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Distr.
LIMITED

IPCT.37(SPEC.)
23 June 1987

ENGLISH

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

TECHNOLOGY PROFILE

ON
MINI SOAP AND SYNTHETIC DETERGENT PLANTS*

Prepared for

INTIB - THE INDUSTRIAL AND TECHNOLOGICAL INFORMATION BANK

by
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V.87-86744

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ACKNOWLEDGMENT

I am grateful to UNIDO for entrusting the Project to Dr. CVS Ratnam and Associates (P) Ltd., I extend my grateful thanks to Dr. H.W. Pack, Chief, INTIB, UNIDO for his guidance and support. I extend heartfelt thanks to Mr. BK Thungappa and Mr. MN Subba Rao, Consultants. I acknowledge the assistance provided by Mr. VM Pai, Technical Director and Dr. KB Patil, Manager, R&D in M/s Karnataka Soaps and Detergents Limited, Bangalore.

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PREFACE

This Profile on Mini Soap and Synthetic Detergent Plants is of interest to those developing countries where markets for soaps and synthetic detergents are relatively small and local market conditions are favourable to justify the establishment of such units. The Profile after giving the background and the need for such units, discusses the topic in two broad sections:

1. Toilet Soaps - Cake and Liquid
2. Laundry Soaps - Bar and Flakes.

Under each case, two alternatives are discussed.

1. Mini units with a capacity of 600 to 1000 tonnes per annum.

2. Units which can be operated as a cottage industry having a capacity of about 100 tonnes per annum.

In both, mini unit and cottage unit, the following are discussed:

1. Choice of technology
2. Manufacturing process
3. Flow sheet
4. Main equipment and their specifications
5. Raw material needed
6. Personnel
7. Investment
8. Production cost
9. Environmental problems.

It appears that in small developing countries there could be a case for the establishment of toilet and laundry soap making industry on a cottage scale which is being successfully done in countries like India.

The second part describing the synthetic detergent industry is again divided into two types of units:

1. A mini unit with a capacity of about 300 tonnes per annum.
2. A cottage unit that could manufacture from 10 kgs. to any quantity required.

Here also, the subjects discussed under soaps are discussed including choice of technology, investment and production costs.

While it may not be possible in many developing countries to establish and operate economically a mini synthetic detergent plant making about 300 tonnes per annum, because most of the equipments and raw materials may need to be imported, there could be a case for having cottage sized units to meet local needs. Such a situation exists in India where many household units manufacturing only 10-20 kgs. of synthetic detergent powder per day exist side by side with large synthetic detergent making plants with a capacity of 10,000 to 15,000 tonnes per annum.

The conclusion is inevitable that the need for such mini and cottage scale units has to be assessed case by case so that proper decisions are taken and implemented.

0.0 SUMMARY

0.1 While technology is available for the manufacture of soaps and synthetic detergents, in their many forms and huge plants exist in many developed and developing countries in large numbers, there is a case for establishing mini soap and detergent plants atleast in some developing countries where markets may not justify the establishment of large units and local factors like availability of raw-materials and markets and need for creating additional employment make such units preferable.

0.2 Soap making is a very ancient process known even in prehistoric times. However, modern industry for soap and detergent making is relatively of recent origin especially the latter.

0.3 Soap can be manufactured on any scale from cottage industry to a large plant. A mini toilet soap unit using a semi-mechanised process and having a production capacity of 600 tonnes per annum and investment of about US $ 200,000 can produce soap at US $ 2.3 per kilogram under conditions approximating to those prevailing in India. Numerous units,

making toilet and laundry soaps exist in India where soaps are successfully produced and marketed in competition with those produced on a large scale. At cottage industry level investments are very small, some times less than a few hundred U.S. dollars.

