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(54) Method and apparatus for degreasing articles in a vapour.

(57) Method for degreasing articles in a solvent in a closed space which contains a mixture of air and saturated solvent vapour. The degreasing operation is conducted at a temperature lower than the normal boiling point of the solvent. The apparatus comprises a solvent storage room (5), heating means (6) to evaporate the solvent, a degreasing chamber (2), a closable duct (7) between the evaporator and the degreasing chamber, and means (8) to discharge the vapour-air mixture after the degreasing process.

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Method and apparatus for degreasing articles in a vapour.

This invention relates to a method of degreasing articles in a saturated vapour of a solvent, in which the articles are immersed at a temperature lower than that of the vapour, said vapour being brought to condensation on the article, whereafter the condensate thus formed is allowed to drain off the article, in which draining condensate the grease, the dirt, etc. are entrained, leaving the article behind in a cleaned state.

Thusfar metal products which during the manufacturing process or for other reasons have been polluted with oil, grease, lubricant, emulsion or dirt, are made grease-free at the end of the manufacturing process or otherwise, before being subjected to the next processing step (for example etching, chromium-plating, lacquering, etc.) i.e. they are degreased by lowering same into an open container within the vapour of a degreasing agent or solvent, boiling at normal atmospheric pressure, which solvent is contained as a liquid in the lower part of the container or vapour degreaser.

At its introduction in the container the article to be degreased is colder than the vapour so that the vapour condensates on the article; the drain of the condensate takes along the grease, dirt, etc. dissolved therein and in this way the surface of the article is cleaned.

Suitable solvents for this purpose are (or better: were):

solvent	boiling point	complete name
PER	121°C	tetrachloro-ethylene
1.1.1 TRI	74°C	1.1.1-trichloro-ethane
TRI	87°C	trichloro-ethylene
MC	40°C	methylene-chloride

Care had to be taken that when working with an "open container" no solvent vapour could evade toward the space around the vapour degreaser. Thereto the vapour in the upper portion of the container was cooled, so that in the vapour space a rather stable vapour 'blanket' was formed above the liquid space in the container. The small amount of vapour which still succeeded in escaping to the ambient atmosphere - principally during the introduction of the dirty and withdrawal of the degreased articles into and from the vapour degreaser - was to be neglected under the then prevailing regulations in respect of the environment-burden.

Recently in Germany more stringent regulations in respect of the proection of the surroundings against detrimental vapours and gases have come into force, whereas in Holland (for the time being) the old regulations remain still in force.

Therefore the vapour degreaser with open container has become inadmissible in Germany. Another objection against the vapour degreasing process of nowadays is the use of TRI as solvent, now that it has appeared that this substance is suspect of being cancerogene.

All vapour degreasers being momentarily in use, must be reconstructed, and TRI as solvent, must be refused completely in the new vapour degreaser.

To this end Applicant has developed a new method and apparatus based on the following considerations:

It is intended to degrease in a closed vapour degreaser at normal pressure, then the air present in the degreaser, and polluted with solvent-vapour, must be discharged and purified each time after each 'run'.

If the solvent has at the work temperature a vapour pressure of 1 bar, then all air in the vapour space has to be evacuated every time at the beginning of each 'run', which is very inattractive from an energy technical point of view.

Applicant's new method starts therefore from the idea of cleaning the article in a (saturated) mixture of air and solvent vapour at a temperature being considerably lower than the boiling temperature of the solvent.

Choice of the solvent.

The question now raising is:
Which solvent can be used herewith?

In the past vapour degreasing occurred normally in a saturated vapour of PER (B.P. 121°C), TRI (B.P. 87°C), 1.1.1. TRI-CHLORO-ETHANE (B.P. 74°C) or METHYLENE CHLORIDE (B.P. 40°C).

The choice of the solvent depends mostly on the surface/mass ratio of the articles to be degreased.

Though PER has excellent degreasing capacities, the use of this product was - owing to the high boiling temperature - thusfar exclusively restricted to those cases, where - on account of an infavourable surface/mass ratio - a long heating time is necessitated.

In most cases, however, degreasing at a temperature of circa 80°C suffices, and therefore either TRI or 1.1.1.TRI was chosen. If recovery of the solvents has absolutely to take place, for example by means of an activated carbon filter, being regenerated with steam, then 1.1.1. TRICHLORO-ETHANE drops out due to its instability in contact with water.

The evaporation heat of PER is lower than that of the other solvents. Since the evaporation heat is equal to the heat liberated on condensation, then - if PER is used - more vapour will condensate, before a certain temperature is reached, than when for example TRI is used. That mount of condensate too is determinative for the degreasing capacity. Moreover PER, due to its high boiling temperature, has at room temperature the lowest vapour pressure, so that the emission can be controlled more easily.

