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(54) **CO2 HOT GAS DEFROSTING OF CASCADE REFRIGERATION PLANTS**

ABTAUEN VON KASKADENKÜHLANLAGEN MITTELS CO2-HEISSGAS

DEGIVRAGE A L'AIDE D'UN GAZ CHAUD DE CO2 DANS LES SYSTEMES DE REFRIGERATION
EN CASCADE

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• **PATENT ABSTRACTS OF JAPAN & JP 07 243 726**
A (DAIKIN IND. LTD.) 19 September 1995

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Description

[0001] The present invention relates to a refrigeration system of the cascade type, comprising an operative refrigerating circuit working with CO₂ or another refrigerant and having one or more refrigeration compressors connected so as to suction refrigerant gas from an evaporator equipment and compressing it into a condenser unit, which also acts as an evaporator in a precoupled second refrigerating circuit, and from which condensed refrigerant liquid is conveyed to said evaporator equipment, whereas a defroster circuit is arranged for selectively supplying hot refrigerant to said evaporator equipment for defrosting purposes.

[0002] Defrosting is necessary to remove ice built up on a freezer or a cooler. In most cases it is a question of proper and efficient function of the equipment, but in some cases it is a vital part of the function. One of the latter cases is a plate freezer, where the product is frozen between two metal plates wherein refrigerant is circulated. To be able to remove the product it is necessary to defrost the plates.

[0003] Defrosting can be done in several ways, with the most common being:

- Spraying with hot water, which is very common but not very practical due to hygienic considerations.
- Electrical defrosting by means of electrical heating rods placed near the cooling surface. The main disadvantage is that when compared to the hot gas defrost, the power consumption is much higher. Because of the defrost compressors COP (cooling capacity kW per power consumption kW) the power fed to the defrost system is 4-5 times higher with electrical defrost for the same defrost capacity. Another disadvantage is that, when using electrical defrosting, the ice is melted from the outside, which means that more ice has to be melted before the remaining ice falls from the cooler and that the power consumption is too high.
- Circulation of a hot liquid (usually a glycol/water mix) in a separate circuit within the cooler/freezer. When defrosting from the inside the ice on the surface melts first enabling the ice to fall off as soon as possible.
- Hot gas defrosting where gas is condensed in the cooler/freezer at a temperature above the freezing point. Condensing takes place in the same circuit that is used for cooling/freezing. In some types of evaporators e.g. plate freezers hot gas defrost is the only possible solution for defrosting

[0004] Wherever possible hot gas defrosting is used. Hot gas defrosting is very efficient as heat is delivered where the ice has built up and it is very economical since the heat used is present in the system. Electrical and hot

liquid defrosting requires an external power source which hot gas defrosting does not. During hot gas defrosting the cooler/freezer acts as a secondary condenser dispersing the heat otherwise dispersed in the cooling media (usually water or air).

[0005] With the reintroduction of CO₂, cascade systems are becoming more frequent. Due to the high saturation pressure of CO₂, it is not possible to keep the pressure within the range normally encountered in refrigeration plants while still condensing it against air or water at ambient temperatures. Thus a cascade system is used, wherein a secondary refrigeration plant cools the CO₂ condenser. The secondary refrigeration plant condenses against the available cooling media. The condensing temperature of the CO₂ is usually in the range of -20°C to -5°C.

[0006] If a traditional approach for hot gas defrosting was to be used, the gas, otherwise to be condensed in the cascade cooler, would be led to the evaporator. But in the case of CO₂ the condensing temperature is, as mentioned above, in the range -20°C to -5°C, which is not sufficiently hot to remove ice from the evaporator. When defrosting a cooler it is, of course, necessary to get the temperature of the cooler (well) above 0°C.

[0007] One solution to this problem could be to raise the temperature in the cascade cooler (e.g. refrigeration compressor outlet) to a level above the freezing point. This is possible, but several disadvantages arise from this solution. The overall energy efficiency of the system drops, and more important, components to handle the increased pressure are, at best, expensive or not available. Also a very large part of the plant would be subjected to very high pressures.

[0008] Often a valve in the outlet controls the defrosting pressure in the evaporator. This valve will close when the pressure is lower than the desired pressure. However, this restricts the liquid condensed during the defrosting from leaving the evaporator, thus resulting in a build up of liquid in the evaporator. The build up of liquid reduces the surface inside the evaporator available for condensing and as such reduces the overall effect of the defrosting.

[0009] As a refrigerant CO₂ gives some general advantages:

- Highly efficient system, both with regard to component sizing and energy consumption.
- Efficient to low evaporating temperatures. Other refrigerants become inefficient below -40°C, but CO₂ is efficient down to -55°C, limited only by the triple point (-56,6°C)
- A CO₂ leak will not destroy the product in the processing area affecting not only the yield but also the insurance costs.
- CO₂ is considered a safe refrigerant. It is non-flam-

mable, non-explosive and it is considerably safer to the crew than other refrigerants.

