United States Patent [19]

McDermott

[11] **3,856,570**

[45] **Dec. 24, 1974**

[54] **METHOD AND APPARATUS FOR CLEANING THE INTERIOR OF INDUSTRIAL VESSELS BY USING ROTATING NOZZLE HEADS**

[75] Inventor: **David C. McDermott,** Houston, Tex.

[73] Assignee: **Shell Oil Company,** Houston, Tex.

[22] Filed: **Oct. 11, 1972**

[21] Appl. No.: **296,714**

[52] **U.S. Cl.** ..... **134/24,** 134/36, 134/94, 134/167 R

[51] **Int. Cl.** **B08b 9/08**

[58] **Field of Search** ..... 134/24, 30, 36, 40, 94, 134/98, 99, 123, 166 R, 167 R, 22 R; 118/317

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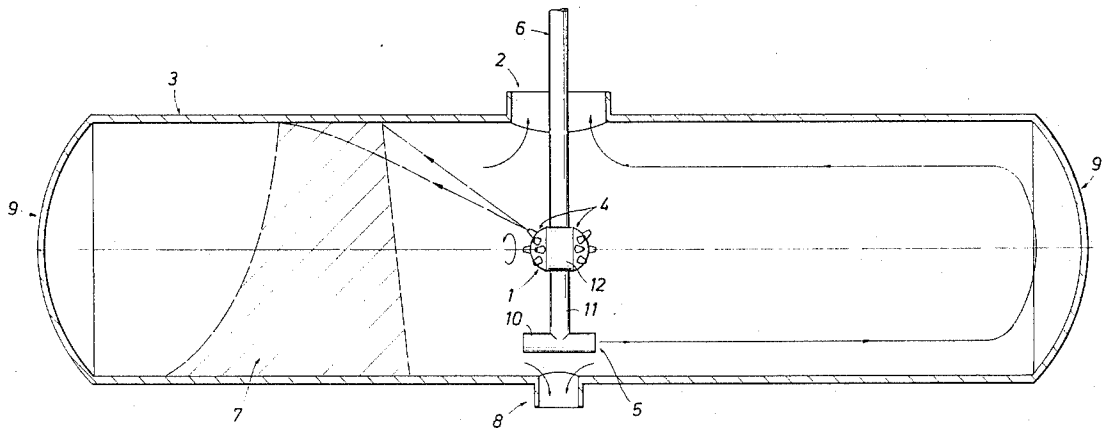
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Primary Examiner—S. Leon Bashore
Assistant Examiner—Richard V. Fisher

[57] **ABSTRACT**

Industrial vessels are cleaned with fluids injected under pressure through rotating nozzle assemblies inserted at positions which take into account vessel symmetry and the location of drainage outlets. In a nozzle assembly, nozzles are distributed symmetrically in the nozzle head, and the nozzles are inclined to the axis of the nozzle head so that each nozzle sprays fluid in a different direction. A gas nozzle is positioned below the rotating nozzle assemblies.