0.4 Similarly, mini synthetic detergent plants can be established in developing countries where conditions are favourable for such development. However, in the case of synthetic detergent plants the need for importing practically all raw materials required is a problem to be faced by many developing countries. However, if these raw materials could be obtained at a competitive price, synthetic detergent powders and cakes could be made in many developing countries in mini units which can be a profit making activity. The investments can be very small, a few hundred dollars onwards. Even if all ingredients have to be imported establishment of a cottage unit for the manufacture of synthetic detergents from 20 kg. per day to any quantity required can be an economical proposition as is being done in India. Many household units and some cottage industry units, manufacturing large quantities of synthetic detergents, comparable to large units, exist in India competing successfully with large scale industry.

0.5 Therefore each proposal to establish mini soap and synthetic detergent units has to be looked into case by case basis with regard to its viability taking into consideration local conditions - markets, availability of raw materials, taxation policies etc.

0.6 Technologies are readily available for establishing such units.

0.7 Equipment can be manufactured partially or fully in many developing countries.

0.8 There is a strong case for establishing mini synthetic detergent units especially on a cottage scale in many small developing countries.

1.0 BACKGROUND

1.1 With rising living standards, increasing need is felt for personal cleansing agents. This is concomitant with social development in which developing countries are interested. Every country needs soaps and detergents for purposes of bathing, washing and cleaning. Toilet soaps are used for personal hygiene and laundry soaps are used for washing clothes, floors and for many other purposes. There are soaps for special purposes e.g. metallic soaps used in engineering industry. Therefore, there has been a steady increase in the production of soaps and detergents in many countries of the world. Table 1* gives production of soaps and synthetic detergents in selected countries in the world. Table 2 gives figures in the organised sector for India which is a developing country.

1.2 While soaps from wood ashes and animal fats were produced more than 5000 years ago(1)** large scale commercial production started early in 18th century. However, synthetic detergents came into use only recently, about four decades ago. Compared to soaps, detergents have certain advantages, in that they do not need edible products, vegetable oils and fats

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* All tables and figures are at the end of the Report

** References given at the end of the paper.

and tallow, for their production and also have some special properties which normal soaps made from vegetable oils, fats and tallow do not have, e.g. non-formation of slime in hard water. Until now, detergents have been used mainly for washing clothes and for industrial purposes. A beginning has now been made in the use of some materials used in the manufacture of synthetic detergents in toilet soaps, However, this practice is not yet established to any extent in developing countries. Table 3 gives per capita consumption of soaps and synthetic detergents in India. It can be seen from data given in Tables 1 and 3 that even in India a relatively advanced country, soap per capita and detergent consumption is of the order of 1.5 kgs. per year, as compared to 12 to 25 kg. per year in some developed countries. However, India is the largest soap producer in the world, about a million tonnes per annum, in the organised and unorganised sectors.

1.3 In view of rising standards of living in developing countries, it can safely bepredicted that soap consumption will increase in those countries. The same will hold good for synthetic detergents also.

2.0 NEED FOR MINI SOAP AND DETERGENT PLANTS IN DEVELOPING COUNTRIES

2.1 Consumption of soaps and detergents is very high in developed countries, and therefore their production runs into thousands of tonnes necessitating establishment of large manufacturing units in these countries. In the U.S.A. the consumption of soaps and detergents in 1940 was 1,045,000 tonnes and 18,120 tonnes respectively. However, by 1980, the consumption of soap decreased to 590,000 tonnes and that of detergents increased to 2,900,000 tonnes. Markets for soap and detergents in developing countries are rather limited, though increasing every year. Therefore, large units cannot be justified in many developing countries. Even in India which is a very large developing country, with a population of about 700 million, in 1985 the total production of soaps and detergents was 380,000 tonnes and 190,000 tonnes per annum respectively(2). In view of this, actual requirements for soaps and detergents in the next decade in many developing countries will not justify establishment of very large units. Therefore, in order to suit the needs of such countries there is need for establishing mini soap and detergent plants in many developing countries. Other reasons for such a development are:

1. Many developing countries import their entire requirements of soaps and detergents, thus incurring foreign exchange outgo.

2. Many developing countries have the needed raw materials for soap making.

3. Local manufacture of soaps and detergents will create employment opportunities for local people.

4. Even when there is need for importing certain equipments and components and raw materials, for example, perfumes, colouring materials, raw materials for detergent making etc. establishment of mini soap and detergent units in developing countries will be an economical proposition, in some cases.

