

Description

The present invention relates to an integral oil separator and muffler.

Background of the Invention

Screw compressors employed in refrigeration applications commonly use oil for sealing, lubricating and cooling. The oil is injected into the working chamber of the compressor and thus into the refrigerant gas being compressed. As a result, the pulsating compressor discharge ordinarily contains oil entrained in the compressed refrigerant gas. The presence of oil interferes with the heat exchange function of the refrigeration system and otherwise degrades the efficiency of the system. The pulsating discharge gas is one of the most significant causes of radiated noise in screw compressors. Generally, the amount of oil carried over to the system is kept as low as possible in order to minimize the degrading of the heat transfer surfaces, to minimize the delivery of oil to remote locations in the system and to keep a sufficient oil supply in the oil sump for sealing, lubricating and cooling needs. The oil removal or separation ordinarily takes place at a convenient place between the compressor discharge and the condenser. A muffler to reduce the discharge pulsations is located at a convenient location near the compressor discharge.

In US-A-3 070 977 there is described an integral oil separator and muffler according to the preamble of claim 1. Particularly, US-A-3 070 977 discloses an integral oil separator and muffler including a closed casing means having an inlet, an outlet and partition means dividing a portion of the casing into a muffler portion and an oil separator portion. The partition means extends radially in the casing and oil separation takes places both in the muffler and in the separate oil separator.

It is an object of this invention to provide efficient oil separation for a screw compressor and to decrease the first few harmonics of the pressure pulsations in the compressor discharge flow. It is an additional object of this invention to provide an integral oil separator and muffler which facilitates to return of the oil trapped in the muffler to the main oil sump.

To achieve this, the integral oil separator of the invention is characterized by the features claimed in the characterizing part of claim 1.

According to the invention, the muffler portion includes a plurality of chambers of different acoustical properties. The partition means extends in longitudinal direction of the casing means. The oil separator portion includes a deflecting means facing the muffler portion, the deflecting means being formed by one end of the casing means whereby flow from the muffler portion is turned approximately 180°. The oil separator portion further includes a flow path including demister means and coalescing means before passing through the outlet.

In a preferred embodiment of the invention, a plural-

ity of flow direction changes is employed in the muffler and the oil separator in combination with a discharge deflector, demisters and a coalescer to remove and collect oil entrained in the refrigerant gas. By locating the muffler upstream of the oil separator, the discharge pulsations in the refrigerant flow will be reduced thereby significantly reducing the radiated noise from the oil separator. Except for oil removed in the coalescer, all of the separated oil drains directly into the main oil sump. The refrigerant gas and entrained oil is subjected to at least two impingements with a resulting change in direction to inertially remove as much oil as possible prior to reaching and passing through the demisters where the amount of oil removal has a direct, temporary effect on the demisters and their flow resistances as the entrained oil impinges, collects and drains to the sump.

Basically the discharge gas from a screw compressor is directed radially and in a generally horizontal direction into the integral oil separator and muffler where it impinges upon the discharge deflector located at the inlet of the muffler portion. Impingement of the discharge flow with the discharge deflector produces a 90° directional flow change with a portion of the oil collecting in an oil pool and/or on the deflection surface due to inertial forces as the flow direction changes. The flow is then directed into the muffler which consists of a series of chambers each having nonaligned tubular inlets and outlets whereby flow directions are changed with some impingement and reverberation of the flow taking place. Each chamber is tuned to a desired waveband. Attenuated flow from the muffler impinges on a mesh pad defining a demister and lining the end of the housing whereby the flow is diverted 180°. The flow then passes through two demisters defined by mesh pads and into a coalescer. The flow passes through the walls of the coalescer leaving any entrained oil trapped in the coalescing media of the element. The coalesced oil gathers on the outside diameter of the coalescer and flows into the secondary oil sump. The refrigerant gas, now nearly oil free, exits the separator and is delivered to the condenser of the refrigeration system.

Brief Description of the Drawings

For a fuller understanding of the present invention, reference should now be made to the following detailed description thereof taken in conjunction with the accompanying drawings wherein:

Figure 1 is a vertical sectional view of the integral oil separator and muffler of the present invention taken along line 1-1 of Figure 4 with the coalescer shown unsectioned;

Figure 2 is a sectional view taken along line 2-2 of Figure 1;

Figure 3 is a sectional view taken along line 3-3 of

Figure 1;

Figure 4 is a partially sectioned cut away top view of the integral oil separator and muffler of the present invention;

Figure 5 is a sectional view taken along line 5-5 of Figure 4; and

Figure 6 is a sectional view taken along line 6-6 of Figure 5.