In so doing it is possible by supplying PER-vapour to the degreasing apparatus, to prepare a PER-air mixture workable at a temperature of circa 80°C for example. At this temperature the vapour pressure of PER is only circa 0,25 bar so that still air of 0,75 bar can remain in the degreasing space. Work can be done satisfactorily in a temperature range from 40 to 90°C.

Because the PER-air mixture is saturated at this temperature, PER will certainly condensate on the cold workpiece, so that cleaning of the articles takes place. The condensate drains together with dirt etc. off the workpiece. After cleaning, the PER-air mixture is exhausted and fresh air is supplied. Due to the supply of air, the PER adhering to the workpiece-surface will evaporate and be discharged too as PER-air mixture. In a separation-station PER is again separated from the air.

Correspondingly the method of the present invention is characterized in that

- the degreasing process, properly said, of the method is conducted in a closed space, which, after the degreasing operation and after a number of other operations, is opened to the ambient atmosphere for unloading and reloading the clean and dirty articles respectively, which space contains a mixture of air and saturated solvent-vapour, whereas the degreasing operation is conducted at a temperature lower than the normal boiling point of the solvent, but higher than the temperature, at which the articles to be degreased are introduced into the condensation-space, in which
- after the degreasing process the air/vapour mixture is exhausted and the two components of the mixture are separated; the air of the mixture is discharged, virtually solvent-free, to the outside atmosphere, and fresh air and possibly a new charge of articles is taken in after first opening the closed space toward the ambient atmosphere; and
- the separated solvent-vapour after condensation is fed back to the liquid space, in which the stock of solvent is maintained in the liquid state.

Further the invention pertains to a degreaser shaped as a container for degreasing articles polluted with grease, oil or the like, within the vapour of a degreasing solvent, deposited by condensation onto the relatively cold article to be cleaned, comprising

- a liquid room, in which the solvent is contained in the liquid state;
- heating means for translating the liquid into the vapour state; and
- a vapour room, in which the degreasing of the article takes place.

The degreaser according to the invention is characterized in that

- the container is closable during the degreasing process;
- the liquid room is separated from the vapour room ;
- the liquid room is connected to the vapour room through a closable duct;
- means are provided to adjust the temperature in the vapour room at a temperature lower than the solvent's boiling point;
- means are provided to discharge the vapour-air mixture after each degreasing process through a cooler, operating in the temperature range below room temperature, so that the greater part of the vapour condensates; and
- means are provided to direct the remaining vapour-air mixture through an activated carbon filter, whereafter what evades to the atmosphere can be considered - even under the new more stringent laws -

as negligible.

Out of the three useable solvents, preferentially PER is chosen, in which case the operative temperature during the process can be set at 80°C, which is clearly below the normal boiling point of PER. The partial pressure of PER is then 0.25 bar and outside the vapour degreaser a cooler is operative in the temperature range from +10 to -20°C.

Advantages of this method over the "conventional vapour degreasing process" are:

a. By setting the temperature in the degreaser the quantity of condensate can be controlled in dependency on the pollution of the workpiece.

b. The quantity of air that has to be discharged after degreasing, is smaller.

c. The separation of a solvent with a high BP from air is simpler. This method combines the advantages of solvents with a low BP with those of solvents with a high BP.

d. Because the heat transfer coefficient of the solvent/air mixture is smaller than that of the solvent vapour sec, condensation throughout occurs along the workpiece's surface and the detrimental effect of the conventional vapour degreaser, where the workpiece is cleaned from below so that the cleaned surface area is polluted over and over by the dirty condensate which starts flowing (later in the process) from a higher level, will not occur.

The inventive method will now be explained here below with reference to the accompanying drawing in which a preferred embodiment of the apparatus according to the invention is shown.

The vapour degreaser according to the invention consists of a space 2, in which the articles or components or parts to be degreased, are placed on a supporting bar grate 21. The container 19 can be closed by doors 3 so that the degreasing process can take place in a closed space. Below the grate 21 is the collecting and buffer tank 5, in which the condensate formed during the degreasing process flows back through a shut-off valve 4. From the PER buffertank 5, cooled PER-liquid flows through a shut-off valve 22 into the evaporation room 6, where the PER is brought to vaporisation. The pure PER-vapour (boiling normally at a temperature of 121°C) is next brought through a wide riser pipe 7 up into the vapour space 2, whereby in that room an air/PER vapour mixture is formed. The desired vapour point is set by means of a temperature setting means 28 provided in the vapour space 2, in the range from 40° to 90°C. The PER-vapour condensates onto the parts to be degreased, whereby these parts are gradually warmed up. If the temperature of the parts has risen to 80°C, the air/PER vapour mixture has got a concentration of circa 2 kg PER/m^3 and the degreasing is completed. The heating is stopped, but the doors 3 remain closed.

