

OLEOCHEMICAL PROCESS INCUBATOR: FALLING FILM REACTOR FOR SULPHONATION

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In 2010, about 13.1 million tonnes of surfactants were used globally, where 56% were anionic surfactants. Almost 49% of the surfactant produced was used in the household product category. Sulphonation plants which mainly produce anionic surfactants are scattered around the globe with capacities varying from 3000 to 50 000 t yr⁻¹. It is estimated that at least 800 sulphonation plants are in operation worldwide. About 20% of the global production of 2 500 000 t yr⁻¹ of sulphonated anionic surfactants is concentrated in the United States, Western Europe and Japan.

OBJECTIVES OF INCUBATION FACILITIES

- To provide a service for the operation of falling film reactor for the sulphonation process.
- To promote methyl ester-based surfactants in detergent and enhanced oil recovery.

METHODOLOGY

The falling film reactor is used for sulphonation. It is typically used as an equipment to keep the reaction at a certain temperature. For the sulphonation process, using the falling film reactor allows a thin film of liquid organic material to be precisely distributed in the inside wall of the tube and to flow downwards co-currently with the sulphur trioxide gas stream. A highly exothermic, rapid reaction takes place between the gas and liquid film and most of the heat arising from this reaction is removed by the reactor jackets. Sulphonic acid products will discharge from the reactor into a vessel (Figure 1). The absorption of sulphur trioxide is rapid but the reaction to form sulphonate is very slow. The sulphonic acid can be bleached and neutralised to produce detergent surfactants.

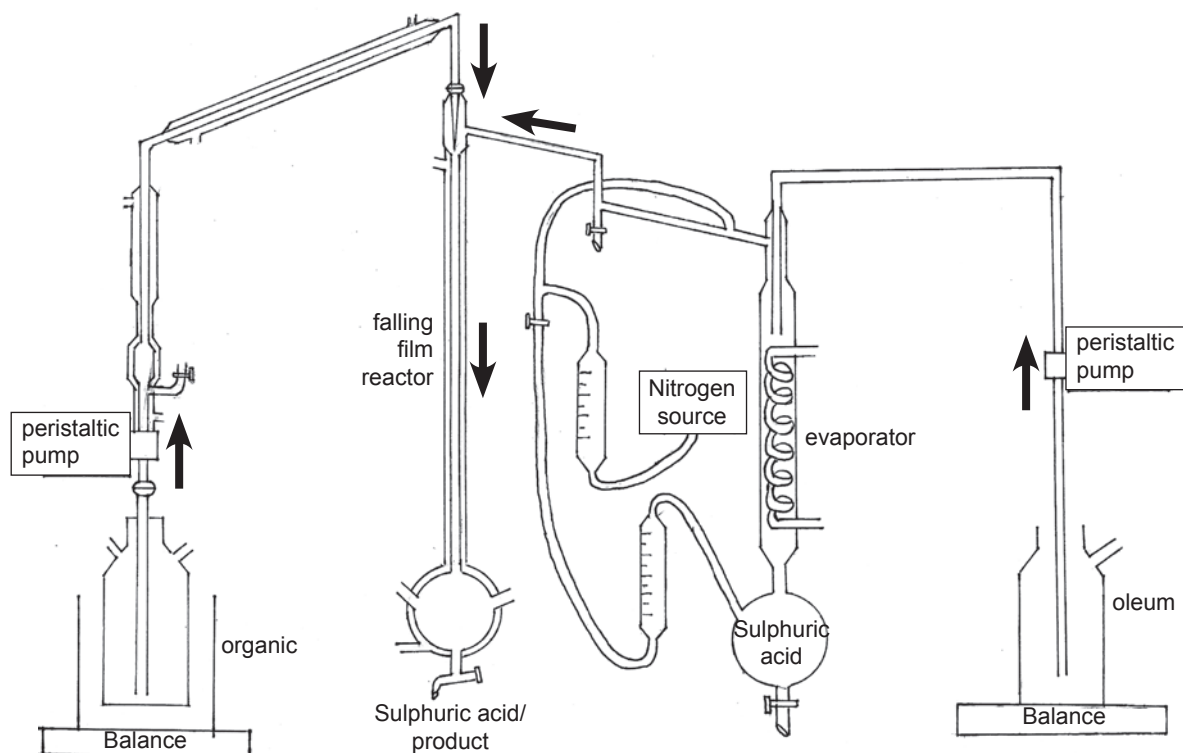


Figure 1. Schematic flow diagram of the falling film reactor.

Different sulphonating agents which are used for sulphonation, include sulphur trioxide (SO_3), chlorosulphonic acid (ClSO_3H), oleum ($\text{H}_2\text{SO}_4 \cdot \text{SO}_3$) and sulphuric acid (H_2SO_4). Oleum is used to sulphonate alkyl benzene, methyl ester and sulphate fatty alcohols for heavy duty detergents. Oleum sulphonation can be operated either as a batch or a continuous process. This process has the dual advantage of low SO_3 cost and low capital equipment cost.

Linear alkylbenzene is the most common organic feedstock used in the detergent industry. As there is a limit to the availability of non-renewable petrochemical-based raw materials, alternative and renewable raw materials are being sought. Thus, oleochemicals have become the future feedstock for the surfactant industry. Currently, methyl ester feedstock is of the main interest in the surfactant industry because they are relatively less expensive and are renewable (Figure 2).

