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Oil-Water Separation from Waste Oily Mixture by Physical Treatment

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Abstract: A large amount of water is being used in the upstream, downstream and automobile industrial processes. Its huge fraction comes out as waste after getting contaminated by oil and other toxic substances. Solid wastes, especially oily mixture still remain a major environmental hazard, demanding safer disposal practices. Physical, chemical and biological treatment technologies are available in the environmental field. The need, is to cost effectively optimize these treatment technologies. In our study, we have adopted heat treatment as a physical treatment for oil-water separation. The aim is to reduce the disposal cost of waste oily mixture generated from an automobile industry. Heat treatment can be effectively used to this type of waste oily scum, as it gives much reduction in disposal cost, in short time, without creating much environmental as well as human health hazards. The study focuses on the optimization of time and temperature, to increase separation of oil–water mixture and to reduce the disposal cost.

Key words: Oily mixture, hazardous waste, phase separation, heat treatment, cost reduction.

Introduction

Oily mixture is an extremely complex and variable combination of organic compounds ranging up to high molecular weight, tars and bitumen. The disposal of this oily mixture is a major threat to the environment since they ultimately deplete the natural capital and degrade the prisnity of the ecosystem. There are certain potential impacts of waste oily mixture disposal into the natural environment like:

(1) Presence of oil in water body affects the potability of water and also its use for agricultural as well as recreational purposes. Even traces of oil can form a thin film on the surface of water body and render it unfit aesthetically. This can also prevent the natural oxygenation of water bodies and in turn affect the ecosystem associated with it.
(2) The layer of oil on aquatic living bodies affects the metabolic activities.
(3) Oil provides a hostile environment to the soil bacteria and prevents the natural nutrient transformation cycle in plants and micro organisms.

Oily mixture, when exposed to open atmosphere will disintegrate due to UV rays and will release volatile organic compounds into the atmosphere which are carcinogenic compounds in nature. These obnoxious gases create odour nuisance to the nearby habitat.

Table 1 shows some of the treatment technologies to treat waste oily mixture.

Defining the Problem

The generated waste oily mixture from the automobile industry comes to effluent treatment plant with waste water. It is then sent to the oil-water separator unit for removal of waste oil from water. The oil water mixture is then stored in the oil pit unit for one day. After one day, settled water is separated and remaining oily mixture

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is transferred to oil bin unit. This oily mixture is again stored in oil bin unit for three days for further separation of remaining oil in water. After three days it is sent to hazardous waste management site for proper disposal. The waste is first incinerated and finally, used for land filling. When this oily mixture is being sent to hazardous waste management site, it contains approximately 50% of unemulsified water content into it. The disposal cost of this oily mixture is approximately Rs. 17,675 per tonne, which is a huge amount. Lot of money is being spent on this hazardous waste management. After every three days this hazardous waste of about 2 tonne is required to be sent for disposal.

If oil and water is being separated from this oily mixture, the weight can be reduced to a considerable extent. The aim behind this study is to reduce the weight of this waste oily mixture, so that the disposal cost can be reduced. Different testing and analysis have been done to reduce the weight of waste oily mixture by increasing the phase separation of oil and water.

Experimental Setup and Procedure

The treatment of oily mixture, involves physical method. Conventional methods for treating waste oily mixture is incomplete and often end up with secondary pollutant which has more lethal impacts to the environment. Advanced treatment technologies, though technically superior, may not always be economically feasible. Therefore an appropriate technology which is techno-economically feasible and environment friendly should be established and implemented.

Authors have tried with physical treatment to treat this type of waste oily mixture.

