Dec. 11, 1951 J. MAIR 2,578,192

METHOD OF SEPARATING WAX FROM LIQUIDS

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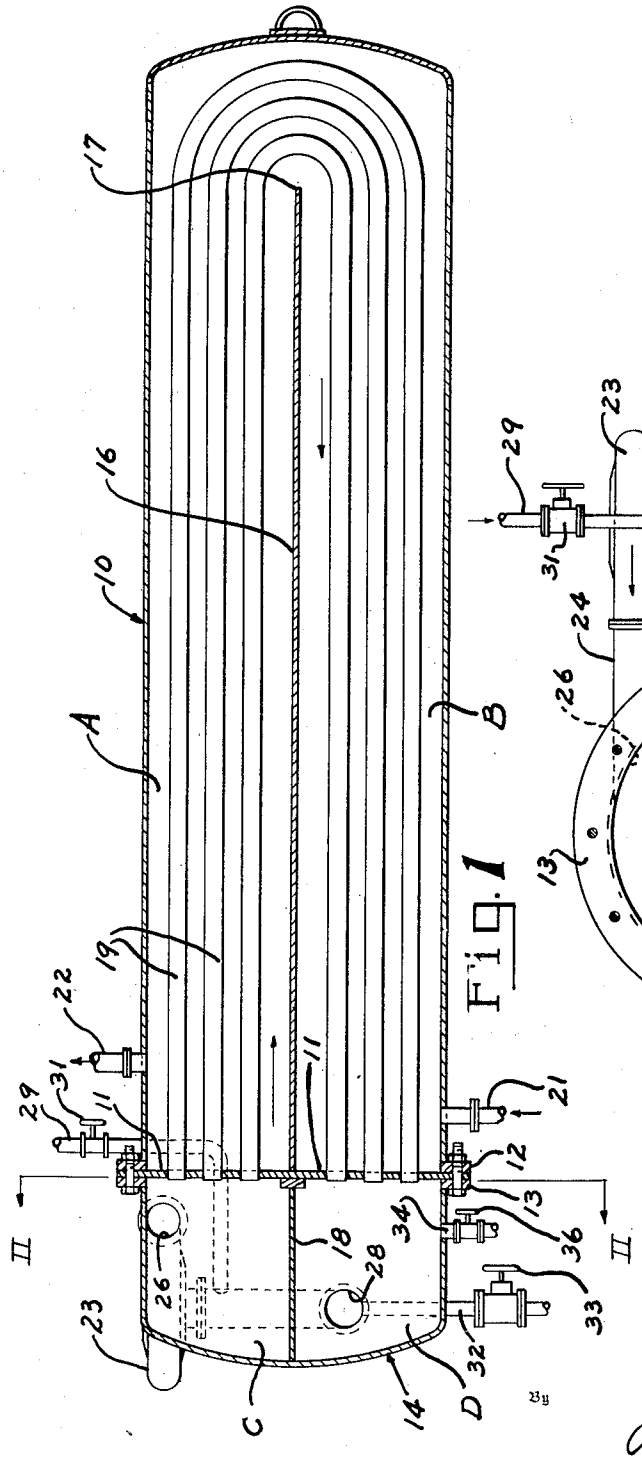


Fig. 1

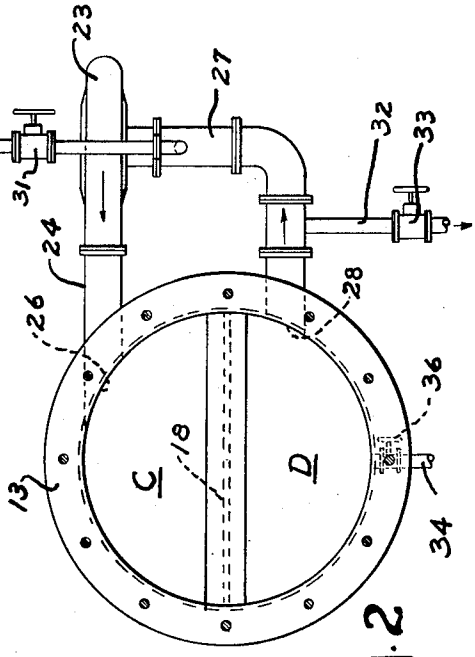


Fig. 2

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METHOD OF SEPARATING WAX FROM LIQUIDS

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My present invention relates to a method of separating wax from liquid solutions in which the wax is dissolved in a solvent and more particularly to chilling wax bearing petroleum oils preparatory to removing the wax by subsequent treatment, and has for an object the provision of a method wherein the wax crystallized out of the solution during chilling does not interfere with the thermal efficiency of the process, thereby to maintain a high coefficient of heat transfer between the solution and coolant.

