



APPARATUS FOR FILTERING CONTAMINATED LIQUIDS,
SUCH AS IN PARTICULAR USED OIL

The invention relates to an apparatus for filtering contaminated liquids.

An apparatus with a high throughput capacity filter, which can be referred to as a high-performance filter, and a pump for feeding the oil through the said filter is known making it possible to filter very large foreign particles from the used or waste oil, so that, whilst reducing the residues, the latter can be burnt. The oil cleaned with such an apparatus cannot be reused, e.g. as lubricating oil.

In addition, large plants and the like are known for the purpose of cleaning and reprocessing used oil, so that it can be reused. Known large plants can only be manufactured on an industrial scale whilst incurring costs of several tens of millions of DM and are only economic if all the used oil can be transported in from a large catchment area. This leads to very high transportation costs, which in turn have an effect on the used oil supplies and it is not possible to make sufficiently economic compared with new oil the reprocessed oil resulting therefrom. In particular where used oil occurs, there is a tendency not to supply it for reutilization, but instead to dispose of it in other ways, some of which may not be legally allowed.

US-A-4 179 019 discloses an apparatus for the recovery of used lubricating oil. It is based on the fact that large lubricating oil quantities are poured away after use, particularly in car workshops, which have to dispose of large quantities of used motor vehicle engine oil. For recovery purposes such oil must be collected and returned to an oil company in sealed barrels, where large industrial oil treatment plants are available. Such costs give little encouragement to vehicle workshops, filling stations or oil users to save oil. In order to improve the recovery of used lubricating oils, US-A-4 179 019 provides an apparatus, which has pumps, filters, heat exchangers and an evaporator



unit operating under vacuum and which are placed in a transportable housing. In this way individual workshops, filling stations and oil users can have their own oil treatment unit, so that the reprocessing of spent or used oil becomes much more attractive.

It can be gathered from the above that it is a small preparation unit suitable for domestic use or a workshop, which can in an acceptable period of time only treat a small amount of oil, such as is present in a single vehicle engine,, such as e.g. a few litres up to a maximum of 5 or 7 litres. A larger oil quantity cannot be treated, because in series with a single 5 micron filter there is only a single filter with a passage width of 0.5 micron. Thus, the throughput is greatly reduced. In addition, the known apparatus is only able to treat oil used in vehicle engines and which only contain a few, clearly defined contaminants, such as fuel and the resulting carbons. This apparatus does not permit a more extensive processing of used oil, particularly of the type mixed with metal shavings or the like during industrial production processes.

US-A-4 352 739 relates to an apparatus for filtering fluids, namely those occurring during oil drilling and in the form of cooling liquids. This document describes an apparatus according to the prior art, which has three filters, but no specific information is given on the nature thereof. As only these filters are provided, it is only possible to clean liquids with a narrow range of solid particle contaminations or the cleaning is unsatisfactory, because in the case of a wide particle range the filters become very rapidly unusable and must be replaced. In addition, the filters necessarily very rapidly become clogged if metal particles occur.

US-A-1 624 385 discloses an apparatus for the recovery of solids from liquids of printing presses with a very small solids percentage. For this purpose the apparatus has a tank into which can be fed the contaminated liquid. Above a screen is positioned



a liquid outlet. On the bottom is positioned an extruder in which it is possible to convey out only the solid particles which have settled.

The problem of the invention, whilst avoiding the aforementioned disadvantages, is to so further develop an apparatus for the filtering of oil, that it permits the treatment of contaminated liquids and in particular used or waste oil with a larger throughput of about 5,000 to 6,000 m³ monthly in such a way that they can be reused as lubricating oils. The same applies for cooling agents and cooling water.

The problem according to the invention is solved by an apparatus according to claim 1.

The high-performance filter is a filter which, like that mentioned hereinbefore, only filters out large particles and consequently has a high throughput capacity. In order not to reduce the overall capacity of the installation compared with that of said first filter or high-performance filter, according to the invention there is a parallel arrangement of several ultra-fine filters.

