IN-LINE HEAT EXCHANGER ASSEMBLY AND METHOD OF USING

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ABSTRACT

An heat exchanger assembly and a method of use thereof adapted for transferring heat to or from a fluid to a surrounding environment within an apparatus, such as motor vehicle engines, as it enters and leaves a fluid-handling device. The heat exchanger assembly includes first and second manifolds, multiple cooling tubes and a return tube. The first manifold has inlet holes therein and the second manifold has outlet holes therein. The multiple cooling tubes fluidically interconnect the first and second manifolds and the inlet and outlet holes thereof. The return tube passes through the first and second manifolds to fluidically interconnect opposite ends of the heat exchanger assembly. The return tube has a first end adapted to mount the heat exchanger assembly to the apparatus and an oppositely-disposed second end that protrudes from the second manifold and is adapted to secure the fluid-handling device thereto.
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CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 61/527,806, filed Aug. 26, 2011, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] The present invention generally relates to heat transfer apparatuses. More particularly, this invention relates to an heat exchanger assembly adapted for installation on an apparatus, such as a motor vehicle engine, to cool oil as it enters and leaves an fluid-handling device.

[0003] Heat exchangers are routinely employed within the automotive industry, such as in the form of radiators for cooling engine coolant, oil coolers, charge air coolers, condensers and evaporators for air conditioning systems, and heaters. In order to efficiently maximize the amount of surface area available for transferring heat between the environment and a fluid flowing through the heat exchanger, heat exchanger designs are typically of a tube-and-fin type in which numerous cooling tubes thermally communicate with high surface area cooling fins. The cooling fins enhance the ability of the heat exchanger to transfer heat from the fluid to the environment, or vice versa.

[0004] Oil coolers for automotive vehicle engine systems typically include a pair of headers and a core having a plurality of cooling tubes disposed between the two headers. A heated oil from a transmission flows through the cooling tubes and air flowing through a grill of the vehicle flows across the cooling tubes in order to remove heat from the oil within the cooling tubes. The oil enters and exits the oil cooler through the headers. The headers are typically connected to the engine and the oil filter by hoses and connectors, such as clamps.

[0005] Oil coolers of the type described above may be difficult to install. Typically, a plurality of metal brackets are welded to a vehicle frame and the oil cooler is attached thereto by threaded fasteners. Disadvantageously, welding requires additional processing steps during vehicle assembly. Further, conventional mounting arrangements typically require multiple threaded fasteners to secure a secure mount. In many instances, the threaded fasteners may work lose which may result in vibration. In addition, the fasteners can be overtightened and may result in damage to the oil cooler.

[0006] Once the oil cooler is mounted, the hoses must be run to the headers of the oil cooler. This requires additional installation steps and clutters the area around the engine. Because oil pressure drops within a hose as the length of the hose increases, the oil cooler may have a negative impact on the performance of the vehicle depending on the location of the mounted oil cooler.

[0007] In view of the above, it can be appreciated that there is a need for an improved heat exchanger assembly for cooling oil within an engine of a motor vehicle, as well as other types of fluid-containing apparatuses. It would be particularly advantageous if such heat exchanger assembly were capable of installation without mounting fixtures to secure the heat exchanger or hoses to transfer the oil between the heat exchanger and components of the engine.

BRIEF DESCRIPTION OF THE INVENTION

[0008] The present invention provides a cooler assembly and a method of use thereof adapted for cooling oil within an apparatus, including but not limited to motor vehicle engines.

[0009] According to a first aspect of the invention, a heat exchanger assembly includes first and second manifolds, multiple cooling tubes and a return tube. The first manifold has inlet holes therein and the second manifold has outlet holes therein. The multiple cooling tubes fluidly interconnect the first and second manifolds and the inlet and outlet holes thereof. The return tube passes through the first and second manifolds to fluidly interconnect opposite ends of the heat exchanger assembly. The return tube has a first end adapted to mount the heat exchanger assembly to an apparatus and an oppositely-disposed second end that protrudes from the second manifold and is adapted to mount a fluid-handling device thereto.