Heretofore in the art to which my invention relates, the method generally used to chill wax bearing petroleum oils and the like prior to dewaxing has consisted in passing a solution of the waxy oil and a suitable solvent for the wax through a series of inclined tubes. Coolant was circulated through a jacket surrounding these tubes while the mixture was being passed through the tubes at low velocities, usually of the order of two to four feet per second. It has been found that the wax which crystallizes out of such a solution when chilled adheres to the sides of the tubes, when moving at such a velocity, with the result that the thermal efficiency of such process is exceedingly low. For instance, in one such method with which I am familiar, the coefficient of heat transfer (U) is in the neighborhood of only 20 to 30 B. t. u. per square foot per hour per degree Fahrenheit. As stated, this low efficiency is due primarily to the fact that the wax accumulates in the tubes effectively insulating the walls thereof. Efforts have been made to keep the tubes free of wax deposits by the provision of continuously operating mechanical scrapers disposed in each tube. Apparatus of this kind for carrying out prior chilling processes is expensive and complicated, and the low thermal efficiency thereof has resulted in high operating costs.

In seeking to overcome the above mentioned difficulties, I have discovered that if a solution of waxy liquid and solvent for the wax be moved through tubes or pipes at a velocity above the streamline velocity of the particular solution, the solution may be chilled without the crystallized wax adhering to the tubes. Accordingly, it is the prime object of my invention to provide a method of chilling waxy solutions in which the solution is caused to flow through a suitable chilling apparatus at a rate of speed above the critical for the given solution, whereby wax crystallized out due to chilling is prevented from accumulating in the apparatus, thus maintaining the thermal efficiency of the process at a high level, permitting the use of simplified apparatus, and hence

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reducing substantially the cost of the chilling operation.

A suitable form of apparatus for carrying out my improved process is illustrated in the accompanying drawings forming a part of this application, in which:—

Fig. 1 is a longitudinal sectional view through a chiller; and,

Fig. 2 is a sectional view thereof taken along lines II—II of Fig. 1.

Referring now to the drawing, I show a chiller embodying an elongated cylindrical tank 10 having a tube sheet 11 at one end. The tube sheet is secured between a flange 12 carried on the end of the tank 10 and between a similar flange 13 carried on the upper end of a cylindrical head 14. The head forms a closure for the end of the tank 10 outwardly of the tube sheet 11.

Disposed axially within the tank 10 is an elongated baffle 16. The baffle is secured by welding to the tube sheet 11 and may be supported along its edges adjacent the side walls of the tank 10 by suitable means. As shown in Fig. 1, the baffle stops short of the end of the tank opposite the tube sheet as indicated at 17, thereby dividing the tank 10 into a pair of compartments A and B, in communication over the end of the baffle. A baffle 18, disposed in alignment with the baffle 16 divides the head 14 into separate compartments C and D.

Secured to the tube sheet 11 are the open ends of a plurality of parallel tubes 19. The tubes 19 preferably are of equal and uniform cross-sectional area as shown in Fig. 1 of the drawing. As shown, the tubes are bent over and around the end of the baffle 16 whereby one half of the length of each tube lies within the compartment A and the other half thereof lies in the compartment B. The ends of the tubes communicate with the compartments C and D of the head 14. Liquid from the compartment C may thus be pumped through the tubes into compartment D in the manner to be explained. A suitable conduit 21 is provided in the tank 10 for the admission of coolant, and a like conduit 22 provides a discharge for the same.

Adjacent the head 14 is a pump 23. The outlet conduit 24 from the pump is connected into the compartment C of the head through an opening 26. The intake conduit 27 of the pump 23 is connected through an opening 28 to the compartment D of the head 14. Liquid to be cooled is admitted through a conduit 29, under control of a valve 31, to the intake side of the pump and preferably immediately adjacent the pump. After

being chilled in the tubes 19, the material being treated is taken out of the system through a conduit 32 in the intake conduit 27, under control of a valve 33. In the lower part of the compartment D, I provide a conduit 34 under control of a valve 36. The purpose of this conduit and valve is to permit the compartment D to be drained when necessary.

From the foregoing my improved method of chilling a wax bearing solution may be readily explained and understood. A solution of waxy oil or the like and a suitable solvent to be chilled is admitted to the system through the conduit 29 until the compartments on both sides of the head 14 and the tubes are filled. A suitable coolant from a suitable source, not shown, is circulated through the compartments A and B of the tank by means of the conduits 21 and 22. The pump 23 is started and run at such a speed as to cause the solution to flow in the direction of the arrows from compartment C through the tubes 19 to compartment D at a speed above the streamline velocity of the particular solution being chilled. While this speed may vary with the particular substance, when chilling the average wax bearing petroleum product mixed with the usual solvent for the wax, it will be in the neighborhood of 8 to 18 feet per second. It will be apparent that the flow in the tubes 19 at such velocity is turbulent. It will be apparent that high velocity flow in the tubes prevents the inner sides thereof from becoming coated with wax, which as is well known, comes out of the solution in the form of crystals. The chilled product discharged through the conduit 32 is actually in the form of a slurry of wax crystals in an oil-solvent solution.