- The low evaporating temperature yields a higher capacity of the production equipment, usually resulting in a faster freezing. The faster freezing has a positive effect on product quality.
- CO₂ is a natural refrigerant with none of the environmental problems associated with older refrigerants such as CFC's and HCFC'S. CO₂ is not harmful to the environment ensuring unrestricted use in the future from the environmental point of view.

[0010] The patent application DK200100310 describes a plant and a process using CO₂ for defrost. This system is a unit that delivers both defrosting and standstill cooling, e.g. keeping system pressure down during standstill. In a combined system like in DK200100310, failure of the defrost system would mean that no standstill cooling is available and it is from some classification societies a demand that the standstill cooling is performed by a separate unit as a part of the safety system.

[0011] The above-mentioned system is connected to the "distribution system", defined as a vessel with gas/liquid equilibrium along with the piping to the consumers e.g. the evaporators. From the application and its definitions it appears that the possible connection points are: A pump separator, a high-pressure receiver, and the piping to the consumers.

[0012] Connecting the defrosting compressor to the refrigeration cycle's low-pressure side results in a very large pressure difference, which most industrial refrigeration compressors cannot handle. Furthermore a defrosting compressor connected to the low pressure side needs to be about 4 times bigger (by swept volume) than one connected to the high pressure side to deliver the same defrosting capacity. Standard refrigeration equipment can be used when connecting to the high-pressure side, while this is not the case when connecting to the low-pressure side.

[0013] If connecting the defrosting compressor to the high-pressure receiver it is very doubtful if sufficient gas is available in the receiver. The receiver essentially collects liquid from the condenser and will normally not contain the large amounts of gas necessary for defrosting.

[0014] In the system described in DK-B1-174257 the suction gas for the compressor is saturated, necessitating a liquid separation. Ensuring that the suction gas contains no liquid is essential for safe compressor operation—especially when using reciprocating compressors.

[0015] It is the purpose of the invention to define a system that can perform a hot gas defrosting of cascade refrigeration plants, particularly those using CO₂ in the cold cycle, where the system can deliver efficient defrosting while offering noticeable benefits in terms of lower overall power consumption of the plant and a high degree of use of standard refrigeration components.

[0016] The present invention relates to a refrigeration system of the cascade type where the suction side of the defrost compressor is connected to the discharge side of one or more compressors, said defrost compressor being operable to supply defrost gas at elevated pressure and temperature to at least one evaporator equipment, said defrost compressor being connectable so as to temporarily operate as a refrigeration compressor in parallel with said one or more refrigeration compressors.

[0017] The system according to the invention limits the high pressure to an absolute minimum number of components while employing as many standard components as possible. Using a dedicated defrosting compressor another pressure level is created with the sole purpose of defrosting. In this way the high pressure can be limited to the defrosting compressor, the defrost pipe, the evaporator to be defrosted and a few valves at the evaporator. The cascade cooler, refrigeration compressor and associated equipment can be held at the temperature/pressure yielding the most overall efficient plant and still be standard refrigeration components. The defrosting compressor is connected to the refrigeration compressor outlet.

[0018] A system according to the invention has a specially dedicated compressor for defrosting. This defroster compressor suction gas is the refrigeration compressor discharge gas. The gas has been desuperheated before entering the defrost compressor to avoid too high discharge temperature that could create a problem with lubrication of the defrost compressor. Furthermore the COP (cooling capacity kW per power consumption kW) of the defrost compressor would be lower and oil cooling would be necessary.

[0019] Desuperheating (cooling) of the suction gas to the defrosting compressor has an effect on the overall power consumption of the plant. Two methods of cooling are the most likely, the first one being cooling with the same media used in the secondary systems condenser (air or water) and the other method is using the cascade cooler.

[0020] Normally a cascade cooler would desuperheat the gas before condensing, so introducing a nozzle in the appropriate place in the cascade cooler would yield a supply of cooled gas. In the cascade cooler the cooling is performed by the secondary system so power will be required by the secondary system. Also it is of very high importance that the gas supplied to the defrosting compressor does not contain liquid. A positive superheat is required to avoid liquid hammer (attempting to compress liquid) in the compressor.

[0021] The other option, the air/water cooled cooler, offers some advantages. As mentioned earlier, it is not practically possible to condense the CO₂ against air/water at normal ambient temperature, but it is possible to use it to cool the gas before entry into the cascade cooler and defrosting compressor. The benefit is that every kW cooled by the cooler does not have to be removed in the cascade cooler. This results in a reduction of both the

size and power consumption of the secondary system. In such a cooler the gas can be cooled to a temperature very close to the ambient temperature, but since the saturation (condensing) temperature is much lower the gas is still sufficiently superheated to avoid liquid hammer. The selection of one of these two systems will be a question of installation costs versus the savings in running costs.

