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METHOD FOR PURIFYING PENETRANT WASTE LIQUORS

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Fig. 1A

Fig. 1B

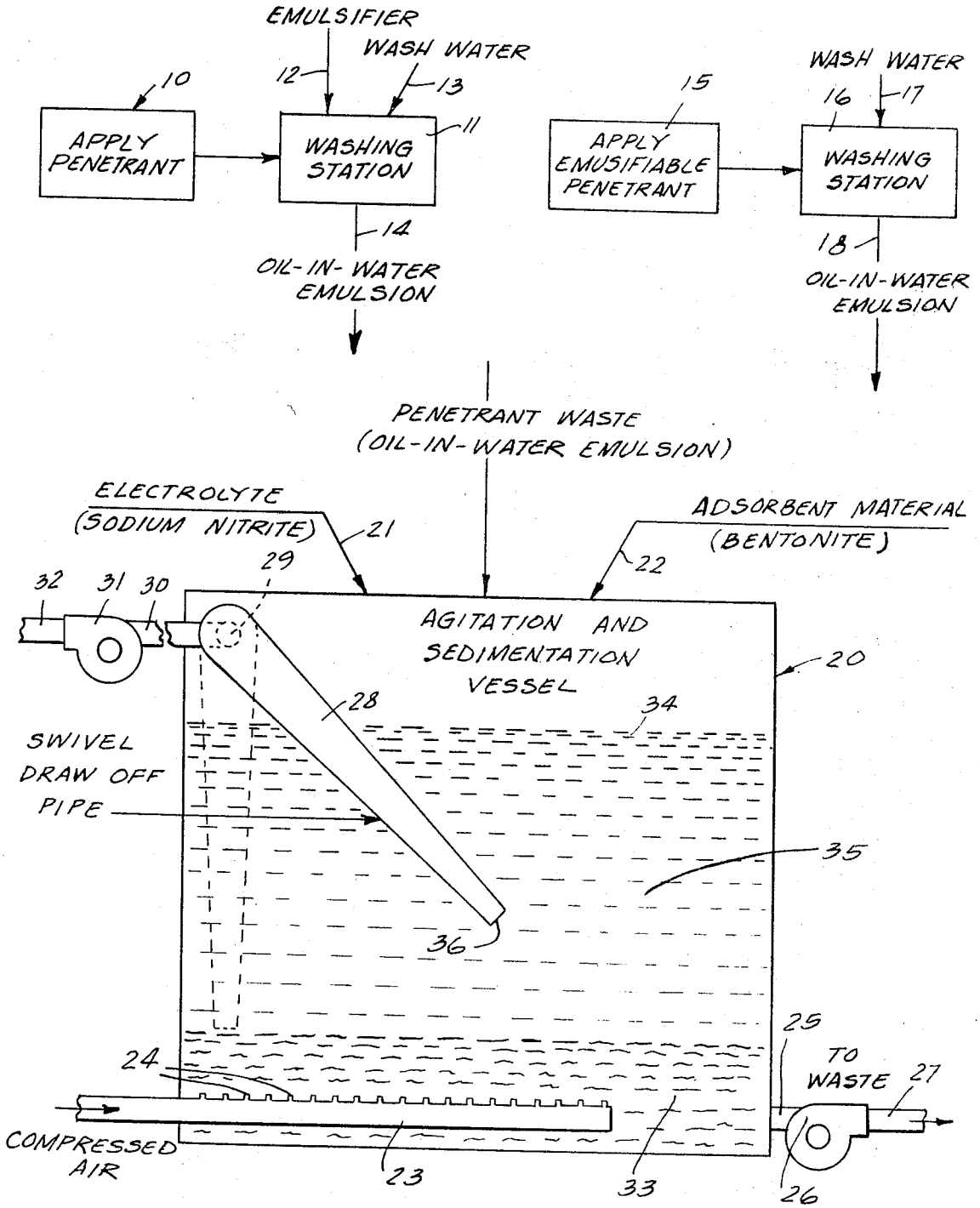


Fig. 2

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METHOD FOR PURIFYING PENETRANT WASTE LIQUORS

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U.S. Cl. 73—104 6 Claims

ABSTRACT OF THE DISCLOSURE

Method for detecting surface discontinuities in objects employing the penetrant-type inspection process wherein the penetrant waste liquor, containing oily penetrant materials, an emulsifier and wash water are introduced into an agitation zone where the waste liquor is combined with an electrolyte emulsion breaker and a clay, the mixture is thoroughly agitated, and then stratified to produce a plurality of layers one of which is essentially an oil free layer of water which can be reused in the washing zone or disposed of without causing pollution.

