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TEMPERATURE CONTROL IN LIQUID PHASE

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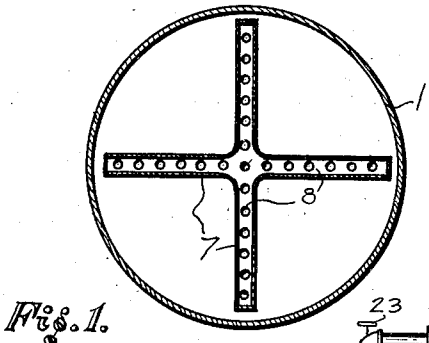


Fig. 1.

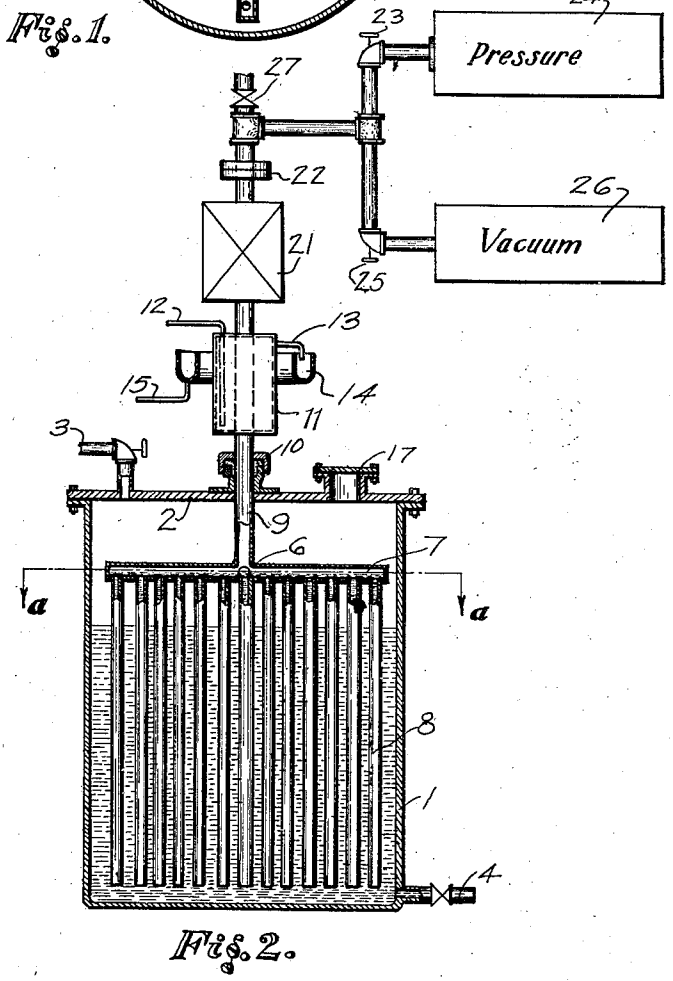


Fig. 2.

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TEMPERATURE CONTROL IN LIQUID PHASE

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This invention relates to a process and apparatus for controlling the temperature in exothermic chemical reactions, in which at least one of the reacting materials is in the liquid phase. It relates more specifically to a prompt and efficient removal of the heat evolved, thus eliminating the likelihood of an abnormal increase in temperature that might interfere with the proper carrying out of the desired reaction. At the same time this invention enables the user to obtain a thorough mixing of the reacting materials, thus causing a greater uniformity of temperature throughout the reacting mass and insuring that the reacting materials come into intimate contact with each other. It is particularly applicable to reactions whose exothermic character combined with a relatively high viscosity of the reacting mass makes temperature control throughout a large charge extremely difficult. Cooling liquids have been circulated through the jackets or coils of apparatus used for such reactions, but where the reaction pot has a relatively great diameter, temperature control in parts remote from the cooling surfaces of the pot is not attained with any degree of accuracy, nor are temperatures throughout the charge equal. By the present invention such difficulties are obviated in that the cooling system continuously changes position and circulates through the reacting mass. Moreover, the temperature of the reacting charge is controlled uniformly at the desired point by removing heat therefrom as latent heat of vaporization of a liquid contained in the cooling system, and at the same time regulating its boiling point by the application of the proper pressure. In this way an increase in the heat developed will cause an increase in the ebullition of the cooling liquid without changing its temperature, thereby providing a positive control of temperature or heat removal in accordance with the amount of heat evolved by the chemical reaction. At any time during reaction of this type, should the heat evolution become so great that the cooling system operating under a certain pressure fails to remove heat sufficiently rapidly, an instantaneous increase in the quantity of heat removal may be brought about by reducing the pressure. Likewise should the heat removed be greater than desired, it may be immediately stopped by increasing the pressure. From this description it is clear that the temperature of the reacting charge can be kept substantially constant and uniform by a regulating means of very simple construction and manipulation.

The invention will be understood from the description in connection with the drawings, in which

Fig. 1 is a section along the line *a—a* of Fig. 2; and Fig. 2 is a side view of the apparatus partly in section.