[0022] The defrost compressor capacity regulation regulates after the discharge (defrost) pressure. The condensing temperature determines the suction pressure in the cooling cycle. This pressure is kept constant by the "hot" refrigeration cycle.

[0023] To avoid excessive changing of the compressor capacity steps and an unintended pressure rise at the end of the defrost period when defrost capacity demand is low, a controllable bypass valve is used to bypass hot gas back to the cascade cooler. The bypass valve is arranged in a connection from the discharge side of the one or more refrigerating compressors. A precise control of the defrost pressure and temperature is thereby enabled and the bypass valve will smoothen the capacity steps and secure that the pressure does not exceed the maximum design pressure. This control method makes it unnecessary to mount control valves on each cooler to control the pressure during defrost. All defrost control is done by the compressor and the bypass valve.

[0024] The defrost pressure/temperature can be set for each evaporator individually by changing the defrost compressor discharge pressure set point. This way the defrost can be optimised for the individual type of evaporator. Some applications can benefit from a more gradual defrost while some need a fast defrost. Considerations when selecting defrost temperature will include heat loss into the surroundings, water/steam contents in the room air and product quality.

[0025] On a system according to the invention the refrigerant outlet from the evaporator equipment can be connected to the suction side of the one or more refrigeration compressors through a liquid operated liquid draining device.

[0026] Draining of the cooler during defrost is a very important issue. When the cooler fills with liquid the surface available for condensing (defrost) becomes smaller and consequently the possible capacity drops meaning a slower defrost. The system according to the invention has for this purpose employed a thermodynamic liquid drain designed for steam and compressed air application. This device allows liquid to pass and stops gas in much the same way as a float valve mechanism. Float valve mechanisms employ a floating ball but these have been difficult or expensive to get for the high pressure needed. The liquid drain used is simple and can accept the pressures. The benefit is that when the compressor controls the pressure completely, the liquid drain only needs to drain the liquid in the freezer and not concern itself with regulating the pressure. The result is an extremely simple

system with an efficient operation.

[0027] A system as described, wherein the entire gas conductor system from the defrost compressor through the evaporator equipment and to the drain pipe of the evaporator can generally be without pressure regulating means and will preferably be laid out for operating at pressures not exceeding 50 bar.

[0028] It can, however, not be excluded that a higher pressure, for instance 55 bar, will be more suitable in an alternative embodiment of the invention.

[0029] All together the installation is considerably simpler, less expensive and secure compared to known solutions.

[0030] The system according to the invention described herein has a plurality of benefits compared to the alternative systems:

- Except for the defrost compressors oil separator there are no vessels in the high-pressure system. The oil separator has a very low volume. Large volumes under high pressure present a safety hazard due to the high energy content.
- The defrost pressure/temperature is controlled by the compressor. The compressor will regulate its discharge pressure rather than the traditional suction pressure regulation. It is possible to regulate the compressor either by the normal compressor capacity step supplemented by a bypass valve to achieve a finer regulation or by using a frequency converter on the compressor motor to regulate the compressor RPM. This can be necessary because of the high capacity of a single capacity step on reciprocating compressors.
- It is not necessary with regulating valves for the cooler. The compressor does all pressure/temperature regulation.
- When the defrost pressure is controlled by the compressor it is only necessary to drain the cooler of liquid. When liquid is drained the maximum surface is available for condensing.
- The drainage is secured by a thermodynamic liquid drain, a commonly available component for compressed air and for steam or by a high-pressure float valve.
- High-pressure is only present while the compressor is running. In effect all pressure will equalize when a critical situation occurs (e.g. a power failure, wrong valve position) or when the compressor emergency stop is pressed.
- By taking the discharge gas from the refrigeration compressors and not from the pump separator the COP (cooling capacity kW per power consumption

kW) is greatly enhanced offering a much better economy. Furthermore the requirement for the compressor size is greatly decreased.

- In systems where the need for defrosting is not continuous, but rather at discrete intervals, the defrost compressor could be used as a normal refrigeration compressor. The compressor used for defrosting can be a dedicated defrost compressor, but can also be anyone of the refrigeration compressors. A system according to the invention can be designed with the possibility to use one or more of a plurality of compressors in the system as defrost compressor. In this way an increased safety and reliability of the system is achieved. The performance of the compressor in the two running conditions is well matched. That is, when running in the defrost condition the compressor yields 3-5 times as much as when in the refrigeration condition. This ratio is deemed suitable for defrosting in a reasonable time. Thus when a cooler is taken out of operation to be defrosted, the excess compressor capacity at cooling level matches the need for defrost capacity.
- The gas for defrosting is greatly superheated which, apart from the actual gain in heating capability, secures the system against condensation in pipes and valves before entering the cooler. If liquid enters a low-pressure area from high-pressure it can be "shot" into the low-pressure area and considerable damage can occur from this.
- The compressor is able to start the defrost "gently" while running up the pressure at the start of the defrost. This reduces the risk of pressure surges and liquid hammer.
- It is possible to make individual defrost conditions for different evaporators to suit the individual needs.

