A method and a system for draining oil from an oil accumulator mounted in a service station for performing service and/or for flushing of A/C systems.
A method and a system for draining oil from an oil accumulator mounted in a service station for performing service and/or for flushing of A/C systems

Field of the Invention

The present invention relates to a method of draining oil accumulated in an oil accumulator in a system for performing service and/or flushing of such air conditioning systems, especially so-called mobile A/C systems mounted in vehicles, such as cars, buses or trucks, and wherein a refrigerant present in the A/C system is recovered and stored in an internal cylinder in the service station during service and/or flushing.

Additionally, the present invention relates to a service station for performing service and/or flushing of air conditioning systems, especially so-called mobile A/C systems mounted in vehicles, such as cars, buses or trucks, wherein the service station comprises an oil accumulator through which a gaseous refrigerant is transferred from the A/C system to a compressor, following which the refrigerant is recovered and stored in an internal cylinder in the service station during service and/or flushing, and wherein the oil accumulator is provided with an oil draining valve.

Prior art

Today, air conditioning systems (A/C systems), e.g. in vehicles such as cars, buses or trucks, etc., contain refrigerants which are not inflammable. The refrigerants are added during the manufacture of the vehicle, and the A/C systems in the vehicles are serviced and repaired from time to time. Equipment for performing this is known.

The most commonly used refrigerant at present is 1,1,1,2-tetrafluoroethane, which is commonly known as R134a. However, owing to the high green
house effect (GWP, Global Warming Potential) of R134a, it is not allowed to use R134a as a refrigerant in new vehicles after 1 January 2011. A/C systems in older vehicle models may continue to run on R134a, and these A/C systems still need service at regular intervals and/or repair from time to time.

Methods and apparatus are known for draining oil which is recovered during a service performed on typical A/C systems in vehicles.

The refrigerant is extracted as a gas from the A/C system and stored in liquid form in an internal cylinder of a service station, while service is performed on the A/C system. The known system includes an oil separator (accumulator) having an oil draining valve, e.g. a solenoid valve, attached to the bottom. During refrigerant recovery, i.e. during a procedure in which the oil accumulator is subjected to pressure, the oil draining valve is activated, which allows the recovered oil to drain from the oil accumulator. Typically, the duration during which the oil draining valve is opened is based on a fixed time interval.

The quantity of oil recovered is variable and depends, among other factors, on the design of the A/C system mounted in the vehicle.

There are many problems with the current technology. As described, the quantity of oil recovered is variable. Additionally, when only a small amount of recovered oil is present in the oil accumulator, opening the oil draining valve based on a fixed time interval could result in releasing refrigerant into the environment. In case of large amounts of recovered oil present in the oil accumulator, a fixed time interval for opening the oil draining valve might not drain all the recovered oil from the oil accumulator.

Since this process is timer controlled, the known system is not able to test
for any failure of said oil draining valve, and the system is not able to produce an effective warning of such a failure either.

Additionally, since oil draining is performed during the refrigerant recycling stage and the refrigerant is utilized as the propellant during the oil draining, there will be a reduction in the quantity of refrigerant reported as the final total recycled amount of refrigerant. One reason of this reduction is that the oil drained from the oil accumulator will contain a considerable quantity of solubilised, suspended and/or dispersed gaseous refrigerant. The amount of gaseous refrigerant present in the drained oil will be detracted from the amount of refrigerant recovered from the A/C system and will not be registered since it does not enter the internal cylinder, in which the amount of recovered refrigerant is determined, e.g. by weighing. Similarly, when the amount of oil transferred to the oil draining container is determined, the actual volume of the oil will also be "inflated" due to the gaseous refrigerant present in the oil, which is extracted from the oil accumulator. Similarly, if the amount of oil is determined by weighing, the weight of refrigerant present in the drained oil will also be included.

Summary of the invention

The present invention relates to a method and an improved design for a service station which solve the above-mentioned problems. The method disclosed in claim 1 relates to draining oil from an oil accumulator mounted in a service station, wherein a refrigerant present in the A/C system is recovered and stored in an internal cylinder in the service station during service and/or flushing. The method is characterized by initiating the oil draining procedure after the refrigerant recovery procedure is completed, and wherein the oil draining procedure comprises the steps of pressurizing the oil accumulator until a predetermined pressure is detected in the oil accumulator, initiating oil draining and draining the oil and/or particulates
present in the oil accumulator, during which a pressure sensor and a
controller monitor the decrease of the pressure in the oil accumulator, and
ending the oil draining when the pressure in the oil accumulator is below a
predetermined target, or when the controller detects a transition in the rate
at which the pressure decreases.