In the drawings reference character 1 indicates a tank for the reaction material. This tank is provided with a cover 2 having a valved inlet pipe 3 and also a valved outlet pipe 4. A multiple connector 6, provided with as many tubes or branches 7 as desirable, is disposed in the tank 2 and has a series of parallel pipes or tubes 8 depending from the tubes or branches 7, the pipes 8 being closed at their lower ends and opening at their upper ends into the tubes 7. A riser pipe 9 extends from the connector 6 through a stuffing-box 10 and the cover 2 of the tank 1. This pipe is surrounded for a portion of its length outside the tank with a jacket 11 through which a cooling fluid, such as water, may be circulated by passing the same thereinto through the inlet pipe 12, which reaches near the bottom of the jacket 11, the cooling fluid passing out through the overflow pipe 13 whose end is turned downwardly and extends into the trough 14, from which an outlet pipe 15 leads.

The riser pipe 9 which also functions as the driving shaft of the cooling system is

supported and held in alignment by brackets of common design not shown, and is rotated by a motor 21 or other suitable rotating means. The riser pipe 9 terminates in a stuffing-box 22, the upper or stationary side of which may be connected by means of the valve 23 to a pressure tank 24 or by means of a valve 25 to an evacuated tank 26 or by a valve 27 to the atmosphere. By adjusting the relative degree of opening of valves 23 and 25 any desired pressure may be exerted upon the cooling system at will. If the temperature of the liquid boiling at atmospheric pressure is proper for controlling the charge, it will be more economical to vent the system through valve 27. Thus any absolute pressure is available, thereby regulating the boiling point at which the liquid in the tubes 8 will boil.

The operation is as follows:

The reaction material, which may for example be two or more liquids that react when they come into contact with each other, is introduced into the tank 1 through the inlet pipe 3 and, if it is necessary to raise the temperature of the same to initiate or better promote the reaction, the tank 1 may be heated externally in any convenient manner. The operation of the motor 21 causes the tubes 8 to be turned, thereby stirring the material and circulating the cooling system throughout the charge. The heat evolved at the start of the reaction is absorbed by the liquid in the tubes 8, thus raising its temperature to the ebullition point, the latent heat of vaporization of the liquid from then on absorbs the heat of reaction, and by adjusting the pressure upon the boiling liquid in the cooling system the desired temperature may be maintained uniformly throughout the reacting charge until the reaction is finished. The vapors rising through the connector 6 and riser pipe 9 are condensed by the cooling fluid circulating through the jacket 11, and the liquid flows back into the tubes 8, thereby automatically replenishing the liquid in the cooling system.

The lower ends of the tubes 8 may be joined together by pipes, if necessary, to insure the same level of liquid in all the tubes 8. However, if the cooling liquid completely fills the tubes 8 as shown in Fig. 1, such bottom connecting pipes are unnecessary. Instead of introducing two or more reacting liquids into the tank 1, one of the materials may be in solid form and the other in liquid form, or the reacting materials may be of such a nature that they will not react upon each other until they come into contact with a catalyst, which catalyst may be placed inside the tank 1 and the reacting materials thereafter introduced. A flanged outlet is shown at 17 by which the tank may be vented, through which solid material may be charged or gases introduced. If the reaction is to be between a liquid and a gas, it is generally considered more advantageous to introduce the gas into the liquid and this may be accomplished through valve 4.

The tubes 8, connector 6, etc., will, of course, be made of such materials that the reacting liquids or vapors will not seriously corrode the same. The sort of liquid inside the tubes 8 that is used for cooling purposes will depend upon the particular temperature that is to be maintained. For example, water may be used if somewhat low temperatures are to be maintained, while liquids, such as mercury for example, may be used if higher temperatures are to be permitted. Whatever liquid is used to control the temperature, its temperature at its boiling point may be widely altered from its boiling point at normal pressures by the application of pressures above or below atmospheric. By the use of only the two liquids mentioned above among a large number of liquids which are applicable for this purpose, a wide range of temperatures is available for various reactions.

I claim:—

1. The process of controlling temperatures in exothermic chemical reactions in the liquid phase including the restraining of temperature increase in the liquid by removing the heat of reaction as latent heat of vaporization of a second liquid which comprises, distributing said second liquid in a suitable container throughout the body of reacting liquid, and moving said container in said body of liquid.

2. The process of controlling temperatures in exothermic chemical reactions in the liquid phase including the restraining of temperature increase in the liquid by removing the heat of reaction as latent heat of vaporization of a second liquid which comprises, distributing said second liquid in a suitable container throughout the body of reacting liquid, regulating the pressure on said second liquid, condensing the vapors of said liquid, and returning the condensate to said container.

3. An apparatus for carrying on exothermic chemical reactions comprising a tank for containing the reacting material, a tube nest comprising a plurality of vertical tubes within said tank for containing a liquid which boils at approximately the temperature of the reaction, said tubes being joined together at the top by means of a header, a pressure regulating device, means for connecting said device with said header so as to regulate the boiling temperature of the liquid, means for rotating said tube nest in said tank, and means for condensing the vaporized liquid and returning the condensate to said tube nest.

4. An apparatus for carrying on exothermic chemical reactions comprising a tank for containing the reacting material, a tube nest comprising a plurality of vertical tubes with-

in said tank for containing a liquid which boils at approximately the temperature of the reaction, said tubes being closed at the bottom and joined together at the top by means of a header, a pressure regulating device, means for connecting said device with said header so as to regulate the boiling temperature of the liquid, means for rotating said tube nest in said tank, and means for condensing the vaporized liquid and returning the condensate to said tube nest.

In testimony whereof I affix my signature.

CHARLES R. DOWNS.