[0010] According to a second aspect of the invention, a method is provided for transferring heat to or from a fluid to a surrounding environment using a heat exchanger assembly. The heat exchanger assembly includes first and second manifolds, multiple cooling tubes and a return tube. The first manifold has inlet holes therein and the second manifold has outlet holes therein. The multiple cooling tubes fluidly interconnect the first and second manifolds and the inlet and outlet holes thereof. The return tube passes through the first and second manifolds to fluidly interconnect opposite ends of the heat exchanger assembly. The return tube has a first end adapted to mount the heat exchanger assembly to an apparatus and an oppositely-disposed second end that protrudes from the second manifold and is adapted to mount a fluid-handling device thereto. The method includes mounting the first end of the return tube of the heat exchanger assembly to the apparatus, mounting at least a first fluid-handling device to the second end of the return tube of the heat exchanger, and then operating the apparatus causing the fluid to flow from the apparatus, through the inlet holes and the cooling tubes of the heat exchanger assembly where the fluid is cooled therein, through the outlet holes into the fluid-handling device, through the return tube and back into the apparatus.

[0011] A technical effect of the invention is the ability to cool oil within an apparatus, such as motor vehicle engines, without the need for complicated mounting fixtures or additional hoses by utilizing a compact oil cooler that can be mounted in-line.

[0012] Other aspects and advantages of this invention will be better appreciated from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a perspective view representing an in-line heat exchanger assembly comprising multiple finned cooling tubes between a pair of headers in accordance with an aspect of this invention.

[0014] FIG. 2 is a side view of the heat exchanger assembly of FIG. 1.

[0015] FIG. 3 is a cross-sectional view representing the heat exchanger assembly of FIG. 2 taken along section line A-A, but with the cooling fins omitted to promote the clarity of the view.

[0016] FIG. 4 is a cross-sectional view similar to the view shown in FIG. 3, but with the cooling fins included.
FIG. 5 is a cross-sectional view representing the heat exchanger assembly of FIG. 4 taken along section line B-B.

FIG. 6 is an isolated side view representing one of the cooling tubes of FIG. 1 and multiple cooling fins mounted thereon in accordance with an aspect of the present invention.

FIG. 7 is a top view representing one cooling fin of the multiple cooling fins of FIG. 6 in accordance with an aspect of this invention.

FIG. 8 is a perspective view representing the heat exchanger assembly in position between an oil filter and a wall of an apparatus in accordance with an aspect of this invention.

FIG. 9 is a side view representing the heat exchanger assembly of FIGS. 1 through 8 adapted for use with a coolant in accordance with an aspect of this invention.

DETAILED DESCRIPTION OF THE INVENTION

FIGS. 1 through 9 represent nonlimiting examples of a heat exchanger 10 according to embodiments of the present invention. The heat exchanger 10 is adapted to be mounted on an engine or other apparatus through which a fluid flows and adapted to mount and fluidically connect a fluid-handling device to the apparatus. Such apparatuses include, but are not limited to, engines for automobiles, recreational vehicles, motorcycles, boats, lawn mowers, etc., compressors, or hydraulic units, as well as various types of assemblies in which cooling or heating of a fluid within the assembly is desired. An example of the fluid-handling device is an oil filter. The heat exchanger 10 is adapted to transfer heat to or from the fluid from the environment. In the case of an automobile engine and oil filter, the heat exchanger 10 is configured to allow oil cooling capabilities within an engine without reliance on additional hoses or mounting fixtures, such as those required by types of oil coolers known in the art.

To facilitate the description of the heat exchanger 10 provided below, the terms "top," "bottom," "side," "upper," "lower," "above," "below," "right," "left," etc., will be used in reference to the perspective of the orientation shown in FIGS. 1 through 9, and therefore are relative terms and should not be otherwise interpreted as limiting the scope of the invention.

FIGS. 1 and 2 are perspective and side views representing the heat exchanger 10, respectively. FIGS. 3 and 4 are cross-sections of the heat exchanger 10 taken along section line A-A of FIG. 2, showing the heat exchanger 10 without and with cooling fins 24, respectively. As labeled in FIGS. 1 through 4, the heat exchanger 10 is an assembly comprising a filter flange 12, top cooler manifold 14, bottom cooler manifold 16, a mounting flange 18, a central return tube 20, cooling tubes 22 surrounding the return tube 20, cooling fins 24 on the cooling tubes 22, and a gasket 26 (only shown in FIG. 3) for sealing the mounting flange 18 against a mounting surface, such as an engine block. FIG. 5 is a cross-section of the heat exchanger 10 taken along section line B-B of FIG. 4, and represents the heat exchanger 10 as having six cooling tubes 22 each with multiple cooling fins 24 mounted thereon. FIG. 6 represents one of the cooling tubes 22 with cooling fins 24 mounted thereon. FIG. 7 is a top view representing one of the cooling fins 24 from FIG. 6. As represented in FIGS. 6 and 7, the cooling fins 24 may have a corrugated cross-sectional shape and a continuous circular-shaped outer perimeter. Other fin shapes are also within the scope of this invention. Furthermore, it is foreseeable that the heat exchanger 10 can be configured to operate without the use of cooling fins 24, to have any number of cooling fins 24, to have any number of cooling tubes 22, to have any number of cooling tubes 22 that are formed to have shapes other than straight tubes having round cross-sections.