Description of the Preferred Embodiment

In the Figures, the numeral 10 generally indicates the integral oil separator and muffler of the present invention. The external portion of the oil separator 10 is an essentially cylindrical shaped casing 12 having an inlet 13 with a flange 14 and an outlet 15. Casing 12 is partitioned by divider plate 16 which, as best shown in Figures 1 and 4, does not extend the full length of casing 12. Divider plate 16 is welded to and divides casing 12 into muffler 18 and oil separator 19. Referring now to Figure 5, it will be noted that divider plate 16 divides the casing 12 into a major segment of a circle which defines oil separator 19 and a minor segment of a circle which defines muffler 18.

A horizontal screw compressor (not illustrated) is attached to flange 14 of inlet 13 by bolts (not illustrated). As the first step of oil removal, a partition 30 is provided at one end of muffler 18 and acts as a discharge deflector, as best shown in Figure 4, and coacts with divider plate 16 to deflect flow entering inlet 13 into muffler 18. As best shown in Figure 2, discharge deflector 30 is generally annular and provides a partition relative to casing 12. Referring to Figures 4-6, it will be noted that muffler 18 includes three partitions 18-1, 18-2 and 18-3 having tubes or pipes 18-4, 18-5 and 18-6, respectively, extending therethrough. A first chamber 18-7 is formed between partitions 18-1 and 18-2 and a second chamber 18-8 of a different size and acoustical properties is formed between partitions 18-2 and 18-3. Tubes 18-4, 18-5 and 18-6 are of different lengths and coact with the different sized chambers 18-7 and 18-8 so as to attenuate different chosen frequencies. Oil drain holes 18-9, 18-10 and 18-11 are formed in partitions 18-1, 18-2 and 18-3, respectively, near their bottoms, at progressively lower heights. The flow entering inlet 13 goes through a 90° turn due to the coaction of deflector 30 and divider plate 16. Any oil separating out will collect and flow through oil drain hole 18-9 when the level thereof becomes high enough. The flow then passes through tube 18-4 into chamber 18-7. Because tubes 18-4 and 18-5 are not aligned the flow tends to reverberate in chamber 18-7 before exiting via tube 18-5. Any oil separating out plus any oil entering chamber 18-7 via drain hole 18-9 will collect and flow through drain hole 18-10 into chamber 18-8 when the level thereof becomes high enough. Tube 18-5

is of a different length than tube 18-4 to be responsive to different frequencies. Flow passing through tube 18-5 goes into chamber 18-8 which has different acoustical properties than chamber 18-7 so as to capture different frequencies. Because tubes 18-5 and 18-6 are not aligned the flow tends to reverberate in chamber 18-8 before exiting via tube 18-6. Any oil separating out plus any oil entering chamber 18-8 via drain hole 18-10 will collect and flow through drain hole 18-11 into major oil sump 26 when the level thereof becomes high enough. The turning of the flow due to the coaction of deflector 30 and divider plate 16 as well as the reverberation and dwell time of the flow in chambers 18-7 and 18-8 thus causes oil to separate out of the flow, as noted, and collect on partitions 18-1, 18-2 and 18-3, plate 16 and the inner wall of shell 12. The separated oil tends to flow downwardly and drains into oil separator 19 and major oil sump 26 as described above.

As is best shown by the flow indicating arrows in Figure 4, the flow exiting muffler 18 via tube 18-6 into chamber 22 impinges upon agglomerating mesh pad 40 which forms a liner with respect to the end of casing 12 and causes the flow to be diverted 180° while removing and collecting some oil therefrom. The removed oil flows by gravity into main oil sump 26. The refrigerant gas, which now contains only fine droplets or a mist of oil, passes serially through demister pads 41 and 42, respectively, which, as best shown in Figure 1, are partially immersed in main oil sump 26. The demister pads 41 and 42 remove oil by impingement and as the oil gathers in the fine wire mesh of the pads, it drains downwardly by gravity to maintain the oil reservoir defined by main oil sump 26. Demister pads can extract as much as 99.9% of the oil still in circulation when it reaches the demister pads. The preliminary removal of the large oil droplets is therefore necessary to prevent overwhelming the demister pads and greatly increasing flow resistance.

