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Manufacturing of sulphated castor oil (Turkey red oil) by sulphonation process

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ABSTRACT:The sulphated castor oil known as "Turkey Red Oil" is obtain from castor oil directly sulphonated with So_3. The Turkey red oil manufacturing process known as sulphonation process is the faster process than present process. The castor oil is mixing with lye solution (NaOH) and reaction with EDTA (Ethylene diaminetetraacetic acid). The EDTA acts as a catalyst in this process. In this process no waste product are formed. The reaction occurs according to stoichiometry of batch or continuous process. The process requires less man power. The process can only occurs when the temperature range is maintained at 20-30℃. The cooling provided through the jacket for maintaining temperature up to 20-30 °c at atmospheric conditions. The adding of Sulphuric Acid in the castor oil solution upto 3 hours with continuous agitation. The process gives maximum yield.

KEYWORDS: Stoichiometric material balance, sulphonation process, Kinetic theory, Solubility curve.

I.INTRODUCTION

Definition:-Sulphated castor oil is a reaction product of 96% sulphuric acid with castor oil, with a starting acid concentration of 20%.

Castor oil, also called Ricinus Oil, non-volatile fatty oil obtained from the seeds of the castor bean, Ricinus communis, of the spurge family(Euphorbiaceae). It is used in the production of synthetic resins, plastics, fibres, paints, varnishes, and various chemicals including drying oils and plasticizers.[1] Castor oil is viscous, has a clear and colourless to amber or greenish appearance, a faint characteristic odour, and a bland but slightly acrid taste, with a usually nauseating aftertaste.India is the world's largest producer of castor seed. India produces 8 to 8.5 lakh tonnes of castor seed annually.[2]Both beans and oil are produced principally by India and Brazil and consumed primarily in the United States, largely in industry.

Castor oil is a vegetable oil obtained by pressing the seeds of the castor oil plant(*Ricinus communis*).[1] The common name "castor oil", from which the plant gets its name, probably comes from its use as a replacement for castoreum, a perfume basemade from the dried perineal glands of the beaver (*castor* in Latin).[2]

Turkey red oil, also called sulphonated (or sulphated) castor oil, is made by adding sulphuric acid to vegetable oils, most notably castor oil. It was the first synthetic detergent after ordinary soap. It is used in formulating lubricants, softeners, and dyeing assistants.[3] Turkey Red oil is also used in agriculture as organic manure, in textiles as surfactants and wetting agents, in paper industry for defoaming, in cosmetics as emulsifiers, in pharmaceuticals as undecylenate, in paints inks and as lubricants.

II. LITERATURE SURVEY

As the Industrial Revolution spread across Europe, chemists and manufacturers sought new red dyes that could be used for large-scale manufacture of textiles. One popular colour imported into Europe from Turkey and India in the 18th and early 19th century was Turkey red, known in France as rouge d'Andrinople.[9] Beginning in the 1740s, this bright red colour was used to dye or print cotton textiles in England, the Netherlands and France. Turkey red used the root of the rubia plant as the colorant, but the process was long and complicated, involving multiple soaking of the fabrics in lye, olive oil, sheep's dung, and other ingredients[4]. The fabric was more expensive but resulted in a fine bright and lasting red, similar to carmine, perfectly suited to cotton. The fabric was widely exported from Europe to Africa, the Middle East and America. In 19th-century America, it was widely used in making the traditional patchwork quilt.[3]

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Turkey red a name applied to one of the most durable and beautiful colours which have been produced on cotton. The process of dyeing cotton Turkey red is said to have been practiced in India from time immemorial; at present, the main seat of the industry is in the neighbourhood of Glasgow.[4] The operations are long and tedious, and their effect could scarcely be explained theoretically. Thus no reason could be given for the part of the process which consists in soaking the cloth in olive oil for a considerable length of time; yet this is well known to be one of the most essential operations in the dyeing process and is believed to be the cause of the rich appearance of the dye. Turkey red is one of the colours of alizarin which can be obtained either from madder (Rubia tinctorum) or by an artificial process of manufacture from coal-tar.[6]

III. SELECTION CRIATERIA

A) SELECTION OF RAW MATERIAL

While selecting raw material the following criteria should be considered.

1. The oil should contains of high fats & oils.
2. The oil should have high viscosity with decreasing temperature.
3. The oil should also have miscible with other acid.
4. The oil should have solubility criteria.

The castor is unique among all the criteria's suitable for selection process. The Castor Oil have fats & oil in that it has more fatty acid composition. It comprises approximately 90% of fatty acid. The castor oil is also known as ricinus oil is triglyceride of fatty acid. Castor oil is well known as a source of ricinoleic acid, a monounsaturated, 18-carbon fatty acid. Among fatty acids, ricinoleic acid is unusual in that it has a hydroxyl functional group on the 12th carbon.

The table shows composition of castor seed oil.