As evident from FIG. 3, oil is able to enter the bottom cooler manifold 16 through inlet holes 28 in the gasket 26 and mounting flange 18, pass through the cooling tubes 22 before entering the top cooler manifold 14, and then exit the heat exchanger 10 through outlet holes 42 in the filter flange 12. Oil exiting the heat exchanger 10 in this manner may subsequently flow through, for example, an oil filter 30, as represented in FIG. 8. After flowing through a filtering media of the filter 30, the oil is returned to an engine 32 (a wall portion of which is shown) through the return tube 20. For use in combination with the oil filter 30, the return tube 20 can be adapted to serve as a fastener for the heat exchanger 10. In preferred embodiments of the invention, an exterior of one end of the tube 20 is preferably threaded to threadably accept the oil filter 30, and an interior of an opposite end of the return tube 20 is preferably threaded to accept a mounting stud 34 of a type that is conventionally provided on the engine 32 to mount the filter 30 in the absence of the heat exchanger 10.

As represented in FIG. 3, the cooling tubes 22 can have dimples 36 or other surface features to create turbulence within oil flowing through the cooling tubes 22. Heat transfer from the oil within the cooling tubes 22 to the surrounding environment is promoted by the cooling fins 24, which are stacked onto each tube 22 to define an axial fin stack. The cooling fins 24 can be secured to the cooling tubes 22 by diametrically expanding the cooling tubes 22 by such hydraulic expansion methods or other suitable means. The cooling tubes 22 and cooling fins 24 can then be assembled with the manifolds 14 and 16 by inserting ends of the cooling tubes 22 into appropriately sized holes formed in the manifolds 14 and 16. Similarly, the return tube 20 is inserted through the manifolds 14 and 16, after which the filter flange 12 and mounting flange 18 can be assembled to the return tube 20 and secured to the manifolds 14 and 16 to close and seal the manifolds 14 and 16. Known brazing and soldering techniques can be employed to join components of the heat exchanger 10. The gasket 26 can then be secured to the mounting flange 18 to result in the construction shown in FIGS. 1 through 8.

An alternative to the embodiment described above is to enclose the cooling tubes 22 and cooling fins 24 between the manifolds 14 and 16, and then flow a coolant, for example, a liquid such as water or antifreeze, through a resulting cavity. FIG. 9 is a side view representing the heat exchanger 10 further comprising a jacket 38 enclosing the cooling tubes 22 and cooling fins 24. The heat exchanger 10 may include at least a fitting 40 or other similar features that serve as one or more inlets and outlets through which the coolant flows into and out of a cavity (not shown) defined by the jacket 38 between the manifolds 14 and 16. Such embodiment may be preferable in applications requiring high heat transfer rates. Modifications to the heat exchanger 10 may be necessary or preferable when coolant is utilized. For example, higher heat transfer rates may allow the removal of the cooling fins 24 or fluid dynamics of the coolant may require the cooling fins 24 to be formed with a different shape.

To install the heat exchanger 10 in-line with the oil filter on the engine 32, the oil filter 30, if present, is removed from the mounting stud 34 of the engine 32. The heat exchanger 10 is then mounted directly to the mounting stud 34, and thereafter the oil filter 30 is mounted to the heat
A heat exchanger assembly comprising:

1. A heat exchanger assembly comprising:
   - first and second manifolds, the first manifold having inlet holes therein and the second manifold having outlet holes therein;
   - multiple cooling tubes fluidically interconnecting the first and second manifolds and the inlet and outlet holes thereof; and
   - a return tube passing through the first and second manifolds to fluidically interconnect opposite ends of the heat exchanger assembly, the return tube having a first end adapted to mount the heat exchanger assembly to an apparatus, the return tube having an oppositely-disposed second end that protrudes from the second manifold and is adapted to secure a fluid-handling device thereto.

2. The heat exchanger assembly of claim 1, further comprising cooling fins (24) mounted to exteriors of the cooling tubes.

