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(54) **Device and method for cooling oil**

(57) The present disclosure relates to a method and a device for cooling oil, e.g. lubricating or hydraulic oil. The method involves feeding oil to a primary circuit of a heat exchanger (1,3), and feeding cooling water to a secondary circuit of the heat exchanger in order to cool the oil. In the secondary circuit, a sub-atmospheric pressure is maintained, such that the cooling water boils in the secondary circuit, even if the temperature of the incoming oil is relatively low, resulting in a water-steam mixture. The method further involves separating the water-steam mixture in order to provide process steam, which may be used for other purposes, thereby recovering a considerable portion of the thermal energy in the oil.

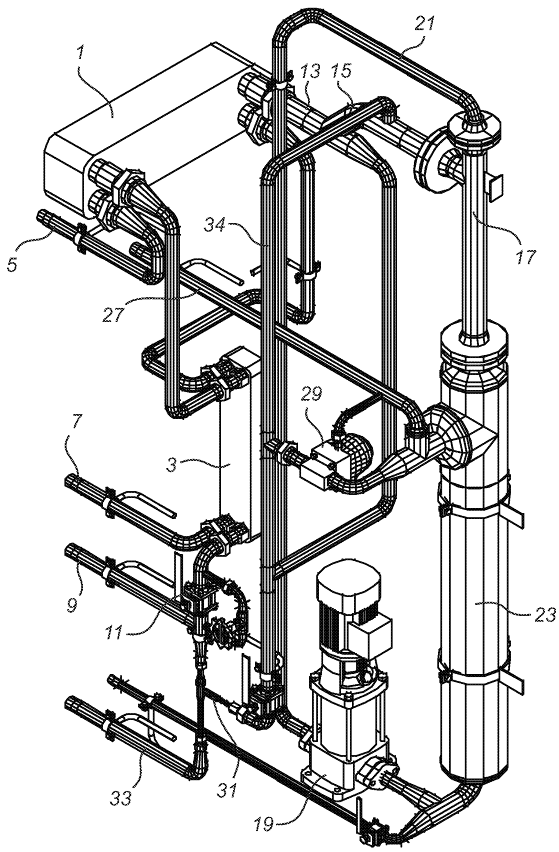

Fig. 2

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Description

Technical field

[0001] The present disclosure relates to a method and a corresponding device for cooling oil. The method involves feeding oil to a primary circuit of a heat exchanger, and feeding cooling water to a secondary circuit of the heat exchanger in order to cool the oil.

Background

[0002] Systems employing such a method are used e.g. in steel and paper mills but may also be applied in a wide range of other environments including most industries.

[0003] Cooling of oil may be applied in a lubrication circuit, e.g. where lubrication oil is fed to bearings, e.g. in connection with a paper mill cylinder roll, and is heated by losses in those bearings. Cooling may need to be applied as the oil otherwise may become too thin for its purpose.

[0004] Another application where oil is cooled is in a central unit supplying hydraulic oil at a high pressure to different devices such as hydraulic motors. Losses in such a motor, or in a similar device, heat the oil to some extent, implying a need for cooling.

[0005] The typical way of providing a cooling function e.g. in a paper mill is to use a nearby natural water source. Paper mills are, for other reasons, often build in the vicinity of rivers or the like. Such water is pumped through the heat exchanger to cool the oil, and is subsequently let out back into the river or other water source.

[0006] While this may cool the oil in a simple way, the loss of energy is considerable. For instance, the lubrication system of a typical paper machine may heat 100 m^3 of water 20°C each hour, implying a loss of 2 MW. While this loss still may be considered minor in the context of a paper mill, there still exists a need for providing a more economic solution in terms of energy consumption.

[0007] In some cases waste thermal energy from different processes may be recovered by using the energy to heat residential buildings and the like. In this case however, the oil is often only about 80°C or less, which limits the water heat in such a way that distribution to residential buildings may be inefficient.

Summary

[0008] One object of the present invention is therefore to provide an oil cooling method and device which is more economic.