The oil draining procedure is initiated as a separate procedure after the
refrigerant recovery procedure is completed and the registration of the
quantity of refrigerant recovered from the A/C system has been finalized.
This results in a faster service and/or repair procedure when the present
method of oil draining is used, since the oil draining step is no longer
performed during the refrigerant recovery step. The natural stratification of
the gaseous refrigerant and oil also results in a more purified oil being
drained, i.e. the oil contains less solubilised, suspended and/or dispersed
refrigerant. This also results in a more accurate amount of refrigerant being
recorded, as the amount of gaseous refrigerant escaping from the oil
present in the oil accumulator will be recorded during refrigerant recovery
instead of being drained together with the oil. Furthermore, by delaying the
oil draining process until the refrigerant recovery is completed, more oil
drains to the bottom of the oil accumulator due to gravity. This also has the
results that the recorded quantity of oil drained from the oil accumulator will
be more accurate in relation to the physical quantity actually removed from
the vehicle A/C system. Since the recorded amounts of refrigerant and oil
recovered are more accurate in relation to the actual amounts present in
the A/C system, the recorded amounts help the user of the service station
to determine the correct amount of refrigerant and/or oil when refilling
refrigerant and/or oil into the A/C system after service and/or repair. Since
the pressure monitoring capability is available, the inherent transition of
pressure between oil draining and refrigerant draining allows the system
controller to stop the process, when a sufficient amount of the oil
accumulated in the oil accumulator has been drained. This added
methodology will also reduce any refrigerant losses to the atmosphere to a minimum. In addition, this method is useful in relation to service stations used for servicing A/C systems running on an inflammable refrigerant, since the service equipment will not leak any significant amount of inflammable refrigerant through the oil draining valve. Thus, the service station will also fulfil the ATEX Directive 94/9/EU concerning equipment and protective systems intended for use in potentially explosive atmospheres or inflammable atmospheres.

When, as stated in claim 3, the method comprises monitoring the initial decrease of pressure in the oil accumulator during draining, and activating an alarm signal if the initial rate at which the pressure decreases is below a predetermined target, it is possible to monitor and provide an alarm in case that the oil draining valve is defective.

As disclosed in claim 4, it is expedient when the method comprises pressurizing the oil accumulator to an initial pressure of up to 2 bars, or up to 1-1.5 bars, such as 0.3-1.5 bars or preferably 0.5-1.1 bars.

Additional expedient embodiments of the method are disclosed in claims 2, 5 and 6. Claim 2 discloses draining oil from the oil accumulator by opening an oil draining valve connected to the oil accumulator. Claim 5 discloses pressurizing the oil accumulator by opening valves and transferring refrigerant from the internal cylinder into the oil accumulator, and claim 6 discloses opening one of these valves intermittently, such as in stages and/or controlled by a timer.

In another embodiment of the method, the opening and/or closing of the valve(s) that enables transfer of refrigerant to the oil accumulator is controlled by a timer as disclosed in claim 7. As disclosed in claim 8, the method may alternatively comprise controlling the opening and/or closing of
the valve(s) on the basis of the pressure detected in the oil accumulator.

The present invention also relates to an improved design for a service station, as disclosed in claim 9, and for carrying out service and/or for flushing of an A/C system, wherein the service station comprises an oil accumulator through which a gaseous refrigerant is transferred from the A/C system to a compressor, following which the refrigerant is recovered and stored in an internal cylinder in the service station during service and/or flushing, and wherein the oil accumulator is provided with an oil draining valve. When used for the above-mentioned method, the service station also solves the above-mentioned problems by providing the oil accumulator with a pressure sensor for detecting the pressure in the oil accumulator during an oil draining procedure.