2.2 In the light of the above, the United Nation Industrial Development Organisation (UNIDO), Vienna have thought it necessary to publish a Profile on Mini Soaps and Detergents Plants suitable for establishment in developing countries. UNIDO requested Dr. CVS Ratnam and Associates Pvt. Ltd., Bangalore, India, a consulting firm in Technology, Industry and Management to prepare this Profile.

3.0 THE FORMAT OF THE PROFILE

3.1 The Profile basically consists of two parts, one dealing with soaps and theother with detergents. The part dealing with soaps will discuss the manufacture of the following types of soaps.

1. Toilet soaps - cake and liquid
2. Laundry soaps - bar and flakes.

3.2 The soap unit will be discussed again under two heads: modern mini soap plants utilising relatively sophisticated equipment and those units which require relatively less sophisticated equipment and which can be operated as cottage industries. The second part will deal with detergents. Under the detergents, the following will be discussed:

1. Detergent powder
2. Detergent cake.

Even in this case, two types of production units will be suggested:

1. A Mini Unit with relatively sophisticated equipment.
2. A Unit which can be operated as a cottage industry.

3.3 Under each of these heads, attention will be focussed on the following:

1. Choice of technology
2. Manufacturing process
3. Flow sheet
4. Main equipment and their specifications
5. Raw materials needed
6. Personnel
7. Investment
8. Production cost
9. Environmental problems.

4.0 TOILET SOAP

4.1 Toilet soaps have been manufactured during the last 5000 years. Soap is formed by the reaction of a fatty acid with an alkali. Normally the source of the fatty acid is a vegetable oil or fat or tallow. Animal tallow is extensively used. The normal alkali used is sodium hydroxide. The reaction is represented as follows:

1. Oils and fats + Alkali $\rightarrow$ Soap + Glycerine
2. Fatty acid + Alkali $\rightarrow$ Soap.

4.2 Even in the case of laundry soaps, the reaction is the same. In the case of liquid toilet soaps, instead of using sodium hydroxide, potassium hydroxide is used. In that case it is called a soft soap. There are other types of soaps for example shampoos and industrial soaps. Here too the basic soap making process is the same.

4.3 The reaction between oils and fats and an alkali is called saponification. When saponification takes place, the resultant products are soap and glycerine. The reactions are given below:

$$\underset{\text{Oil or Fat}}{\begin{array}{l} CH_2OCOR \\ | \\ CHOCOR \\ | \\ CH_2OCOR \end{array}} + 3\ NaOH \text{ --- } \underset{\text{Soap}}{3\ RCOONA} = \underset{\text{Glycerol}}{\begin{array}{l} CH_2\ OH \\ | \\ CH\ \ OH \\ | \\ CH_2\ OH \end{array}}$$

5.0 MINI SOAP PLANT

5.1 Choice of Technology

5.11 While the basic reaction is saponification of oils and fats by an alkali, technology has to be chosen depending upon the scale of operation. In large commercial production units, there is relatively greater mechanisation and automatic handling of raw materials and products, in that liquids and solids are handled by conveyors, crushers, dryers, pumps, stamping machines, packing machines etc. In smaller plants, mechanisation is restricted. In small units there may not be any need for automatic packaging machines. Transfer of materials from one stage of operation to another could be done manually. Saponification in big units is done on a continuous basis whereas in smaller units this could be a batch process.

5.12 In the light of the above, for the Mini Soap Unit suggested in this paper, a technology which can be called "semi-mechanised" was chosen. This Plant will have a capacity of two tonnes per day or 600 tonnes per year of soap assuming 300 working days. Processes using oils and fats as well as fatty acids as raw materials are described in this Report.

5.13 Another choice is available for the manufacture of soaps as a cottage industry. In this case, the equipments are manually operated and the production could be about 100 kilograms per day or more. This process is also described in this paper.

