

Description

The invention relates to a liquid ring compressor unit with a horizontal shaft and a compressor housing, wherein connected to, if applicable, the last compression stage, a pressure chamber is provided in communication with a pressure connector, which is divided by a wall in the geodesically upper zone of the pressure chamber and projecting upwards at least to the shaft height and at least to the height of the pressure opening of the compression stage into a first zone, into which the pressure opening discharges, and a second zone, which zones are connected to one another above the wall to form a path for the conveyed medium and the second of which zones is in communication with the pressure connector.

It is known that liquid ring compressors require an operating liquid which takes part in the formation of the compressor compartments, which seals clearances inside the delivery chambers and assists in dissipating the heat occurring when compression takes place. It is inevitable that a portion of the operating liquid will become entrained in the conveyed gas and will flow with the latter through the pressure opening out of the delivery chamber of the compressor stage and will be carried away by the conveyed gas. Therefore, a liquid separator is generally arranged downstream, which effects the separation of the entrained liquid from the gas flow, so that gas which is in fact saturated with vaporised liquid but which is otherwise substantially liquid-free flows out of the separator outlet. The liquid remaining in the separator will then either be cooled in the circuit, returned to the compressor or removed via a separate outlet.

Liquid separators are known which are associated with the compressor as separate components. Embodiments are known, for example, in which the liquid separator is installed near the compressor in open or closed construction,

which results in a substantial space requirement. It is also known to install the liquid separator above the compressor on the overhead intake connector; apart from the considerable space requirement and complicated design, it has the disadvantage that it is necessary to provide control devices to ensure that, after the unit has been switched off, excessive liquid does not flow back into the compressor, thereby assuring that it can be restarted without any difficulty.

In another embodiment, the separator is incorporated into the basic frame of the unit; however, this is complicated and expensive in respect of construction and difficulties are also encountered in returning the operating liquid into the compressor, after the unit has been switched off. It is also known to provide the compressor in a separating container of pot-like shape, wherein the separating chamber surrounds the compressor. This is possible only with small compressor designs. Moreover, this arrangement has structural disadvantages because either the intake and pressure connectors have to be disposed in a housing part on one axial side of the compressor or, if one of the connectors is disposed on the separating vessel, it is necessary for the vessel to be made correspondingly strong and is thus expensive (DE-C 12 93 942).

Finally, it is known (FR-A 22 25 637) to provide a trough below the pressure chamber, which contains a separating wall for diverting the flow of medium, inside the pedestal or base plate of the compressor, which trough forms a separator vessel; since this trough is substantially deeper than the operating chamber of the compressor, it is difficult to effect the return of liquid after switching off has taken place.

Liquid separators are also known in vane-type compressors. These separators serve to remove any oil which has entered the gas flow, said oil being used to lubricate the compressor. However, there are fundamental differences in respect of liquid separation in liquid ring compressors, on

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the one hand, and vane-type compressors, on the other hand. In liquid ring compressors the liquid is directly involved in the formation of the compressor compartments, in which case because of the extensive phase interchange large amounts of the operating liquid are discharged from the operating chamber with the gas flow. However, the amounts of oil which enter the gas flow in a vane-type compressor are comparatively small so that relatively small liquid separators are satisfactory. Accordingly, it has been proposed to join the liquid separator to the compressor in a common housing; of course, this results in very complicated and thus expensive housing shapes (GB-A 393 977, DE-C 459 056, US-A 20 57 381).