7 Claims, 2 Drawing Figures



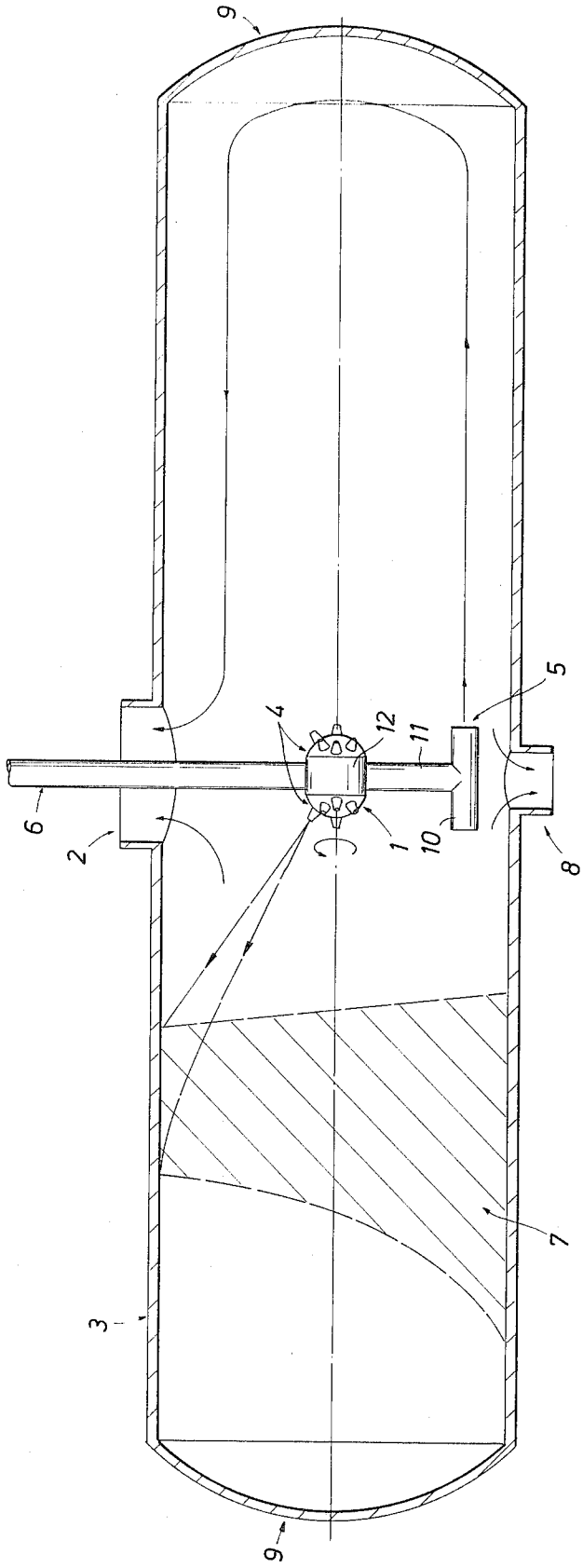


FIG. 1

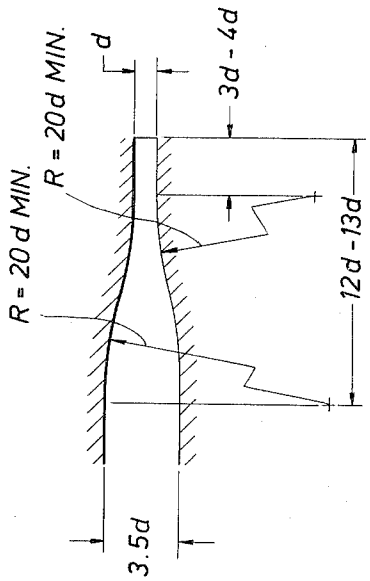


FIG. 2

METHOD AND APPARATUS FOR CLEANING THE INTERIOR OF INDUSTRIAL VESSELS BY USING ROTATING NOZZLE HEADS

BACKGROUND OF THE INVENTION

It is well known that in-plant tank car cleaning can vastly improve the utilization of tank cars because the intrinsic inefficiency due to random demand can be reduced by increasing the number of cars in multiple service, and this can be achieved in many cases by routinely cleaning tank cars between trips, thus making them available for shipping any one of several products on the next trip. Also, time-consuming activities can be changed in order to reduce the total round-trip-time for each tank car. Thus, an example is the elimination of the travelling time to and from a contractor's cleaning plant by carrying out tank car cleaning at the manufacturer's shipping point.

If cleaning is to be carried out in the plant, such a method must satisfy at least two criteria. That is, the method must be rapid so that single-spot cleaning centers on small areas of land can handle large numbers of tank cars; and the quantity of effluent resulting from the cleaning operation must be small so that the problem of disposal is minimized.

Unfortunately, present tank car cleaning generally achieves neither of these criteria. In addition, the problem is further complicated by a multi-product use of tank cars. Thus, present cleaning apparatus is not sufficiently diversified so that it can be used for cleaning different products without making substantial changes in the apparatus.

The present invention overcomes the above described difficulties of the prior art, and provides a successful solution thereto, as will be apparent from the following description thereof.

SUMMARY OF THE INVENTION

The primary purpose of this invention resides in providing a method and apparatus whereby multi-product tank cars can be efficiently and economically cleaned of products for improved utilization.

