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(12) # EUROPEAN PATENT APPLICATION

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(54) **High vacuum pump for pumping high temperature saturated steam**

(57) A vacuum pump is described, functioning in conditions of saturated or almost saturated steam with high temperatures, without a cooling system, preferably of the rotary blade type. The pump is advantageously applied to steam sterilisation systems.

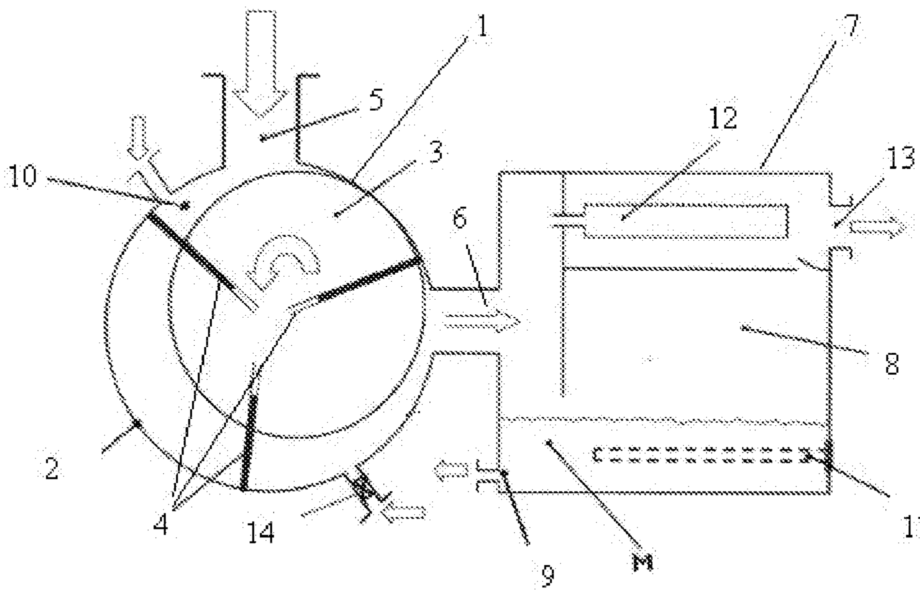

Fig.1

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Description

TECHNICAL FIELD

[0001] The invention relates to a vacuum pump in conditions of saturated or almost saturated steam at a high temperature, capable of producing a better degree of vacuum without the use of water and without the need for a cooling system. The pump of the invention is able to aspirate saturated steam at a high temperature, constantly maintaining a high degree of final vacuum. The pump of the invention is applied in apparatuses for sterilisation, disinfection and drying such as autoclaves, stoves, etc.

PRIOR ART

[0002] To date the system adopted for producing vacuum, in particular in steam sterilisation autoclaves, and also in industrial drying apparatuses, is based on the use of liquid loop pumps. They succeed in disposing of saturated vapours and gases at a high temperature which, in contact with the process water of the same pump, condense totally or partially and are conveyed therewith to the discharge.

[0003] Liquid loop pumps, however, have performance limits such as:

a) poor degree of working vacuum (generally 30-60 mbar), limited by the high vapour pressure of the process water, whose temperature increases due to the supply of heat of the aspirated steam;
b) high consumption of water, increasingly undesirable and costly.

[0004] The adoption of costly closed circuit water cooling units only partially overcomes the limitations described and also requires more complex and bulky and poorly reliable systems.

[0005] Other systems are known which, however, do not solve the problems described. They include the air ejector combined with the liquid loop pump, with low efficiency both in terms of flow rate and vacuum.

[0006] Diaphragm pumps, generally adopted on small laboratory autoclaves in that with the flow rate is limited, also give a poor degree of vacuum, smaller than that of liquid loop pumps.

[0007] Rotary dry blade pumps have proved unsuitable both due to the insufficient degree of vacuum and the total incompatibility of the mechanical parts with the steam.

[0008] Traditional lubricated blade pumps with a high degree of vacuum have proved unsuitable due to their inability to dispose of the steam which, emulsifying with the oil, causes its rapid deterioration with consequent lowering of the degree of vacuum and mechanical seizure of the pump.

[0009] The need is therefore felt to provide a pump such as to solve the following technical problems:

a) release from use of process water;
b) obtaining of an improved degree of vacuum.