As the now relatively oil-free refrigerant gas passes through demister pad 42 into coalescer 50, it must make another 180° change in direction since, as best shown in Figures 1 and 2, the only exit from chamber 22 in oil separator 19 is via radially displaced opening 51 in plate 52 followed by opening 61 in plate 62 which opens into coalescer 50. Coalescer 50 is, in part, made of fiberglass and is of a generally annular cylindrical shape and with no openings other than 61 which serves only as an inlet. The refrigerant gas entering coalescer 50 via opening 61 must pass through the cylindrical fiberglass walls to reach chamber 60 thereby leaving any entrained oil trapped in the coalescing media of coalescer 50. The coalesced oil gathers on the outside surface of coalescer 50 and drops downward, by gravity, as gravitational forces in the collected oil overcome viscous forces and collects in secondary oil sump 28.

The oil collected and maintained in oil sumps 26 and 28 is withdrawn via outlets 27 and 29, respectively, and is either reinjected into a lower pressure area of the compressor by pressure differential or passed through a

pump (not illustrated) where its pressure is raised to be delivered back to the compressor. The oil is injected into the compressor to seal, lubricate and cool the mechanism.

Although a preferred embodiment of the present invention has been illustrated and described, other changes will occur to those skilled in the art. For example, the number of chambers in muffler 18 can be increased and the sumps can be connected.

Claims

1. An integral oil separator and muffler including a closed casing means (12) having an inlet (13) and an outlet (15) and:

partition means (16) dividing a portion of said casing means (12) into a muffler portion (18) and an oil separator portion (19),
said muffler portion (18) providing a fluid path between said inlet (13) and said oil separator portion (19),

characterized by said muffler portion (18) including a plurality of chambers (18-7, 18-8) of different acoustical properties,
said partition means (16) extending in longitudinal direction of said casing means (12) towards one end thereof,

said oil separator portion (19) including a deflecting means (40) facing said muffler portion (18), said deflecting means (40) being formed by said one end of said casing means (12) whereby flow from said muffler portion (18) is turned approximately 180°, and

said oil separator portion (19) further including a flow path including demister means (41, 42) and coalescing means (50) before passing through said outlet (15).

2. The integral oily separator and muffler of claim 1, characterized in further including sump means (26) located in said casing means (12) and in fluid communication with both said muffler portion (18) and said oil separator portion (19) whereby oil separated out in said portions (18, 19) can drain into said sump means (26).

3. The integral oil separator and muffler of claim 1, characterized in further including radially extending partition means (30) located axially between said inlet (13) and said outlet (15) and dividing said casing means (12) into a first portion (22) including said inlet (13) and a second portion (60) including said outlet (15),

passage means (51) in said radially extending partition means (30) whereby a continuous flow path is defined from said oil separator portion (19),

through said passage means (51) into said coalescing means (50), through said coalescing means (50) to said outlet (15).

4. The integral oil separator and muffler of claim 3, characterized in further including sump means (26) located in said first portion (22) and in fluid communication with both said muffler portion (18) and said oil separator portion (19).

Patentansprüche

1. Integraler Ölabscheider und Schalldämpfer, der eine abgeschlossene Gehäuseeinrichtung (12) umfasst, welcher einen Einlass (13) und einen Auslass (15) und:

eine Trennwandeinrichtung (16), welche einen Anteil der Gehäuseeinrichtung (12) in einen Schalldämpferanteil (18) und einen Ölabscheideranteil (19) unterteilt,

wobei der Schalldämpferanteil (18) einen Weg für die Strömung zwischen dem Einlass (13) und dem Ölabscheideranteil (19) bereit stellt, hat,

dadurch gekennzeichnet, dass der Schalldämpferanteil (18) eine Vielzahl von Kammern (18-7, 18-8) mit verschiedenen akustischen Eigenschaften umfasst,

wobei sich die Trennwandeinrichtung (16) in Längsrichtung der Gehäuseeinrichtung (12) gegen ein Ende desselben hin erstreckt,

wobei der Ölabscheideranteil (19) eine Ablenkungseinrichtung (40) umfasst, die durch das eine Ende der Gehäuseeinrichtung (12) gebildet wird, wodurch die Strömung aus dem Schalldämpferanteil (18) um ungefähr 180° gedreht wird, und

wobei der Ölabscheideranteil (19) weiter einen Strömungsweg umfasst, der eine Demistereinrichtung (41, 42) und eine Coalescereinrichtung (50) umfasst, bevor der durch den Auslass (15) hindurch geht.