The sample is collected from the oil bin unit. The volume of the sample is 500 ml. The heating is provided through an electrical coil. The collected sample is then transferred into 1000 ml volumetric flask. Steam is passed through aluminium coil (because heat transfer capacity of aluminium is high), which is immersed in the sample. Readings are taken at different temperature, 70 ºC, 80 ºC,

Table 1: Treatment technologies for oily mixtures

	Treatment Technology	*Function*
1.	*Thermal reduction*	
	Multiple hearth incineration	Volume reduction Resource recovery
	Fluidized bed incineration	Volume reduction
	Wet air oxidation	Volume reduction
	Vertical deep well reactor	Stabilization, volume reduction
2.	*Heat drying*	
	Flash dryer Spray dryer Rotary dryer Multiple hearth dryer	Weight and volume reduction
3.	*Dewatering*	
	Vacuum filter Centrifuge Belt filter press Filter press	Volume reduction
4.	*Thickening*	
	Gravity thickening Floatation thickening Centrifugation Gravity belt thickening Rotary drum thickening	Volume reduction
5.	*Ultimate disposal*	
	Incineration Landfill	Final disposal

(*Courtesy:* Metcalf and Eddy, Inc., 1999)

90 ºC and 100 ºC after every 1, 2, 3 hours of heating. The readings are taken as per weight and volume basis to see the rate of separation.

Conclusion

Heat treatment can be effectively used to treat this type of waste oily scum as it gives much reduction in cost in shorter duration of time without creating much environmental as well as human health hazards. Increase in temperature and duration of heating, gives more separation and maximum reduction in disposal cost. The optimum temperature is at 80 ºC for 3 hours. After this temperature and time of heating more separation can be seen but at very small rate.

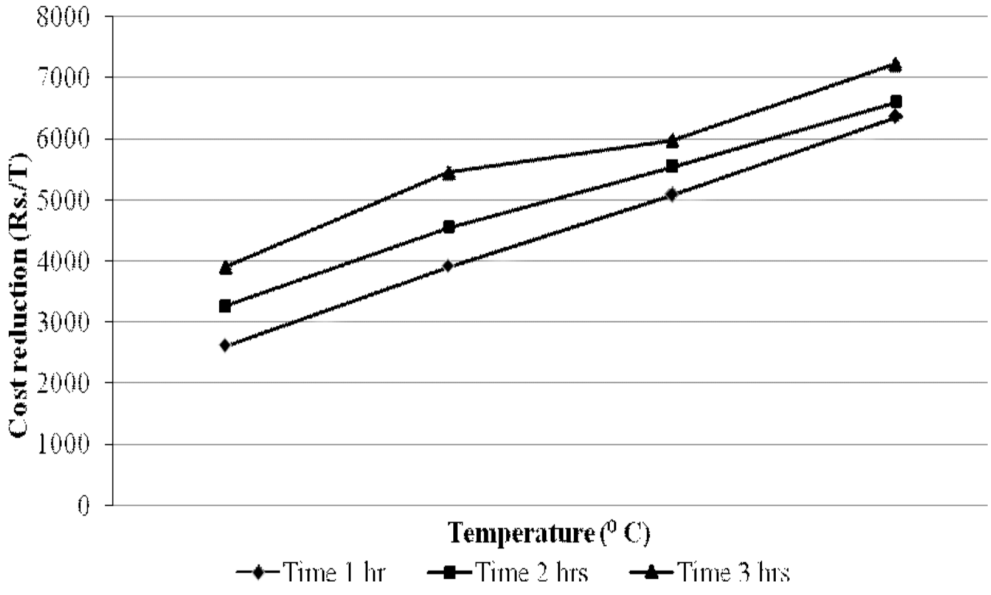
Table 2 shows the heating temperature and heating time with respect to disposal cost reduction in waste oily mixture. It indicates that the 80 ºC for 3 hours is the optimum temperature and heating time for efficient dewatering of waste oily mixture and thereby reducing the disposal cost.