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of our Ser. No. 609,883 filed Jan. 17, 1967, now abandoned.

BACKGROUND OF THE INVENTION

Field of the invention

This invention is in the field of testing objects for surface discontinuities employing the oily-type dyed penetrant in which the penetrant is either self-emulsifiable or is subsequently emulsified to produce a waste liquor which presents disposal problems.

DESCRIPTION OF THE PRIOR ART

The penetrant method of flaw detection has been in use since the early 1940's. Basically, the method involves applying an oily penetrant containing either a visible or a fluorescent dye onto the surface of a test piece, removing excess penetrant while leaving the penetrant lodged in any surface flaws which may exist, applying a developer which is typically a particulated material or a suspension of finely divided absorptive particles in a volatile liquid, and then inspecting the part for the presence of flaws. The penetrant is drawn into the developer by capillary action whereupon the indication is enlarged and thereby rendered more readily visible to the inspector, using white light if a visible dye was used, or ultraviolet light where a fluorescent penetrant was used. Processes of this type are described in Switzer Pat. No. 2,259,400 issued Oct. 14, 1941.

Improvements in rendering the penetrants removable by water were effected during the commercialization of this type of process. U.S. Pat. No. 2,405,078 to Ward describes penetrant compositions which contain water emulsifiable materials therein so that water alone could be used to effect their removal.

Further improvements in the art were made by De Forest and Parker when, in U.S. Pat. No. 2,806,959 they described a more sensitive system wherein an oily penetrant devoid of emulsifier was employed in combination with a wash water which contained an emulsifier. Using this system, the emulsifier diffused into a superficial portion of the penetrant coating and was thereupon washed away leaving an emulsifier free penetrant trapped in the discontinuities which could bleed out to the surface and be detected by the developer.

Whether the emulsifying agent is included in the penetrant, per se, or added as part of the wash water, a penetrant waste liquor is produced which contains an oil-in-water emulsion of the oily constituents of the penetrant, in combination with emulsifier, water soluble components of the penetrant and the wash water. Heretofore it has been customary to discharge this penetrant waste liquor from the washing zone in which the emulsion is formed to a sewage system without making any attempt to recover the water content of the waste liquor or to eliminate its oily content. This type of disposal is objectionable for two reasons. For one, the presence of the oily materials in the waste liquor is objectionable from the standpoint of pollution of water courses into which the waste liquor is dumped. In addition, large amounts of water are used for washing purposes in large plants and with rising water costs, the water discharged into the sewer may represent a considerable sum.

It has been proposed to treat the effluent from the washing station to break the oil and water emulsion and thereafter separate the oil from the water by sedimentation or froth flotation techniques. However, such treatments are predicated on the assumption that penetrant wastes can be completely broken down into two non-miscible liquid phases, one water and the other oil. This, however, is not a valid assumption, since most penetrant waste liquors contain organic emulsifiers, such as petroleum sulfonates which are water soluble, or organic solvents that are water miscible. Consequently, penetrant waste liquors as heretofore treated may result in a waste water component that still contains oil and organic materials as contaminants in sufficient quantity to strain local sewage treatment facilities.

SUMMARY OF THE INVENTION

The present invention resides in a method for detecting surface discontinuities using an oily base penetrant wherein excess penetrant is removed by emulsification with wash water in a washing zone to produce an oil-in-water emulsion, and the oily components are removed from the emulsion by adding an emulsion breaking electrolyte thereto in combination with an effective amount of a clay capable of forming a slurry with the oily components, agitating the resulting mixture thoroughly, stratifying the resulting admixture into a plurality of layers including a layer of a clay slurry containing oily components adsorbed by the clay and a layer of water containing water miscible penetrant components, and separating the layers. The water layer can be recycled back to the washing stage or it can be discharged directly into the sewage line since it is substantially free from non-biodegradable components.