[0031] Power consumption of the system is considerably affected if the system according to the invention is employed. Heat absorbed in the evaporators will, along with the CO₂ compressor motor heat, be delivered to the secondary (usually R717) refrigeration system in the cascade cooler. Even though the cascade temperatures have been fixed at the overall most efficient point, the secondary system accounts for 60-70% of the overall power consumption. But when the defrosting compressor is in action the defrost compressor suction gas need not be condensed by the secondary system resulting in a drop in required cooling capacity of the secondary system.

[0032] The gas will, after compression in the defrosting compressor, be condensed in the evaporator to be defrosted. However, the COP (cooling capacity kW per power consumption kW) is much higher in the defrosting compressor than in the secondary systems compressor.

The difference is naturally dependent on the type (refrigerant etc) of the secondary system and running conditions, but in general terms a factor of two is realistic. This means that for every 100 kW used by the defrosting compressor, the power consumption of the secondary system drops with 200 kW with a resulting overall drop of 100 kW.

[0033] With 100 kW power consumption, the defrost compressor employed in this system will deliver approximately 600 kW heating. If electrical defrosting is to be used, all 600 kW is needed in electricity, so the comparison is really an increase of 600 kW compared to a drop of 100 kW. If hot glycol is to be used the heating could be extracted in the system (most likely the secondary systems hot side) so the power consumption only increases with the pump power. However, no gain similar to the one described above is achieved.

[0034] On a plant according to the invention it has been discovered that there is a large over all efficiency benefit during defrosting, as mentioned above. For the understanding of the invention it has to be mentioned that the compressors used are mainly large industrial compressors for industrial cooling purposes, but that the invention also can be used in connection with plants comprising commercial compressors capable of handling the given pressure and temperature. As an example cooling and freezing plants in butcher shops, in supermarkets or in other retail shops can be mentioned as places to use the system.

[0035] To save even more energy using the system according to the invention it is possible to use the defrost compressor capacity to supply hot gas to other elements than to a traditional evaporator e.g. to elements consisting of heating/evaporator pipes placed in areas where ice otherwise will built up.

[0036] Freezers that need defrosting is often used on-board fishing vessels and in such plants heating/evaporator pipes can be installed in the floor in the freezing area. In this area there will typically be ice formations, which today is removed or controlled by electrical heating elements. By replacing these elements with heating/evaporator pipes less electrical power is needed and the defrost compressor is used more efficient whereby energy is saved in the second condensing unit.

[0037] CO₂ hot gas from the defrost compressor can be used for traditional defrosting, for heating and for defrosting in all places where the temperature is below 10 °C.

[0038] In the following the invention will be described with reference to the drawing where:

Fig. 1 shows a system according to the invention and Fig. 2 shows a log(P)-H diagram of defrost according to the invention in cascade systems.

[0039] Referring to fig. 1, which shows a system according to the invention, the systems function will be described. Please note that the fig. is simplified to ease understanding.

[0040] The freezing system 2 is executed in the tradi-

tional manner. The pump separator 4 contains liquid refrigerant at the evaporating temperature. The pumps 6 pump refrigerant liquid to the evaporator 8 through the valve station 10.

[0041] In the evaporator 8 the refrigerant liquid is partially or completely evaporated and returned through the valve station 10 to the pump separator 4. The gas generated in the evaporator 8 is removed by the refrigeration compressor 12, which compresses the gas to the condensing pressure. From the refrigeration compressor 12 the gas is primarily led to the cascade cooler 14 where the gas is condensed before being led back to the pump separator 4. A secondary condensing unit 16 provides cooling for the cascade cooler 14. The freezing system 2, as described here, is well known technology and is as such not interesting, but the defrosting system is the essence of the invention described here.

[0042] The defrost compressor 20 takes suction from the discharge of the refrigeration compressor 12 (e.g. at condensing pressure) and compresses it to the desired defrost pressure. Please note that the gas from the refrigeration compressor 12 is significantly superheated. To avoid too high discharge temperature (oil problems) from the defrost compressor 20 it could be necessary to desuperheat (cool) the gas before entry into the defrost compressor 20. This cooler has not been included on the sketch because the function is not vital to the principal function of the defrost system. The gas cooling could take place in an external heat exchanger or it could take place in the cascade cooler 14. As mentioned this gas cooling is not essential for the principal function of the system 2, but since some energy efficiency issues arise from this it will be discussed later in detail.