As a result of the magnetic filter the loading of the ultra-fine filters is reduced and consequently the necessary frequency for the cleaning and replacement thereof is also reduced. Magnetizable particles, i.e. in particular magnetizable metals are removed beforehand from the used oil and also particles from white or black glistening metals down to a size of 5 μ m are removed from the oil to be treated.

It has been found that by the additional provision of ultra-fine filters, the normally still present particle size of about 120 μ m and more can be reduced by a factor of 10 to 20, i.e. to 5 μ m, so that oil cleaned and treated with the apparatus according to the invention only contains particles down to this size and max 15 μ m and the particle proportion in the oil is also reduced by a



factor of about 20. Thus, a specific test revealed that as a result of the apparatus according to the invention the gravimetric contamination according to ISO/DIN 4405 could be reduced from 427 mg/l to 26 mg/l.

The pump is preferably placed upstream of the first filter. According to other preferred developments the ultra-fine filters can be connected in groupwise for the treatment of liquid. As a result, of the existing number of ultra-fine filters one or more groups can continue to be used for filtering, so that the apparatus according to the invention remains in operation, whereas at least one group is disconnected from the liquid flow and consequently can be cleaned or the filter materials replaced. This contributes to an economic operation of the apparatus according to the invention.

The ultra-fine filters are preferably constructed in such a way that they have a cylindrical housing with a central hollow shaft and that between them is positioned filter material. Such ultra-fine filters correspond per se to the filter part of filters such as can e.g. be gathered from DE-OS 39 38 686 or German utility model 89 13 769, whose content is made by reference into the subject matter of the present application.

With regards to a possible running out of oil during the cleaning and replacement of the ultra-fine filters, according to a preferred development below the ultra-fine filters are provided one or more oil collecting pans or trays.

An effective cleaning of tar oils, which can also be provided with sand, is preferably helped in that it is possible to position upstream of the pump and the first high-performance filter can be provided a heating device with a water devapourizing flow device.

According to other preferred developments the inlet stage is a



prestorage tank provided with a screen. Therefore it is possible to remove a weight differing considerably from the oil to be treated can be removed beforehand by storage in said tank, so that they do not act in a prejudicial manner on the filtering and cleaning system.

Whilst in the first development according to the invention the additional magnetic filter is preferably located within the ultra-fine filter means, in another development of the apparatus the magnetic filter is the inlet stage of the apparatus. Then, in preferred manner, on the magnetic filter is positioned a pump with a lever through which, as a function of the liquid used, the latter can either be supplied to a continuous heater or to an edge gap filter or separator. As a result of this development it is possible to clean oil, used oil or tar oil, as well as cooling agents and cooling water, the latter passing heated following the passage through large plants to the magnetic filter of the inlet stage. The heated liquid can then be cooled to the necessary temperature by a cooling unit or heat exchanger provided according to the invention. Oil can be correspondingly heated to the necessary temperature. By means of the edge gap filter or separator oil present in the cooling agent or water is separated from the water and abraded dust, so that the latter can be separated from the liquid to be treated upstream of the ultra-fine filters. Thus, there is no detrimental action on the filtering and cleaning system. Correspondingly when cleaning oil metallic particles are removed by means of a magnetic shocker, a wide-surface filter and a fleece roll from said oil, so that these particles do not have a detrimental action on the filtering and cleaning system.

According to further developments a double filter is provided through which in alternating manner by reversing liquid can be filtered. Thus, in the second development of the apparatus according to the invention only one unit is required for effectively cleaning oil or cooling agents/water.



For checking the operation of the apparatus according to the invention inspection windows can be positioned upstream and/or downstream and a sampling point is provided. In order to check the throughput, a flowmeter is provided in a preferred development.

The invention provides an apparatus, which can be installed in transportable manner at the used oil production point, such as in transportation companies, bus companies, factories, where machines are operated with oil, etc., so that these enterprises can independently treat and reuse the used oil produced by them, without requiring assistance from third parties. This also applies with respect to larger motor vehicle workshops, which act as service organizations for third parties and change the oil of their customers.