5.2 <u>Raw Materials</u>

5.21 Practically, all vegetable oils, fats and tallow can be the raw materials for soap making. However, the choice of raw materials will depend upon their local availability. In a number of countries, coconut oil is being utilised as the raw material. Other oils used are groundnut oil and palm oil. In some countries due to non-availability of surplus edible oils, several other vegetable oils, some times called minor oils, like Mahua (Bassia Longifolsa), Karanja (Pongania Glabra), Sal (Shorea Robusta), Pilu (Salvadora Persica), Undi (Calophyllum Indphyllum), Neem (Azadirchta Indica), Marooti (Hydrocarpus Wightiana) are used. There could be others, Rice bran oil and hydrogenated vegetable oils are also being used. However, use of such oils, called 'minor oils' in India, necessitates additional process steps for removing colour and odour. The other basic raw materials required is caustic soda. Relatively small quantities of perfumes and colours are required. In the case of laundry soaps, fillers are also used, sodium silicate, soda ash etc. Rosin and tall oil are also used in the manufacture of laundry soaps.

5.22 In hydrogenation factories there exists a good raw material for manufacturing laundry soaps. This is called soap stock. This is a product of the reaction of free fatty acids and alkali.

5.3 MANUFACTURING PROCESS

5.31 Fig. 1 gives a flow sheet for the manufacture of toilet soaps. Fig.2 gives a flow sheet for laundry soaps. The essential difference between the two flow sheets is this. In the case of laundry soaps after saponification the soap is cast into blocks adding a perfume like citronolla, lemon grass or pine oil. The blocks are then cut into bars, stamped, wrapped and sold. In the case of toilet soaps, the soap is allowed to solidify, converted into chips, dried, mixed with perfume and colour, milled, extruded and cut into cakes. The cakes are then stamped, wrapped and packed.

5.4 Description of the process

5.41 A detailed account of manufacturing toilet soaps is given at Annexure 1. Except for some finishing stages, the manufacture of laundry soaps is the same. Oils, fats and tallow in set proportion are pumped into soap boiling kettles. Needed caustic soda solution of specific gravity 1.3 is then pumped into the kettle. The contents of the kettle are then heated to around 97 to 98°C.

5.42 The boiling process is spread over four to five days with each batch of oil and alkali fed after settling the previous batch. During settling, spent lye containing glycerine and excess alkali is drained out. At the end of four or five days, the soap, in the form of a liquid, is tapped out into frames where blocks of soap slowly get formed. From here there are two different procedures, one for making toilet soap and another for washing soap.

5.43 Another alternative available for the manufacture of toilet soaps is to use fatty acids as the starting raw material instead of normal oils and fats. If this can be done, the soap making process becomes simpler in that no boiling of fats and oils with alkali need be done. This will also avoid problems of handling spent lye with glycerine reducing problems on the disposal of wastes. Also, steam consumption will be very much reduced, and processing becomes simpler. To this extent there will also be savings in investment.

5.44 The procedure for soap making starting with fatty acid will be as follows:

Measured quantities of fatty acid and alkali will be slowly fed into a pan heating the same with a thermic fluid. This will give good control for the operation. The reaction can be stopped ensuring full neutralisation of the fatty acid. The temperature in the pan will be around 80^{o}C to 90^{o}C and the reaction will be over within 20 to 30 minutes. After the soap is formed, it can be poured into individual plastic moulds and cooled at room temperature so that soap blocks of about 10 kgs. each can be obtained. Once these blocks are available, further processing of the blocks into cakes of toilet soaps will be the same as that in the case where oils and fats are the starting raw materials.

5.5 Laundry Soap

5.51 While tapping the liquid soap into frames an essential oil like citronella oil or lemon grass oil is added. These oils become part of the soap blocks. The blocks are then cut into slabs and slabs into bars. The bars are stamped suitably and wrapped for sale.

5.52 For manufacturing laundry soap flakes or chips an additional step is needed. Here the slabs are cut into small pieces and the pieces are fed into a chipping or flaking machine. The chips or flakes are then weighed and packed into cartons. These cartons could be made of card board or even materials like coconut leaves, palm leaves etc.