The above purpose has been achieved by using traditional cleaning fluids with improved means and techniques for distributing them. All of the cleaning fluids are injected into tank cars from a single nozzle assembly lowered through a man-way. Resulting liquids are removed through the bottom outlet while resulting vapors are removed through the man-way. For this improved method, a new nozzle design is provided which results in cleaning which is faster, cheaper, and more efficient than existing methods. An important economic benefit resulting from rapid in-plant cleaning is the improved utilization of a tank car fleet.

The nozzle assembly of the invention, which drops through a man-way, includes two main parts combined into one unit: (1) at least one and preferably a pair of rotating nozzle heads for producing high velocity liquid jets, and (2) a gas nozzle. Sufficient nozzles are provided to cover the entire tank wall surface and the rate of rotation of the nozzle head is adjusted so that each part of the tank wall preferably receives fresh cleaning fluid several times each minute. The axis of rotation of the nozzle head generally coincides with the tank axis. In the case of gas nozzles used for air or for steam cleaning, the gas enters through a concentric supply line supplying the nozzle assembly and exits from a T-shaped nozzle set about parallel to the tank car axis just above the floor of the tank car. A flow pattern is established which extends the length of the tank car so that gas is deflected by each head and forced to return along the upper portion of the tank to exit finally via the manway.

Within the framework of the above described apparatus and method, the present invention not only solves the above mentioned problems of the prior art, but also achieves further significant advantages as will be apparent from the description of preferred embodiments following.

DESCRIPTION OF THE DRAWINGS

FIG. 1 provides a schematic showing of cleaning fluid distribution within a tank car;

FIG. 2 discloses the dimensions of a nozzle.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In accordance with the present invention there are provided various techniques and apparatus for cleaning several types of products shipped by tank car. Such products may be divided into four groups: Oils which can be removed with detergent solutions, waxes which can be removed with hot water, solvents which can be removed by steam distillation, and other materials which must be removed in solution with a solvent. Alternatively. such products may be divided into four main classes including medium or high vapor-pressure products, waxes, oils, and other products. Medium or high vapor-pressure products can be removed by extracting the vapor from the car, thereby causing further evaporation. In addition, the process for removing such materials can be made more rapid by heating the product. The general group of liquids known as "solvents" falls into this class that also includes water, which must always be removed as the final step in the cleaning operation. The remaining materials which do not fall within the first three classes or groups includes low vapor pressure products such as glycerine and hexylene glycol.

If routine in-plant cleaning is carried out, tank cars used for products within each of the above four groups or classes can be used for multiple product service. Cars can also be changed from one service group to another if necessary, but such service changes may require additional cleaning procedures to those used within one group of products. All the cleaning fluids utilized in the present invention can be injected into the tank car from a single-nozle assembly lowered through the manway. Resulting liquids are removed through the bottom outlet while resulting vapors are removed through the manway.

Most of the products in the above described categories can be removed by means of basic cleaning fluids such as heated or cold dry air, steam, hot water, hot water containing detergent, and solvents. Air is used primarily for distilling water as the final stage of the cleaning process. It is useful also for distilling materials other than water which do not present a fire hazard. If air is used for water distillation, it must have low relative humidity, which can be achieved either by heating ambient air of high humidity or by cooling and then heating ambient air. If the tank car to be dried is warm as a result of a prior cleaning operation, then air at ambient temperature can be used, but if the tank car is

cold, heated air is used. Steam is used as a distillation medium for products other than water, and its use removes the danger of fire or explosion provided care is taken to remove the air originally present in the tank car. The mixture of steam and vapor leaving the tank car may be conducted to a condensation column for recovery of the product. Steam also provides an efficient means for heating products such as wax, prior to removal with water. Steam for this purpose may be blown directly into the tank car, or can be passed through heating coils. Melted wax can be removed with hot water at a temperature above the melting point of the wax. No detergent or solvent is necessary, which is convenient because the wax on freezing separates from the water and can then be recovered and recycled. It is necessary to use a detergent for removing oils, since water alone is ineffective. The oil cannot easily be separated from detergent solution, but provided the solution is used only for removing surface films of oil, it can be re-used many times. Many types of solvents, including water, are available for a wide variety of products, and each is chosen for the particular case.