In addition, apparatuses according to the invention, which are transportable, can also be used as small regional, central collecting and treatment points for filling stations and smaller vehicle workshops, where their own treatment system would not be worthwhile.

This leads to less expensive transportation routes and reduced transportation costs. The costs for a unit according to the invention, despite the relatively high throughput and therefore relatively high capacity from both the quantitative and qualitative standpoint, namely the improvement of the purity level by a factor of 100, are below those of central units or plants. The apparatus according to the invention can be operated much more economically than is the case in the known large units, because in particular there is no need for a continuous large supply of used oil to enable them to operate economically.

Although reference has been made hereinbefore to a monthly capacity of 5,000 to 6,000 m³ with an apparatus purchase cost of approximately DM 150,00 (without heating device), the unit can



also be adapted to the actual used oil production quantity, by designing it e.g. for a larger or smaller throughput and in particular through a design with ultra-fine filters positioned parallel to the oil feed path, a reduction of the volume throughput can also have an advantageous price influence.

Further advantages and features of the invention can be gathered from the following claims and description of an embodiment of an apparatus according to the invention and with reference to the attached drawings, wherein show:

- Fig. 1 A diagrammatic overall view of a first embodiment of the apparatus according to the invention.
- Fig. 2 A larger-scale and somewhat more detailed representation of the filtering and cleaning unit in side view.
- Fig. 3 A part sectional, front view of the unit of fig. 2.
- Fig. 4 A diagrammatic overall representation of a second embodiment of the apparatus according to the invention.
- Fig. 5 A rear plan view of an ultra-fine filter set.
- Fig. 6 A side view of the ultra-fine filter set of fig. 5.

In the represented first embodiment the apparatus according to the invention firstly has a prestorage tank 1, in which can take place a settling of in particular larger particles with a much higher specific weight or gravity than that of the liquid to be filtered. Generally the liquid spends 24 hours in this prestorage tank before being supplied to the further processing or treatment with the apparatus according to the invention. The prestorage tank 1 has an inlet pipe 51, which projects under screens 52. Into the prestorage tank and over the screens 52



projects a suction nozzle 2, by means of which the liquid can be sucked out of the prestorage tank 1 by means of a pump. The screens prevent coarse particles rising up to a suction head 2a of the suction nozzle 2 and also being subject to suction action. The suction head 2a of the suction nozzle 2 is constructed as a float, so that the head always rests on the liquid surface 53, independently of the filling level, and the suction nozzle 2 only exerts a suction action on the upper liquid zone. In order that the suction head 2a can follow the liquid level, the suction nozzle 2 is at least axially movable. For this purpose as shown, it can be constructed as a telescopic tube 54, but could alternatively be a flexible hose.

In the represented embodiment below the screens 52 in the vicinity of the opening of the inlet tube 1 is provided an extruder 55 with stationary magnets 56 located on its circumference. The magnets attract magnetizable particles and in particular the larger particles and this is facilitated by the movement of the liquid through the extruder. This can be also helped by an air supply to the liquid. The particles deposited on the magnets 56 are then stripped from the extruder and passed by the latter out of the tank 1. An end coarse filter 57 is located on a suction line 2b connected to the suction nozzle 2. To said filter 57 can be connected, for the processing of tar oil, a heating unit, in order to heat the tar oil to be cleaned and give same a lower viscosity, whilst expelling from the liquid water moisture. For this purpose heating takes place to above 100°C, so that water can be evaporated and removed.

This takes place in a water devapourization flow device 4, which can be connected to the heating unit 3. The latter is followed by the actual filter means 6 with an inlet 7, a magnetic filter 8, the pump unit 9, which is preferably a geared pump unit with a pressure of 0.6 bar and a power of several kilowatts. The pump 9 is then connected to a first, relatively high-performance filter 11 for filtering out large particles and which is referred to



hereinafter as a high-performance filter. Preferably use is made of a filter such as is sold under the designation SLE 270 030 by EPE Eppensteiner GmbH & Co. Filterbau, D-68775 Ketsch. The high-performance filter 11 is carried by a frame 12. The inlet of the high-performance filter 11 is located laterally at 13 (fig. 2), whereas the outlet is positioned centrally below the filter 11 at 14. Such power filters are known per se.

