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PURGING ARRANGEMENT FOR ABSORPTION REFRIGERATION SYSTEMS

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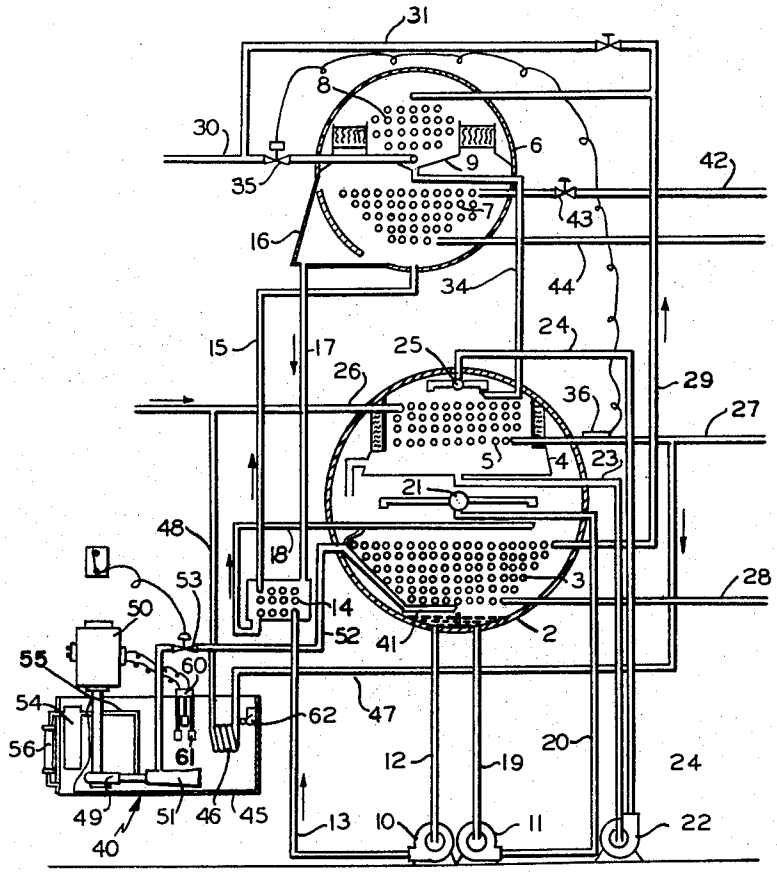

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PURGING ARRANGEMENT FOR ABSORPTION REFRIGERATION SYSTEMS

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This invention relates to a purging arrangement for an absorption refrigeration system and, more particularly, to a purging arrangement including expendable control elements for withdrawing non-condensable gases from the refrigeration system without substantial loss of refrigerant or absorbent in the system.

In Leonard application, Serial No. 565,324, filed February 14, 1956, entitled Purging Arrangement for Absorption Refrigeration Systems, there is disclosed a purge arrangement for an absorption refrigeration system which includes a container, a pump, and an ejector in the container. The ejector is connected to the absorber of the refrigeration system. The pump forwards absorbent solution from the container to the ejector and discharges the solution into the container. The absorbent may comprise a solution of lithium bromide and water. Discharge of solution through the ejector induces non-condensable gases from the system through the absorber, the non-condensable gases being discharged from the container to ambient atmosphere. The non-condensable gases may carry a minor amount of refrigerant vapor which is absorbed by the solution in the container resulting in a gradual rise in the level of solution of the container. In addition, a small amount of strong solution may be supplied to the container from the refrigeration system to assure maintaining a desired absorbent concentration in the container.

It is necessary to return solution at various times from the container to the absorber to prevent the container from overflowing and to reconcentrate the solution in the container, and to reclaim refrigerant. Various control arrangements for this purpose have been proposed. The most satisfactory control arrangement devised includes a plurality of spaced probes extending within the container, connected to a control in the electrical circuit actuating the pump. An increase in volume of solution in the container completes an electrical circuit between the probes, thus actuating the control to discontinue operation of the pump thereby discontinuing withdrawal of non-condensable gases from the system and permitting atmospheric pressure to force solution in the container to pass to the absorber of the system.

A predetermined decrease in solution volume in the container breaks the circuit between the probes, permitting the control to actuate the pump thereby again withdrawing non-condensable gases from the absorber.

Frequently, a minor amount of octyl alcohol is added to the absorbent solution in the refrigeration system; the octyl alcohol serves as a wetting agent, assists in the absorption of water vapor by the lithium bromide solution and improves purging. The octyl alcohol, of course, mixes with the lithium bromide solution.