5.6 Toilet Soap

5.61 The soap blocks are cut into slabs and slabs made into smaller pieces and fed into a chipping machine. Depending on climatic conditions, the wet chips are kept in trays and dried either in the sun or in a closed steam drying chamber. The dried soap chips containing less than 10-15% moisture are fed into an amalgamator where perfume and colouring matter are added. The material then goes to a three roller milling machine and after milling the soap is taken out as fine ribbons. The ribbons are fed into a plodder. A rod of soap emerges from the plodder. The rod is cut into billets of soap which are suitably stamped, wrapped and packed.

5.7 Liquid Toilet Soap

5.71 Another soap based toilet product is liquid soap which is used in hotels, restaurants, households and also for making shampoos. For producing liquid soaps, the raw materials have to be chosen with care and the materials processed with care.

5.72 The normal raw materials are coconut oil and potassium hydroxide. As the quantities involved can be relatively small, liquid soap can be manufactured in small quantities as needed in a batch process. A kettle having a 25 kg. capacity could suffice in a number of cases especially in developing countries where markets for such soap are limited.

5.73 The procedure for making liquid soap is as follows:

Calculated quantities of coconut oil mixed with other soft oils and potassium and sodium hydroxide are fed into an open pan having a capacity of 25kgs. of oil and four kgs. of potassium hydroxide as a 30% solution can be the feed. The pan can be heated with a fire underneath until saponification is completed. In order to avoid glycerine separation, the contents in the pan are stirred by hand using a wooden stirrer. Afterwards some water is added to reduce the specific gravity of the mix to 6° to 7°TW. Some foaming agents and perfume can be added to the liquid soap. Then it is passed through a plate and frame filter press. The soap is then packed in containers, labelled and sold.

5.8 Main Equipment

5.81 Toilet soap unit for manufacturing 2 tonnes of soap per day

1. A mild steel kettle with open and closed steam heating coils
2. Casting frames made up of mild steel
3. Chipping machine
4. Tray dryer and a drying chamber. In the case of countries which have abundant sun and not much rain, sun drying can also be practised.
5. Amalgamator
6. Milling machine with three chilled steel rollers
7. Plodder
8. Cutter
9. Stamping machine with dies
10. Package boiler to generate about 1000 kg. steam per hour.

5.82 Table 4 gives approximate investment for a mini toilet soap unit having a capacity of two tonnes per day. Table 5 gives the capital investment for a 3.3tonnes per day laundry soap unit. Table 6 gives personnel required for operating a toilet soap unit and Table 7, a laundry soap unit.

5.83 It is quite possible to integrate the two operations, manufacture of toilet soap and manufacture of laundry soap depending upon the needs of situation. The extra cost in such an integration is very small. So it will be worthwhile for an entrepreneur interested in establishing such units to have an integrated toilet and laundry soaps manufacturing facilities. Some care in alignment of equipment and planning of operations would facilitate convenient production of toilet soap and laundry soap in the same unit.

5.9 Environmental Impact

5.91 Environmental damage from soap plant varies depending upon the scale of operations and the raw materials used.

5.92 In the case of large units which normally have glycerine recovery units, environmental problems are relatively minor because all the materials fed into the system come out as products for sale. Relatively small quantities of effluents are encountered. However, glycerine recovery system is not justified for units of capacity suggested in this report namely 2 tonnes of soap per day. The capital investment will not justify a glycerine recovery unit. The liquid called spent lye containing glycerine, excess alkali and salt will have to be disposed off by draining it into a channel where it will not affect any plant or animal life. Care has to be taken to take this point into consideration while locating a soap manufacturing unit. The same consideration applies even while locating a mini laundry soap factory.

5.10 Investment

5.101 The following assumptions were made in suggesting investment for a Mini Soap Unit.

1. The practice as exists in India is taken into consideration because it is difficult to get costs of such equipment as available in other countries. However, it is suggested that those who want to establish such units must reassess the cost of equipment and the total investment, taking into consideration the specifications and technology.

2. The costs are given in U.S. dollars, converted from Indian rupees at the rate of Rs.13 per one U.S. dollar. There is a constant fluctuation of exchange values. This has to be taken into consideration while arriving at total cost.