[0043] From the defrost compressor 20 the gas is led to the evaporator 8. In fig. 1 the gas is led to the liquid/gas "outlet" 22 of the evaporator 8, resulting in a defrosting backward. Considerable differences of opinion exist about defrosting forward or backward, but in this case backward defrosting is considered most efficient and thus it is outlined here. Furthermore backward defrosting is safer since the risk of liquid bullets being shot through the system is reduced. In the evaporator 8 the defrost gas condenses and it is led out through the liquid "inlet" 24 of the evaporator 8. Returning this (for now high-pressure) liquid is done in the normal return line 26 to the pump separator 4, however, the pressure needs to be reduced to the evaporating pressure before entering the return line 26. This is done in a high-pressure float valve 28 or a component with the same characteristics. The purpose of this component 28 is both to reduce the pressure, but also to allow all liquid to drain from the evaporator 8, but not allowing any gas to pass during defrosting. With the use of this float valve 28 (or like) the evaporator 8 will always be completely drained during defrosting resulting in an efficient defrost. Furthermore, since the evaporator 8 will be full of liquid from the freezing cycle at the beginning of the defrosting, a fast and efficient drainage is secured with the float valve system 28.

[0044] One small thing needs to be observed with this arrangement. During the freezing cycle the float valve 28 could act as a short circuit and bypass all the liquid pumped to the evaporator 8 back to the return line 26. This is avoided by adding a valve 30 in series with the float valve 28. This valve 30 has an opening pressure that is larger than the pressure loss in the evaporator 8 and will thus remain closed during the freezing cycle.

[0045] Regulation of the pressure during defrosting is performed by the compressor 20 capacity regulation. The compressor 20 capacity regulation will regulate according to the discharge pressure as opposed to the "normal" suction pressure regulation. This method of regulation is common in heat pumps. The suction pressure for the defrosting compressor 20 (e.g. the condensing pressure in the CO₂ circuit) is kept constant by the secondary condensing unit 16. Regulating the pressure with the compressor 20 while the float valve 28 drains the evaporator 8 (regardless of the pressure) has some benefits:

- Rather than using a regulating valve for each evaporator 8, the control is at one point only resulting in a more simple control. Furthermore pressure regulators for 50 bars pressure are not standard refrigeration equipment.
- Changing the compressor discharge pressure set point makes it possible to adapt the defrosting to the component to be defrosted. For instance in a plate freezer 8 the defrosting time is very important and thus the maximum temperature would be specified to the compressors control system, while in a air cooler in a freezing storage room it could be desirable to minimize the heat ingress into the room. This could be done with a defrosting at a lower temperature for a longer time.
- The evaporator 8 is, as mentioned, completely drained and thus offering the maximum surface area for condensing. Once the gas has condensed, e.g. given off its latent heat, it is of little use in the defrosting process. Removing the liquid enables the maximum defrosting capacity to be achieved.
- The defrosting compressor 20 can be put in an idling mode when no defrost is required, thus reducing wear from excessive start-stop situations.
- When no defrosting is required over a longer period the defrosting compressor 20 can be stopped or used as a refrigeration compressor 12.

[0046] To avoid excessive changing of the compressor capacity steps, a controllable bypass 32 valve is arranged in a connection from the discharge side of the defrost compressor and the discharge side of the one or more refrigerating compressors to bypass hot gas back to the cascade cooler 14.

[0047] Fig. 2 is showing a log(P)-H diagram of defrost according to the invention in cascade systems. The diagram shows the normal refrigeration cycle (34). From evaporating pressure (36) the refrigerant is compressed (38) up to the condensing pressure (40). From the compressor discharge (42) the gas is cooled and eventually condensed before it is flashed back to the evaporating pressure (36). The system according to the invention connects the defrosting compressor (20) after the refrigeration compressors discharge port (42) and before condensing takes place (44) in the condenser/cascade cooler.

[0048] On other known systems for CO₂ defrosting the defrost compressor is connected at the refrigeration compressors suction side (46) or after the condenser/cascade cooler (48).

Claims

1. A refrigeration system of the cascade type (2), comprising an operative refrigerating circuit working with CO₂ or another refrigerant and having one or more refrigeration compressors (12) connected so as to suck refrigerant gas from an evaporator equipment (8) and compressing it into a condenser unit (14), which also acts as an evaporator in a pre-coupled second refrigerating circuit (16), and from which, condensed refrigerant liquid is conveyed to said evaporator equipment (8), wherein a defroster circuit (18) is arranged for selectively supplying hot refrigerant to said evaporator equipment (8) for defrosting purposes, said defroster circuit (18) comprising a defrost compressor (20) **characterized in that** the suction side of the defrost compressor (20) is connected to the discharge side of one more of said refrigeration compressors (12), said defrost compressor (20) being operable to supply defrost gas at elevated pressure and temperature to at least one evaporator equipment (8), said defrost compressor (20) being connectable so as to temporarily operate as a refrigeration compressor in parallel with said one or more refrigeration compressors (12).
2. A system according to claim 1, in which the suction side of the defrost compressor (20) is connected to the discharge side of one or more refrigerator compressors (12) through a desuperheater unit, preferably constituted by said condenser unit (14).
3. A system according to claim 1, wherein a controllable bypass valve (32) is arranged in a connection from the discharge side of the defrost compressor (20) and the discharge side of one or more refrigerating compressors (12).
4. A system according to claim 1, wherein the refrigerant outlet from the evaporator equipment (8) during

defrost is connected to the suction side of one or more refrigeration compressors (12) through a liquid operated liquid draining device (28).

