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STUDIES ON SOLVENT SELECTION IN EXTRACTION OF OIL FROM WASTE MUD

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ABSTRACT

The most important adsorbent used in bleaching fats and oils is bleaching earth mixed with activated char coal. After every adsorption cycle, considerable amount of oils and fats were wasted by adsorption. In this study, we suggested an extraction process to recover oil wastes from adsorbent. Three different solvents namely, hexane, benzene and toluene were used for the experimental studies. The effective solvent was selected based on the removal efficiencies of the solvents. The influences of temperature and solvent to feed ratio were studied. The results showed that for any solvent studied, the removal efficiency increased with increase in solvent to feed ratio. Also, for any solvent at any solvent feed ratio studied, the removal efficiency increased with increase in temperature. From the results obtained hexane is considered as effective solvent for the extraction of oil from the waste mud.

Key words: Bleaching earth, Extraction, Solvent to feed ratio, Oils and Fats.

INTRODUCTION

The raw edible oil taken from any type of vegetable source before its commercialization should be refined well. Refining of vegetable oils is essential to ensure removal of gums, waxes, phosphatides and free fatty acid (F.F.A.) from the oil; to impart uniform colour by removal of colouring pigments and to get rid of unpleasant smell from the oil by removal of odor[1]. In degumming section, the oils are given acidic treatment where by gums are precipitated and separated out by centrifugal separation or sometimes only gum conditioning is carried out (when gum content is low) and gums are separated in subsequent neutralizing process. In neutralization process pretreated oil is subjected to alkali refining. The

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caustic soda reacts with Free Fatty Acids (F.F.A.) present in the oil and forms soap stock, the soap stock is separated out by centrifugal separator, oil is washed with water for complete removal of soap stock. The wash water is separated out by centrifugal separators. In bleaching process the neutralized oil is treated with bleaching earth/activated carbon for removal of colouring pigments. The bleaching agent is filtered out in vertical pressure leaf filters.

In edible oil refining, the bleaching process is generally considered to be of critical importance in determining the quality and stability of the final product. Although bleaching was originally intended for the removal of coloring substances from the oil, it is now recognized that this process is responsible for the removal of a whole range of impurities. Besides decolourization, the most important purpose of this bleaching process is the removal of trace elements such as iron, copper, calcium, magnesium, nickel and phosphorus, some of which elements are known to promote oxidation of the oil and to limit the storage stability of the oil, if they are not removed. These trace elements may be associated with phospholipids, but also with fatty acids in the form of soaps, especially when the oil results from caustic refining or hydrogenation. Bleaching of edible oils or fatty acids is also carried out to remove constituents that deactivate hydrogenation catalysts and thus lead to a more reproducible hydrogenation process and product, and to reduce catalyst usage.

In bleaching process usually bleaching earth with activated charcoal is used as adsorbent. The continuous usage of this bleachers earth makes it to get deactivated after some period. The deactivated adsorbent is called as waste mud. That waste mud consists of some residual oil is generally disposed in landfills[2]. The disposal of waste mud in landfills may cause fire and pollution hazards due to the substantial oil content in the mud. This disposal constituted a significant economic waste and an environmental burden. By recovering the oil, the cost of the disposal will be reduced effectively and the recovered oil may be reused[2-4]. Instead of discarding the waste mud, we can recover the oil from it by solvent extraction technique.

The purpose of this work is to study the removal efficiencies of solvent to recover the residual oil present in the waste mud. The effect of temperature and solvent feed ratio were studied.

EXPERIMENTAL

Material

Waste mud obtained from vegetable oil refineries nearby Chennai was used as received. Three different solvents namely, hexane, benzene and toluene were used for the extraction studies.[1,2]

Experimental Set-up

All experiments were carried out in a Soxhlet apparatus (Fig. 1). This apparatus is used for extracting valuable components from a solid by suitable solvent[5]. The solid material is placed in a thimble made of thick filter cloth and placed in a specially designed reflex condenser with a suitable solvent. The chamber holding the thimble fills with warm solvent and this is fed back to the source via a side arm. The apparatus can be operated continuously, until to reach equilibrium.