3. It is quite possible that many developing countries could manufacture at least some equipments needed for a soap plant. This should be explored keeping in mind government regulations in the country, specially with regard to safety and protection of environment, local fabrication facilities, and equipment and raw materials that need to be imported.

5.102 Tables 8 and 9 give respectively cost of production of toilet soaps and laundry soaps in a Mini Soap Plant as can be established in India. These figures are only indicative and cost of production has to be calculated in each individual case, taking into consideration local conditions.

6.0 SOAP MANUFACTURE AS A COTTAGE INDUSTRY

6.1 As mentioned earlier, both toilet soaps and laundry soaps can be manufactured as a cottage industry. In such an operation, very few mechanical equipments are used. No mechanical conveying of raw materials and products is done and minimum amount of processing equipment is used. A number of countries have gone in for this technology because it provides employment, does not require much of capital investment and caters to local markets. Also environment problems are minimal. For example, in India, there is a well established cottage industry for the manufacture of toilet and laundry soaps. Technology for this purpose has been developed by institutions interested in rural development. The main organisation in India is the Khadi and Village Industries Commission (KVIC). The process suggested in this Report is based on the experience of the KVIC.

6.2 Toilet Soap (300 kg. per day or 90 tonnes per annum

6.21 For toilet soap to be manufactured on a cottage scale a careful choice of oils, fats and alkali has to be made. Preferably, oils like coconut oil and tallow should be used. Carefully regulated amount of alkali is used. The excess alkali and spent lye are removed by washing the soap portion. The soap is then processed just as in a larger unit but with smaller equipment; cutting, rolling, plodding, cake making and wrapping. Fig. 3 gives the flow sheet. The investment required for a 300 kg. per day unit is given in Table 13 and production cost in Table 14.

6.3 Laundry Soap

6.31 Oils and fats are put into an open pan and needed alkali is added. The pan, made of mild steel, may have a capacity of about 20 kgs. or less of oil and fat. The pan is heated from below using whatever fuel is available.

6.32 During the saponification of oil and fat the mixture gets thickened and towards the end of the reaction the thickened material is poured into moulds. Before this, a suitable perfume is added to the soap solutions. Because there is no way of removing excess alkali in this process, accurate quantities of oil, fats and alkali have to be fed into the pan. Otherwise, excess alkali will remain in the soap and can prove injurious to skin when soap is used, either as toilet soap or laundry soap. The hardened soap is then cut into suitable cakes, stamped, wrapped, and packed for sale. A flow sheet is given in Fig.4. The investment in a laundry soap unit of capacity 50 tonnes per annum is given in Table 15 and production cost in Table 16.

6.4 Quality Control

The Indian Standard Specification for toilet soaps and laundry soaps are given in Tables 10 & 11. It is necessary that the product from a mini soap plant adheres to these specifications. This is possible by proper control of operations in the factory and providing a small laboratory adequately fitted with needed instruments which are not cost very much. Table 10 gives the main laboratory equipments required with approximate cost.

7.0 SYNTHETIC DETERGENTS

7.1 Synthetic detergents are manufactured on a big scale in many countries. As indicated in Table 1, the quantities of detergents manufactured are very large. As a matter of fact in the USA more detergents are used than soaps, because laundry soaps have gone out of use. This has become possible after many advances in manufacture of petro chemicals. Due to limited availability of vegetable oils and tallow which can be used as food materials, the need for developing synthetic detergents has become quite essential. Also, synthetic detergents do not form scums in hard water, which sometimes has to be used for laundry purposes for lack of soft water. The above circumstances provided the driving force for the development of processes for making synthetic detergents.