As disclosed in claims 10, 11 and 13, the service station is provided with a controller, by means of which a pressure building step is monitored, and which controls the pressure in the oil accumulator by opening and/or closing the valves for transferring refrigerant to the oil accumulator and/or for opening and/or closing the oil draining valve. The controller preferably comprises a timer for enabling timer based control of the opening and/or closing of the valves which transfer refrigerant from the internal cylinder to the oil accumulator.

As disclosed in claim 12, it is expedient when the pressure sensor is a pressure transducer.

The Drawing

The invention will be explained in the following with reference to the only drawing which shows a diagram of a service station for the filling, emptying and/or flushing of especially mobile A/C systems.
Detailed description

A diagram of a service station for the filling, emptying and/or flushing of A/C systems, especially, but not limited to mobile A/C systems (called MAC in the following), is shown in the figure. When performing a normal service on the MAC (not shown in the figure) the service station is connected to the MAC by connecting port A to the gaseous side of the MAC and by connecting port B to the liquid side of the MAC. The refrigerant is recovered by initially withdrawing it from the MAC and into an internal cylinder 7 of the service station. The gaseous refrigerant is sucked through the service station pipe line 1 and through an oil separator (also called an oil accumulator) 2, which will be discussed later, and into the compressor 4, optionally via a filter 3. The gaseous refrigerant is compressed in the compressor 8, which results in a heated gaseous, or a heated and partially condensed refrigerant, which is transferred to the internal cylinder 7 via a compressor oil separator 5 and cooling means (not shown) for the condensation of the refrigerant prior to storage in the internal cylinder 7. When substantially all the refrigerant has been withdrawn from the MAC, a normal service may be performed.

When the normal service is completed, the MAC is filled with liquid refrigerant through port A connected to the gaseous side of the MAC by opening the valves 8, 13 and 14 and closing the valve 16. When filling is completed, the service station is detached from the MAC.

In some situations, e.g. in case that the MAC requires repair, a flushing sequence is also required. After the recovery of the refrigerant from the MAC, liquid refrigerant is flushed from the internal cylinder 7 and into the liquid side of the MAC via the port B by opening the valves 8, 13 and 15, while a flushing accumulator (not shown) is mounted externally to the
service station, i.e. the port A and the gaseous side of the MAC. During such a flushing sequence, practically all oil is accumulated in the externally mounted flushing accumulator, and almost no oil is accumulated in the oil accumulator 2 inside the service station.

The oil accumulator 2 receives a mixture of gaseous refrigerant and oil drops present in the refrigerant, which is sucked from the MAC and into the service station by the compressor 4 via the port A. As the compressor sucks gaseous refrigerant out of the oil accumulator 2, the oil accumulator 2 is cooled strongly. The heating coil 6 in the oil accumulator receives heated compressed refrigerant gas from the compressor 4, and waste heat in the compressed refrigerant gas is utilized for heating the gas in the oil accumulator 2. The oil accumulator 2 is connected to an oil drain accumulating container 12 via a valve 11, which is connected to an outlet at the bottom of the oil accumulator 2, e.g. by a tube or a pipe.

The system according to the invention is improved by attaching a pressure sensor 10, e.g. a pressure transducer to the oil accumulator 2. The pressure transducer 10 is capable of monitoring the pressure in the oil accumulator 2. The present invention is not limited to using a pressure transducer. Other commercially available pressure sensors may also be applicable for detecting the pressure in the oil accumulator 2.

The present invention also relates to a method of draining oil from an oil accumulator in a service station. The oil draining procedure is initiated after the refrigerant recovery procedure is completed. It is to be noted that after the process of emptying the MAC for refrigerant, the oil accumulator 2 will be under a certain vacuum, because the compressor 4 has sucked a substantial part of the gaseous refrigerant out of the oil accumulator 2 and into the internal cylinder 7. Thus, a conventional emptying procedure merely based on a timer based opening of the oil draining valve 11 is
ineffective at this stage.

The procedure of draining oil from the oil accumulator 2 is in principle performed in two steps by first increasing the pressure in the oil accumulator and then by draining the oil from the oil accumulator 2.