[0009] This object is achieved by means of an oil cooling method as defined in claim 1, and by means of a corresponding oil cooling device as defined in claim 5. More specifically, the method of the initially mentioned kind then involves maintaining a sub-atmospheric pressure in the secondary circuit, such that the cooling water boils in the secondary circuit resulting in a liquid water-steam mixture, and separating the water-steam mixture in order to provide process steam.

[0010] By using this method, a considerable portion of the thermal energy removed from the oil may be recovered by providing steam, which may be used by other sub-processes in a plant. For instance, in a paper mill, steam may be used in a drying section, and in a steel mill, steam may be used to heat rolls or to preheat materials. Since a part of the needed steam may be provided by the oil cooling device, less steam need be produced in conventional ways, thereby providing a reduction of energy costs.

[0011] The water flow through the heat exchanger may be achieved by means of a liquid driven steam injector, where a steam flow is driven by a superheated pressurized liquid water flow.

[0012] The method may be employed for cooling lubricating oil, hydraulic oil, or both if two primary circuits are used in the heat exchanger. A combined hydraulic/lubrication oil cooling device may thus also be considered.

[0013] The pressure in the secondary circuit may be in the range 0.1-0.5 bar (a), which may allow an incoming oil temperature as low as 80°C or even lower to be useful.

[0014] The present disclosure also relates to a corresponding device for cooling oil.

[0015] In such a device, the flow in the secondary circuit may be driven by a liquid driven steam injector, in which a steam flow is driven by a superheated pressurized liquid water flow.

[0016] The steam injector may be connected to a dome, in which a liquid water level is maintained, and steam may be withdrawn from the dome. The steam injector may be driven by a pump receiving liquid water from the dome.

[0017] The sub-atmospheric pressure may be achieved by sucking water through a constriction, which is placed in the secondary circuit and upstream the heat exchanger.

Brief description of the drawings

[0018]

Fig 1 describes a layout for an oil cooling device according to the present disclosure.

Fig 2 shows a perspective view of a device corresponding to the device of fig 1.

Detailed description

[0019] Fig 1 describes a layout for an oil cooling device according to the present disclosure, and fig 2 shows a perspective view of a similar device. In the following it is alternatingly referred to figs 1 and 2.

[0020] The general purpose of the present arrangement is to cool incoming oil from an initial temperature exceeding 55°C, often about 80°C, to outgoing oil with a temperature of about 45°C. However, those temperatures may differ within the scope of the present invention. The major part of the heat reduction of the oil is exploited to produce steam that is useful for other purposes. With reference to fig 1, the actual cooling takes place in a heat exchanger 1, 3, having an oil inlet 5 and an oil outlet 7. As illustrated in fig 2, the heat exchanger may comprise two sub-units 1, 3. In the first sub-unit 1, oil is cooled e.g. from 80°C to 50°C, and in the second sub-unit 3, oil is further cooled e.g. to 45°C. Cooling water, flowing via a water inlet 9 and a constriction 11, is first pre-heated in the second sub-unit 3 to about 50°C, and is then passed to the first sub-unit 1 where the water boils. The water boils at this low temperature as the constriction 11, through which the water is sucked by the system, lowers the pressure to a suitable level of about 0.15 bar (a), which implies that the boiling temperature is about 50°C.

[0021] The constriction 11 may comprise a valve which is partly bored up.

[0022] Typically, about 1/3 of the incoming water flow is boiled in the first heat exchanger sub-unit 1, which means that the cooling water leaves the first sub-unit 1 through a mist outlet 13 as a water/steam mixture or mist. Most of the liquid content is drained off by means of a separator unit 15 and the remaining portion of the steam/ water proceeds to an injector 17. As illustrated in fig 2, the separator unit may comprise a simple branching where the lower branch to a great extent receives liquid water and the upper branch mostly receives steam.

[0023] The injector 17 is a fluid-driven steam injector/ ejector, i.e. the steam flow from the heat exchanger 1, 3 is driven by a superheated pressurized fluid water flow accomplished by means of a fluid pump 19 in a drive circuit 21. A fluid driven injector of this kind may be achieved by modifying a steam driven steam injector by reducing the drive inlet opening to take into account that liquid water is more compact. As the water in the drive circuit is superheated, a portion of the liquid will vaporize flash as soon as it leaves the drive inlet, thereby increasing the amount of steam in the driven steam flow (from the heat exchanger).