3. The heat exchanger assembly of claim 2, wherein the cooling fins have a corrugated cross-sectional shape and a continuous circular-shaped outer perimeter.

4. The heat exchanger assembly of claim 2, wherein the cooling fins are secured to the cooling tubes by diametrically expanding the cooling tubes.

5. The heat exchanger assembly of claim 2, wherein each of the cooling tubes comprises at least one cooling fin mounted thereof.

6. The heat exchanger assembly of claim 1, wherein the cooling tubes are enclosed between the first and second manifolds to yield a cavity for a coolant to flow therein.

7. The heat exchanger assembly of claim 2, wherein the cooling tubes and cooling fins are enclosed between the first and second manifolds to yield a cavity for a coolant to flow therein.

8. The heat exchanger assembly of claim 1, wherein the fluid-handling device is an oil filter.

9. The heat exchanger assembly of claim 1, wherein the fluid-handling device is an additional heat exchanger assembly.

10. The heat exchanger assembly of claim 1, wherein the apparatus is an engine of a motor vehicle.

11. The heat exchanger assembly of claim 1, wherein the apparatus is a compressor.

12. The heat exchanger assembly of claim 1, wherein the apparatus is a hydraulic unit.

13. A method of transferring heat to or from a fluid to a surrounding environment using the heat exchanger assembly of claim 1, the method comprising:
   - mounting the first end of the return tube of the heat exchanger assembly to the apparatus;
   - mounting at least a first fluid-handling device of the apparatus to the second end of the return tube of the heat exchanger; and then
   - operating the apparatus causing the fluid to flow from the apparatus, through the inlet holes and the cooling tubes of the heat exchanger assembly where the fluid is cooled therein, through the outlet holes into the fluid-handling device, through the return tube and back into the apparatus.

14. The method according to claim 13, further comprising removing the fluid-handling device from the apparatus prior to mounting the first end of the return tube of the heat exchanger assembly to the apparatus.

15. The method according to claim 13, further comprising cooling the heat exchanger assembly with a coolant.

16. The method according to claim 13, wherein the first fluid-handling device is an additional heat exchanger assembly, the method further comprising mounting a second fluid-handling device to the second end of the return tube of the additional heat exchanger assembly prior to operating the apparatus.

17. A method of transferring heat to or from a fluid to a surrounding environment using an exchanger assembly comprising first and second manifolds, the first manifold having inlet holes therein and the second manifold having outlet holes therein, multiple cooling tubes fluidically interconnecting the first and second manifolds and the inlet and outlet holes thereof, and a return tube passing through the first and second manifolds to fluidically interconnect opposite ends of the heat exchanger assembly, the return tube having a first end adapted to mount the heat exchanger assembly to an apparatus, the return tube having an oppositely-disposed second end that protrudes from the second manifold and is adapted to secure a fluid-handling device thereto.

18. The method according to claim 17, wherein the fluid-handling device is an oil filter.
the heat exchanger assembly, the return tube having a first end adapted to mount the heat exchanger assembly to an apparatus, the return tube having an oppositely-disposed second end that protrudes from the second manifold and is adapted to secure a fluid-handling device thereto, the method comprising:
mounting the first end of the return tube of the heat exchanger assembly to the apparatus;
mounting at least a first fluid-handling device to the second end of the return tube of the heat exchanger; and then operating the apparatus causing the fluid to flow from the apparatus, through the inlet holes and the cooling tubes of the heat exchanger assembly where the fluid is cooled therein, through the outlet holes into the fluid-handling device, through the return tube and back into the apparatus.

18. The method according to claim 17, further comprising removing the fluid-handling device from the apparatus prior to mounting the first end of the return tube of the first heat exchanger assembly to the apparatus.

19. The method according to claim 17, further comprising cooling the heat exchanger assembly with a coolant.

20. The method according to claim 17, wherein the fluid-handling device is an oil filter.

21. The method according to claim 17, wherein the apparatus is an engine of a motor vehicle.

22. The method according to claim 17, wherein the apparatus is a compressor.

23. The method according to claim 17, wherein the apparatus is a hydraulic unit.

24. The method according to claim 17, wherein the first fluid-handling device is an additional heat exchanger assembly, the method further comprising mounting a second fluid-handling device to the second end of the return tube of the additional heat exchanger assembly prior to operating the apparatus.

25. The method according to claim 24, wherein the second fluid-handling device is an oil filter.