[0010] The authors of the present invention have developed a pump which solves the problems described, producing a high degree of final vacuum to the benefit of the phase of drying and avoiding the use of process water for its functioning

[0011] Further advantages of the pump of the invention are:

a) reduction in the duration of the process cycles;
b) reduction in the costs of installation thanks to the extreme simplification of the vacuum circuit;
c) reduction in the energy costs resulting from the lower input of installed power and the considerable reduction in the process times;
d) reduction in the costs of maintenance due to its greater reliability and the elimination of the problems related to the depositing of limescale from the water;
e) elimination of the cost of water, no longer necessary for creating the vacuum;
f) elimination of the need for connecting to the water supply system.

DESCRIPTION OF THE INVENTION

[0012] The object of the present invention is therefore a vacuum pump functioning in conditions of saturated or almost saturated steam with high temperatures, characterised in that:

a) it does not have a cooling system;
b) it comprises a lubrication circuit with a tank wherein a lubricant fluid resistant to high temperatures and with high anti-emulsifying power circulates, with filtering means able to separate the steam from the lubricant fluid;
c) it is provided with means for the automatic disposal of any steam residues present in the lubricant fluid;

such that at each steam pumping cycle the separation of fluid/condensed steam in the tank takes place constantly.

[0013] In a preferred embodiment the pump of the invention is of the rotary blade type, however an expert in the field may also find other pumps, for example a lobed pump.

[0014] In a preferred embodiment the pump also comprises thermostat-controlled heating means inside the tank.

[0015] The lubricant fluid to be used in the pump must have properties of high specific weight, stability at high temperatures and anti-emulsifying properties.

[0016] The lubricant fluid can be mixed in a defined proportion, with a specific additive which confers antioxidant properties to the metal surfaces of the pump. In this way the formation of rust and incrustations is avoided.

[0017] The expert in the field will adopt materials and special elastomers suitable for withstanding constant pumping of the steam at a high temperature.

[0018] The pump is also made in a hermetic version (without oil guards) with transmission of the rotary motor/pump movement by means of a magnetic joint. The benefits obtained from the embodiment of this version relate to the safety and reliability of operation of the pump. In fact the risk of leakage of the fluid due to possible breakage of the oil guards is eliminated; moreover the operations of maintenance are limited to only the periodical control of the level of the lubricant and an overhaul for the cleaning and replacement of the seals in the medium and long term.

KEY TO THE DRAWINGS

[0019] The present invention will now be described in its embodiments by way of nonlimiting examples with reference to the following drawing:

Figure 1 is a schematic representation of the pump of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0020] Referring to Figure 1, the pump 1 is provided with a stator body 2 containing an eccentric rotor 3 with bearings for facilitating its rotation and at least one blade 4, with an aspiration conduit 5 and a discharge conduit 6. The pump 1 is also provided with a lubrication circuit 7, comprising a storage tank 8 with an intake point 9 of the lubricant fluid (M) placed on the base and an aspiration chamber 10. The storage tank 8 can be provided at its base with a thermostat-controlled heating resistor 11 and a coalescence filter 12, able to separate the vapours of the lubricant fluid, recovering them in the same tank. The flow of steam traverses the filter 12 together with the non-condensable gases and with them is conveyed towards the output 13.

[0021] The pump 1 is provided with appropriate seal means, for opening and closure of the conduits, such as valves, diaphragms and oil guards.

[0022] The lubricant fluid (M) is drawn through vacuum from the intake point 9 of the tank 8 towards the aspiration chamber 10, thus ensuring constant and optimal lubrication of the rotor 3/stator 2/blades 4 assembly and all the other components, such as valves, diaphragms, oil guards, bearings, etc., required for the proper functioning of the pump 1.

[0023] The pump is also provided with a gas ballast device 14, placed at the base of the stator 2, for automatic disposal of the humidity residues in the lubricant fluid.

[0024] The force of cohesion of the fluid (M) with the surfaces of the mechanical members of the pump 1 (e.g. the internal walls of the stator 2) prevents the steam aspirated by the conduit 5 from scouring them, ensuring constant lubrication thereof.