I have found in practice that the octyl alcohol is emulsified in the ejector of the purge arrangement and the emulsion tends to carry corrosion products such as iron oxides, copper oxide, copper complexes, etc., toward the top of the solution in the container. Since the level of solution in the container varies, the corrosion products

collect on the probes resulting in the probes becoming badly scaled and coated with a thick deposit of such corrosion products. This deposit reduces the conductivity of the probes since it serves as an insulator preventing the probes from functioning as conductors thus preventing operation of the control of the purge arrangement. The present invention solves this problem by the use of expandable probes which inherently present conductive surfaces throughout their lives.

The chief object of the present invention is to provide a purging arrangement for an absorption refrigeration system employing water as a refrigerant and lithium bromide and water solution as an absorbent which obviates the disadvantages inherent in prior purging arrangements.

An object of the invention is to provide a purging arrangement including expendable control elements which present conductive surfaces throughout their lives, thus assuring accurate control of the purging arrangement.

A further object is to provide a purging arrangement for an absorption refrigeration machine including a control arrangement for automatically removing non-condensable gases from the absorber of the refrigeration system and for returning absorbent solution to the absorber of the refrigeration system, the control arrangement including copper probes which retain conductivity throughout their lives. Other objects of the present invention will be readily perceived from the following description.

The present invention relates to a purging arrangement for an absorption refrigeration system designed to remove non-condensable gases from the system. The arrangement includes a container for an absorbent solution which may consist of a solution of lithium bromide and water. A pump is provided for circulating solution in the container. An ejector is connected to the pump. A line connects the ejector with the absorber of the system whereby discharge of solution through the ejector by the pump induces non-condensable gases from the absorber and forwards the non-condensable gases to the container for discharge to ambient atmosphere.

A motor is provided to actuate the pump. The motor is placed in an electrical circuit and control means are provided in the electrical circuit. The control means include a plurality of spaced expendable probes, such as copper probes, extending within the container. An increase in volume of solution in the container completes a circuit between the probes to discontinue operation of the pump permitting solution to be forced to flow to the absorber. A predetermined decrease in solution volume in the container again energizes the motor of the pump, thereby actuating the pump to withdraw non-condensable gases from the absorber.

The attached drawing in a diagrammatic view of an absorption refrigeration system including the purging arrangement of the present invention.

Referring to the attached drawing, there is illustrated the purging arrangement of the present invention employed in an absorption refrigeration system of the type disclosed in my copending application, Serial No. 580,052, filed April 23, 1956, and now Patent No. 2,918,807. The absorption refrigeration system comprises a shell 2 containing a plurality of tubes 3 which cooperate with the shell to form an absorber. Placed in shell 2 above absorber 3 is a pan-like member 4 and a coil 5 which cooperate with shell 2 to form an evaporator.

A second shell 6 preferably is placed above the first shell. Tubes 7 extend in the lower portion of shell 6 and cooperate with shell 6 to form a generator or boiler. A plurality of tubes 8 are placed in the upper portion of shell 6 and cooperate with a pan-like member 9 to form a condenser.

A double pump arrangement is provided to circulate

solution through the system. This arrangement includes pump 10 which serves to supply weak solution from the absorber to the generator and pump 11 which serves as an absorber pump. These pumps are driven by a suitable motor or motors (not shown).

Pump 10 withdraws weak solution from absorber 3 through line 12. Pump 10 forwards the weak solution through line 13, heat exchanger 14 and line 15 to generator 7. Strong solution flows from generator 7 through overflow arrangement 16, line 17, heat exchanger 14, and line 18 to absorber 3 by forces of gravity.

Strong solution may be sprayed in the absorber over the tubes 3 or, if desired, may be discharged against an interior wall of shell 2. It will be understood the strong and weak solutions are placed in heat exchange relation in heat exchanger 14.

Pump 11 is the absorber pump and is employed to withdraw a solution of intermediate concentration from absorber 3 through line 19, forwarding the recirculated solution through line 20 to spray arrangement 21 of the absorber. Spray arrangement 21 distributes the recirculated solution over the tubes throughout the length of the absorber 3. It will be understood the strong solution mixes to some extent with solution in the absorber and that further mixing occurs as pump 11 forwards the mixed solution so that a solution having a concentration intermediate the concentration of the strong and weak solutions is circulated. It is important that the strong solution be discharged in the absorber in a place where interference with the purging operation cannot occur.