The first step of the method is to pressurize the oil accumulator 2, which is necessary since, as mentioned above, the oil accumulator is under a certain vacuum after the refrigerant recovery procedure is completed. This vacuum results in refrigerant gas being liberated from the oil phase during a standstill period between the refrigerant recovery and the oil draining procedure. The pressurizing procedure is initiated by a controller (not shown), which opens the valve 8 completely and the valve 9 periodically, i.e. in timer based intervals, in order to increase the pressure in the oil accumulator 2. During the pressurizing step, the pressure transducer 10 monitors the change of pressure in the oil accumulator 2 and transmits the measured pressure values to the controller. At the instant the pressure in the oil accumulator 2 reaches a predetermined target, the process of building pressure is discontinued and the valves 8 and 9 are closed. In another embodiment the valve 8 may be opened stepwise based on timer controlled intervals.

As an alternative to a timer controlled procedure, the opening and/or closing of the valves 8 and 9, as described above, may be controlled on the basis of the pressure in the oil accumulator 2 as detected by the pressure transducer 10. Thus, the pressure may be controlled in order to increase the pressure in the oil accumulator 2 in a stepwise manner, or, alternatively, the increasing pressure may follow a predetermined curve.

The oil draining step starts when the pressure in the oil accumulator 2 has reached the predetermined target. A suitable pressure applied to the oil
accumulator 2 prior to oil draining will be in the range of up to 1-2 bars and preferably in the range of up to 1-1.5 bars, such as 0.3-1.5 or more preferred approximately 0.5-1.1 bars. The controller then opens the oil draining valve 11, which opens the connection between the bottom of the oil accumulator 2 and the oil drain container 12. The pressure in the oil accumulator 2 decreases during the entire oil draining process and will normally follow an exponential decay curve. In case that the oil draining valve 11 is defective, the initial rate of reduction of the pressure in the oil accumulator 2 will not meet a predetermined rate of change, following which the controller initiates an alarm indicating that the oil draining valve 11 is defective. This test of the oil draining valve 11 is not possible when a timer controlled emptying procedure is used.

As the oil leaves the oil accumulator 2 during the oil draining procedure, the controller continues to monitor changes in the pressure transmitted from the pressure transducer 10. When all oil present in the oil accumulator 2 is drained, gaseous refrigerant starts escaping from the oil accumulator 2 through the bottom outlet, which results in a sudden change of rate in the decrease of pressure. When this transition in the decrease rate of pressure is detected, the controller closes the oil draining valve 11. Alternatively, the valve 11 is closed when the pressure in the oil accumulator 2 gets below a predetermined set point or target. These procedures result in the oil accumulator 2 being emptied completely, or almost completely, every time regardless of the amount of oil present in the oil accumulator 2.

Additionally, these procedures significantly reduce the escape of refrigerant to the environment, which is likely to occur in a timer based emptying procedure, when only a small amount of oil is present in the oil accumulator 2, and the oil is drained from the oil accumulator 2 before a timer controlled draining step is ended. Thus, refrigerant losses will be kept at a minimum due to the detection features provided by the pressure transducer 10 and the controller, and, in addition to this, the oil accumulator is also emptied.
completely in every emptying procedure regardless of the amount of oil present in the oil accumulator 2.

Therefore, the total amount of recovered refrigerant reported by the controller in the service station will not be reduced by any loss occurring during oil draining. Furthermore, the length of time which has elapsed since oil was introduced into the oil accumulator 2 allows natural oil and vapour (gaseous refrigerant) separation to occur, which also results in a maximized oil accumulation at the bottom of the oil accumulator 2.

Additionally, the vacuum present in the oil accumulator 2 after the recycling procedure is terminated and before the oil draining procedure is initiated, further improves the separation of refrigerant gas bubbles from the oil present inside the oil accumulator 2, since the gaseous refrigerant is more likely to escape from the oil phase when a vacuum is present above the oil phase, i.e. an equilibrium between suspended and/or solubilised refrigerant gas in the oil phase vs. gaseous refrigerant present above the oil phase in the oil accumulator 2 is pushed towards the gaseous refrigerant. It is not possible to establish this vacuum in the oil accumulator using the prior art timer based oil draining method, since oil draining is performed during the refrigerant recovery procedure, during which the oil accumulator is under pressure.