[0025] The condensation inputted by the aspiration conduit 5 is pumped with the air and the steam and, together with the vapours of the lubricant fluid (M), is conveyed into the storage tank 8. The high anti-emulsifying power of the lubricant fluid, its high temperature and the difference in specific weight with water, encourage the separation of fluid/condensation and the localisation of the latter at the top of the tank 8. Thus constant dehydration of the lubricant fluid (M) in the lower layers of the tank 8 is ensured. Via the intake point 9 the fluid is drawn, due to a difference in pressure, inside the aspiration chamber 10 of the pump 1.

[0026] In this way the pump constantly succeeds, even after having performed repeated cycles of pumping of the steam, in reaching a high degree of vacuum in the aspiration conduit 5.

[0027] The device 14 known as "gas ballast" allows the automatic disposal of the residues of humidity present in the lubricant fluid (M). The feeding of air via the device 14 reduces the partial pressure of the condensable gases in the mixture in the compression phase. In this way their transformation into the liquid phase is avoided, encouraging their expulsion and preventing them from mixing with the lubricant fluid.

[0028] An effective coalescence filter 12, placed at the discharge, separates the vapours of the lubricant fluid, recovering them in the bath of the tank. The flow of vapour traverses the filter together with the non-condensable gases and with them is conveyed towards the output. Any condensation which remains in the tank is placed, floating, on the lubricant liquid in the tank from where, due to the high temperature of the fluid, it is re-circulated in the form of vapour and disposed of through the output.

[0029] The efficacy of the filter reduces to negligible values the consumption of the lubricant fluid used, contributing to safeguarding the surrounding environment.

[0030] To further guarantee functioning also in the cases of pumping of quantities of steam above the limits of thermal balance of the pump, a thermostat-controlled heating resistor 11 was inserted in the fluid storage tank. In this way the latent heat of evaporation is supplied, necessary for disposal of the excess condensation present on the bath.

[0031] The seals, diaphragms, blades, oil guards, bearings, etc. are made with materials that resist temperatures of continuous operation of at least 130°C.

[0032] In fact the body of the pump functions without the system of forced cooling, obtaining an increase of approximately 30°C of the temperature value under normal conditions.

[0033] Cooling, in traditional pumps lubricated with mineral oil, serves to keep the working temperature low so as to avoid overheating and consequent loss of lubricating power of the oil. The pump of the invention must instead work at high temperatures, above 100°C, to prevent condensation of the aspirated steam and to reduce to a minimum the presence of residual humidity in the lubricant fluid (M).

[0034] The lubricant fluid used, Fomblin (Solvay Solexis), has high specific weight, over double compared to that of mineral oil, and very high chemical stability at high temperatures, with outstanding anti-emulsifying and antioxidant properties.

[0035] The lubricant fluid (M) can be mixed in a defined proportion, with a specific additive which confers antioxidant properties to the metal surfaces of the pump. In this way the formation of rust and incrustations is avoided.

[0036] The pump 1 is also made in a hermetic version (without oil guards) with transmission of the rotary motor/pump movement via a magnetic joint. The benefits obtained from the provision of this version relate to the safety and reliability of operation of the pump. In fact the risk of leakage of the fluid due to a possible breakage of the oil guards is eliminated in full. Moreover the operations of maintenance are limited to only the periodical check on the level of the lubricant and an overhaul for cleaning and replacement of the seals in the medium-long term.

ANALYSIS

[0037] The following is a description of the typical process of sterilisation performed on a traditional sterilisation autoclave equipped with a liquid loop pump.

[0038] The various phases of the process are:

a) Loading of the chamber of the autoclave with the objects to be sterilised.
b) Emptying of the chamber by means of a traditional liquid loop pump.
c) Pulsations of steam/vacuum (2 to 3) in the chamber. The pulsations encourage extraction of the air and penetration of the steam in the masses to be sterilised, to compensate the insufficient degree of vacuum of the liquid loop pump whose residual pressure is >30 mbar (limit vacuum).
d) Feeding in the chamber of saturated steam at 3 bar at a temperature of 134°C.
e) Steam sterilisation phase (approximately 10 min).
f) Release of steam from the chamber towards atmospheric pressure.
g) Extraction via a vacuum pump of the residual saturated steam in the chamber.
h) Subsequent phase of drying in vacuum of the sterilised objects.
i) Feeding of sterile air into the chamber.
j) Opening of the chamber and removal of the sterilised objects.

[0039] Total time of the sterilisation cycle: approximately 45 min.