The distribution technique of the present invention transmits the cleaning fluid with the greatest possible efficiency to the product which is distributed over the walls of the tank car, and the used fluid with its entrained product is then efficiently removed from the tank car. This technique is conducted satisfactorily with the system shown schematically in FIG. **1.** The nozzle assembly **1,** which drops in through the manway **2** of the tank car **3,** includes two main parts, combined into one unit: (1) a pair of rotatable nozzle heads **4** for producing high velocity liquid jets and (2) a gas nozzle **5.** Concentric supply pipes **6** provide liquid and gas for the respective nozzles.

The rotating nozzle heads **4** are used for water, detergent, or solvent. In order to limit incoming fluid volumes to available outflow capacity, no attempt is made to cover the entire surface area of the tank continuously. Instead, as the nozzle head rotates, each nozzle covers a band **7** of the tank approximately 3 feet long. Sufficient nozzles are provided to cover the entire tank wall surface and the rate of rotation of the nozzle head is such that each part of the tank wall preferably receives fresh cleaning fluid several times each minute. The axis of rotation of the nozzle heads approximately coincides with the tank axis. Fluid from the jets sweeps over the tank car walls and runs down to the bottom of the tank where it drains toward the center and exits through the bottom outlet **8.** Because the jet angles are oblique with respect to the tank car wall, except at the heads of the tank, there is generally a component of the flow parallel to the surface causing a "sweeping" action.

The gas nozzle **5** is used for air for drying or for steam for distillation. The gas enters through the concentric supply line **6** supplying the nozzle assembly and exits from a T-shaped nozzle set parallel to the tank car axis just above the floor of the car. The gas exiting from the nozzle sets up a flow pattern which efficiently sweeps the tank car walls. The flow extends the full length of the car and the gas is deflected by each head **9** and is forced to return via the upper portion of the tank to exit finally via the manway **2.**

Vapors are extracted from the manway by means of fans or other vapor moving equipment (not shown) and released to the atmosphere or diverted to a condensation column (not shown). Liquids are extracted from the bottom outlet **8** and pumped back to a holding tank (not shown), to a settling tank (not shown), or to waste. Recirculation of the cleaning fluids may be carried out to reduce the quantities of cleaning fluids used and to reduce the volume of effluent. Both air drying and steam distillation require evaporating a fluid off the tank car interior by circulating air or steam through the tank.. By manifolding the steam and air outside the tank car, the same inlet piping and "nozzle" can be used for drying and for steam distillation. The nozzle is inserted into the manway as an integral part of the nozzle assembly described hereinafter. Air and/or steam is directed toward both ends of the car from the central location.

The head **10** of the nozzle **5** is limited to a length of about 15 inches in order to pass through a typical manway. Each half of the tee head should be a minimum of about 2 diameters in length in order to effectively direct the jet issuing from the nozzle. This allows the nozzle exit diameter to be a maximum of about 4 inches. Smaller nozzle exit diameters result in too rapid a temperature drop after the air leaves the nozzle, so the maximum diameter of 4 inches is preferred.

The riser **11** passes through the nozzle head assembly **4** and out the manway. The distance from the tee head **10** to the nozzle head assembly **4** is adjustable in order for the tee to be placed at the proper height in cars of varying diameter. The precise height of the tee above the tank car floor is not critical so long as it is within the range of about 4 to 8 inches from the tank car bottom.

The technique according to the present invention for cleaning wax cars includes a steam soak which is long enough to melt the wax followed by washing the walls with hot water at a temperature above the wax melting point. Washing the walls is accomplished by inserting a rotating nozzle assembly into the car through the manway. Nozzles suitably arranged on a rotating head direct streams of water to the entire car interior. The impact of the water jet on the walls and the subsequent rapid drainage of the hot water down the walls transports the wax out of the car in a shorter time than required for the unaided gravity drainage of molten wax.

With the addition of detergent to hot water supply, the system above described for wax cars can be used for oil cars. The addition of detergent is accomplished using a manifold system located at the hot water supply so that all of the equipment involved in placing the rotating nozzle head into the car is the same for both oil and wax cars. The nozzle head design described heereinafter is suitable for both wax and oil car cleaning.