Table 1 .The composition of castor seed oil / fatty acid chains[1].

Average composition of castor seed oil / fatty acid chains	
Acid Name	Average percentage range
Ricinoleic Acid	85-95
Oleic Acid	2-6
Linoleic Acid	1-5
α-Linolenic acid	0.5-1
Stearic Acid	0.5-1
Palmltic Acid	0.5-1
Dihydroxystearic Acid	0.3-0.3
Others	0.2-0.5

B) SELECTION OF REACTANTS

While selecting reactants following points should be considered.

1. Castor oil is used as a source of vegetable oil which, on reaction with warm concentrated alkali.
2. Relatively the castor oil has high viscosity and specific gravity and it highly Soluble in alcohols in any proportion.
3. The castor oil sulphation results largely in a sulphuric acid.
4. The sulphate group acts as a hydrophile imparting in the reaction.
5. In addition to acting as retarding agent on the action of sulphuric acid, one and only this property we getting turkey red oil.[8]

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C) SELECTION OF CATALYST

The selection of catalyst is depends upon the following criteria &the right catalyst selection is most important for maximum yield.

1. The catalyst should have the chilling property to reduce the reaction temperature.
2. The catalyst also have colourless & water soluble.
3. The catalyst should prevent Metal ion impurities.
4. The catalyst also have neutral PH.

From above points we have choose the EDTA for better performance. The only EDTA is having all above properties.

EDTA is an animopolycarboxylic acid and colourless and water soluble solid as well as it is chelating agent to reduce the reaction temperature. EDTA is highly stable and having neutral-pH.[8] Reduce water hardness and do not form precipitate with the action of surfactant.

How does it work?

EDTA is a chemical that binds and holds on to (chelates) minerals and metals such as chromium, iron, lead, mercury, copper, aluminium, nickel, zinc, calcium, cobalt, manganese, and magnesium. When they are bound, they can't have any effects on the body and they are removed from the body.

IV. METHODOLOGY

The method of making Turkey red oil using castor oil known as sulphonation process.

Sulphonation and sulphation are major industrial chemical processes used to make a diverse range of products, including dyes and color intensifiers, pigments, medicinals, pesticides and organic intermediates. Additionally, almost 500,000 metric tons per year of lignin sulphonates are produced as a by-product from paper pulping. Petroleum sulphonates are widely used as detergent additives in lubricating oils. However, the majority of the 1.6 million metric tons of sulphonates and sulfates produced annually in the United States are used as surfactants in laundry and consumer products applications. This chapter focuses only on commercial techniques for production of detergent range sulphonates and sulphates.

- **Experimental Setup**

Fig. 4.3 Experimental setup of manufacturing of Turkey red oil.

- **Procedure**

1) Take castor oil (500 ml)in beaker and measure the quantity of raw material taken.
2) The sodium hydroxide is taken in a other beaker for preparation of 1N solution. The 1N solution is prepared from raw material we taken. Because the 1N solution is 60% of raw material we taken.

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3) After the preparation of 1N solution of sodium hydroxide the catalyst should be add in it. The catalyst is 1% of raw material we taken. The raw material basis catalyst is strictly use for preparation of product.
4) When the catalyst and sodium hydroxide are added in the other beaker the castor oil (raw material) is added partially and slowly in it.
5) Mix up gradually the solution by glass rod while the bubbles created are in the form of mixture.
6) The solution is subjected to stirring process using water bath and gradually 1000 rpm speed of agitator/stirrer.
7) Add sulphuric acid from top drop by drop to the process. It takes long time to react.
8) The stirring process is about 2 to 3 hours from starting of stirrer.
9) Wait and check the temperature of the solution by thermometer in around 15 min.
10) The temperature of solution changed due to process of sulphuric acid added change water from water bath by cool.
11) Allow to cool the solution in at 20 to 25℃ when it is on the above 25℃ temperature.
12) When the solution is totally mixed up of colour brown the solution is subjected to the separating funnel.
13) The separating process may take a night time.
14) After the separation process is done the solution may separate out in separate beaker.
15) The upper layer of the solution is the Turkey red oil and lower layer is water.
16) The water is waste and other product we have is use for many purposes.