[0040] With the pump of the invention it was possible to make the following improvements applicable to the following phases of the process described:

a) Emptying of the chamber via a pump with a high degree of vacuum without the use of water.
b) Elimination or reduction of the steam pulsations, possible only with the use of a pump with a high degree of vacuum.
c) Extraction of residual steam via a pump with high degree of vacuum.
d) Forced drying of the sterilised objects via a pump with a high degree of vacuum able to reach improved residual pressures of 2 mbar.

[0041] Total time of sterilisation cycle: approximately 32 min.

ANALYSIS OF RESISTANCE

[0042] The pump worked uninterruptedly for 1,500 hours at temperatures around 105°C, obtaining a vacuum of 2 mbar.

Claims

1. Vacuum pump operating in conditions of saturated or almost saturated steam at high temperatures, **characterised in that**:

    a) it does not have a cooling system;
    b) it comprises a lubrication circuit with a tank, wherein a lubricant fluid circulates, resistant to high temperature with high anti-emulsifying power, with filtering means able to separate the steam from the lubricant fluid;
    c) it is provided with means for the automatic disposal of any steam residues present in the lubricant fluid;

    such that at each cycle of pumping of the steam the separation of fluid/condensed steam in the tank takes place constantly.

2. Vacuum pump according to claim 1, being of the rotary blade type.

3. Vacuum pump according to claim 1 or 2, also comprising thermostat-controlled heating means inside the tank.

4. Vacuum pump according to one of the previous claims wherein the lubricant fluid is mixed with an antioxidant additive.

5. Vacuum pump according to one of the previous claims wherein the transmission of rotary motor/pump movement is by means of magnetic joints.

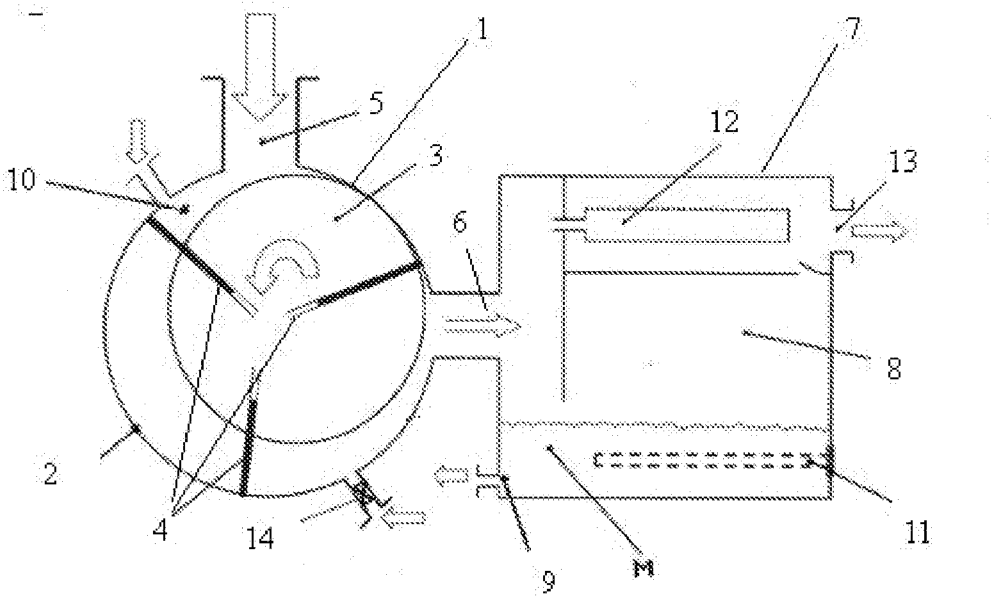

Fig.1

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EUROPEAN SEARCH REPORT

Application Number
EP 07 12 0582

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	GB 1 535 058 A (GEN SIGNAL CORP) 6 December 1978 (1978-12-06) * page 1, lines 14-43 * * page 1, lines 52-70 * * page 2, lines 39-53 * * page 2, lines 76-80 * * page 2, lines 39-53 * * page 2, lines 76-80 * * page 2, line 117 - page 3, line 21 * * page 3, lines 94-110; claim 1 * -----	1,3-5	INV. F04C18/344 F04C29/00
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 May 2008	Richmond, Robin

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 12 0582

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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