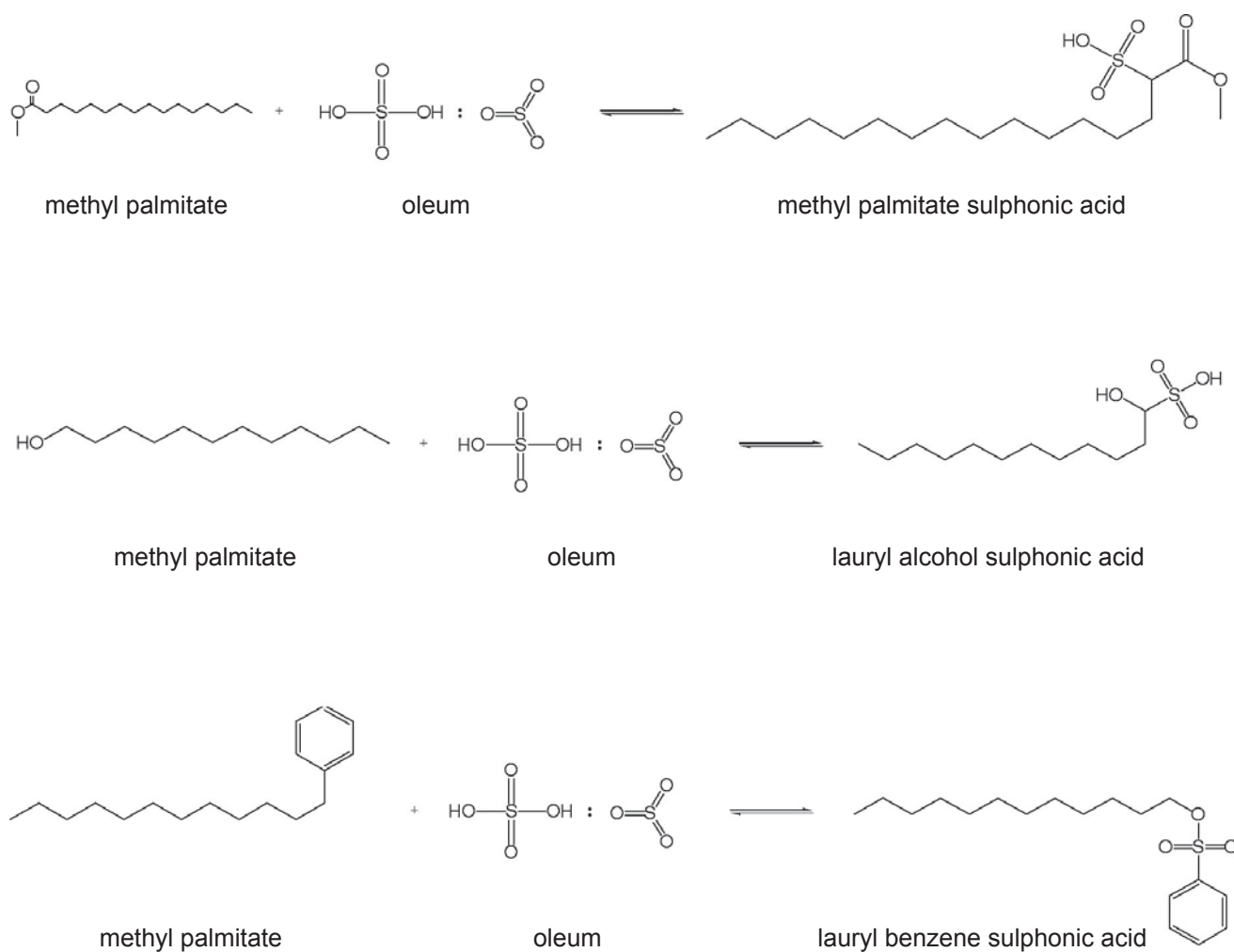


Figure 2. Reaction mechanism of the sulphonation process with different feedstocks.

BENEFITS

- Mini sulphonation pilot plant, which consists of a falling film reactor with a rate of production of 600 g hr⁻¹.
- It can be used for development and the optimisation process in producing anionic surfactants for detergents or to enhance oil recovery.
- About 5 kg of sulphonated products can be produced per day.

INDICATIVE RENTAL FEE

The rental fee is RM 550 per day (2013) and is subject to change.

PLANT DETAILS

The plant (*Figure 3*) is equipped with:

- peristaltic oleum pump;
- peristaltic organic feed pump;
- evaporator (140°C -160°C);
- falling film reactor (80°C -90°C);
- heating bath (three units);
- weighing balance (two units);
- nitrogen purging system; and
- exhaust ducting.



Figure 3. Mini sulphonation pilot plant of 600 g hr⁻¹ production capacity.

ECONOMIC ANALYSIS

Item	Cost (RM)
Cost of equipment	250 000
Total production cost	84 911
Production of sulphonic acid Production capacity = 5 kg day ⁻¹	1 160 kg yr ⁻¹
Internal rate of return (IRR)	11%
Net Present Value (NPV)	8 300
Payback period	1 yr

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