Pump 22 is the evaporator pump and recirculates liquid refrigerant in the evaporator 4. Pump 22 withdraws liquid refrigerant from the evaporator through line 23 and returns the refrigerant to the evaporator through line 24, the liquid refrigerant being flash-cooled by discharge in the evaporator and being sprayed by nozzles 25 over the tubes 5 of the evaporator.

Medium to be cooled passes through the tubes of the evaporator in heat exchange relation with liquid refrigerant being sprayed thereover. The medium to be cooled is supplied to the tubes 5 through line 26 and leaves the evaporator through line 27 to a place of use such as the cooling coil of an air conditioning system, medium to be cooled, returning to the evaporator again through line 26.

Condensing water is supplied through line 28 to the tubes 3 of the absorber. The condensing water, after passage through tubes 3, passes through line 29 to the tubes 8 of the condenser. The condensing water after passage through the tubes 8 of the condenser is discharged to a cooling tower or drain through line 30. If desired, a bypass line 31 is provided about tubes 8 of the condenser, extending from line 29 to line 30.

Condensate leaves condenser 8 through line 34 and is returned to the evaporator being flash-cooled in the evaporator. The flashed vapor passes to the absorber, while the cooled refrigerant is discharged over the tubes of the evaporator in heat exchange relation with medium to be cooled. It will be appreciated that recirculated liquid refrigerant is also flash-cooled when discharged in the evaporator through nozzles 25.

The control arrangement for the absorption refrigeration system may be pneumatically or electrically actuated. The control arrangement employed may be the arrangement shown in Patent No. 2,722,805, issued November 8, 1955, entitled "Control Arrangement for Absorption Refrigeration Systems." Reference is made to such patent for a full description of a suitable control arrangement and the manner in which it operates. The control arrangement includes a valve 35 placed in line 30 which serves to regulate passage of condensing water through the tubes 8 of the condenser. Valve 35 is moved toward open or closed positions in response to the temperature of cooled medium, leaving the evaporator through line 27, such temperature being reflected by bulb 36 in contact with line 27.

The term "weak solution" is used herein to describe a solution weak in absorbing power. The term "strong solution" is used herein to define a solution strong in absorbing power.

A preferred absorbing solution is a solution of lithium bromide in water; the preferred refrigerant is water. With such solution, preferably, the solution concentration leaving the generator is 66%. A greater concentration may permit crystallization to occur causing solidification in the heat exchanger and, perhaps, in other portions of the system.

Steam is supplied to the tubes 7 of the generator through line 42. A pressure regulating valve 43 is placed in line 42 to assure desired steam pressure in the generator. Valve 43 assures that pressure of steam passing to the generator is controlled at a predetermined point. Steam condensate leaves the tubes 7 of the generator through line 44, a steam trap (not shown) being placed in line 44 to assure that only condensate leaves the generator.

The purging arrangement indicated generally at 40 removes non-condensable gases from the system. A purge line 41 extends generally longitudinally of the absorber below the tube bundle, preferably, at the center of the bundle.

Purge arrangement 40 includes a tank or container 45 adapted to contain a solution of absorbent and refrigerant similar to the absorbent and refrigerant used in the absorption refrigeration system. The solution employed in the purging arrangement comprises a solution of lithium bromide and water similar to the absorbent and refrigerant employed in the absorption refrigeration system with which the purging arrangement is employed. Other solutions of absorbent and refrigerant may be employed of course, depending upon the absorbent and refrigerant employed in the refrigeration system.

A cooling coil 46 is placed in the container and is connected to line 27 by line 47. The outlet of coil 46 is connected to line 26 by line 48; water after passing through coil 46 in heat exchange relation with absorption solution in container 45 is returned to the evaporator of the refrigeration system. Other sources of supply of cooling water may be employed if desired.

A pump 49 driven by motor 50 is connected to an ejector 51. Ejector 51 is connected through line 52 to purge line 41 of the absorber. A valve 53 is placed in line 52. Valve 53 may be operated manually or automatically and assures that line 52 is closed when the purging arrangement is not in operation. A filter arrangement 54 is connected to the discharge of pump 49 by a line 55. Filtered solution is passed through the sight glass 56, the filtered solution returning to container 45.