The oil filtered warm in the high-performance filter is then supplied to the ultra-fine filters 16, which are able to filter even the smallest particles from the warmed oil and by means of the outlet 17 deliver same for further use or reuse.

The magnetic filter 8 has a very strong magnet by means of which magnetizable particles can be drawn from the flow path. A vent valve 21 is located on the top of the magnetic filter 8. The magnetic filter 8 also has an indicator 22. It is also provided with its own switch 23, so that it can be switched on and off as required (fig. 3). A connection box 24 is provided for the electric supply and switching of the entire unit. Upstream of the pump unit 9 is provided a coarse filter 26 preventing large particles from entering the pump unit 9 and impeding or damaging the latter, to the extent that such particles have not already been separated in the prestorage tank 1, e.g. because they do not have a very different specific weight compared with the liquid or if in certain cases no such prestorage tank is used.

In addition, between the magnetic filter 8 and the pump unit 9 a cutoff valve 8a is provided at the inlet 7a in order to optionally shut-off the system. In addition, an inspection window can be provided permitting a check to be made on the consistency, particularly cloudiness of the liquid compared with that delivered at the outlet, where an inspection window can also be provided.

The liquid cleaned by means of the high-performance filter 11 is



supplied by means of a branch 46 of the outlet line of two parallel distributing tubes 27, 28 to two, i.e. in each case a group of several ultra-fine filters 16. By means of the double-throw or changeover switch 29 the liquid can be supplied either to one or other group of ultra-fine filters, or simultaneously to both. The two first alternatives make it possible, despite the operation of the unit, to replace the ultra-fine filters to which the liquid is not being supplied and consequently the unit does not have to be completely shut down. The liquid passes via a central inlet 31 located on the underside of the ultra-fine filter into an ultra-fine filter 16 and by a lateral outlet 32 on the underside out of said filter again and is passed via collecting lines to the main pipe 33 and in the latter to the drain flange 34. In the main line 33 can be provided a flowmeter 36. Upstream of the drain flange is provided a viewing panel 37. Here again a cutoff device can be provided.

Used oil, as well as tar oil to be cleaned, is initially fed into the prestorage tank and stored there for an adequate time, e.g. 24 hours, so that larger particles are separated therein. Optionally a plurality of prestorage tanks can be provided with which in each case is connected the filtering means.

The oil is then sucked out of the prestorage tank 1 by means of the suction nozzle 2 and the pump unit 9 and, in the case of tar oil, passage initially takes place through the heating unit 3 in which heating takes place to about 100°C, so that the water moisture can be given off via the water devapourization flow device 4.

The liquid to be cleaned then passes into the magnetic separator 8 in which the magnetizable particles are separated. The liquid is then forced by the pump unit through a high-performance filter 11 and a first filtering takes place therein. The liquid is then forced through the ultra-fine filters 16, in which even the smallest particles down to a size of about 15 μm can be filtered



out. After passing through the ultra-fine filters 16 the cleaned oil can be discharged through the outlet 34 and supplied for reuse.

In another embodiment the apparatus according to the invention firstly has a magnetic filter 101 with a self-cleaning device as a prefilter, into which the liquid is fed via a gravity line 102. A magnetic prefiltration takes place in the magnetic filter 101, in that magnetizable particles are drawn by magnets from the liquid. Coarse, iron-containing particles are so built up to a filter cake that also smaller dirt particles can in this way be removed from the liquid. If the not shown chamber for receiving the filter cake has attained a certain filling level, then automatic removal takes place.