No liquid separator is provided in the type of liquid ring compressor (GB-A 377 476) described at the beginning of this description. The pressure chamber contains a separating wall which projects upwards to the level of the pressure opening of the pump stage and which divides it into two zones. This wall serves to retain in the first zone, immediately following the pressure opening, a supply of liquid which prevents gas from flowing back into the start of the pressure opening. The second zone of the pressure chamber disposed behind the wall leads directly to the pressure connector. In this embodiment, the total amount of liquid contained in the conveyed gas flow is discharged from pressure chamber through the pressure connector, so that it is necessary to provide a liquid separator downstream thereof. It is evident that the pressure chamber cannot be used as a liquid separator because no measures are taken to remove the separated liquid separately from the gas flow. According to another known proposal (DE-B 20 36 295 = FR-A 21 03 218), the pressure chamber is divided by walls into first and second zones so that a liquid level far above the pressure opening is always maintained in the first zone. This is intended to effect sound-proofing by preventing any direct sound communication between the pressure opening and the pressure connector through the liquid-gas mixture filling the first pressure chamber zone. No separating action can be



achieved in this known pressure chamber; moreover, all the liquid accumulating here has to be removed with the gas flow into a separately provided liquid separator.

The invention is based on the object of providing a liquid separator for a liquid ring compressor of the type indicated at the beginning, with relatively low space requirement and construction costs.

The object according to the invention is achieved in that at its middle height the second zone of the pressure chamber has a liquid overflow separate from the pressure connector, and in that a plurality of deflectors and/or baffles are provided in the path for the conveyed medium disposed in the upper zone of the pressure chamber, which shield the pressure connector disposed above the liquid overflow from the pressure opening.

These features are already partly known from the state of the art but in each case fulfill different functions therein, whereas in the context of the invention they co-operate so as to provide mutual assistance. The wall separating the two zones of the pressure chamber serves to maintain a water supply ahead of the pressure opening while the compressor is in operation, so as to prevent any back flow of gas.

At the same time it has an action which is conducive to the separation of liquid but which is not utilised in the state of the art; namely, the liquid emerging from the pressure opening and impinging against the wall tends to be separated from the gas flow simultaneously flowing out of the opening. A more or less stabilised supply of liquid accumulates in the second zone of the pressure chamber, wherein both the function of forming a liquid supply and the removal of the separated liquid through an overflow is utilised. The ribs provided in the upper zone of the pressure chamber have, in known manner, a separation-inducing function, wherein they co-operate with the aforementioned projecting wall and with the pressure chamber zone for collecting the separated liquid, and by shielding the pressure connector

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from the pressure opening they prevent a portion of the gas flow from reaching the pressure connector without it first having been subjected to an adequate separating action.

The overflow of the second pressure chamber zone is preferably situated approximately at shaft height; however, it may also be situated elsewhere inside approximately the middle third of the pressure chamber height.

The feature that the pressure chamber is formed connected to the compressor stage in the compressor housing is generally intended to signify that the pressure chamber and the operating chamber of the compressor stage extend substantially over the same width and height within the same housing limits, in which case slight variations in the upper and/or lower perimeters are possible insofar as the unity of the housing construction is not adversely affected thereby. The unity of the housing construction is at least assured if the walls of the pressure chamber can be considered to be substantially a continuation of the walls of the operating chamber, particularly in the axial direction. A continuous cylindrical construction of the housing walls of the pump stage and of the pressure chamber is especially preferred, wherein the pressure connector is advantageously connected to the pressure chamber at the top. It is not necessary for the housing parts enclosing the pressure chamber and the pump stage to be integral.

At least one portion of the operating liquid contained in the pressure chamber can be returned to the circuit in the operating chamber of the compressor through a flow connection from the second zone of the pressure chamber, the principle of which is known for such purposes. It is also possible to remove one portion of the required operating liquid from the pressure chamber and to admit constantly another portion fresh from another extraneous source, in which case the latter portion can be cooled to such an extent that the temperature of the operating liquid is kept at the desired level. It is also

possible for a cooling device to be provided in the liquid separator of the pressure chamber, in a manner known per se.

The flow connection may be formed by a separate duct which leads from the second zone of the pressure chamber into a part of the operating chamber at lower pressure. It may be formed by an opening in the wall dividing the pressure chamber, through which liquid flows back into the first zone of the pressure chamber and from here through the pressure slot or separate flow connections into the operating chamber of the compressor. Irrespective of any flow connection for returning operating liquid into the operating chamber of the compressor, at least one level-compensating opening of narrow cross-section can be provided in the wall, which in the event of the machine being shut off enables any excess liquid, which in the operating chamber would lead to difficulties when restarting, to flow out via the first zone of the pressure chamber. Conversely, the supply of liquid accumulating in the second zone of the pressure chamber, which is required for restarting the pump, can be returned to the operating chamber through this opening.