[0024] The injector 17 increases the steam pressure of the steam from the heat exchanger and forces the steam flow to a dome 23 which constitutes a high pressure liquid container, where the liquid is kept at a predetermined level 25. The liquid water in the dome is fed to the fluid pump 19 that drives the injector 17. The fluid pump 19 also serves to keep the pressure low in the heat exchanger 1, 3 by sucking steam therefrom while giving the injector its motive flow. From the dome 23, steam is led to a steam outlet 27. While this steam may have a too low pressure to be used directly in an industrial process its pressure can be easily increased by use of a regular steam compressor. At the same time, most of the energy needed to generate useable steam, i.e. corresponding to the enthalpy of vaporization, has already been absorbed. Thanks to the low pressure in the heat exchanger 1, 3, this can be done at the temperature range provided by an oil to be cooled.

[0025] A float trap 29 makes sure that the liquid level 25 in the dome 23 is kept constant, and evacuates any excess liquid. That liquid, as well as the liquid removed from the mist in the separator unit 15 is returned to the water supply by means of a return pump 31 and through a water outlet 33. As illustrated in fig 2, the return pump 31 may comprise a small injector driven by another water flow from the water inlet 9. Liquid flowing through the float trap 29 will flash to some extent due to falling pressure, and the resulting steam flow is lead to the injector 17 via a return conduit 34.

[0026] As so much of the excess thermal energy from the oil is recovered as steam, the cooling water flow may comparatively be small, typically around 30 l/hour for an oil flow of 1800 1/hour. This implies an additional advantage. The low water flow as compared to previous devices means that cooling water with relatively low quality in terms of purity may be used. With a much greater flow and similar water quality, the cooling system would be clogged to a much greater extent. The water quality requirement is therefore less demanding in an oil cooling device of the disclosed type.

[0027] In summary, the present disclosure relates to a method and a device for cooling oil, e.g. lubricating or hydraulic oil. The method involves feeding oil to a primary circuit of a heat exchanger, and feeding cooling water to a secondary circuit of the heat exchanger in order to cool the oil. In the secondary circuit, a sub-atmospheric pressure is maintained, such that the cooling water boils in the secondary circuit, even if the temperature of the incoming oil is relatively low, resulting in a water-steam mixture. The method further involves separating the water-steam mixture in order to provide process steam, which may be used for other purposes, thereby recovering a considerable portion of the thermal energy in the oil.

[0028] The scope of the invention is not limited by the above described example which may be altered in different ways within the scope of the appended claims.

Claims

1. A method for cooling oil comprising:

- feeding oil to a primary circuit of a heat exchanger, and
- feeding cooling water to a secondary circuit of the heat exchanger in order to cool the oil, **characterized by**
- maintaining a sub-atmospheric pressure in the secondary circuit, such that the cooling water boils in the secondary circuit resulting in a water-steam mixture, and
- separating the water-steam mixture in order to provide process steam.

2. A method according to claim 1, wherein the water flow through the heat exchanger is achieved by means of a liquid driven steam injector, where a steam flow is driven by a superheated pressurized liquid flow.

3. A method according to any of the preceding claims, which is used for cooling lubricating oil and/or hydraulic oil.

4. A method according to any of the preceding claims, wherein the pressure in the secondary circuit is within the range 0.1-0.5 bar (a).

5. Device for cooling oil comprising:

- a heat exchanger (1, 3) having a primary circuit (5, 7) receiving oil to be cooled, and a secondary circuit (9, 13) receiving cooling water, **characterized by**
- means (11, 17) for maintaining a sub-atmospheric pressure in the secondary circuit, such that the cooling water boils in the secondary circuit resulting in a water-steam mixture, and
- means (15) for separating the water-steam mixture in order to provide process steam.

6. A device according to claim 5, wherein the flow in the secondary circuit is driven by a liquid driven steam injector (17), in which a steam flow is driven by a superheated pressurized liquid water flow.

7. A device according to claim 6, wherein the steam injector is connected to a dome (23), in which a liquid water level is maintained, and steam is withdrawn from the dome.

