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A Study of the Effect of Time on the Separation of Tank Bottom Sludge (TBS) for Difference Volume of Extraction Solvent (XYLENE) Used

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Abstract: The crude oil Tank Bottom Sludge (TBS) is made up of fine oil coated particles that occur in crude water mixture and settles at the bottom of the crude storage tank. This sludge contains an appreciable volume of crude; hence their indiscriminate disposal will present not only an economic loss but also a serious environmental pollution problem. This study therefore, is an investigation of the best method of disposal of TBS such that the effect on the environment is reduced. The method of study was to examine the different solvents as extraction solvent for the separation of TBS. It was found that out of the four solvents stated -ethyl acetate, hexane, benzene and xylene, only xylene proved effective in the separation of aqueous layer. With the chosen extraction solvent (xylene), the effect of operating conditions such as time and volume of surfactant are examined to obtain the best results of separation. For each volume of xylene used, percentage volume of the aqueous layer was found to be 20%. The aqueous layer was in the form of water-sand mixture. No matter how long centrifuging was carried out, there was no separation between the water and muddy phase, but separation did occur with greater amount of the aqueous phase. The maximum volume of aqueous layer was 10 mL, which was obtained after 45 min of separation. Further increase in xylene from (5-25 mL) and separation time did not increase the aqueous layer. The volume of xylene required, 5 mL represents 10% of the volume of TBS treated. The optimum combination of TBS, xylene and surfactant, was obtained at centrifuging time of fifteen minutes which give an aqueous layer of 10 mL. Further centrifuging resulted in the separation of each 10 mL aqueous phase into 3.5 and 6.5 mL of mud.

Key words: Desolventised, raffinate, environmental pollution, recovery, thermal techniques, depretone

INTRODUCTION

The crude oil Tank Bottom Sludge (TSB) is made up of fine oil coated particles that occur in crude oil water mixture and settle at bottom of the crude storage tank. This sludge contains an appreciable volume of crude; hence their discriminate disposal will represent not only an economic loss but also a serious environment pollution hazard. Difference methods have been use for the treatment TSB. These include their use as fuel preferably with heat recovery, biological immobilization and solvent extraction (Walley and Sporgbr, 1970). The method use depends on several factors, deposition of TBS the location of the tank which accumulate TBS and the availability of facilities such as power equipment. In this study (Thompson, 1959), the non destructive method of recovery of TBS is envisage in which the crude oil, mud and water are to be recovered because this is an environmentally sound method of disposal of TBS. Indications are that the present method of disposal of TBS are not economically friendly. This study (Zoball, 1973) poses a challenge not only from the environmental point of view but also from economic point of view.
The aims of study are:

- To find a good combination of solvent type, surfactant type and operating conditions such that would give a good separation of the major components of TBS i.e. crude oil, mud and water.
- To determined the percentage recovery of the oil.

Method and scope of study: The method of study consists of the following steps:

- Examination of different solvents as extraction solvent for the separation of TBS.

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- With the chosen solvent, the effect of operating condition such as temperature, separation time and selected surfactant are examined to obtain the best results of separation. The complete analysis of the TBS was not affected due to equipment time reagents limitations. This could have afforded a good comparative study of the process condition used.

Relevance of study: Available information from literature indicates that the present methods of disposal of TBS are not environmentally friendly. Finding an effective alternative method of treatment of TBS would bring about economic benefits such as:

- Recovery of crude for reuse
- Recovery of mud for reuse, most especially for construction purposes.
- Reduction of environmental pollution to the barest minimum.

Thermal techniques

Pyrolysis: Oil sand is mixed with hot recycled sand in a screw mechanism in the Lurgi-Ruhrgas process for coking oily sands (Rammer, 1970). Gases evolved by the decomposition reaction are sent to the separation system where water and oily products are recovered. The waste sand is collected and some it recycled via a lift pipe in which the carbonaceous residues burnt off and the hot sand recycled to provide process heating, part of the heavy ends from the recovered oil will probably be required to satisfy the energy demands of the process.

Tar sands processes: Tar sands processes techniques (Perry and Cecil, 1974) such as hot water treatment, solvent extraction or distillation are possible oil recovery methods, although there is little recorded experience of their application to oil spill clean up. Fixed installations are generally employed for tar sands processing, but the techniques merit consideration both for future development and in cases where improvisation of disposal methods is required.

Disposal of tarballs: This method solves the problem of disposals of tarballs and oily sands. Experiments (Perry and Cecil, 1974) have been carried out by heating the sand oil mixture to the bitumen (the last in case the mixture is too soft).

Landfilling and dumping: Oily wastes (Knowlton and Rucker, 1979; Rammer, 1970) must never be buried on the beach or on shores (close to off shore drilling area) where they may be uncovered by exceptional tides. Only dry or pastry oily waste with relatively low hydrocarbon contents should be disposed of by landfilling. This implies that in the disposal of crude oil sludge, using landfilling method, it would undergo some other form of treatment before being landfilled.

Immediate ploughing in or burial: This technique (Elen, 1972) was employed on sludge in Great Britain and has also been used in the USA. The risk of groundwater contamination must be by the use of impermeable layers or minimized by the use of binding agents. Wastes to be buried must contain not more than 3% hydrocarbon and should be spread to a depth of 0.4-0.6 m.

Land-filling after stabilization: The aim of treatment is to render the waste physically and chemically suitable for use as filling material or to be left in situ in a stabilized condition.

Treatment with quicklime: In this case treatment may be carried out near the shore.

Treatment near the shore: The waste is spread out into a bed of 0.2-0.3 m depth and mixed using "Pulverizing mixer" which incorporate the lime. The quantity of lime must be determined by tests in situ (from 5-20% according to either ordinary quicklime with or without additives such as aluminum sulphate or Phopogypsum) or hydrophilic lime as used in the Bolsing process is composed of 98% lime and 2% Oleic acid and other additives. Suitable protective clothing and high protection goggles must be worn while spreading the lime. After mixing, the material is compacted using standard high way construction equipment.