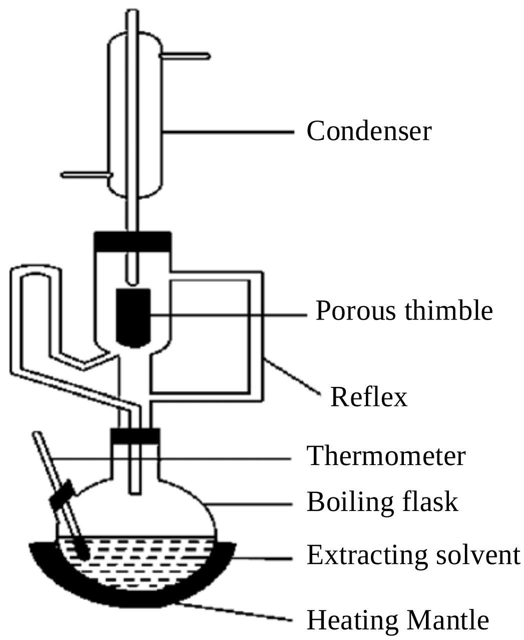

Fig. 1: Extraction Set-up

Experimental procedure

A known weight of the waste mud was kept in the porous thimble and a known volume of solvent is taken in the boiling flask[6]. The required temperature for extraction is fixed by using thermostat. The experiments were carried out at two different conditions. Initially keeping the extraction temperature as constant and varying the solvent to feed ratio then keeping the solvent to feed ratio as constant and varying the extraction temperature. The experimental conditions for various solvents are listed in Table 1.

Table 1: Experimental conditions for solvents tested

S. No.	Temperature (°C)			Solvent to Feed Ratio		
	Toluene	Hexane	Benzene	Toluene	Hexane	Benzene
1	95	55	65	6.069	4.62	6.16
2	100	60	70	6.502	4.95	6.6
3	105	64	75	6.933	5.28	7.04
4	110	68	80	7.369	5.61	7.48

RESULTS AND DISCUSSION

Effect of solvent to feed ratio

Effect of solvent to feed ratio of all the three solvents were tested and the results are shown in Fig. 2. From the figure, it can be noted that for hexane, effective extraction was taking place at the solvent to feed ratio of 5.6, where as for toluene and benzene, the values were 7.4 and 7.5, respectively.

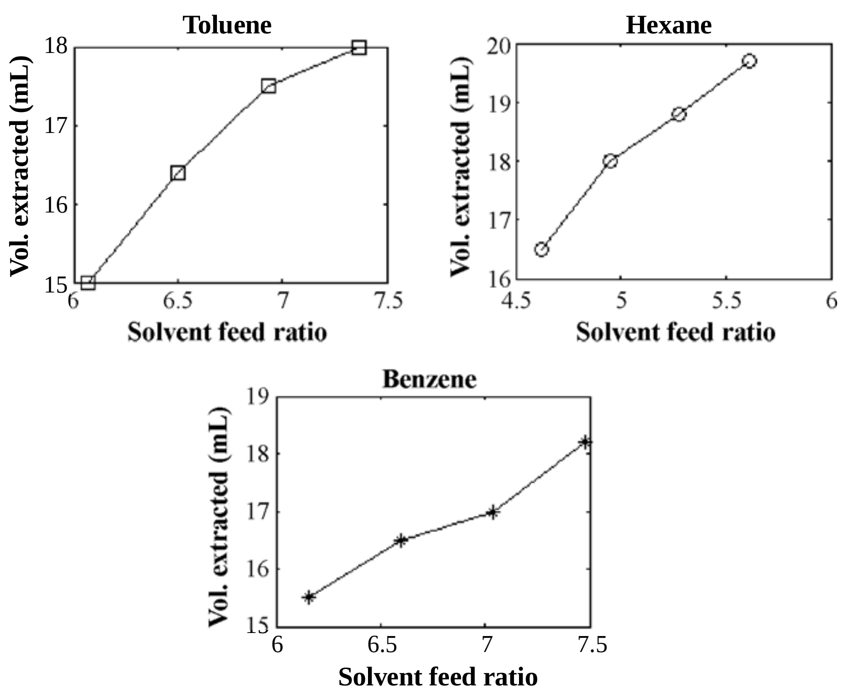

Fig. 2: Effect of solvent to feed ratio on extraction of oil from waste mud

This shows that hexane is an effective solvent for the extraction of oil from waste mud. Furthermore, though toluene and benzene systems used higher solvent to feed ratio, the amount of extracted oil was still lesser than that of hexane system (19.8 mL). Toluene and benzene, being aromatic solvents, have structural complexity when compared to the alkane, hexane. The reason is that the solution formation is basically by hydrogen bonding of solutes with solvents. Alkanes facilitate hydrogen bonding compared with aromatic compounds. This may be the reason for the poor extraction capacity exhibited by toluene and benzene.

