

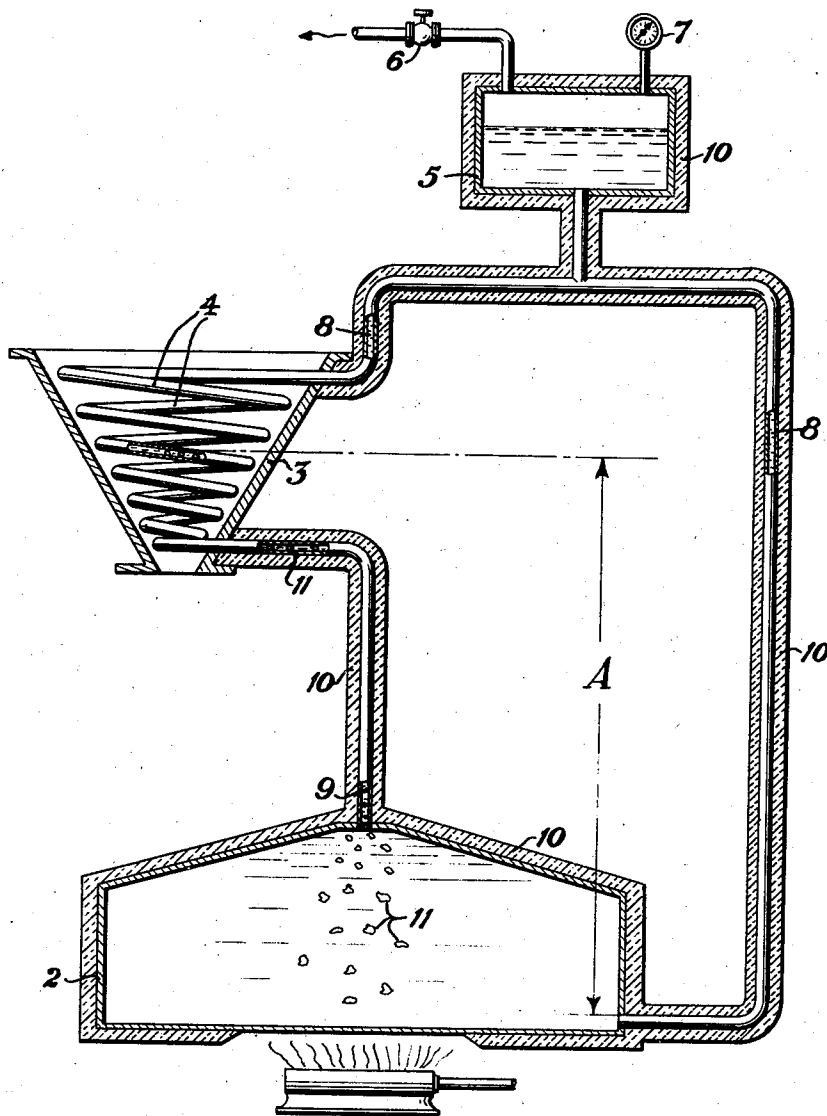
Oct. 17, 1944.

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2,360,665

APPARATUS FOR HEAT EXTRACTION

Filed April 29, 1943



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2,360,665

APPARATUS FOR HEAT EXTRACTION

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Application April 29, 1943, Serial No. 485,026

5 Claims. (Cl. 126—343.5)

This invention relates to a method of heating and, more particularly, it relates to a method of heating by means of a circulating high boiling liquid. Still more particularly it relates to a heating apparatus and system of heating for use in the chemical and related arts by means of a high boiling liquid at boiling temperature.

It is an object of this invention to provide an improved system of heating by means of high boiling liquids. A more specific object is to provide a method of heating chemical and related apparatus, which is free from moving mechanical parts. Another object is to provide such a method which may be operated with a high degree of efficiency, a high heat output, and a minimum of control. Still another object is to provide a method of heating chemical apparatus which can be controlled over a narrow range of temperature. Still further objects will become apparent from the following description of the invention.

These objects are accomplished according to the method of this invention by heating a high boiling liquid in the boiler of a closed system comprising a boiler, a riser, a heat exchange unit, an expansion chamber situated on the outlet side of the heat exchange unit and at the topmost portion of the heating system, and a return line connecting the heat exchange unit to the lower portion of the boiler. The system is filled with a heat transfer liquid to such an extent that when said system is heated to the operating temperature the liquid level will be within the expansion chamber. In operation of the system, bubbles of vapor form in the boiler and ascend through the riser tube to the heat exchange means where heat is extracted from the vapor-liquid mixture thereby causing the vapor to condense, which condensate then flows by way of the return tube to the boiler because of the unequal densities existing between the hydrostatic heads A of the return line and the riser line of the heating system.