Other objects, features and advantages of the invention will be readily apparent from the following description of certain preferred embodiments thereof, taken in conjunction with the accompanying drawings, although variations and modifications may be effected without departing from the spirit and scope of the novel concepts of the disclosure, and in which:

FIG. 1A is a schematic representation of the "post emulsification" process for penetrant inspection;

FIG. 1B is a schematic representation of another type of penetrant inspection process; and

FIG. 2 is a diagrammatic showing of an apparatus for separating the water phase from the oil-in-water emulsion produced by either of the processes shown in FIGS. 1A or 1B.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1A reference numeral **10** has been applied to to a penetrant applicator station wherein an oily base penetrant containing either a visible dye or a fluorescent dye is applied to the article to be tested by means of spraying, dipping, painting, or other suitable means of application. After application of the penetrant, the workpiece is passed to a washing station generally indicated at reference numeral **11** where it is subjected to the action of an emulsifier introduced into the station **11** through a line **12** and wash water introduced into the washing station **11** through a line **13**. The emulsifying composition is applied as a more or less static layer over the penetrant on the surface of the workpiece and migrates into the penetrant to assist in the removal of the excess penetrant. The wash water is generally applied as a stream to displace the excess penetrant which has become emulsified while leaving an emulsified penetrant entrapped in any flaws. After removal of the excess penetrant, the piece is ready for development and inspection in accordance with any of the well known development techniques. The oil-in-water emulsion which results from the interaction of the penetrant, emulsifier and wash water in washing station **11** is withdrawn from that station and through a line **14** for treatment in accordance with the procedure to be described.

In another form of penetrant inspection process, that shown in FIG. 1B, the workpiece is treated with an emulsifiable penetrant in an applicator station **15**. The penetrant treated workpiece is then passed to a washing station **16** where it is subjected to a spray of wash water entering that station through a line **17**. The resulting oil-in-water emulsion is periodically withdrawn from the washing station **16** through a line **18** for further processing in accordance with the present invention.

The oil-in-water emulsion, of whatever source is introduced into a treating vessel **20**, together with an electrolyte, such as sodium nitrite, which is added by means of a line **21**. An adsorbent clay material, such as bentonite, is added to the vessel **20** through a line **22**. The resulting contents of the vessel **20** are then thoroughly agitated by means of compressed air introduced near the bottom through a header **23** and through upwardly directed discharge nozzles **24** spaced along the length of the header. The vessel **20** is also provided with a bottom discharge outlet **25** from which a pump **26** pumps settled material for discharge through piping **27**. The vessel **20** is further provided near its top with a swivel draw-off pipe **28**, swiveled at its upper end, as at **29**, to permit the lower end **36** thereof to be raised or lowered. The draw-off pipe **28** is connected through a pipe **30** to a pump **31** which serves to draw off supernatant liquid from the vessel **20** by means of a pump **31**. The oil-free water which is thus withdrawn can be pumped back into the washing station or it can be discharged directly into the sewer since it is quite innocuous.

After the air agitation and consequent mixing of the contents of the vessel **20**, the air is shut off and the contents of the vessel are allowed to remain quiescent for a number of hours, usually overnight or for an equivalent length of time. While in its quiescent state, the mass within the sedimentation vessel **20** stratifies into a lower layer **33** which is a relatively heavy pumpable slurry of adsorbent material and of the material adsorbed thereon, including oily materials and coloring matter, and a relatively thin supernatant layer **34** which may be in the nature of a scum of foreign floatable solids and contaminants brought to the surface with air bubbles from the header **23**. This layer of scum may be easily skimmed off. A main body layer **35** which is of considerable depth, consists largely of water containing water soluble organic materials from the penetrant referred to herein as water miscible organic solvents. The water in the layer **35** is of sufficient purity for reuse at the washing station.

After skimming off the layer **34**, the water containing water miscible organic solvents is drawn off through the swivel draw-off pipe **28** until a level of the water reaches about that of the level of the slurry, or the free flowing slurry may be pumped out in advance of drawing off the water layer **35**. The pump **31** serves to draw the water out through the swivel draw-off pipe **28** from the various depths to which the open end **36** of the draw-off pipe is lowered (as indicated by the pipe **28** in dotted lines) into the pipe **32** for further disposition.