When operation takes place with cooling and in order to maintain a minimum level of liquid in the pressure chamber throughout the operating period, a level-regulating means can be provided in the liquid separator of the pressure chamber.

With only a slight increase in the external dimensions of the compressor, the invention makes it possible to dispense with the otherwise additionally necessary liquid separator, while still achieving satisfactory separation of gas and liquid.

The invention will be illustrated in more detail below with reference to the drawing, the single Figure of which shows a diagrammatic longitudinal section through a compressor.

The compressor housing comprises an intake cover 1, a control disc 2 on the intake side, a housing 3 of the compressor stage, a control disc 4 on the delivery side

and a pressure chamber housing 5. When viewed in section transversely to the drawing plane, these housing components are of substantially matching, circular cross-sectional shape.

The intake cover 1 comprises an intake chamber 6, into which the gas to be conveyed is admitted via the intake connector 7 arranged thereabove. It also comprises a hub with a shaft bore which encloses a seal 8 for sealing a rotor shaft 9.

The intake cover 1 closely adjoins the control disc 2 on the intake side, which disc includes the intake opening 10 at a suitable, known location which does not necessarily correspond to the position shown.

The housing 3 of the compressor stage closely adjoins the control disc 2 on the intake side. This housing forms an annular housing wall, the inner surface 11 of which is disposed eccentrically with respect to the shaft 9, and with the impeller 12 mounted on the shaft encloses the operating chamber 13, in which the liquid ring (indicated by dots) circulates radially outwardly to seal off from the outside the compartments between the vanes. In the embodiment illustrated the top of the operating chamber 13, namely the location with the smallest radial distance between the inner surface 14 of the housing part 3 and the rotor 12, is disposed geodesically uppermost.

The compressor stage is closely adjoined by the control disc 4 on the delivery side, which disc comprises the pressure opening 15 at a suitable known location. The latter is always situated near the inner boundary 16 of the vane compartments in the direction of circulation just in front of the top of the operating chamber. Therefore, in the embodiment illustrated here it is provided above shaft height.

It is closely adjoined by the pressure chamber housing 5 which, for example, is formed by a cylindrical wall part 17 and a flat end wall part 18, and to which the pressure connector 39 is attached at the top. A wall 19

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projects vertically into this housing from the bottom up to the level of the pressure opening 15, said wall separating the first pressure chamber zone 20 from the second pressure chamber zone 21, wherein the axial dimensions of the first zone 20 are approximately $1/3$ to $1/2$ of the axial width of the operating chamber 13, whereas the axial dimensions of the second zone 21 are approximately 2 to 3 times as large. The second pressure chamber zone 21 has an outlet or overflow opening 22, the lower edge of which determines the level 23 in the second pressure chamber zone 21 and the wall 19 extends substantially therebeyond.

A substantially horizontal rib 24 is disposed above the first pressure chamber zone 20 and the wall 19, whereby the flow of medium emerging from the pressure opening 15 and impinging against the wall 19 is constrained to undergo another deflection in horizontal direction. Beyond the wall 19 there follows a rib 25 which protrudes from the rib 14 [sic] and deflects the flow of medium downwards. Here it impinges against a rib 26 which diverts the flow of medium obliquely upwards and which shields the liquid accumulating in the second pressure chamber zone 21, thereby preventing the already separated liquid from being entrained once more with the flow of gas. Said rib comprises one or more openings 27 through which the separated liquid can pass downwards. One portion of the flow of medium deflected upwards by the rib 26 encounters a horizontal rib 28, which forms an extension of the rib 24, so as to be subsequently deflected horizontally from the upper part of the housing wall 17 towards the pressure connector 39. The ribs 24, 28 effectively shield the the pressure connector 39 from the pressure opening 15 and those regions of the flow of medium in which even greater proportions of entrained liquid are to be expected.

