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REFRIGERATING MACHINE OF THE COMBINED
COMPRESSION-ABSORPTION TYPE

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Fig. 2

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2 Sheets-Sheet 2
It is known to combine in one refrigerating machine the compression method and the absorption method, also called affinity method, and to produce an oversaturated solution of the cooling fluid by causing the latter to be absorbed by the liquid solvent under a pressure exceeding that of the evaporator.

According to this invention, the absorber is only in part under a super pressure and compressing is achieved between an absorber part in which no pressure obtains and another part which is under a super pressure, using conveniently therefor a compressor for the gases and a pump for forcing the solution.

There may be advantageously provided a vessel in which the gaseous and liquid portions may be separated from each other.

Following absorption, the solution is directed, as usual into the boiler, or still in order to cause the evolution of the dissolved gas. This evolution is effected in two steps, the liquid being partially weakened in a first boiler and passing, then, into a second boiler, heated at higher temperature.

Preferably:
(a) The boilers, or stills consist of double walled tubes with external heating;
(b) The cooling and heating fluids flow in opposite directions in said tubes;
(c) The cooling fluid enters said tubes at the lower part thereof;
(d) To the vapour which has been used to heat the relatively high temperature boiler are added exhaust gases of an engine the counter pressure of which may be controlled by or in accordance with the temperature desired in the relatively low temperature boiler;
(e) The gas evolved in the high temperature boiler is introduced into the other boiler;
(f) The gas produced in both boilers is led into one or several rectifiers;
(g) The mist evolved in the rectifier or rectifiers are returned into the low temperature boiler;
(h) The mixture leaving the absorber is forced by a pump into a rectifier;
(i) The oversaturated liquid leaving a rectifier is led into a heat interchanger, or exchanger, before being introduced into the low temperature boiler;
(j) The weakened liquid leaving the high temperature boiler is led into said interchanger before being sent into the absorber.

A refrigerating machine designed in accordance with the invention is shown as an illustrating example on the accompanying drawings in which:

Fig. 1 is a diagrammatic flow view of a first embodiment,

Fig. 2 is a similar view of a modification.

The refrigerating machine shown in Fig. 1 comprises two boilers, or stills, 2, 4, the former being at a lower temperature than the latter; two rectifiers 3, 5, the first of which, of the plate type, is arranged in the upper part of the still 2; two condensers, 7, 8, separated from each other by an accumulator 6; an evaporator 10; two absorbers 11, 15 respectively at low and high pressure; a receiver 12 connected with the outlet of absorbers 11; a pump 13 and a compressor 14, both arranged in parallel pipes connected with outlets of receiver 12 and respectively adapted to force the liquid into the absorber 15 and to compress the gas; a pump 19, connected with the outlet of absorber 15, for forcing the liquid into the rectifier 6; an interchanger 17, heated by the weakened liquid from still 4, for heating, in turn, the strengthened liquid from the rectifier 6; and two sets of coils 5 and 1 respectively arranged in the stills 4 and 2, the former 5 being fed with vapour entering at 48 and the latter 1 being fed with a mixture of said vapour from coil 5 and exhaust gases entering at 44, the mixture being effected at 46. Besides, the machine comprises a number of connecting pipes 20 to 25, 27 to 32 and 34 to 42, the purpose of which is given hereafter. Cocks 25, 33 and 43 are provided for controlling the rate of flow in the corresponding connecting pipes.

The operation is as follows:

