SMI - Soap Production

☐ Ainie Kuntom, Hamirin K and K Y Cheah

Soap is an essential cleaning agent in our daily life. Besides its cleaning property, it is also a carrier for numerous skin-care agents and perfumes. In today's market, consumers demand a wide range of soap products catering for the various therapeutic needs of the skin. For a soap to carry the various additives successfully, it has to be of good quality. High quality palm based soap noodles are abundantly available from the Malaysian fatty acid manufacturers and are easily processed to fine soaps. The demand for innovative soaps has roused the interest of entrepreneurs to venture into soap business. This article aims at assisting these beginners in starting up small and medium-scale industries (SMI).

SOAP

Soap is a sodium salt of a mixture of C16-C18 and C12-C14 fatty acids which are derived from oils and fats of both animal and vegetable origins. The choice of oils and fats depends on their fatty acids composition. The ratio of saturated and unsaturated, long and short chain fatty acids is an important requirement, and it influences the qualities such as stability, foamability, hardness, solubility and detergency of the finished products.

The traditional sources for C16-C18 and C12-C14 fatty acids are tallow and coconut oil, respectively. However, with the phenomenal growth of the palm oil industry in Malaysia, palm oil and palm kernel oil are gaining popularity as substitutes for tallow and coconut oil.

In Malaysia, replacement of the traditional raw materials by palm products for soap making is well established. Generally, the ratio of palm oil to palm kernel oil in soap is 80:20. This ratio will produce a soap with efficient cleaning properties, good lather and solubility. Palm stearin can also be used as an alternative source of C16-C18 fatty acids but it has to be blended with other oils/fats in order to give a final product with the desired hardness. Otherwise, the soap obtained will have high titre and poor lathering qualities.

Soap-Making Process

Basically, modern soap-making process can be divided into two main steps, *i.e.* (a) preparation of the soap base, and (b) treatment of the soap base to obtain the finished product.

Currently, there are three commercially available processes for the production of soap base using two basic reactions - saponification and neutralisation. The type of process used depends upon the starting raw materials: neutral oils/fats, fatty acids and methyl esters. In the oils/fats route, the neutral oils/fats are directly saponified with caustic to produce soap and glycerine. The glycerine is recovered from the soap mass prior to the production of the neat soap. In the fatty acid route, the fatty acids are simply neutralised with a caustic to form the soap. In the methyl esters route, the methyl esters are reacted with caustic soda to produce the soap and methanol. The methanol can be recovered and recycled back to the transesterification process. Methyl esters are produced by the transesterification of oils/fats with methanol.

The neat soap produced is spray dried to an appropriate moisture content and then plodded into a homogenized form such as soap noodles or chips. The soap noodles or chips are then processed into finished products in a finishing line.

Basic Equipment

For SMI, there are three options available to start soap manufacturing on a small-scale, depending on the starting raw materials: palm based soap noodles, palm oil/ palm kernel oil and palm based fatty acids. *Table 1* is a list of soap plant suppliers.

Option I - Palm-based Soap Noodles

It is more appropriate for a new entrepreneur to start from soap noodles. The basic equipment is the finishing line which consists of an amalgamator, a roll mill, a plodder, a cutter, a stamping machine and a packaging facility. The processes involved at the soap finishing line stage are aging, mixing, refining, extrusion and moulding.

An amalgamator. This equipment is used for mixing the soap noodles with solid or liquid additives at level of 1% to 5%. In a standard amalgamator, mixing is carried out using mixing blade where the outer surfaces of the soap noodles are coated with the additives. For a more intensive mixing, a mixer blade with chopping action can be used. This type of mixing blade, not only coats the soap noodles with the additives, but also breaks them up to increase the surface area exposed to the additives. In this way, there is a greater penetration of the additives into the soap noodles.

A roll mill. A roll mill is used to mix the soap mixture thoroughly to produce a homogeneous and uniform product. During milling, the soap mixture is subjected to pressure and shearing stress between one layer and another to obtain the β-phase crystal structure. This mechanical action will also enhance lather and solubility of the soap product.

Soap milling is usually carried out using three, four and five roll mills. Generally, the preferred number of roll mills is three due to easy adjustment of the gap between the roll mills and also because of lower cost and ease of operation. The temperature of the soap mixture in the roll mills is controlled using water spray system. Cooling is also necessary to reduce heat/energy generated during the mechanical action.