It is possible for the shaft 9 to be mounted inside the housing at a location (not shown), for example in the control discs 2, 4.

The intake cover 1 comprises in the geodesically lower zone a chamber 30 which is divided by a wall 29 and

which communicates via a bore 31 with a source of fresh liquid (not shown). The chamber 30 communicates with the operating chamber 13 through a bore 32. Accordingly, fresh liquid in the amount desired can be supplied to the operating chamber of the pump stage via the path 31, 30, 32.

The control disc 4 on the delivery side is provided at a geodesically low point with a small bore 33 through which, during operation, operating liquid can flow from the first zone 20 of the pressure chamber back into the operating chamber 13 and which enables level compensation to take place even when the compressor is inoperative. Likewise, the wall 19 is provided at a geodesically low point with a small bore 34 which serves to effect level compensation while the compressor is inoperative.

During operation, the compressor draws in gas from the intake connector 7 via the intake chamber 6 and the intake opening 10, which gas is compressed in the operating chamber 13, whereupon it is expelled through the pressure opening 15 into the first zone 20 of the pressure chamber. The liquid which is retained by the wall 19 in front of the pressure opening accumulates in this zone, so as to form a liquid lock to prevent the backflow of gas into the pressure opening. The outflowing gas/liquid mixture impinges against the upper part of the wall 19, thereby enhancing separation, and it then flows through the curved duct which is formed by the wall 19, the rib 24 and the rib 25 and in which coarse separation takes place, whereupon after further separation in the vicinity of the ribs 26 and 28 it arrives at the pressure connector 39. Along this path the ribs and the pressure chamber walls form deflectors and baffles against which the liquid is separated.

The liquid surplus occurring in the second zone 21 of the pressure chamber flows out through the overflow 22. Part of the liquid situated in the pressure chamber flows through the opening 33 back into the operating chamber 13, whereas another part of the loss in operating liquid is compensated for by a supply of fresh liquid.

When the compressor is shut off, level compensation can take place through the openings 33, 34, thereby ensuring, on the one hand, that the minimum supply of liquid required for restarting is present in the pump operating chamber 13 and, on the other hand, that any surplus liquid flows out through the overflow 22.

The invention is not restricted to the arrangement illustrated. Modifications can be made according to the knowledge of the person skilled in the art. For example, the compressor may be of multistage design, in which case the respective last compressor stage may take the place of the compressor stage illustrated in the drawing. Moreover, the invention is also applicable to those types of compressors in which intake and compressor connections are provided on the same axial side of the pump stage, since both the intake and pressure chambers are formed separately from one another in the same housing part.

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CLAIMS:

1. A liquid ring compressor unit with a horizontal shaft (9) and a compressor housing (1,2,3,4,5), wherein connected to, if applicable, the last compression stage, a pressure chamber is provided in communication with a pressure connector (39), which is divided by a wall (19) in the geodesically upper zone of the pressure chamber and projecting upwards at least to the height of the pressure opening (15) of the compression stage (13) into a first zone (20), into which the pressure opening (15) discharges, and a second zone (21), which zones are connected to one another above the wall (19) to form a path for the conveyed medium and the second (21) of which zones is in communication with the pressure connector (39), characterised in that at its middle height the second zone (21) of the pressure chamber has a liquid overflow (22) separate from the pressure connector (39), and in that a plurality of deflectors and/or baffles (24,25,26,28) are provided in the path for the conveyed medium disposed in the upper zone of the pressure chamber, which shield the pressure connector (19) disposed above the liquid overflow (22) from the pressure opening (15).

2. A liquid ring compressor unit according to Claim 1, characterised in that the liquid overflow (22) is situated at the height of the shaft (9).

3. A liquid ring compressor unit according to Claim 1, characterised in that at least one level-compensating opening (34) is provided in the wall (19).

4. A liquid ring compressor unit according to Claim 1 or 3, characterised in that a flow connection (33,34) leads from the second zone (21) of the pressure chamber to the working chamber (13) of the compression stage.