The volume of solution in the container 45 is regulated by a liquid level control 60 mounted on the purge tank cover. This control is connected into an electrical circuit including pump 50 and is adapted to discontinue operation of the pump at a predetermined high solution level, that is, a predetermined increase in volume of solution in the container. Control 60 includes copper probes 61 extending in container 45. Under normal operation, the volume of solution in the container increases, thus increasing the volume of solution or solution level in the container. At a predetermined level of solution in the container, a circuit is completed between certain probes, thus actuating the control 60 to discontinue operation of pump 50. Under these conditions, since pressure in the absorber shell 2 is less than atmospheric pressure the pressure of atmosphere will force solution in the container through line 52 to the absorber until the volume of solution in the container has decreased to a predetermined low solution level. At this point the circuit between such probes is discontinued since one probe is uncovered while the circuit between the two

lower probes continues thus actuating control 60 to begin operation of pump 50 to resume purging of the absorber.

It will be appreciated that the copper probes do not react with lithium bromide solution. However, since there are various times the probes are exposed to ambient atmosphere, a reaction occurs which forms layers of copper oxide on the exposed probe surfaces. As the volume of solution in the container increases, the probes are covered, the lithium bromide solution reacting with the copper oxide to remove the oxide from the surfaces of the probes thereby assuring that the probes function as conducting members throughout their lives. The probes are expendable since over a long period of time the material composing the same is consumed in the formation and removal of the copper oxide. However, throughout their lives, the probes present fresh, clean surfaces permitting their use as conductors.

A safety control 62 is provided in container 45. Any suitable type of safety control may be employed. If an excessive level of solution is reached in container 45, control 62 functions to discontinue operation of the controls of the refrigeration system, thereby discontinuing operation of the refrigeration system.

The present invention provides a purging arrangement for an absorption refrigeration system which eliminates the disadvantages heretofore encountered due to malfunction of the controls for the purging arrangement. The purging arrangement so provided is economical in initial cost and in operation. The purging operation may be maintained continuously in operation during the operation of the refrigeration system or, if desired, may be operated intermittently. In the purging arrangement provided by the present invention, the controls function to discontinue the purging operation before overflow of solution in the container can occur. Thus, loss of solution from the refrigration system is practically impossible. In addition, an advantage of the present arrangement resides in the fact that the purging lines in the absorber are washed automatically for the solution from the container is returned to the system therethrough.

While I have described a preferred embodiment of the present invention, it will be understood the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. In a purging arrangement for an absorption refrigeration system, the combination of a container, a pump for circulating solution in the container, an ejector connected to the pump, a line connecting the ejector with the absorber of the system, whereby discharge of solution through the ejector by said pump induces non-condensable gases from the absorber and forwards the non-condensable gases to the container for discharge to ambient atmosphere, a motor to actuate said pump, an electrical circuit including said motor, and control means in said electrical circuit, said control means including a plurality of spaced copper probes in said container, increase in volume of solution in the container completing a circuit between said probes to discontinue operation of the pump permitting solution to be forced to flow to the absorber, a predetermined decrease in solution volume in said container again energizing said motor to actuate the pump to withdraw non-condensable gases from the absorber.

2. A purging arrangement for an absorption refrigeration system according to claim 1 in which a cooling coil is placed in the container in heat exchange relation with solution in the container.

3. A purging arrangement for an absorption refrigeration system according to claim 1 in which a safety control is provided to automatically discontinue operation of the pump when a predetermined solution volume in the container is attained.

4. A purging arrangement for an absorption refrigeration system according to claim 3 in which a cooling coil is placed in the container in heat exchange relation with solution in the container.

5. In a purging arrangement for an absorption refrigeration system, the combination of a container for an absorbent solution, means for discharging solution in the container, means to connect said means with the absorber of the system whereby discharge of solution in the container by said first means induces non-condensable gases from the absorber and forwards the non-condensable gases to the container for discharge to ambient atmosphere, and control means including a plurality of expendable probes extending within the container for discontinuing withdrawal of non-condensable gases from the absorber while permitting solution in the container to be forwarded to the absorber through said second means, increase in volume of solution in the container completing an electrical circuit between the probes to discontinue the operation of said first means permitting solution in the container to return to the absorber, a predetermined decrease in solution volume in said container again actuating said first means to discharge solution in the container thereby again withdrawing non-condensable gases from the absorber.

6. A purging arrangement for an absorption refrigeration system according to claim 5 in which the expendable probes consist of copper.

7. A purging arrangement for an absorption refrigeration system according to claim 5 in which the solution discharged within the container comprises a solution of lithium bromide and water.

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