When starting, the stills 2 and 4 are under pressure of 11 kgs. (per square centimeter) and contain an oversaturated ammonia solution, for instance 560 kgs. of gas ammonia and 480 kgs. of water. The still 2 is heated by exhaust vapours at a temperature of 90° C. and by the vapour flowing from the coils 5, whereas the still 4 is heated by steam under such a high pressure that the temperature of the ammonia solution is brought to 140° C. By being heated at 90° C. in the still 2, under a pressure of 11 kgs., the solution gives up 258 kgs. of gas ammonia. In proportion as it becomes weaker, said solution passes by the pipe 20 into the still 4, in which it is heated to 140° C. under the same pressure, i.e., 11 kgs., and in which it further gives up 177 kgs. of gas ammonia. The latter flows by way of pipe 20 into the still 2, in which its temperature is brought back to 90° C. Mixing of gas ammonia from the stills 2 and 4 causes a first rectification,
and a second rectification is then caused by the mixture flowing in the rectifier on whose plates descends the mist flowing from the rectifier 6 through pipe 42 and the rich solution, the so-called "strong aqua" conveyed to said rectifier 3 by way of the pipe 41. The gas flows through pipe 21 into the rectifier 6 in which the drying thereof is completed. The gas thus dried flows into the condenser 11 in which it is liquified. The liquid ammonia passes by way of the pipe 23 into the accumulator 8, from which it flows through pipe 25 into the subcooler 9, and then through pipe 26, into the evaporator 10, in which it volatilizes, giving up calories. The cool ammonia gas thus formed escapes by way of pipe 27 and enters the cooler 9, in which the liquid ammonia is cooled thereby. The cooled ammonia gas discharged from the cooler 9 is led by the pipe 28 into the low pressure absorber 11, in which it is absorbed by the "weak aqua" introduced therein by way of pipe 29 from the still 4 after passing through the interchanger 17. Since the absorption in 11 is not complete, the mixture of liquid and gas passes through the pipe 29 into the receiver 12 in which the gas and the liquid are separated from each other. The partially concentrated ammonia solution is sucked into pipe 30 by pump 15, while the ammonia gas flows through pipe 31 into compressor 14, which delivers it under pressure, by way of pipe 32, into the high pressure absorber 15, joining therein the partially strengthened ammonia solution driven into pipe 37 by pump 13. In said absorber 15 dissolving of said ammonia gas in said solution is completed. The enriched solution, or "strong aqua," is then sucked into pipe 38 by pump 15, which forces it through pipe 39 into the tubes of rectifier 6. Said strong aqua cools the gas from the still 2 flowing outside of said tubes and passes then through pipe 40 into the tubes of heat exchanger 17, in which it is reheated by the weak aqua flowing from pipe 31 into the space outside of said tubes. The partially reheated strong aqua issuing from the tubes of exchanger 17 flows through pipe 41 into the top part of rectifier 6, and the cycle is repeated.

It will be noted that the still 2 may be heated to the temperature of 100° C. or 110° C., for example, in order to reduce the amount of gas to be produced in still 2, by simply increasing the vapour pressure.

Obviously, the present invention is not limited to the described example. Thus, for example:

(a) The stills 2 and 4 may be replaced by a single still or boiler, though this has the drawback of causing sometimes a turbulent boiling.

(b) Said stills 2 and 4 may also be designed in the manner shown in Fig. 2, in which the members similar or corresponding to those of Fig. 1 are designated by the same numbers. As shown in Fig. 2, the boilers 2 and 4 consist of double walled tubes 1 and 5. The vapour entering at 46 flows into the outer wall or annular space of tubes 5, is then conveyed by means of pipe 47, under the control of a cock 43, to the point 48, where it will eventually mix with exhaust gases from pipe 44; this heating fluid flows in the annular space of tubes 1 and escapes through pipe 45. The strong aqua is admitted by a pipe 10 into the lower part of the inner wall of tubes 1 and flows upwardly in said tubes to be progressively heated therein, the mixture of liquid and gases passing through a pipe 102 into a separator 101, from which the gases escape through the plate rectifier 3. The liquid being partially freed from the gases is led through pipe 30 into the lower part of the inner wall of tubes 5, in which it is submitted to the progressing heating action of the vapour; said liquid is thus progressively weakened, and the mixture of liquid and gases passes through a pipe 402 into the separator 401, the gases entering the rectifier 3 through pipe 26, whereas the weakened liquid is led by pipe 31 into the plate rectifier 11.

(c) There may also be provided between the receiver 12 and the compressor 14 a rotary or paddle pre-compressor, preferably of the multi-cellular type, whose suction side will thus be connected with the evaporator 10 and whose delivery side will be connected with the suction side of compressor 14. This permits of increasing the output of the described plant.