Through an exhaust-fan 8 and shut-off valve 23 the air/vapour mixture in the container 19 is conveyed to a deep-cooling installation 9, in which the mixture from container 19 is cooled until an economical balance is reached between cooling and effective use of an activated carbon filter 12. Herewith PER-vapour is condensated, which condensate flows back through duct 14 into the bufferroom 5.

In order to avoid a too great condensation of water vapour, which is always present in the air vapour mixture, the gas flows after deep cooling in cooler 9 through a duct 24 into a two-parts condensor 10, in the first part 10a of which the mixture is warmed slightly again. The slightly warmed air leaves the condensor space 10a through duct 16 and flows out into the vapour degreasing space 2. The combination of condensor 10, evaporator 9 and compressor 11 constitutes a "heating pump" 20. The second part 10b of the condensor 10 serves to bring in equilibrium the heat balance between the vapour air flow and the energy supplied from the "heating pump". The excess in energy supplied is discharged by means of a cooling fan 26.

After the concentration of PER in the air/vapour mixture is reduced in this manner to circa 12 g/m^3, the degreaser is subjected to a slight under-pressure by exhausting the space a little which brings the air outwards through a duct 17 and an activated carbon filter 12. Due to the combination of concentration and temperature, this carbon filter 12 can be kept small.

The doors 3 can now be opened and the degreased parts 1 can be taken out of the degreaser. Thanks to the very low concentration of PER-vapour in the degreaser and the light under-pressure present therein, no PER-vapours will enter into the work-space.

Claims

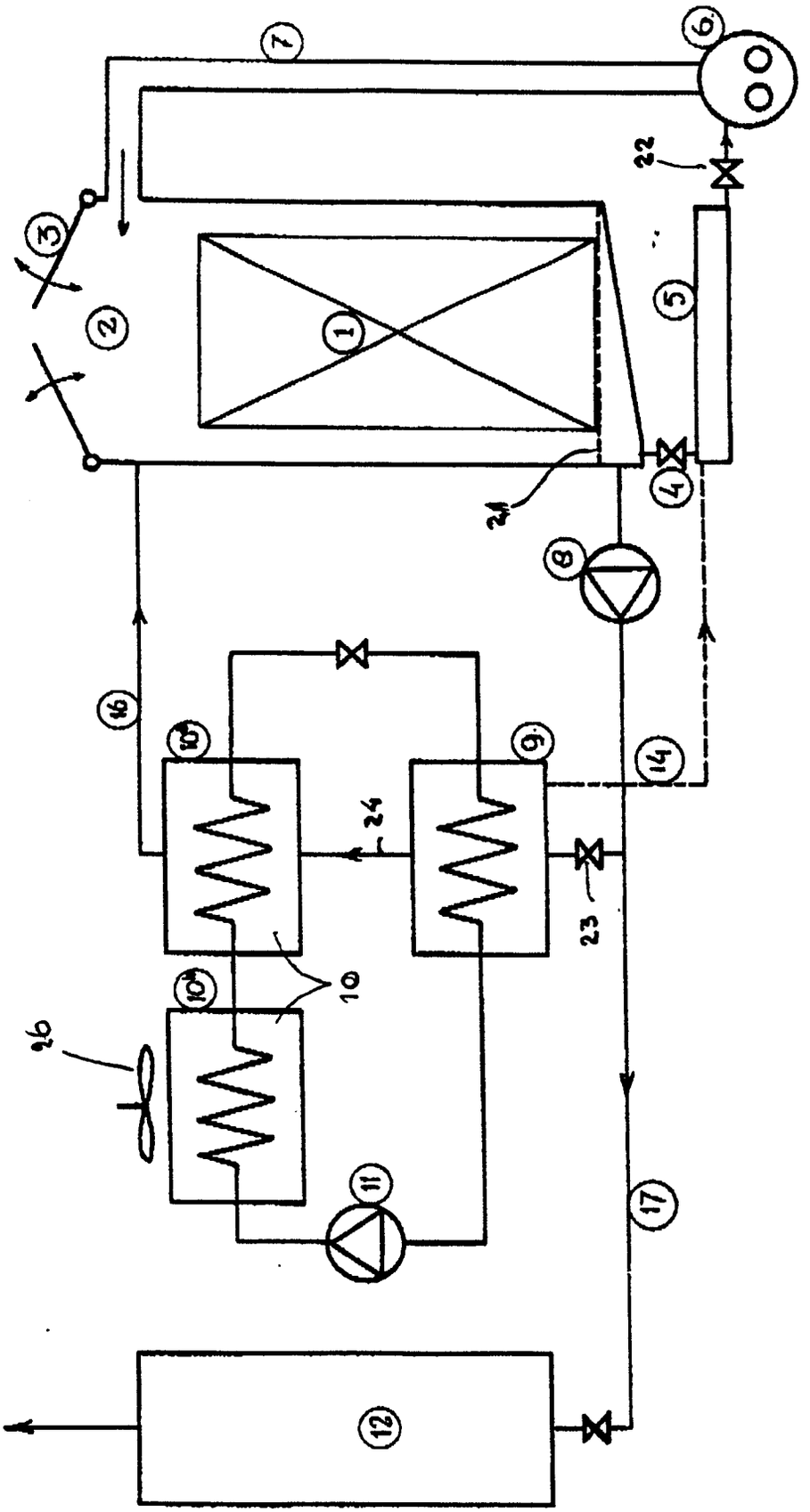
1. A method of degreasing articles in a saturated vapour of a solvent, in which the articles are immersed at a temperature lower than that of the vapour, said vapour being brought to condensation on the article, whereafter the condensate thus formed is allowed to drain off the article, in which draining condensate the grease, the dirt, etc. are entrained, leaving the article behind in a cleaned state, characterized in that