Effect of temperature

Effect of temperature on extraction of oil from waste mud using various solvents was studied and the results are shown in Fig. 3. Figure illustrates, that the volume extracted increases with increase in temperature, irrespective of solvent. This is due to the common fact that extraction is facilitated by increasing the temperature. Solubility is normally affected with temperature raises. The solubility of oil is based on the viscosity and density of solvent/oil system. Increasing temperature would decrease the viscosity and in turn the density which helps in the easier dissolution of oil in solvent. Furthermore, extraction rate is a phenomenon of diffusion of solvent in to the waste mud bed. Diffusion is invariantly affected by the temperature, for any solvent. By increasing the temperature of the system, diffusion of solvent through bed increases which in turn increase the extraction rate. From the figure, hexane showed better extraction of oil. At a temperature of 68^{o}C, about 20 mL of oil was extracted from waste mud. This is the lowest temperature in all the three solvent systems investigated. Low temperature extraction has an added advantage to the process, because, it needs less energy to be provided for effective processing. Energy is an important asset to the process which duly affects the product cost. By consuming less energy, process produces a product of lower cost. By comparison with other two solvents, hexane may be considered as a best solvent from the results.

As per Arrhenius theory, reaction rate is affected by temperature. Reaction of dissolution of oil in to solvent is also affected by temperature. Due to increase in the temperature, the collision of molecules increases and activation energy of the dissolution is decreased. This facilitates the dissolution phenomenon. The reduced activation energy required less temperature for the reaction to start. From the experimental data obtained, hexane/oil system has less activation energy, so, by providing less energy to the system, the efficiency of the extraction could be favoured. Hence, hexane is an effective solvent for extraction of oil from waste mud.

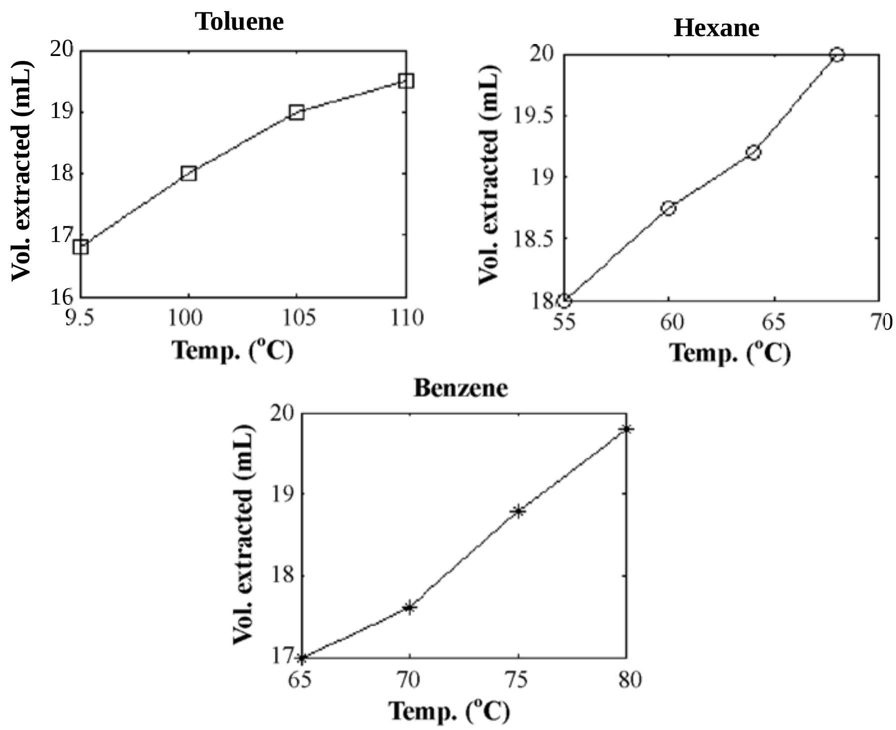

Fig. 3: Effect of temperature on extraction of oil from waste mud using various solvents

CONCLUSIONS

From the experimental results obtained in this study, the following conclusions can be made:

(i) Waste mud contains oils that can be extracted and used for various purposes effectively and hence it is not advisable to discard it as a landfill.

(ii) Of the three solvents studied, hexane showed better extraction property.

(iii) Optimum solvent to feed ratio for hexane is 5.6 and optimum temperature is 68°C.

(iv) The extracted oil can be utilized effectively for soap manufacturing or biodiesel production.

(v) The spent waste mud could be used for manufacture of bricks.

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