

5 Method for cleaning tanks

The present invention relates to a method for cleaning tanks, such as storage tanks and ship tanks.

Hitherto such tanks were vented, in particular after having contained hazardous materials such as benzene. Venting is a time-consuming blower operation, accompanied by development of vapours, which may be hazardous to the environment. Therefore the exciting vapours have to be burned in an incinerator, or alternatively ships have to vent in the open sea. Thus both alternatives are expensive.

GB-A-470,419 relates to a method and apparatus for cleaning the interior of enclosed spaces such as tank cars, fuel tanks and oil and chemical carrying containers which may have become fouled on their interior surfaces. The method comprises introducing a solvent into the enclosed space in both vapour and liquid form, and removing the liquid solvent containing dissolved impurities from the enclosed space.

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US-A-3,046,163 relates to a method and apparatus for interiorly cleaning a tank by first passing a hot vapour of a chlorinated hydrocarbon solvent into the tank, condensing said vapour on the tank walls, draining off the contaminated condensate and recovering the solvent, followed by pressure spraying the interior with liquid solvent, then again passing hot solvent vapour into the tank and finally

passing unheated outside air through the tank to remove remaining traces of solvent vapour from the air.

The above patents both relate to a method for removal of residual material clinging to the walls of a tank, using a suitable solvent and recirculating the recovered solvent until said material has been removed from the walls and apparatus suitable for use in said method.

As both patents expired well over twenty years ago it would have been obvious to use these methods and apparatus as an easy way out to avoid the high costs and environmental damage of the venting system as presently used, but apparently these methods and apparatus were not sufficiently refined to obtain adequate cleaning of tanks.

The above disadvantages are avoided by the method according to present invention.

The present invention provides a method for removing hazardous material from a tank, whereby 90% of the hazardous material are removed from the tank within 1-2 hours.

The present invention provides a method for removing residues of hazardous materials from vapour in a tank, wherein a vapour, comprising hazardous material, present in a tank, is heated, passed outside the tank and is subsequently cooled and the remaining dry vapour is recirculated, characterized in that the vapour comprising hazardous material is heated by appropriate means to a temperature of at least 5°C above the melting point and below the selfignition point of the hazardous material to be removed, is passed by means of a pump through a cooler,

wherein the vapour is cooled by appropriate means to a temperature at least 5°C lower than the initial temperature and above the melting point of the hazardous material, the liquefied components of the vapour are recovered and the remaining dry vapour is recirculated to the tank, and recirculating being continued until the desired level of hazardous material has been achieved.

In the method described above the vapour is preferably a dry vapour. The pump is required to achieve a high throughput of the vapour, thus reducing the processing time.

In order to make the tank available for further use any possibly remaining undesired material is removed with a scrubber or in another suitable way.

As examples of materials transported in the tank may be mentioned amongst others benzene, petroleum and petroleum products, such as petrol(gasoline), palm oil and olive oil.

More specifically the method according to the invention relates to the treatment of benzene and ethanol as hazardous material. The contents of the tank are preheated to the desired temperature level at the start. Preferably benzene vapour is cooled to a temperature above 6°C, or ethanol vapour to a temperature above 4°C, the cooling preferably being performed by means of chilled medium such as water, while the initial vapour is at a temperature between 11°C and 30°C for benzene and a temperature between 9°C and 30°C for ethanol. Heating is preferably performed by means of appropriately heated medium, such as water.

The hazardous material will condense in the cooling unit (cooler) and can be isolated from there while the remaining vapour is returned to the tank. This treatment is repeated by recirculating the vapour until the desired level of hazardous material is achieved.

With respect to benzene the vapour may be cooled to below the solidification point of benzene, $5,5^{\circ}\text{C}$, in a final recirculation step.

In the following the invention is further elucidated with references to the drawing, in which the sequence of units for carrying out the method according to the invention for a tank is shown schematically.

A vapour, heated to a suitable temperature by heating means (not shown), is passed from a tank 1 to a cooling unit 4 via a conduit 2 by means of a pump 3. Said cooling unit is provided with a jacket 10 (only the lower part being shown). Condensed vapour is discharged from the cooling unit 4 to collector 12 by means of conduit 11. Cooling unit 8 provides cooling medium to the jacket 10 of cooling unit 4 via conduit 9, said cooling medium being returned to the cooling unit 8 via collecting vessel 6 and conduits 5 and 7. The remaining vapour in the cooling unit 4 is returned to the tank 1 via the last part of conduit 2. All conduits may consist partially or completely of flexible hoses.

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Having thus described the present invention, it will be understood by those skilled in the art that variations and modifications can be effected in the described embodiments

without departing from the scope and spirit of the invention.

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Claims:

1. A method for removing residues of hazardous materials from a tank, characterized in that a gas mixture is passed a)
through the tank containing residues of hazardous material at a temperature of at least 5°C above the melting point and below the self-ignition point of the hazardous material to be removed,
b) the vapour mixture thus formed is passed from the tank through a discharge unit to a recovery unit,
c) is cooled to a temperature of at least 5°C lower and above the melting point of the hazardous material in a recovery unit,
d) the liquid components of the vapour are recovered and the dry gas mixture is recirculated to the tank while reheating to the temperature as under a),
e) said recirculation is repeated until the required level of hazardous material has been achieved.
2. A method according to claim 1, characterized in that the gas mixture is a dry gas mixture.
3. A method according to any one of claims 1 and 2, characterized in that as a final step remaining undesired material is removed with a scrubber.
4. A method according to any one of the preceding claims, characterized in that the hazardous material is benzene.
5. A method according to claim 4, characterized in that benzene is cooled to a temperature above 6°C.
6. A method according to any one of claims 4 and 5, characterized in that the cooling is performed by means of chilled water.

7. A method according to any one of claims 4 to 6, characterized in that the temperature of the initial gas mixture is at a temperature between 11°C and 30°C.

8. A method according to any one of the preceding claims, characterized in that contents of the tank are preheated to the desired temperature level prior to passing through the initial gas mixture.

9. A method according to any one of claims 7 and 8, characterized in that the heating is performed by means of appropriately heated water.

10. A method according to any one of claims 4 and 9, characterized in that cooling is performed by means of cooled medium.

11. A method according to any one of claims 9 and 10, characterized in that the temperature of the initial vapour is between 9°C and 30°C.

12. Method according to any one of the preceding claims, characterized in that the vapour in the tank is preheated to the desired temperature level prior to being conducted to the cooler.

13. Apparatus for removing residues of hazardous material from vapour in a tank, comprising a conduit 2, provided with a pump 3, leading to a cooler 4 and from said cooler back to the tank, said cooler 4 being provided with a cooling jacket 10 wherein cooling medium is passing through conduit 5 via collecting vessel 6 for cooling medium and is circulating via conduit 7 via cooling unit 8 and conduit 9, and condensed hazardous material may be removed from cooling unit 4 by means of conduit 11 to collecting vessel 12.