modes after system 10 has been left running at the end of a shift. Electronics 34 may then return system 10 to an operating state at the beginning of the next shift.

[0023] Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

1. A method for preventing pack-out in a system for pumping hybrid material, the method comprising:
monitoring activity of a pump that pumps hybrid material;
shutting off a heater that melts pumped hybrid material at an inactivity threshold level; and
relieving pump pressure.

2. The method of claim 1 and further comprising:
solidifying the hybrid material in the heater before relieving pump pressure.

3. The method of claim 1 wherein relieving pump pressure comprises routing pressurized hybrid material from a pump outlet to a pump inlet.

4. The method of claim 1 wherein relieving pump pressure comprises opening a relief valve.

5. The method of claim 1 and further comprising:
powering off a motor that drives the pump at the inactivity threshold level.

6. The method of claim **1** wherein the inactivity threshold comprises a period of time for which the pump undergoes no movement.

7. The method of claim **1** and further comprising:
reducing heat output of the heater at an idle threshold level before shutting off the heater at the inactivity threshold.

8. The method of claim **7** wherein the inactivity threshold comprises a period of time longer than a period of time comprising the idle threshold.

9. The method of claim **1** and further comprising:
reactivating the system.

10. The method of claim **9** wherein reactivating the system comprises:
pressurizing the pump; and
activating the heater.

11. The method of claim **10** wherein pressurizing the pump comprises:
closing a pump relief; and
powering a pump motor.

12. The method of claim **9** wherein reactivating the system comprises:
automatically reactivating the system.

13. The method of claim **1** wherein monitoring activity of the pump comprises determining a position of a pump shaft or determining a position of a dispenser lever.

14. A material pumping system comprising:
a pump that pumps material, the pump having an inlet and an outlet;
a heater that receives pumped material from the outlet;
a dispenser that receives heated pumped material from the heater; and
electronics that monitors activity of the pump and is configured to reduce output of the heater and pump at threshold levels of inactivity.

15. The material pumping system of claim **14** wherein the heater is coupled to the dispenser and is spaced from the pump outlet by a hose.

16. The material pumping system of claim **14** and further comprising:
a position sensor coupled to the pump and in electronic communication with the electronics.

17. The material pumping system of claim **14** and further comprising:
a relief valve positioned in a return line fluidly coupling the inlet with the outlet and in electronic communication with the electronics.

18. The material pumping system of claim **17** and further comprising:
a material hopper connected to the return line between the pump inlet and pump outlet.

19. The material pumping system of claim **14** and further comprising:
a motor configured to drive the pump.

20. The material pumping system of claim **14** wherein:
the electronics are configured to shut-off the heater and pump after detecting that the pump has been inactive for a first period of time.

21. The material pumping system of claim **20** wherein:
the electronics are configured to reduce output of the heater after detecting that the pump has been inactive for a second period of time less than first period of time.

22. A method for preventing pack-out in a system for pumping hybrid hot-melt material, the method comprising:
pumping hybrid hot-melt material with a pump;
heating the hybrid hot-melt material with a heater;
detecting activity of the pump;
determining a first period of inactivity;
reducing heat output of the heater; and
depressurizing the pump.

23. The method of claim **22** wherein reducing heat output of the heater comprises powering off the heater.

24. The method of claim **23** wherein depressurizing the pump comprises turning off a pump motor.

25. The method of claim **24** wherein depressurizing the pump further comprises opening a pressure relieve valve fluidly coupled to an outlet of the pump.

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