The invention will be further described in greater detail with reference to the accompanying drawing which is provided in illustration of a practical embodiment of it.

In the drawing, there is a diagrammatic representation of suitable apparatus which may be employed in the operation of the invention, the boiler unit 2 is provided with a heating unit 1, a heating fluid outlet line or riser 9, and a heating fluid return line 8. The heat exchange unit 3 includes heating coils 4 surrounded by the object to be heated. Thus, they may be embedded in the walls of a chemical reaction vessel, extrusion press, or the like, or maintained in intimate

contact with the walls of such apparatus or inserted directly into reacting fluids or polymerization media. The heating fluid return line 8 serves to connect the outlet side of the heat exchange unit 3 with the boiler 2. An expansion chamber 5, having a vapor dome in its upper part is inserted at the high point in the heating fluid return line 8. This expansion chamber 5 is provided with a valve 6 for bleeding-off gases or applying pressure and a pressure gauge 7. This entire closed loop system is lagged with heat insulation material 10.

The heating system of this invention operates at the boiling point of the liquid employed as the heat transfer medium. However, since the boiling point of any liquid is dependent upon the absolute pressure on said liquid, the operating temperature of the heating system of this invention may be varied by adjusting the operating pressure of the system. Thus, by utilizing either a partial vacuum, or subatmospheric pressure, atmospheric pressure or elevated pressure, it is possible with a heat transfer liquid such as diphenyl, diphenylether, or mixtures of these two, alkylated-diphenyl and diphenyl ether, retene, etc., to operate the heating systems of this invention at temperatures over a wide range, e. g., between 120° C. to 320° C., or even higher, if desired.

It is particularly useful for liquefying plastic materials and maintaining them in a fluid state. It is especially useful for melting polyamides, such as nylon, and for keeping them molten during an extrusion, molding, or injection molding operation.

Various types of heating units may be employed to furnish the heat necessary to boil the liquid. Thus, the heating means 1 of the drawing may constitute an electric resistance or induction heating element, or a fuel-fired unit, e. g., a gas-fired, oil-fired, or coal-fired unit, or the like.

Although the drawing and description herein has represented the process of this invention as operating with only one heating loop and heat exchange unit, it is entirely practical to operate more than one heating loop from the same boiler provided the heat output of the heat supply 1 be sufficient to furnish the requisite amount of heat to the separate heat exchange units, and that all heating loops operate at the same temperature.

The line leading from the top of the boiler to the heat exchange unit 3, herein referred to as the "riser" should preferably ascend directly from the boiler to the heat exchange unit. A perpendicular or substantially perpendicular riser is

most advantageous. However, a riser which ascends at a marked angle can be used provided that a substantial upward pitch be present in all sections of the line. Thus, the riser preferably should be free of sections possessing a downward pitch, for these sections generally lead to difficulties when the operation of the heating system is begun. Furthermore, the higher the heat exchange unit 3 is above the boiler 2, the more rapid and efficient will be the circulation. The expansion chamber 5 provides for the fluid volume expansions which result during operation of the system and for the accumulation of vapors or gases and vaporous decomposition products. This expansion chamber should be situated at the high point of the system. When the liquid level is within the expansion chamber a continuous liquid circuit is formed throughout the various sections of the apparatus.

The heat exchange unit 3, as previously stated, comprises a series of coils 4 surrounded by the mass to be heated. The illustrated unit 3 may be replaced by substantially any variety of heat exchange unit, e. g., a heat-jacketed chemical reaction vessel. The heating method of this invention is of special utility in the case where the unit 3 has coils which have a small rise or pitch. It is especially useful in a conical, free-draining superpolyamide melting unit.