The apparatus shown in fig. 4 can be used for filtering used oil, hydraulic oil, tar oil, as well as for filtering and cleaning cooling water used in machines and cooling agents used in tool plants. During the filtering of the first-mentioned media the liquid, following a corresponding setting of a lever 104 located on a pump 103, passes via an inlet 105 into a continuous heater 106. The pump 103 with a pressure of 4 to 5 bar removes the liquid precleaned by the magnetic filter 101 from a not shown chamber, serving as a preliminary tank, and located below the filter 101. In order in the case of a throughput of $2 \text{ m}^3/\text{h}$ to heat the liquid to 80°C , the continuous heater 106 preferably has a calorific power of 84.6 kW. By means of said continuous heater 106 the oil to be cleaned is given a lower viscosity and also any water or moisture present is expelled from the liquid. The continuous heater 106 is provided with an excess pressure valve and a heat regulator to prevent liquid overheating. To the continuous heater 106 is connected an electromagnet shocker 107 and as a result of its influence the fine metallic particles agglomerate. The electromagnet shocker 107 is followed by a mechanical filter stage 108 as a high-performance filter. This



filter stage is a wide-surface or wide-bed filter 108. On said wide-surface filter are deposited the agglomerated particles such as dust, sludge, soot, etc. and in this way form a filter cake. The throughput is preferably 220 l/min. However, in large plants it can also be 400 or 600 l/min. By means of a not shown fleece roll serving as a continuous roll the particles forming the filter cake are discharged almost dry at the end 109 of this filtering zone 110..

By means of a second pump 111 the prefiltered liquid passes to a double filter 102. This double filter 112, whose filters can be connected in at random, prevents any coarser particles present from entering the ultra-fine filter system. The double filter 112 can be a ceramic or paper cartridge filter. It is also possible to use a high-grade steel screen with a pore size of 3 to 5 μm .

A continuous counter 113 can be directly connected to or follow the double filter and can have a permanent or day counting mechanism. This makes it possible to check the throughput during used oil cleaning. The filtered liquid then passes into the ultra-fine filter system 114 and is supplied to the ultra-fine filters 115, which filter even the smallest particles out of the liquid and pass on the same via an outlet 116, by means of which the fine-filtered medium passes into a not shown empty tank for receiving the cleaned medium, particularly oil. By means of the ultra-fine filter system 114 residual substances of metals such as lead, zinc, aluminium, soot, emulsions and water are filtered to a very high degree.

The apparatus according to the invention in this embodiment also has a switch box 117 by means of which all the switching operations take place and which is provided with warning and overload indicators so that, if necessary, the complete plant or unit can be disconnected or shut down.



If the apparatus according to the invention shown in fig. 4 is used for cooling medium or water cleaning, then the medium passes through the magnetic filter 101, particularly if high water percentages have to be removed and which after passing through large plants has a temperature of about 50 to 70°C, in the same way as the oil. Then the medium passes via the pump 103 no longer to the continuous heater 106, but instead after reversing the lever 104 to an edge gap filter 118. By means of the edge gap filter 118 the oil is separated from the water and dust. By means of a not shown valve in the lower region of the edge gap filter 118 the solid sludge contamination or the contamination itself is removed. A separator can be used in place of an edge gap filter 118.

After this filtering the liquid medium passes to a heat exchanger or a cooling unit 119 and is cooled there to approximately 20°C. This heat exchanger 119 is either directly followed by the ultra-fine filter system 114, or the medium passes, following the reversal of a lever 120, via the pump 111 to the double filter 112 and optionally the flowmeter 113 into the filtering system 114. The lever 120 is reversed by means of the switch box 117.

All the components 101 to 120 are mounted on a not shown, common substructure, which can be reinforced with a steel frame. The complete unit is constructed in transportable or stationary manner, including all the necessary pipes, connections and fittings. At the installation location it is then merely necessary to provide the power connections, as well as the supplies and outflows for the liquid.