- the degreasing process, properly said, of the method is conducted in a closed space, which, after the degreasing operation and after a number of other operations, is opened to the ambient atmosphere for unloading and reloading the clean and dirty articles respectively, which space contains a mixture of air and saturated solvent-vapour, whereas the degreasing operation is conducted at a temperature lower than the normal boiling point of the solvent, but higher than the temperature, at which the articles to be degreased are introduced into the condensation-space, in which
- after the degreasing process the air/vapour mixture is exhausted and the two components of the mixture are separated; the air of the mixture is discharged, virtually solvent-free, to the outside atmosphere, and fresh air and possibly a new charge of articles is taken in after first opening the closed space toward the ambient atmosphere; and
- the separated solvent-vapour after condenstaion is fed back to the liquid space, in which the stock of solvent is maintained in the liquid state.

2. A method according to claim 1, characterized in that with PER being used as solvent, the proportions of the PER-air mixture components are chosen such that a degreasing vapour is formed out of said mixture at a much lower temperature than the normal boiling point of PER, for instance between 40 and 90°C.

3. A method according to claim 1 or 2, characterized in that after the cooling step the gas mixture is heated slightly to avoid a too great condensation of watervapour.

4. Degreaser shaped as a container for degreasing articles polluted with grease, oil or the like, within the vapour of a degreasing solvent, deposited by condensation onto the relatively cold article to be cleaned, comprising
- a liquid room, in which the solvent is contained in the liquid state;
- heating means for translating the liquid into the vapour state; and
- a vapour room, in which the degreasing of the article takes place, characterized in that
- the container (19) is closable during the degreasing process;
- the liquid room (5) is separated from the vapour room (2);
- the liquid room (5) is connected to the vapour room through a closable duct (7);
- means (28) are provided to adjust the temperature in the vapour room (2) at a temperature lower than the solvent's boiling point;
- means (8, 23) are provided to discharge the vapour-air mixture after each degreasing process through a cooler (9), operating in the temperature range below room temperature, so that the greater part of the vapour condensates; and
- means are provided to direct the remaining vapour-air mixture through an activated carbon filter (12), whereafter what evades to the atmosphere can be considered - even under the new more stringent laws - as negligible.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EUROPEAN SEARCH REPORT

Application Number

EP 88 20 0014

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	DE-C- 742 414 (Dr. A. WACKER GESELLSCHAFT) * Claims; figure *	1,2,4	C 23 G 5/04 C 23 G 5/02
A	FR-A- 854 111 (R.J. KAHN) * Abstract; figure 1; page 2, left-hand column, lines 5-48 *	1,4	
A	GB-A-2 113 719 (G. ZUCCHINI) * Claims 1-4; figure 1 *	1,4	
A	EP-A-0 087 055 (LANGBEIN) * Claims; figure 1 *	1,4	
A	US-A-4 101 340 (BURTON RAND) * Claims; figure 1 *	1,4	
A	US-A-3 111 952 (E.O. ROEHL) * Claims; figure 1 *	1,4	
A	DE-A-1 621 638 (PERO KG)		TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	GB-A-1 135 181 (I.F. EYLES)		C 23 G 5/00 C 23 G 3/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18-04-1988	TORFS F.M.G.

CATEGORY OF CITED DOCUMENTS

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