8. A device according to claim 7, wherein the steam injector is driven by a pump (19) receiving liquid water from the dome.

9. A device according to any of claims 5-8, wherein the sub-atmospheric pressure is achieved by sucking water through a constriction (11) placed in the secondary circuit and upstream the heat exchanger.

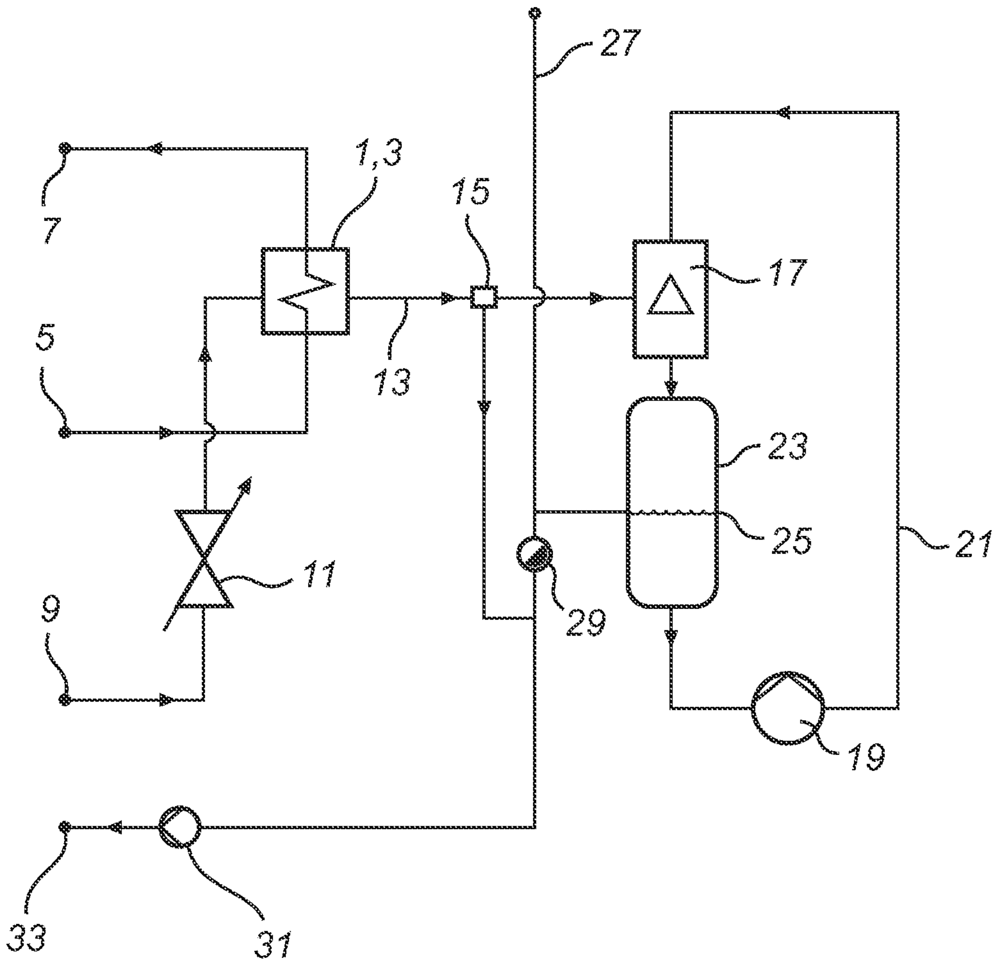

Fig. 1

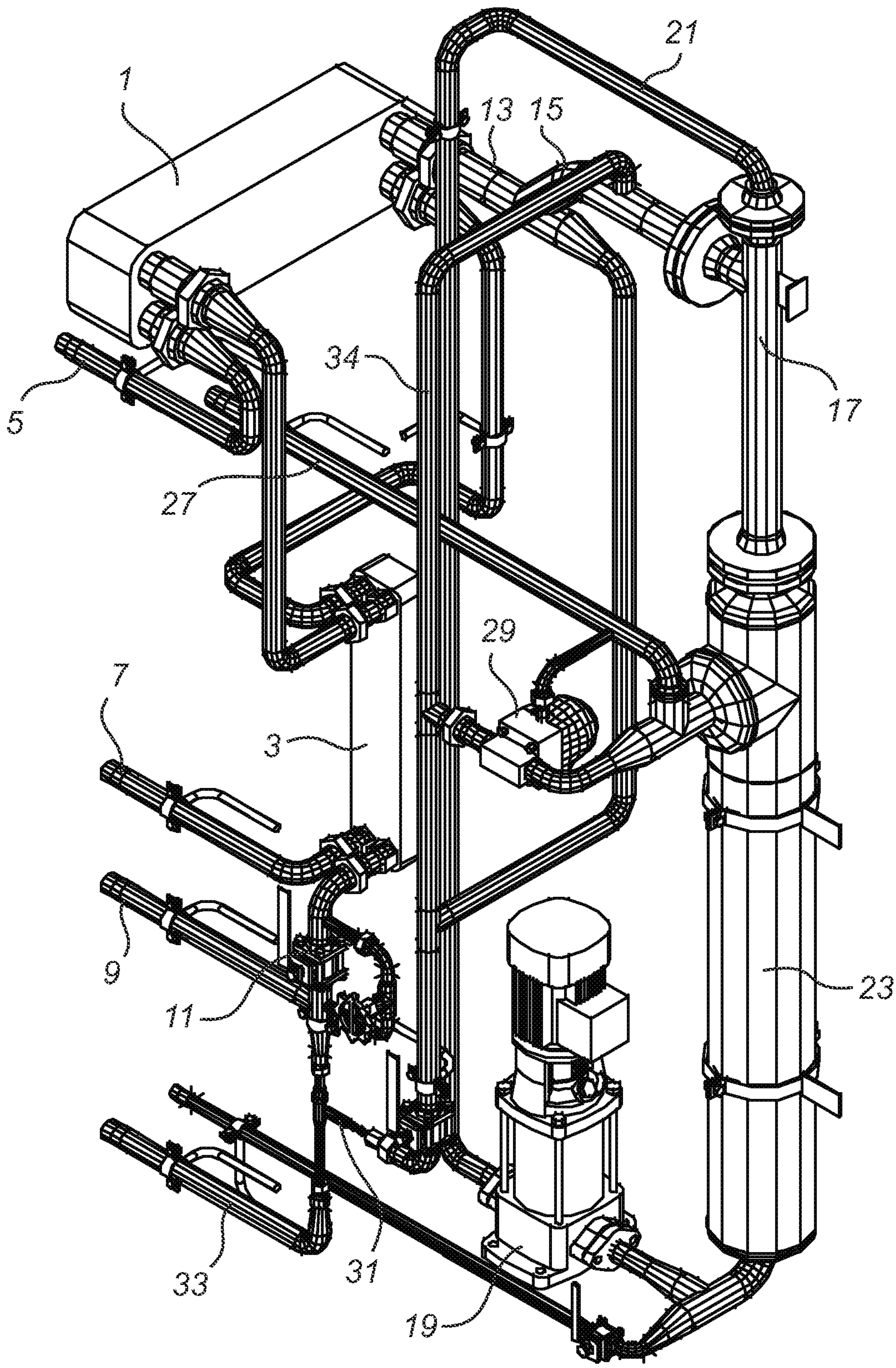

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 10 17 5742

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2010/070703 A1 (JAPAN COPPER DEV ASS [JP]; JAPAN RENEWABLE ENERGY DEV CO [JP]; SUGAWAR) 24 June 2010 (2010-06-24) * paragraph [0010] - paragraph [0011]; figure 1 * -----	1,5	INV. F01K13/00 F01K15/00
A	DE 20 2006 017581 U1 (BRUECKNER JUERGEN [DE]; GERECKE HERBERT [DE]; KERSTEN RALF [DE]) 25 January 2007 (2007-01-25) * paragraph [0012]; figure 1 * -----	1,5	
			TECHNICAL FIELDS SEARCHED (IPC)
			F01K

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	10 August 2011	Coquau, Stéphane

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 17 5742

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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10-08-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2010070703 A1	24-06-2010	NONE	
DE 202006017581 U1	25-01-2007	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82