A plodder. A plodder is also used to refine, compress and extrude the soap mixture. There are three types of plodders used in the soap finishing line: simplex refiner, duplex refiner and duplex vacuum plodders. Plodders are offered in single and twin-worm versions. A simplex refiner consists of a plodder designed to operate with a 50 mesh refining screen. It is used to eliminate gritty particles and purify the soap mixture. This type of plodder is also used to pre-refine dry and aged soap base before mixing with the additives and for post-refining dry

TABLE 1. SUPPLIERS OF THE SOAP PLANTS

Neutral Fat Saponification	Fatty Acid Neutralisation	Methyl Ester Saponification
Kettle Processes	Mazzoni SC & SCC	Lion Process
	Mecchaniche Morderne	Ballestra/
Semi-boiler	Alfa Laval	Colgate
Boiled	Sato	
	Dial Saponiflex	
Modern Process	Weber Seelander	
Mazzoni SCNC-N		
Meccaniche Morderne		
Alfa-Laval Centripure		
Hitachi		
Dial Saponifle		

Source: Soap Technology for the 1990's. Edited by Luis Spitz, AOCS, Champaign, Illinois, 1990.

soap base after mixing with the additives. A duplex refiner consists of two simplex refiners mounted in tandem. Each plodder is fitted with a 50 mesh refining screen. The product is refined and pelletized twice. The duplex vacuum plodder consists of two plodders mounted in tandem and connected by a vacuum chamber. The preliminary stage plodder is exactly the same as a simplex refiner fitted with a 50 mesh refining screen. The final stage plodder is an extrusion stage where the refined pellets are compacted and extruded as a continuous slug (billet) without any entrapped air (Spitz, 1990).

Cutter. The extruded slug is cut to the required length to fit the size of die during the stamping process.

Soap press. The equipment is used to press the soap into various shapes such as rectangular, oval, round and irregular. The die or mould is usually chilled for easy release of the stamped bar soap.

Packaging facility. Packaging of soap varies depending on the final product. There are various packaging machines available in the market, from the simple wrapping of the soap bar to the sophisticated soap box.

Quality and processing. Processing of the soap noodles will depend on the quality of the final product. For specialty soaps, the soap base required is of the highest quality. Soap base of vegetable oils origin is usually chosen rather than animal fats for this purpose. The soap base is thoroughly refined and milled at least three times to produce the finest base. Additives for this type of soap base are usually high quality natural products such as fruit flavours, goat's milk, *etc.* and they are added at about 3%-5% depending on the consumers' desire.

Option II - Oils and Fats

This option requires additional facilities to produce the soap base via the saponification process. Saponification is a process whereby oils/fats are reacted with appropriate amounts of sodium hydroxide to produce the neat soap with glycerol as co-product. In this process, the equipment required to produce the soap noodles are the soap kettle or mixer, vacuum dryer and extruder. Saponification can be a fully continuous or batch process.

Soap kettle or mixer. The kettle can be fabricated locally. The oils/fats, caustic soda, brine, water and column lye are pumped into the kettle and the reaction mixture heated to about 120°C. From the kettle, the soap mixture is transferred to the cooling mixer where it is cooled to 85°C-90°C. Once the reaction is completed, the soap mass will separate into soap phase and lye phase.

After cooling, the neat soap is separated from the heavy spent lye phase. It is then washed to remove the glycerine and lye

Figure 1. Palm-based soap

soluble impurities. The number of washings plays an important role in the overall recovery of glycerine. The more washings are carried out, the more glycerine is recovered.

Soap drying unit. The neat soap from the mixer is heated and sprayed through revolving nozzle into the vacuum spray chamber. Vacuum spray drier is easy to operate, versatile and is flexible enough to dry a variety of soap bases such as those for toilet soap, soap and synthetic mixtures, translucent and laundry soaps. During spray drying, the neat soap is converted into irregular soap flakes.

Plodder. A Simplex plodder is used to extrude the soap flakes into soap noodles which are then ready to be processed by the finishing line into finish products.

Option III - Fatty Acids

If fatty acids are used as a raw material, the process is known as neutralisation. Similar to option two, this option requires additional facilities to produce soap base via the neutralisation reaction. Neutralisation is a process where fatty acids are neutralised with sodium hydroxide to produce soap and water. The equipment for this process involves a mixer, a drier and an extruder. Neutralisation of fatty acid for soap making is simpler and cleaner compared to the oils/fats saponification process.

Neutralisation unit. This unit can be fabricated locally and would not involve much expense. The pre-heated fatty acids and caustic soda are pumped into the turbo-dispenser together with brine (salt solution). The ratio of caustic soda to fatty acid is determined by the acid value of the fatty acid feedstock. Salt solution controls the viscosity of the reaction fluid. From the turbo-dispenser, the mixture flows into the jacketed mixer which has a crutcher design. The soap mixture is moved from the bottom of the tank to the top by the crutcher and transferred to the holding tank. The neat soap is then transferred to the drying and plodding units as described in the previous section.

Other Materials

Besides fatty materials, the other most important material is caustic alkali usually sodium hydroxide. Other ingredients or additives are perfume, titanium dioxide or whitening agent, chelating agent and antioxidants. The perfume added must be compatible with palm base soap noodles/chips otherwise it will cause discoloration to the soap. A chelating agent such as ethylenediaminetetracetate (EDTA) is used to chelate metal contaminants if present. An antioxidant is used to retard or prevent oxidation of the fatty materials in the soap. Colouring matter is added as required in the final product.

RECOMMENDATIONS

The first option is the most favourable for the newcomer since this technique does not require high skilled manpower. The operation is simple and the raw materials, *i.e.* palm-based soap noodles/chips are readily available in Malaysia. When the skill and experience have been acquired and the market is favourable, they can proceed to produce soap noodles via the oils or fatty acids routes depending on the final products required.

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