The method by which heating is accomplished according to the process of this invention will be further illustrated by reference to the following example:

The system illustrated in the drawing is charged with an amount of a mixture of diphenyl and diphenyl oxide, sufficient to reach into the expansion chamber when the contents of the system are raised to the operating temperature. Since the expansion chamber is the highest point in the system, when the liquid level of the system reaches this chamber, the liquid forms a complete loop from the boiler, through the riser, the heat exchange unit, and the return tube. Heat is applied by means of the heating unit 1 to the boiler so as to cause the heating liquid, composed of 26.5% diphenyl and 73.5% diphenyloxyde, contained therein to boil. The pressure on the system is adjusted to zero pounds gauge. As the liquid boils in the boiler, bubbles of vapor 11 rise in the liquid and ascend into the riser tube of the heating system. As soon as this riser contains vapor bubbles as well as liquid, the hydrostatic head A in the riser tube 9 is less than that of the hydrostatic head A in the return tube 8. This difference in hydrostatic heads results in a forced circulation of the heating fluid throughout the heating apparatus. As the bubbles of the vapor enter the heat exchange unit, they are condensed into liquid which is then returned to the boiler. The forced circulation of the heating fluid continues so long as any vapor is being produced in the boiler. Operating in this fashion, the heat exchange unit 3 can be maintained constantly and easily at a temperature of 258° C. In another case, the temperature of the unit 3 is maintained at a temperature of 279° C. by adjusting pressure on the system to 18 pounds per square inch gauge. In still another case, the temperature of the unit 3 is maintained at a temperature of 121° C. by adjusting the pressure to 29.5 inches of vacuum.

Since this system combines the virtues of both vapor heat and liquid circulation, temperature control may be effected by either thermostatic or manostatic control. In addition, since the

invention employs a completely closed system with no moving parts and valves or packing glands in the circulation lines, heat losses by the system of this invention are small in comparison with mechanical circulation systems. Furthermore, the heating system is capable of much greater output and efficiency than convection or mechanical circulation liquid heating systems. Since the system is completely closed, no heating fluid can escape. Decomposition products do not interfere with the operation of the system, since they collect in the expansion chamber, from which they may be removed at infrequent intervals. The process and apparatus of this invention, therefore, provide a very efficient, easily operated method for heating which is free of adverse mechanical difficulties and offers the advantages of operating at high degrees of efficiency and heat output, close regulation of temperature, high rate of heat transmission, and minimum danger of localized overheating.

The heating system of this invention possesses extreme utility in melting such materials as the synthetic linear polymers, especially polyamides which melt at relatively high temperatures and within a relatively narrow temperature range, but which must not be overheated because of the ease with which they decompose when heated slightly above their melting point. Such polymers are disclosed in U. S. P. 2,130,948 and their extrusion in U. S. P. 2,295,942. Furthermore, this heating system is very useful for furnishing the heat necessary to operate chemical reaction vessels.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

I claim:

1. A heating apparatus comprising a boiler, a heat exchange unit disposed above said boiler comprising a coiled tube, a riser connecting the top of said boiler and the bottom of the coiled tube; an expansion chamber having an expansion zone above said unit and connected to the top of said coiled tube and a return line connecting the top of the coiled tube and the boiler, said chamber being partly filled with a stable, inert, high boiling liquid so that the entire system below the chamber is filled with said liquid at operating temperatures.

2. A system for liquefying plastic materials comprising a boiler, a heat exchange unit consisting of a melting unit for plastic materials comprising a charging vessel having a coiled tube in intimate heat exchange relationship therewith, a riser connecting said boiler and the bottom of said coiled tube, an expansion chamber having an expansion zone above said unit and a return line connecting the upper part of the coiled tube and the chamber with the boiler, said chamber being partly filled with a stable, inert, high boiling liquid so that the remainder of the entire system is filled with said liquid at operating temperatures.

3. A system for melting filament-forming polyamides comprising a boiler, a heat exchange unit consisting of a funnel-shaped charging vessel and a tube of small dimension coiled in a helix of low pitch on the inner wall of said vessel, a riser connecting the upper portions of said boiler and the lower end of said tube, an expansion chamber having a vapor dome disposed above said vessel, a return line connecting the upper end of said

tube and the bottom part of said boiler, the lower end of said chamber being connected to said return line at the highest point of said line, the chamber being partly filled with a stable, inert, high boiling liquid so that the remainder of the entire system, except said vapor dome, is filled with said liquid at operating temperatures.

4. A system as set forth in claim 3 wherein the vapor dome is provided with means for bleeding-off decomposition vapor products and for placing said system under superatmospheric pressure.

5. A heating apparatus comprising a boiler, a heat exchange unit disposed above said boiler, a riser connecting the top of said boiler and the bottom of said heat exchange unit, an expansion chamber connected to the top of said unit having an expansion dome, and a return line connecting said unit and chamber with said boiler, said chamber being disposed above said unit and partly filled with a high boiling liquid so that the remainder of the entire system is filled with said liquid at operating temperatures.

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