The methods of the application of quick with or without various addition formulations are the subject of patents and patents application which stands in the name of Professor Bolsing is the inventor. The patents specifications also include description of the treatment of oils and oily sludges in stationary installations.

Treatment in a fixed mobile station: The same treatment can be effected at a depot which includes a loading hopper, as sack opener, continuous weighing of the waste (for adjusting the weight of the lime), a mixer and a discharged hopper. Improved dosing of the lime (and consequently increases the efficiency of the treatment) is obtain by containment within a load, which also reduces powder spillage. A transportable installation could be designed for local treatment (Concawe Report, 1980b).

Treatment with other biding material: Similar reaction to the hydration phenomena with lime occur with variety of propriety hydraulic bind materials like CHM FIX, PETRIFIX, SIALOSALC. The methods (Concawe Report, 1980b) consist essentially of thorough mixing of oily wastes with inorganic reagent (judiciously selected after tests in situ) in a fixed or mobile unit. The mixed and reacted material is in the form of pseudo mineral powder or solid blocs which are stable practically insoluble.

Another method in which sludge is binded with other material before landfilling is the use of chemically inert biodegradable natural polymer to entrap and immobilize the sludge into a clear, which would be non polluting easy and ready to handle. This technique enables the sludge/polymer mixtures to be neatly to handle. This technique enables the sludge/polumer mixtures to be neatly packaged, evacuated and disposed without a risk of damaged or contamination to environment by careful and controlled incineration and landfilling of the residue using laterite and fertilizer inoculated with bacteria.

MATERIALS AND METHODS

From literature, the best possible way to separate the sludge into its different component both for economic and disposal purposes was found to be the solvent extraction method. In this study effort was made to describe the materials and experiment used in the study.

- TBS: This refers to the crude oil tank bottom sludge. This was obtained from S P D C tank farm (Bonny Terminal) in Rivers State.
- Hexane, Benzene, ethyl acetate and xylene used are of the standard laboratory grade.
- Surfactant was obtained from S P D C, Port Harcourt. The surfactant which has the trade name "Depreton" was given to Company (i.e. S P D C) as a sample to test its effectiveness in separation of sludge's.

Procedure: The experiment was carried out by varying time for each volume of solvent used: 50 mL of TBS were measured into each of five centrifuge tubes. To each of these tubes were added 5, 10, 15, 20 and 25 mL, of solvent, respectively. The tubes were transferred into centrifuge and the extent of separation taken after each 15 min for an hour. The results are as shown on Table 1 and Fig. 1.

Table 1: Effect of time on TBS by centrifuging for each volume of xylene used to effect separation

Volume of surfactant (mL)	Time (min)	Volume of organic layer (mL)	Volume of aqueous layer (mL)
5	15	45.30	9.70
	30	45.00	10.00
	45	45.00	10.00
	60	45.00	10.00
10	15	50.10	9.90
	30	50.00	10.00
	45	50.00	10.00
	60	50.00	10.00
15	15	55.20	9.80
	30	55.05	9.95
	45	55.00	10.00
	60	55.00	10.00
20	15	60.20	9.80
	30	60.00	10.00
	45	60.00	10.00
	60	60.00	10.00
25	15	65.30	9.70
	30	65.00	10.00
	45	65.00	10.00
	60	65.00	10.00

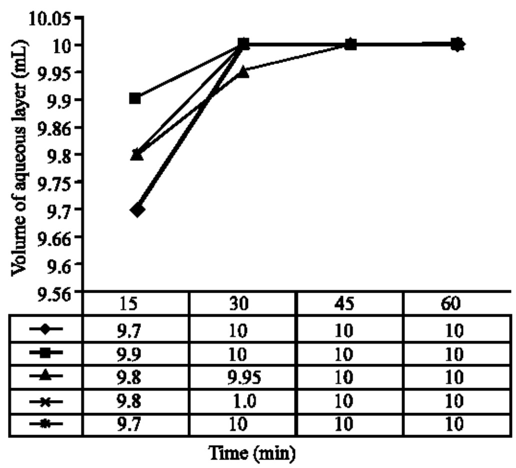

Fig. 1: Effect of time and value of xylene on the separation of TBS

RESULTS AND DISCUSSION

For each volume of xylene used, percentage volume of the aqueous layer was found to be 20%. This is in accordance with reported studies (7, 8, 9) in which 70-80% separation will be required for oil to be suitable for reuse. The results are recorded on Table 1 and illustrated on Fig. 1. The aqueous layer was in the form of water – sand mixture. No matter how long centrifuging was carried out, there was no separation between the water and muddy phase.

The maximum volume of aqueous layer was 10 mL. This was obtained after 45 min of separation. Neither increasing the volume of xylene from 5-25 mL nor that of the separating time increased the aqueous layer. The volume of xylene required, 5 mL represents 10% of the volume of TBS treated.

CONCLUSION AND RECOMMENDATIONS

The following conclusion and recommendations can be drawn from the results of the study.

- Out of the four solvents stated-ethyl acetate, hexane, benzene and xylene, only xylene proved effective in the separation of aqueous layer.
- The surfactant used (Depretone) improved the separation of the aqueous layer.
- The centrifuging time had an effect not only on the amount of the aqueous layer but also on the separation of the aqueous phase. For the optimum combination of TBS, xylene and surfactant, centrifuging for only fifteen minutes gave an aqueous layer of 10 mL. Further centrifuging resulted in the separation of each 10 mL aqueous phase into 3.5 and 6.5 mL of mud.

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