The purpose of the electrolyte is to aid in causing the adsorbent material to settle out as completely as possible and leave a main layer **35** of clear liquid. Sodium nitrite is the preferred electrolyte because it is also a corrosion inhibitor, but any highly ionizable inorganic salt can be used that will aid in causing an effective settling out of the adsorbent material. As the adsorbent material, it is preferable to use bentonite, but any equivalent oil-adsorbent material having adsorbent properties toward water-immiscible contaminants, such as oil, can be used. The adsorbent material during air agitation is thoroughly dispersed and becomes coated with the water-immiscible components and with the coloring matter of the penetrant waste liquor. Upon settling, there is left a clear intermediate or body layer **35** of water containing water-miscible organic solvents. The layer **35** has little or no fluorescence in cases where fluorescent dye is used in the penetrant.

As to the concentrations that are employed, sufficient quantities of sodium nitrite and bentonite are added to give a solution of about 2.5 grams of sodium nitrite per liter, and 10 grams of bentonite per liter of the liquid contents of the vessel **20**. With a penetrant waste liquor containing about 0.1% by weight of total penetrant components, these respective concentrations of sodium nitrite and bentonite result in a separate layer **35** of water and water-miscible organic solvents of sufficient purity so that the resulting water solution can be reused in the washing station, or discharged into water courses.

In a typical operation, after overnight sedimentation, the free-flowing slurry of bentonite contaminated with the oily and color constituents of the penetrant waste liquor is drained or pumped off at the beginning of the day. Layer **35** may be returned to the washing station, together with fresh water equal to the combined volumes of layers **33** and **34**, to make up the original volume of the system. The cycle is then repeated.

Where the reclaimed water is reused in the washing station, the invention provides a closed system wherein a finite volume of water is recycled to the washing station of a penetrant inspection operation from the zone in which, by means of agitation followed by sedimentation, purification is effected through the use of an electrolyte and an adsorbent material to provide a separable layer of water containing organic water-miscible solvents from the penetrant. The so separated and recycled water component effects a very considerable economy in the overall operation by reducing the amount of fresh water required. As much as 60% of the penetrant introduced into the closed system may remain in solution in the system during continued recycling. During such recycling, the volume of the slurry of oil and color-contaminated adsorbent material that is removed to waste each time after overnight settling and stratification is somewhere between about 25 and 35%, or about 32% of the total volume of the contents of the sedimentation vessel. It is this volume that is replaced at the beginning of the day with a fresh mixture of adsorbent material and electrolyte plus a sufficient volume of water to make up the original volume.

The make-up volume will vary somewhat depending upon the particular penetrant involved and upon the specific electrolyte and the specific adsorbent material used, but the above figures are illustrative when sodium nitrite and bentonite are employed. Other suitable electrolytes

are sodium or potassium nitrate, chloride, sulfate, and the like. Instead of bentonite, other oil adsorbent clays and silicates, oil adsorbent aluminas, such as "Alon-C," a product of Degaussa Inc., Pigment Division, Kearney, N.J., and oil adsorbent silicas, such as "Cab-O-Sil," a pyrogenic silica product of Cabot Corporation can be used.

We claim as our invention:

1. In the method of detecting surface discontinuities wherein an oily base penetrant is applied to a workpiece and excess penetrant is removed by emulsification with wash water in a washing zone to produce an oil-in-water emulsion, the steps of removing oily components from said emulsion which comprise charging said emulsion into an agitation zone, incorporating into said emulsion an effective amount of an electrolyte capable of breaking said emulsion and an effective amount of a clay capable of forming a slurry with the oily components of said penetrant in said emulsion, thoroughly mixing said emulsion, said electrolyte and said clay in said agitation zone, stratifying the resulting admixture into a plurality of layers including a layer of a clay slurry containing oily components adsorbed by said clay and a layer of water containing water miscible penetrant components, separating said layers and recirculating said layer of water back to said washing zone.

2. The method of claim 1 in which said electrolyte is an inorganic salt and said clay is bentonite.

3. The method of claim 1 in which said penetrant as applied to said workpiece contains an emulsifying agent.

4. The method of claim 1 in which said penetrant as applied to said workpiece is devoid of an emulsifier and the emulsifier is added in said washing zone.

5. The method of claim 1 in which said electrolyte is sodium nitrite and said clay is bentonite.

6. The method of claim 1 in which said agitation is effected by passing air through the mixture in said agitation zone.

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