Recommendations

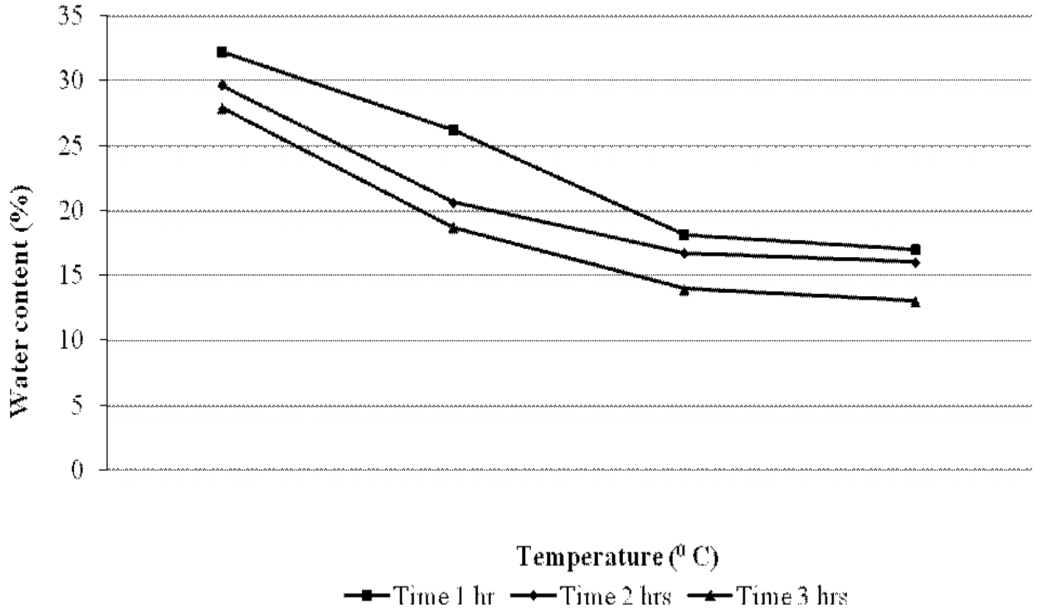
Graph 1 shows the disposal cost reduction versus temperature; indicates that with increase in temperature, separation of oil and water increases. There is a reduction of water content in the oily scum when temperature increases. It can be seen from Graph 2 that the slope of 70 ºC (3 hours) and 80 ºC (3 hours) is maximum. The

Table 2: Heating temperature and time wise disposal cost reduction in waste oily mixture

Heating temperature (ºC)	*Heating time (hours)*	*Volume (ml)*				*Total volume (ml)*	*Final moisture (%)*	*Cost reduction (Rs./tonne)*
		Oil	*Oily scum*	*Water*	*Sludge*			
70	1	5.6	492.1	94.9	9.3	601.9	32.2	2628
	2	27.4	490.5	101	11.8	630.7	29.6	3272
	3	41.9	481.7	112.6	16	652.2	27.9	3899
80	1	29.8	489.8	123.4	14.4	657.4	26.2	3916
	2	40.3	474.9	138.9	16	670.1	20.6	4557
	3	58	452.9	157.7	17.7	686.3	18.7	5445
90	1	41.9	460.9	157.7	25.1	685.6	18.1	5089
	2	59.7	458.5	160.3	17.6	696.1	16.7	5552
	3	74.1	450.5	164.4	24.2	713.2	13.9	5979
100	1	72.5	463.5	180.7	25.8	742.5	17	6374
	2	77.4	461.4	185.3	33.8	757.9	16	6603
	3	91.9	443.4	196.7	38.7	770.7	13	7226



Graph 1: Optimization of time and temperature (from set 1 to 6).



Graph 2: Reduction in water content (from set 1 to 6).

difference in disposal cost reduction at 80 ºC (2 hours) and 80 ºC (3 hours) is Rs. 888, which is the maximum. Hence, it can be concluded that the optimum temperature is 80 ºC and the heating time is 3 hours, for most favourable separation of this type of oil-water mixture and thereby highest reduction in the disposal cost.

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