2. Integraler Ölabscheider und Schalldämpfer nach Anspruch 1, dadurch gekennzeichnet, dass er weiter eine Sumpfeinrichtung (26) umfasst, die in der Gehäuseeinrichtung (12) angeordnet ist und fluidleitend sowohl mit dem Schalldämpferanteil (18) als auch mit dem Ölabscheideranteil (19) verbunden ist, wodurch Öl, das in diesen Anteilen (18, 19) abgeschieden wurde, in diese Sumpfeinrichtung (26)



pump (not illustrated) where its pressure is raised to be delivered back to the compressor. The oil is injected into the compressor to seal, lubricate and cool the mechanism.

Although a preferred embodiment of the present invention has been illustrated and described, other changes will occur to those skilled in the art. For example, the number of chambers in muffler 18 can be increased and the sumps can be connected.

Claims

1. An integral oil separator and muffler including a closed casing means (12) having an inlet (13) and an outlet (15) and:

partition means (16) dividing a portion of said casing means (12) into a muffler portion (18) and an oil separator portion (19),
said muffler portion (18) providing a fluid path between said inlet (13) and said oil separator portion (19),
characterized by said muffler portion (18) including a plurality of chambers (18-7, 18-8) of different acoustical properties,
said partition means (16) extending in longitudinal direction of said casing means (12) towards one end thereof,
said oil separator portion (19) including a deflecting means (40) facing said muffler portion (18), said deflecting means (40) being formed by said one end of said casing means (12) whereby flow from said muffler portion (18) is turned approximately 180°, and
said oil separator portion (19) further including a flow path including demister means (41, 42) and coalescing means (50) before passing through said outlet (15).

2. The integral oily separator and muffler of claim 1, characterized in further including sump means (26) located in said casing means (12) and in fluid communication with both said muffler portion (18) and said oil separator portion (19) whereby oil separated out in said portions (18, 19) can drain into said sump means (26).

3. The integral oil separator and muffler of claim 1, characterized in further including radially extending partition means (30) located axially between said inlet (13) and said outlet (15) and dividing said casing means (12) into a first portion (22) including said inlet (13) and a second portion (60) including said outlet (15),

passage means (51) in said radially extending portion means (30) whereby a continuous flow path is defined from said oil separator portion (19),

through said passage means (51) into said coalescing means (50), through said coalescing means (50) to said outlet (15).

4. The integral oil separator and muffler of claim 3, characterized in further including sump means (26) located in said first portion (22) and in fluid communication with both said muffler portion (18) and said oil separator portion (19).

Patentansprüche

1. Integraler Ölabscheider und Schalldämpfer, der eine abgeschlossene Gehäuseeinrichtung (12) umfasst, welcher einen Einlass (13) und einen Auslass (15) und:

eine Trennwandeinrichtung (16), welche einen Anteil der Gehäuseeinrichtung (12) in einen Schalldämpferanteil (18) und einen Ölabscheideranteil (19) unterteilt,

wobei der Schalldämpferanteil (18) einen Weg für die Strömung zwischen dem Einlass (13) und dem Ölabscheideranteil (19) bereit stellt, hat,

dadurch gekennzeichnet, dass der Schalldämpferanteil (18) eine Vielzahl von Kammern (18-7, 18-8) mit verschiedenen akustischen Eigenschaften umfasst,

wobei sich die Trennwandeinrichtung (16) in Längsrichtung der Gehäuseeinrichtung (12) gegen ein Ende desselben hin erstreckt,

wobei der Ölabscheideranteil (19) eine Ablenkungseinrichtung (40) umfasst, die durch das eine Ende der Gehäuseeinrichtung (12) gebildet wird, wodurch die Strömung aus dem Schalldämpferanteil (18) um ungefähr 180° gedreht wird, und

wobei der Ölabscheideranteil (19) weiter einen Strömungsweg umfasst, der eine Demistereinrichtung (41, 42) und eine Coalescereinrichtung (50) umfasst, bevor der durch den Auslass (15) hindurch geht.

2. Integraler Ölabscheider und Schalldämpfer nach Anspruch 1, dadurch gekennzeichnet, dass er weiter eine Sumpfeinrichtung (26) umfasst, die in der Gehäuseeinrichtung (12) angeordnet ist und fluidleitend sowohl mit dem Schalldämpferanteil (18) als auch mit dem Ölabscheideranteil (19) verbunden ist, wodurch Öl, das in diesen Anteilen (18, 19) abgeschieden wurde, in diese Sumpfeinrichtung (26)



abtropfen kann.