The arrangement of the ultra-fine filters 201 shown in figs. 5 and 6 is usable both for the ultra-fine filter 16 of figs. 1 to 3 and the ultra-fine filters 115 of fig. 4. The ultra-fine filter system has an ultra-fine filter set 202, which in the represented embodiment has reciprocally displaced or staggered units 203, 204, 205 with the ultra-fine filters 201. Below the ultra-fine



filter set 202 is located a tank 206 for receiving the cleaned medium. By means of an inlet 207 with distributing tubes 208 the heated or cooled medium is supplied to the individual units 203, 204, 205. On the individual distributing tubes 208 are in each case provided shutoff cocks 209, so that in each case one unit 203, 204, 205 can be shutdown in order to replace the ultra-fine filters 201. In each case the filters 201 have a filter housing 210 with a lid and a clip closure. Upstream of the ultra-fine filter housing 201 is located the inlet with a barometer 211. Between the shutoff cock 209 and the barometer 211 is provided a drain 212 for the sludge and dust. After cleaning has taken place in the ultra-fine filter 201 the cleaned medium passes to the outlet 213, which preferably has a check valve. By means of said outlet 213 the medium either passes into the tank 206 or into a pipe, so that it can be supplied to its reutilization.

CLAIMS

1. Apparatus for filtering contaminated liquids, particularly oil, used oil, tar oil, as well as cooling agents, cooling water, etc., using filters and at least one pump (9, 103) forcing the liquid through the filters, a high-performance filter (11, 108) being followed by several additional ultra-fine filters (16, 115, 201) arranged parallel to one another in the flow path and a magnetic filter (8, 101) with a magnet which can be connected in for extracting magnetizable solid particles from the liquid.
2. Apparatus according to claim 1, characterized in that the pump (9) is positioned upstream of the high-performance filter (11).
3. Apparatus according to claim 1 or 2, characterized in that the ultra-fine filters (16, 115, 201) can be connected in group-wise for treating the liquid.
4. Apparatus according to one of the claims 1 to 3, characterized in that the ultra-fine filters (16, 115, 201) have a cylindrical housing with a central hollow shaft and that between the two is provided filter material.
5. Apparatus according to one of the preceding claims, characterized in that the inlet stage is a prestorage tank provided with at least one screen (52).
6. Apparatus according to claim 5, characterized in that the inlet (51) to and outlet (2, 2a) from the tank (1) are positioned on different sides of the screen (52).
7. Apparatus according to claim 5 or 6, characterized in that the outlet (2, 2a) from the tank (1) is provided with a float.
8. Apparatus according to one of the claims 5 to 7, character-



ized in that an extruder (55) is positioned below the inlet (51).

9. Apparatus according to claim 8, characterized in that with the extruder (55) are associated stationary magnet jaws (56) in such a way that the extruder (55) strips collected magnetizable coarse particles and can remove them from the tank (1).

10. Apparatus according to one of the preceding claims, characterized in that upstream of the pump (9) and a first filter (11) is provided a heating device (3) with a water devapourization flow device (4).

11. Apparatus according to one of the claims 1 to 10, characterized in that the magnetic filter (101) is the inlet stage of the apparatus.

12. Apparatus according to one of the claims 1 to 10, characterized in that the magnetic filter (8) is located within a filter means (6).

13. Apparatus according to claim 11, characterized in that the magnetic filter (101) is followed by a pump (103) with a lever (104).

14. Apparatus according to claim 13, characterized in that the pump (103) can optionally be followed by a continuous heater (106) for oil or an edge gap filter or separator (118) for cooling medium or water.

15. Apparatus according to claim 14, characterized in that the continuous heater (106) is followed by an electromagnet shocker (107) and a wide-surface filter (108, 109).

16. Apparatus according to claim 14, characterized in that the edge gap filter or separator (118) is followed by a heat exchanger or cooling unit (119).



17. Apparatus according to one of the preceding claims, characterized by a further pump (111).

18. Apparatus according to one of the preceding claims, characterized by a double filter (112).

19. Apparatus according to one of the preceding claims, characterized by upstream and/or downstream inspection windows (37).

20. Apparatus according to one of the preceding claims, characterized by a sampling point.

21. Apparatus according to one of the preceding claims, characterized by a flowmeter (36, 113).

22. Apparatus according to one of the preceding claims, characterized in that an oil collecting tray is provided, particularly below the ultra-fine filters (16, 115, 201).