While the temperature at which the chilled material is taken from the system may vary within wide limits, it has been found that the usual waxy petroleum oils should be chilled to less than zero F. before sending the slurry to filters for removal of the wax. It will be apparent that at temperatures in this range my improved method is highly effective in preventing the deposition of wax on the tubes of the apparatus, and that the heat transfer coefficients of the process are high. Instead of a value of U equal to around 30, my method raises this coefficient to around 200.

The internal diameter of the tubes 19 of the chiller may vary as may the velocity of the material through them. However, in constructing such apparatus for treating given solutions or mixtures and in selecting the pump therefor, I maintain a Reynolds number in the range of turbulent flow.

From the foregoing it will be apparent that I have devised an improved method for chilling wax bearing mixtures in which the apparatus required therefor is extremely simple and inexpensive. It will be noted that the movement of the material being treated and the coolant are counter to each other, whereby the material drawn off through the conduit 32 is taken from the coldest point in the system. It will be understood that valves 31 and 33 may be regulated so that a continuous rate of replacement and withdrawal of the material being chilled may be maintained. Or, if desired, the process is equally effective in chilling a batch of material and may be operated intermittently. In either instance, I preferably employ a pump having sufficient capacity to cause material being chilled to make several passes through the tubes prior to being withdrawn. This assures even and adequate cooling of all the material in its passage through the chiller. It is to be noted that I am enabled to use a chiller embodying a plurality of tubes of relatively small diameter, and that the tubes may be placed parallel to each other. My improved method therefore permits the use of compact apparatus resulting in a saving of space and material.

The particular solvent to be employed with a given wax bearing liquid will vary among various products which may be chilled by my improved method. However, the ones commonly used when chilling waxy petroleum oils are methyl ethyl ketone or benzol, although others may suggest themselves to those skilled in the art.

While I have described my improved method in but one form and have specifically mentioned that it is especially adapted for chilling waxy petroleum oils, it will be apparent to those skilled in the art that it is not so limited, but that a variety of materials may be effectively dewaxed in the manner disclosed, and I desire, therefore, that only such limitations shall be imposed thereon as are specifically set forth in the appended claims.

What I claim is:

1. The method of treating a wax bearing solution which comprises moving the solution through a closed circuit of uniform cross-sectional area at a velocity above the streamline velocity thereof, and chilling the solution to the temperature of crystallization of the wax while moving at said velocity.

2. The method of treating a wax bearing liquid solution which comprises moving the solution a plurality of times through a closed circuit of substantially uniform cross section at a velocity above the streamline velocity of the solution, and chilling the solution while in said closed circuit and at said velocity to a temperature below the temperature of crystallization of the wax.

3. The method of treating wax bearing petroleum oil which comprises passing a solution of oil and solvent for the wax simultaneously in separate streams through a plurality of closed circuits at a substantially constant velocity above the critical velocity of said solution, and chilling the solution to the temperature of crystallization while at said velocity in said closed circuits.

4. The method of treating wax bearing oil which comprises mixing with the oil a solvent for the wax therein, passing the solution through a closed circuit and in a confined path at a substantially constant velocity of from 8 to 18 feet per second, and chilling the solution while moving at said velocity to a temperature at which said wax crystallizes out of the solution by completely surrounding the confined path with a cooling medium.

5. The method of treating a solution of wax bearing petroleum oil and solvent for the wax which comprises passing the solution through a closed circuit at a substantially constant velocity of from 8 to 18 feet per second, completely surrounding said circuit with a coolant and circulating the coolant in an opposite direction to the flow of said solution, and chilling said solution to a temperature at which said wax crystallizes out of the solution while moving the same at said velocity in the closed circuit.

6. The method of treating a solution of waxy oils and solvent for the wax which comprises passing the solution at substantially constant velocity through a closed circuit under conditions

wherein the Reynolds criterion is in excess of 2,000 and while in heat transfer relation to a coolant completely surrounding said closed circuit and having a temperature sufficiently low to cause crystallization of the wax.

7. The method of treating a wax bearing solution which comprises circulating said wax bearing solution having mixed therewith a solvent for the wax through a uniform confined path in a closed circuit at a velocity above the streamline velocity thereof, chilling the solution to the temperature at which said wax crystallizes out of the solution, removing a portion of the chilled product from one point in the circuit and simultaneously adding substantially an equal amount of the unchilled wax bearing solution and solvent to the closed circuit at another point.

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