- **Reaction Stoichiometry**

Reaction of the experiment is according to stoichiometry.
Feed= Castor oil+Sulphuric acid
Product= Turkey red oil
Residue= Spent acid

The overall reaction is as follow
1)Castor oil+sulphuric acid ⟶ Sulphonated Castor Oil + Spent Oil
2) Sulphonated Castor Oil + Sodium Hydroxide ⟶ Turkey red Oil + Spent Oil

From above reaction the reaction 1) forms intermediate. The intermediate forms from reaction 1) is the sulphonated castor oil. The both reactions may be carry out separately or single overall reaction. The single overall reaction may be as follow.

$$C_{54}H_{100}O_7 + 3H_2SO_4 + 6\ NaOH \xrightarrow{EDTA} 3C_{18}H_{32}Na_{206}S + H_2 + 7H_2O$$

1. $C_{54}H_{100}O_7$= Castor Oil
2. H_2SO_4= Sulphuric Acid
3. NaOH = Sodium Hydroxide
4. $C_{18}H_{32}Na_{206}S_3$ = Turkey Red Oil

V. EXPERIMENTAL RESULTS

The result required to find out the solubility of the solution. There is the method to check out the solubility that is amount of castor oiltaken to the amount of sulphuric acid taken to dissolve the salt in solution with rise in temperature. The process for check out te solubility of the acid in castor oil is follows.

1. If the compound is insoluble in 5% HCl and 5% NaOH, add 1 drop of a liquid sample or about 25 ml of a sample to 0.5 ml of concentrated sulfuric acid (H2SO4) in a dry test tube. Tap the tube with your finger to mix or stir gently with a glass stirring rod.
2. Record the sample as soluble or insoluble. Interpret a color change or a precipitate as soluble.
3. If the compound is soluble in sulphuric acid, the sample is an alcohol.

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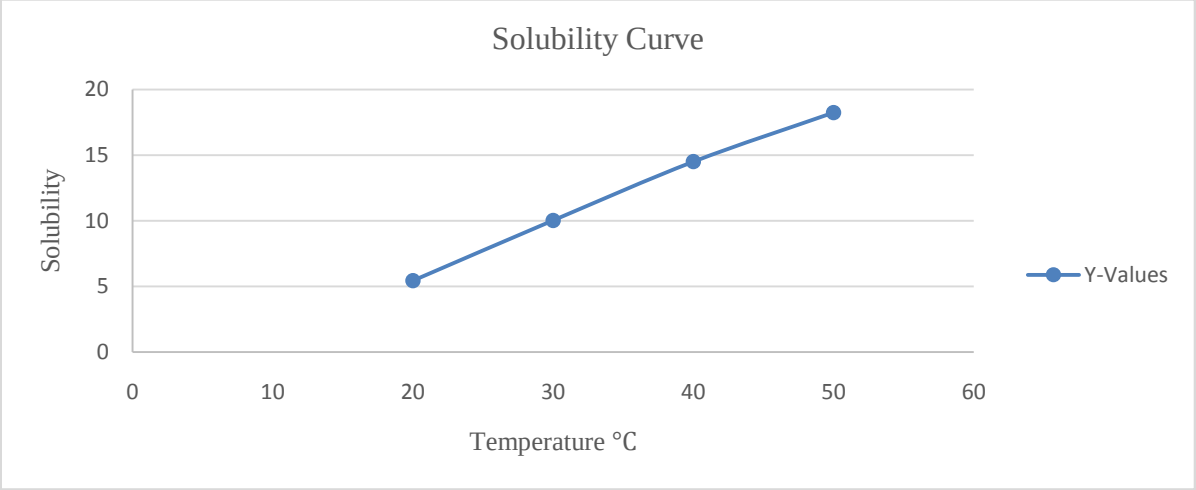
Table 2. Solubility Data

Temperature	Solubility
20	5.43
30	10.02
40	14.49
50	18.23



The above data is as per experiment. The data shows while rise in temperature the solubilityof oil is also increase. The results getting from our experiment shows the better identification of 100% sure product quality also gets the expected effect on the yield while using the catalyst.As per standard specifications of product the following results found from experiment (table 3). The Turkey red oil is the product that should be use as dyeing agent, synthetic detergent etc.

❖ **Result**

The experimental results shows the maximum yield of getting 100% better quality of our product with using catalyst. From the study the following data we have found with compare the standard specifications. The catalyst is more efficient with 0.1 % of that of feed for getting maximum yield.

The standard specification values of the Turkey red oil & our experimental result are approximately same.

Table. 3. Data are evaluated from our project.

Specifications	Values	result
PH	7-8	7.89
Appearance	Amber colour viscous liquid	Dark Brown
Viscosity (27°C)	102-120 mm/ s	106 mm/s
TRO As Sulphonated Oil	Oil	Oil
Purity	40-80%	76.50%
Specific gravity	1-1.10	0.97
Solubility	Miscible in water	Miscible in water
Acid value	0.10-0.40	0.20
Iodine value	50-90	70
Sulphonation degree	Min. 40	-

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VI.CONCLUSION

In this experiment, we have implemented the method of preparing of Turkey red oil from castor oil by sulphonation process at min 3 hours with continuous stirring and adding of conc. Sulphuric acid drop by drop maintaining the temperature 20-30°C for getting maximum yield of Turkey red oil. By this process, we have got 70% yield of Turkey red oil from feed. This is the easy process of getting maximum yield of product. From this experiment we studied the PH is 7.89 it means the product is light alkali.

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