5. A system according to claim 1, wherein the entire gas conductor system between the defrost compressor (20) through the evaporator equipment (8) and to the drain pipe (24) of the evaporator (8) is generally without pressure regulating means and is laid out for operating at pressures not exceeding 50 bar.
6. A system according to claim 1, wherein the discharge side of the defrost compressor (20) is selectively connectable to any one or more of a number of evaporator units (8) during defrost mode in said evaporator equipment, while the remaining units are still operable in refrigeration mode.
7. A system according to claim 1, wherein at least one refrigeration compressor (12) in parallel with one or more refrigeration compressors is connectable so as to temporarily operate as a defrost compressor (20).

Patentansprüche

1. Kälhsystem vom Kaskadentyp (2), umfassend einen wirksamen, kühlenden Kreislauf, der mit CO₂ oder einem anderen Kühlmittel funktioniert und umfassend einen oder mehrere Kühlkompressoren (12), die so verbunden sind, dass sie Kühlgas von einem Verdampferapparat (8) saugen und das Gas in eine Kondensatoreinheit (14) komprimieren, welche Kondensatoreinheit auch als Verdampfer in einem vorgeschalteten zweiten Kühlkreislauf (16) funktioniert, und von welcher Einheit kondensierte Kühlflüssigkeit zum Verdampferapparat (8) geleitet wird, worin ein Enteisungskreislauf (18) für die selektive Versorgung des genannten Verdampferapparats (8) mit heissem Kühlmittel für Enteisungszwecke angeordnet ist, wobei der Enteisungskreislauf (18) einen Enteisungskompressor (20) umfasst, **dadurch gekennzeichnet, dass** die Saugseite des Enteisungskompressors (20) mit der Entlastungsseite von einem oder mehreren der Kühlkompressoren (12) verbunden ist, wobei der Enteisungskompressor (20) dafür ausgelegt ist, Enteisungsgas bei erhöhtem Druck und Temperatur wenigstens einem Verdampferapparat (8) zuzuführen, wobei der Enteisungskompressor (20) derart verbindbar ist, dass er sich zeitweise als Kühlkompressor in parallel mit dem oder den genannten einen oder mehreren Kühlkompressoren (12) betriebsbar ist.
2. Kälhsystem nach Anspruch 1, worin die Saugseite des Enteisungskompressors (20) mit der Entlastungsseite eines oder mehrerer Kühlkompressoren

(12) durch eine vorzugsweise aus der Kondensatoreinheit (14) gestalteten Enthitzungseinheit verbunden ist.