Finally, the amount of drained oil reported will not be too low because of insufficient draining of oil from the oil accumulator 2, as may be the case in a timer based system, and it will not be too large because refrigerant gas bubbles present in the drained oil "inflate" the volume of the drained oil, as may be the case when draining oil during the refrigerant recycling procedure.
A/C systems in new vehicle models manufactured or sold after 1 January 2011 run on an inflammable refrigerant, following which the service station must fulfil the ATEX Directive 94/9/EU concerning inflammable atmospheres, which implies that the new equipment must comply with considerable technical requirements when the new medium is to be added.

Therefore, the externally mounted flushing accumulator and the internal oil accumulator 2 are substituted by an internal flushing accumulator mounted in a ventilated area of the service station for performing service and/or flushing of MAC's running on the new inflammable refrigerant. The present method is also applicable for draining oil and/or particulates from this internal flushing accumulator, when a pressure sensor, e.g. a pressure transducer as described above, is mounted on the internal flushing accumulator, and the service station contains means for conveying refrigerant from the internal cylinder, which stores the recovered refrigerant in the service station, and transferring the refrigerant to the internal flushing accumulator.
Claims

1. A method of draining oil from an oil accumulator mounted in a service station for performing service and/or for flushing of an A/C system, especially so-called mobile A/C systems mounted in vehicles, such as cars, buses or trucks, and wherein a refrigerant present in the A/C system is recovered and stored in an internal cylinder in the service station during service and/or flushing, characterized by initiating the oil draining procedure after the refrigerant recovery procedure is completed, and wherein the oil draining procedure comprises the steps of

   a. pressurizing the oil accumulator (2), until a predetermined pressure is detected in the oil accumulator (2),

   b. initiating oil draining and draining the oil and/or particulates present in the oil accumulator (2), during which a pressure sensor (10) and a controller monitor the decrease of the pressure in the oil accumulator (2), and

   c. ending the oil draining when the pressure in the oil accumulator (2) is below a predetermined target, or when the controller detects a transition in the rate at which the pressure decreases.

2. A method according to claim 1, characterized in that oil is drained from the oil accumulator (2) through an oil draining valve (11) by opening the valve (11) connected to the oil accumulator (2).

3. A method according to claim 2, characterized by monitoring the initial decrease of pressure in the oil accumulator (2) during draining, and activating an alarm signal if the initial rate at which the pressure decreases is below a predetermined target.
4. A method according to claim 1, characterized by pressurizing the oil accumulator (2) to an initial pressure of up to 2 bars, or up to 1-1.5 bars, such as 0.3-1.5 bars or preferably 0.5-1.1 bars.

5. A method according to any one of claims 1-4, characterized by pressurizing the oil accumulator (2) by opening valves (8) and (9) and transferring refrigerant from the internal cylinder (7) into the oil accumulator (2).

6. A method according to claim 5, characterized by opening the valve (9) intermittently or in stages.

7. A method according to any one of claims 5-6, characterized by controlling the opening and/or closing of the valve (8) by a timer.

8. A method according to any one of claims 5-6, characterized by controlling the opening and/or closing of the valve (8) on the basis of the pressure detected in the oil accumulator (2).

9. A service station for carrying out the method of any one of claims 1-8 and for carrying out service and/or for flushing of an A/C system, especially so-called mobile A/C systems mounted in vehicles, such as cars, buses or trucks, wherein the service station comprises an oil accumulator through which a gaseous refrigerant is transferred from the A/C system to a compressor, following which the refrigerant is recovered and stored in an internal cylinder in the service station during service and/or flushing, and wherein the oil accumulator (2) is provided with an oil draining valve (11), characterized in that the oil accumulator (2) is provided with a pressure sensor (10) for detecting the pressure in the oil accumulator (2) during an oil draining procedure.
10. A service station according to claim 9, characterized in that a pressure building step is monitored by a controller, which controls the pressure in the oil accumulator (2) by opening and/or closing valves (8, 9).

11. A service station according to any one of claims 9 or 10, characterized in that the changes in the pressure in the oil accumulator (2) are monitored by the controller, which also controls the oil draining valve (11).

12. A service station according to claim 9, characterized in that the pressure sensor (10) is a pressure transducer.

13. A service station according to claim 10, characterized in that the controller comprises a timer for enabling timer based control of the opening and/or closing of valves (8, 9).
A. CLASSIFICATION OF SUBJECT MATTER

INV. B60H1/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B60H

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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