The rotating nozzle head **4** is in the form of a spherical sector; this shape is chosen to provide a large surface area for mounting the nozzles while still allowing a clear region between nozzles. The body **12** supports a rotating head **4** on each side and contains a drive mechanism (not shown) for the heads. As above noted, the supply pipes **6** which extend down through the tank car manway hold the nozzle assembly on its lower end and contains piping (not shown) which supplies cleaning fluid to the heads. The support member also contains a pipeline (not shown) which passes through the body of the water nozzle assembly down to the air/-steam nozzle near the car bottom. The nozzle heads may be rotated either hydraulically or mechanically. A

rotational speed of at least about 10 rpm is preferred and a supply pressure of about 250 psi is suitable.

The nozzle of this invention is designed to throw an effective stream of water the distance necessary to clean a large 24.000 gallon capacity car. The interior shape of the nozzle is chosen so that the fluid velocity is increased by reducing the cross-sectional area while at the same time a minimum amount of additional turbulence is introduced into the fluid. It is the turbulence which eventually destroys the stream of fluid once it is outside the physical confines of the nozzle. To minimize the turbulence, the inside of the nozzle has no protuberances, such as a gasket, and has a smooth surface finish.

The nozzle interior is shown in FIG. **2**. All internal fillets have a radius of at least about 20 nozzle diameters (*d*). The preferred value of the exit diameter, *d*, is 3/16-inch. If internal fillet radii of about 4 inches are used (21.3 *d*), the internal nozzle length is about 2½ inches.

I claim as my invention:

1. A method for cleaning the interior of a tank car comprising:

inserting within the tank car interior a nozzle assembly including a pair of rotatable nozzle heads for producing high velocity liquid jets of cleaning fluid and a tee-shaped gas nozzle, the liquid nozzle heads and the gas nozzle being mounted on concentric supply pipes which supply liquid to the rotatable nozzles and gas to the gas nozzle, the liquid nozzle heads generally coinciding with the tank axis, and the gas nozzle being parallel to the tank car axis just above the floor of the tank car;

rotating the liquid nozzle heads at least about 10 rpm for producing liquid jets about an axis generally coinciding with the tank axis so as to obliquely sweep a circumferential area approximately 3 feet long of the tank car wall with each nozzle so that each part of the tank wall receives a sweeping action of fresh cleaning fluid several times each minute continuously removing the liquid from a bottom outlet of the tank car; and

establishing a gas flow pattern from the tee-shaped gas nozzle which extends the length of the tank car so that gas is deflected by each head of the tank car and returned via the upper portion of the tank car to exit via a manway, the gas nozzle comprising a cylindrical head having opposing nozzles with exit diameters not more than about 4 inches and the length of each half of the head being a minimum of about two diameters of the head in order to effectively direct the gas jets issuing from the nozzles.

2. The method of claim **1** wherein liquid is supplied to the liquid nozzle heads at about 250 psi.

3. In combination with a tank car, a nozzle assembly for cleaning the interior of the tank car comprising: a riser passing through a manway and into the interior of the tank car,

at least one rotatable nozzle head, in communication with the riser, for producing high velocity liquid jets from multiple nozzles positioned in the head to liquid sweep substantially all of the tank car interior, the axis of rotation of the nozzle head generally coinciding with the longitudinal tank axis;

at least three nozzles distributed both circumferentially and longitudinally in the nozzle head, so that both radial and longitudinal distances between nozzles are constant, and the nozzles are inclined to the axis of the nozzle head so that each nozzle sprays fluid in a different direction, the nozzles having internal fillets of at least about **20** nozzle exit diameters;

a tee-shaped gas nozzle positioned below the rotatable nozzle head and set about parallel to the tank car axis just above the floor of the tank car to gas sweep substantially all of the tank car interior, comprising a cylindrical head having opposing nozzles with exit diameters not more than about 4 inches, the head being in commmunication with the riser, and the length of each half of the head being a minimum of about two diameters of the head in order to effectively direct the jets issuing from the nozzles; and

concentric supply pipes which supply liquid to the rotatable nozzle head and gas to the gas nozzle.

4. The apparatus of claim **3** wherein the nozzle exit diameter is about 3/16 inch.

5. The apparatus of claim **3** wherein the fillet radii are about 4 inches and the internal nozzle length is about 2½ inches.

6. The apparatus of claim **3** wherein the rotatable head is in the form of a spherical sector.

7. The apparatus of claim **6** wherein two rotatable heads are mounted on opposite sides of a drive mechanism for the heads.

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