3. Integraler Ölabscheider und Schalldämpfer nach Anspruch 1, dadurch gekennzeichnet, dass er weiter sich radial erstreckende Trennwandeneinrichtungen (30) umfasst, die axial zwischen dem Einlass (13) und dem Auslass (15) angeordnet sind und die Gehäuseeinrichtung (12) in einen ersten Anteil (22), welcher den Einlass (13) umfasst, und einen zweiten Anteil (60), welcher den Auslass (15) umfasst, unterteilen,

und eine Durchgangseinrichtung (51) in der sich radial erstreckenden Trennwandeneinrichtungen (30) umfasst, wodurch ein stetiger Strömungsweg vom Ölabscheideranteil (19), durch die Durchgangseinrichtung (51) hindurch in die koaleszierende Einrichtung (50) hinein, durch die koaleszierende Einrichtung (50) hindurch zum Auslass (15) definiert wird.

4. Integraler Ölabscheider und Schalldämpfer nach Anspruch 3, dadurch gekennzeichnet, dass er weiter eine Sumpfeinrichtung (26), die im ersten Anteil (22) angeordnet ist und fluidleitend sowohl mit dem Schalldämpferanteil (18) als auch mit dem Ölabscheideranteil (19) verbunden ist, umfasst.

Revendications

1. Un séparateur d'huile et un amortisseur de bruit intégraux comprenant un moyen d'enveloppe fermé (12) ayant une entrée (13) et une sortie (15) et:

un moyen de séparation (16), divisant une portion dudit moyen d'enveloppe (12) en une portion servant à l'amortissement du bruit (18) et en une portion servant à la séparation de l'huile (19),

ladite portion servant à l'amortissement du bruit (18) fournissant une trajectoire pour le fluide entre ladite entrée (13) et ladite portion servant à la séparation de l'huile (19),

caractérisés par ladite portion servant à l'amortissement du bruit (18), comprenant une pluralité de chambres (18-7, 18-8) de propriétés acoustiques différentes,

ledit moyen de séparation (16), s'étendant dans une direction longitudinale dudit moyen d'enveloppe (12) en direction d'une première extrémité de ce dernier,

ladite portion servant à la séparation de l'huile (19), comprenant un moyen de déviation (40) faisant face à ladite portion servant à l'amortis-

sement du bruit (18), ledit moyen de déviation (40) étant formé par ladite première extrémité dudit moyen d'enveloppe (12), grâce à quoi l'écoulement provenant de ladite portion servant à l'amortissement du bruit (18) est tourné de approximativement 180°, et

ladite portion servant à la séparation de l'huile (19), comprenant en outre une trajectoire pour l'écoulement comprenant un moyen anti-buée (41,42) et un moyen de coalescence (50) avant le passage à travers ladite sortie (15).

2. Le séparateur d'huile et l'amortisseur de bruit intégraux de la revendication 1, caractérisés en ce qu'ils comprennent en outre un moyen de réservoir (26) placé dans ledit moyen d'enveloppe (12) et en communication de fluide avec à la fois ladite portion servant à l'amortissement du bruit (18) et ladite portion servant à la séparation de l'huile (19) grâce à quoi l'huile séparée dans lesdites portions (18,19) peut s'écouler dans ledit moyen de réservoir (26).

3. Le séparateur d'huile et l'amortisseur de bruit intégraux de la revendication 1, caractérisés en ce qu'ils comprennent en outre un moyen de séparation s'étendant radialement (30) placé axialement entre ladite entrée (13) et ladite sortie (15) et divisant ledit moyen d'enveloppe (12) en une première portion (22) comprenant ladite entrée (13) et en une seconde portion (60) comprenant ladite sortie (15), un moyen de passage (51), dans ledit moyen de séparation s'étendant radialement (30), grâce à quoi une trajectoire d'écoulement continue est définie à partir de ladite portion servant à la séparation de l'huile (19), à travers ledit moyen de passage (51), dans ledit moyen de coalescence (50), à travers ledit moyen de coalescence (50) jusqu'à ladite sortie (15).

4. Le séparateur d'huile et l'amortisseur de bruit intégraux de la revendication 3, caractérisés en ce qu'ils comprennent en outre un moyen de réservoir (26) placé dans ladite première portion (22) et en communication de fluide avec à la fois ladite portion servant à l'amortissement du bruit (18) et ladite portion servant à la séparation de l'huile (19).