We claim:

1. A refrigerating machine of the combined compression-absorption type comprising means for heating a mixture of a liquid solvent and cooling fluid, means for separating said solvent and fluid, an evaporator, a first absorber having a pressure therein at most approximately equal to that in said evaporator, a second absorber having a pressure therein higher than that in said evaporator, means for separating said fluid undissolved in said first absorber from the mixture of dissolved fluid and solvent, means for forcing said undissolved fluid and said mixture of dissolved fluid and solvent into said second absorber, said means for separating said undissolved fluid from said mixture of dissolved fluid and solvent being a receiving vessel and said means for forcing said undissolved fluid and said mixture of dissolved fluid and solvent being located between said vessel and said second absorber.

2. A refrigerating machine of the combined compression-absorption type comprising means for heating a mixture of a liquid solvent and cooling fluid, means for separating said solvent and fluid, an evaporator, a first absorber having a pressure therein at most approximately equal to that in said evaporator, a second absorber having a pressure therein higher than that in said evaporator, means for separating said fluid undissolved in said first absorber from the mixture of dissolved fluid and solvent, means for forcing said undissolved fluid and said mixture of dissolved fluid and solvent into said second absorber, said forcing means including a compressor for the undissolved fluid and a pump for the dissolved fluid and solvent.

3. A refrigerating machine of the combined compression-absorption type comprising means for heating a mixture of a liquid solvent and cooling fluid, means for separating said solvent and fluid, an evaporator, a first absorber having a pressure therein at most approximately equal to that in said evaporator, a second absorber having a pressure therein higher than that in said evaporator, means for separating said fluid undissolved in said first absorber from the mixture of dissolved fluid and solvent, means for forcing said undissolved fluid and said mixture of dissolved fluid and solvent into said second absorber, said forcing means including a pre-compressor and a compressor for said undissolved fluid and a pump for said dissolved fluid and solvent.

4. A refrigerating machine of the combined compression-absorption type comprising means for heating a mixture of a liquid solvent and...
cooling fluid, means for separating said solvent and fluid, an evaporator, a first absorber having a pressure therein at most approximately equal to that in said evaporator, a second absorber having a pressure therein higher than that in said evaporator, means for separating said fluid undissolved in said first absorber from the mixture of dissolved fluid and solvent, means for forcing said undissolved fluid and said mixture of dissolved fluid and solvent into said second absorber, said heating means comprising a first boiler to which is conveyed the mixture from said second absorber and a second boiler having a temperature higher than said first boiler and means for conveying the liquid portion of the mixture from said first boiler to said second boiler.

5. A refrigerating machine of the combined compression-absorption type comprising means for heating a mixture of liquid solvent and cooling fluid, an evaporator, a first absorber having a pressure therein at most approximately equal to that in said evaporator, a second absorber having a pressure therein higher than that in said evaporator, means for separating said fluid undissolved in said first absorber from the mixture of dissolved fluid and solvent, means for forcing said undissolved fluid and said mixture of dissolved fluid and solvent into said second absorber, said heating means comprising a first boiler to which is conveyed the mixture from said second absorber and a second boiler having a temperature higher than said first boiler and means for conveying the liquid portion of the mixture from said first boiler to said second boiler, said boilers being constructed of double walled tubes and the mixture in the inner portion of said tubes flows countercurrent to the flow of heating fluid in the annular portion of said tubes.

6. A refrigerating machine of the combined compression-absorption type comprising means for heating a mixture of a liquid solvent and cooling fluid, means for separating said solvent and fluid, an evaporator, a first absorber having a pressure therein at most approximately equal to that in said evaporator, a second absorber having a pressure therein higher than that in said evaporator, means for separating said fluid undissolved in said first absorber from the mixture of dissolved fluid and solvent, means for forcing said undissolved fluid and said mixture of dissolved fluid and solvent into said second absorber, said heating means comprising a first boiler to which is conveyed the mixture from said second absorber and a second boiler having a temperature higher than said first boiler and means for conveying the liquid portion of the mixture from said first boiler to said second boiler, said boilers being constructed of double walled tubes and the mixture in the inner portion of said tubes flows countercurrent to the flow of heating fluid in the annular portion of said tubes.

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