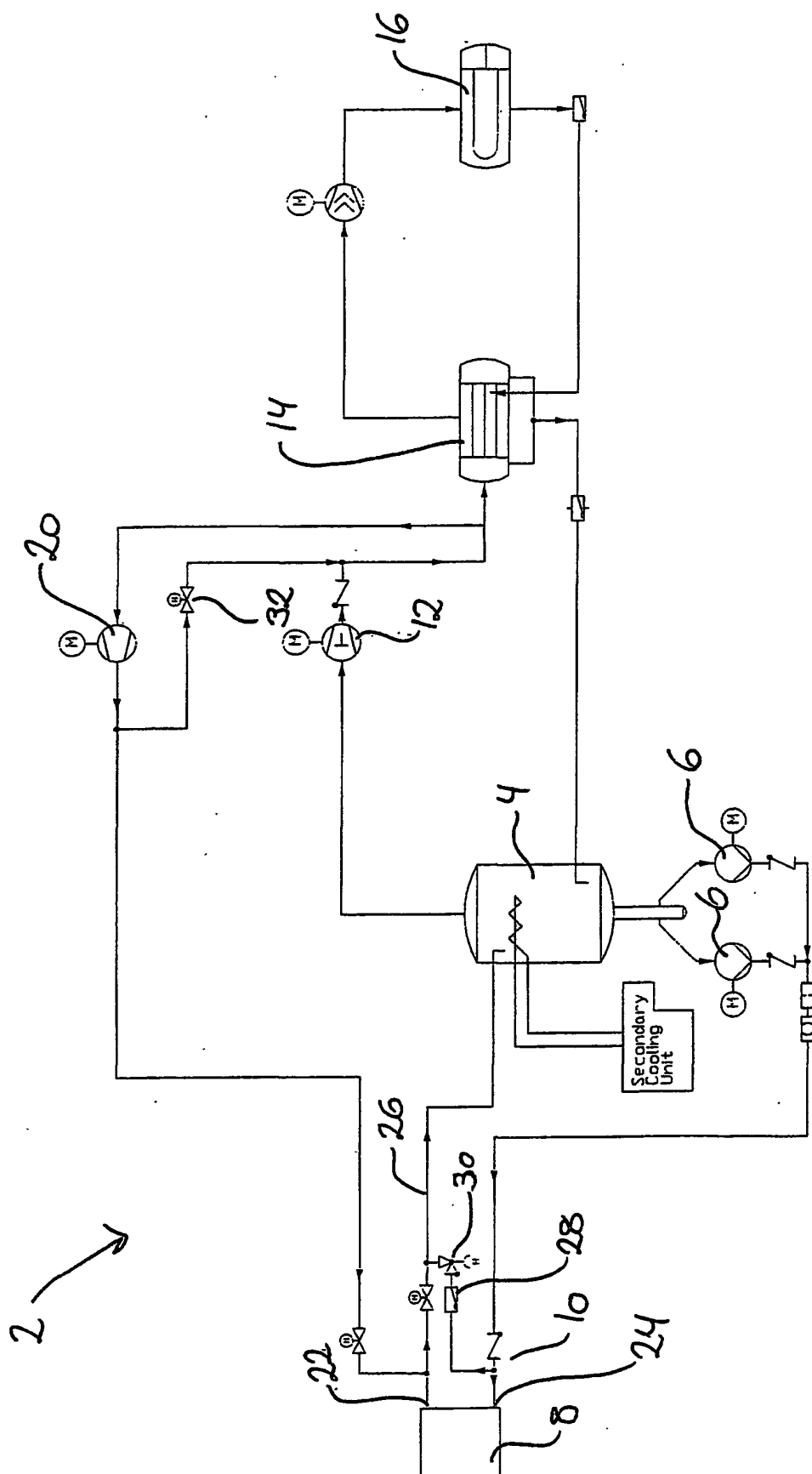
3. System nach Anspruch 1, worin ein regelbares Überlaufventil (32) in einem Anschluss zwischen der Entlastungsseite des Enteisungskompressors (20) und der Entlastungsseite eines oder mehrerer Kühlkompressoren (12) angeordnet ist. 5
4. System nach Anspruch 1, worin der Kühlmittelauslass des Verdampferapparats (8) während der Enteisung mit der Saugseite eines oder mehrerer Kühlkompressoren (12) durch ein flüssigkeitsbetriebenes Flüssigkeitsableitungsgerät (28) verbunden ist. 10
5. System nach Anspruch 1, worin das ganze Gasleitungssystem zwischen dem Enteisungskompressor (20) durch den Verdampferapparat (8) und dem Auslassrohr (24) des Verdampferapparats (8) generell ohne Druckregulierungsmittel und für Betrieb bei Drücke ausgelegt ist, die nicht 50 bar überschreiten. 15
6. System nach Anspruch 1, worin die Entlastungsseite des Enteisungskompressors (20) mit irgendeinem oder mehreren von einer Reihe von Verdampfereinheiten (8) während der Enteisung im genannten Verdampferapparat selektiv schaltbar ist, während die übrigen Einheiten noch während der Kühlung betriebsfähig sind. 20
7. System nach Anspruch 1, worin wenigstens ein Kühlkompressor (12) parallel zu einem oder mehreren Kompressoren schaltbar ist, so dass er zeitweise als Enteisungskompressor (20) betriebsfähig ist. 25

Revendications

1. Système de réfrigération du type cascade (2), comprenant un circuit de réfrigération opérationnel opérant avec du CO₂ ou avec un autre réfrigérant et comportant un ou plusieurs compresseurs de réfrigération (12) réunis de façon à sucer du gaz réfrigérant d'un équipement d'évaporation (8) et le comprimant dans une unité de condensation (14) qui aussi agit en tant qu'un évaporateur dans un deuxième circuit de réfrigération pré-couplé (16), et dont le fluide réfrigérant condensé est dirigé audit équipement d'évaporation (8), dans lequel un circuit de dégivrage (18) est arrangé pour fournir sélectivement du réfrigérant chaud audit équipement d'évaporation (8) dans le but du dégivrage, ledit circuit de dégivrage (18) comportant un compresseur de dégivrage (20), **caractérisé en ce que** le côté aspiration du compresseur de dégivrage (20) est lié au côté refoulement d'un ou de plusieurs desdits compresseurs de réfrigération (12), ledit compresseur de dégivrage 30

(20) étant capable de fournir du gaz de dégivrage à la pression et la température élevées à au moins un équipement d'évaporation (8), ledit compresseur de dégivrage (20) étant connecté de sorte à actionner temporairement en tant qu'un compresseur de réfrigération en parallèle audit un ou plusieurs compresseurs de réfrigération (12).

2. Système selon la revendication 1, dans lequel le côté aspiration du compresseur de dégivrage (20) est lié au côté refoulement d'un ou de plusieurs compresseurs de réfrigération (12) à travers d'une unité de désurchauffeur, de préférence constituée par ladite unité de condensation (14). 10
3. Système selon la revendication 1, dans lequel une soupape de retour contrôlable (32) est disposée dans une connexion du côté refoulement du compresseur de dégivrage (20) et du côté refoulement d'un ou de plusieurs compresseurs de réfrigération (12). 15
4. Système selon la revendication 1, dans lequel la sortie du réfrigérant de l'équipement d'évaporation (8) lors du dégivrage est lié au côté aspiration d'un ou de plusieurs compresseurs de réfrigération (12) à travers d'un dispositif de drainage de liquide activé par liquide (28). 20
5. Système selon la revendication 1, dans lequel tout le système conducteur de gaz entre le compresseur de dégivrage (20) à travers de l'équipement d'évaporation (8) et vers le tuyau de drainage (24) de l'évaporateur (8) est généralement sans moyens régulateurs de pression et actionne à des pressions n'excédant pas 50 bars. 25
6. Système selon la revendication 1, dans lequel le côté refoulement du compresseur de dégivrage (20) peut être sélectivement connecté à une quelconque ou à plusieurs d'un nombre d'unités d'évaporation (8) lors de la procédure de dégivrage dans ledit équipement d'évaporation en même temps que les autres unités restent activées dans le mode de réfrigération. 30
7. Système selon la revendication 1, dans lequel au moins un compresseur de réfrigération (12) en parallèle à un ou à plusieurs compresseurs de réfrigération peut être connecté de sorte à actionner temporairement en tant qu'un compresseur de dégivrage (20). 35



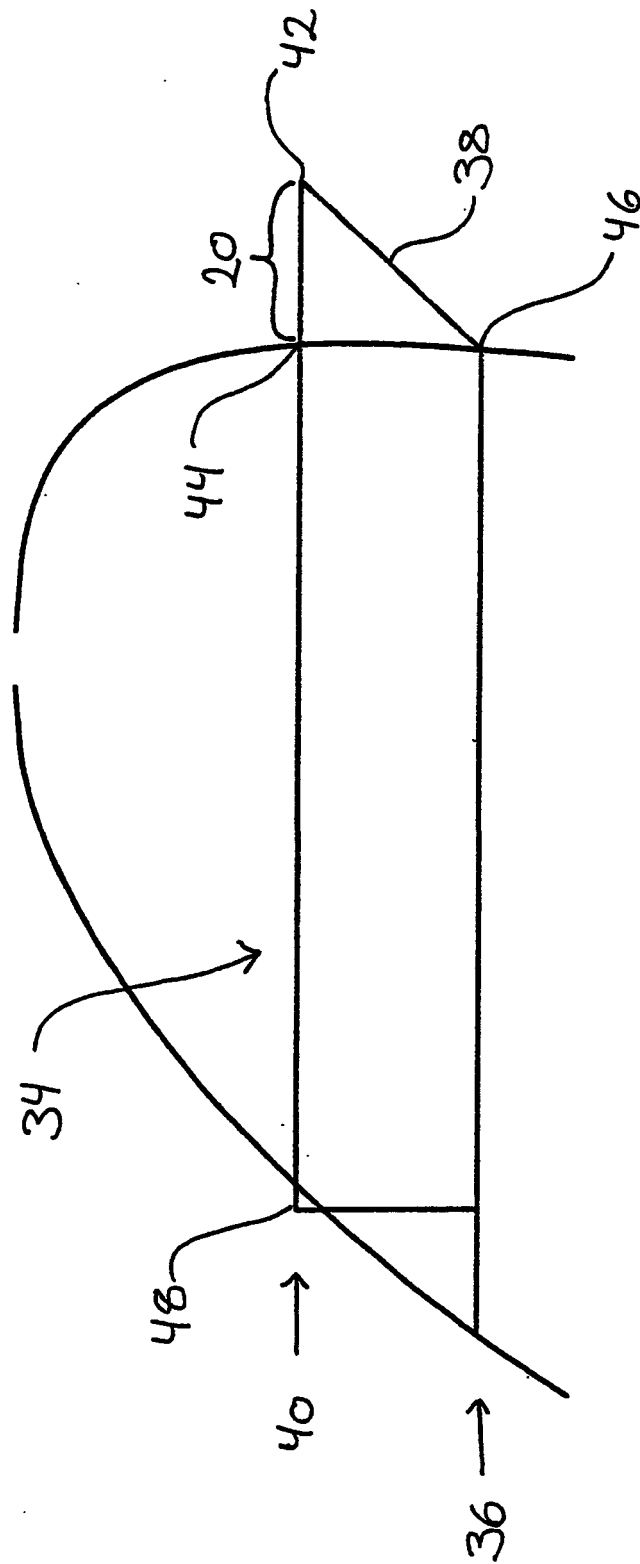


Fig. 2