7.2 Justification for a Mini Synthetic Detergent Plant

7.21 Very large detergent plants exist in developed countries. In Europe and UK, plants normally are having a capacity of 30 to 50 tonnes per day. The largest synthetic detergent plant has a capacity of 240 tonnes per day. However, in developing countries there is limited market and export of detergents may not be an easy proposition. In many cases needed raw materials are generally not available and have to be imported. The raw materials are made in developed countries and those who want to make detergents have to import at least some of the raw materials. However, in some developing countries, detergent plants, even when raw materials as well as manufacturing equipment are not available, can be justified. It could be an economic proposition to import raw materials and equipment for manufacturing synthetic detergents. In view of the above, there is justification for establishing small sized synthetic detergent plants in some developing countries.

7.3 Choice of Technology

7.31 Technology choice for establishing a mini synthetic detergent plant with a capacity of about a tonne per day or 300 tonnes per annum assuming 300 working days in a year, does not vary very much from what is used in a larger factories say, 30 to 50 tonnes per day. Equipment in a mini plant is smaller in size and a spray drier, a requirement in a large unit, can be dispensed with. However, it has to be noted that in India an organization make more than 200,000 tonnes of synthetic detergent powders per annum, all on cottage scale.

7.32 The basic reaction for making a synthetic detergent is sulphonation of linear alkyl benzene (LAB). Sulphonated LAB is reacted with caustic soda to produce sodium salt of linear alkyl benzene sulphonate. This is the active ingredient in all synthetic detergents sold in the market. Normally, there is no need for a synthetic detergent manufacturer to establish a unit for the manufacture of LAB which can be purchased from petrochemicals manufacturers.

7.33 During early years of utilisation of synthetic detergents, a serious environmental problem was encountered. Foam generated during the use of synthetic detergents covered all water sources resulting in choking of drains and sewers. Also this water needed a treatment if it were to be used for any other purpose. To solve this difficulty, biodegradable synthetic detergents have been manufactured. LAB and alpha olefines are the raw materials. The choice of technology in developing countries is between these two processes, one starting with LAB and the other with alfa olefine. Until now, developing countries have gone in for the process utilising LAB. There are two reasons for this.

1. In many developing countries, due to small quantities of detergents being used and not many underground sewerage systems, foaming and choking problems are not serious.

2. LAB process results in cheaper production of the synthetic detergent. Therefore, in this Report technology suggested for the manufacture of synthetic detergents is that using LAB.

However, the process is essentially the same in both cases, except the production costs will vary.

7.4 <u>Raw Materials Required</u>

7.41 The ingredients used for Synthetic Detergents/cakes/bars are listed below.

- Alkyl Benzene Sulphonic Acid-sodium salts (Active matter)
- Sodium Tri-Poly Phosphate
- Sodium silicate
- Sodium carbonate
- Carboxy Methyl Cellulose
- * - Borax
- Sodium sulphate
- Fluorescent Whitening Agent
- Starch
- Wax
- China clay
- Talcum
- Perfume
- Colour including * titanium dioxide
- * - Foam Booster
- * - Perborate
- * - Rosin Soap

* Left to the discretion of the formulator.

It is necessary that the cake/bar formulation should have materials like starches, waxes, China clay and talcum to get the ingredients in a bound solid form.

7.42 In many developing countries especially these with a weak base in chemicals manufacture practically all these raw materials may have to be imported. This is an important point which one has to consider while deciding on the establishment of a synthetic detergent plant in a country. In a large number of developing countries, especially those situated at long distances from sources of raw materials, it is doubtful whether the establishment of such a unit will be economical. Only if the operations are started from the stage of import of synthetic detergent, or acid slurry, the unit could become viable. Even here, import duties play a vital role. Sometimes, the cost of imported final product could be cheaper than making the final product with imported raw material. In such a case the preparation of synthetic detergent will boil down to a mixing and packing operation which can be carried out even as a cottage industry. As stated earlier, in India, there is a unit which manufactures on a cottage industry bases and sells synthetic detergent powder, about 200,000 tonnes per annum. The advantage in India is that most raw materials are locally available.

7.43 Equipment

1. Storage vessels for storing LAB, oleum and other raw materials.
2. A stainless steel sulphonator
3. Vessel for alkali treatment
4. Spray dryer or batch dryer
5. Blender

6. Weighing and packing equipment

7. Package boiler to generate about 500 kg. steam per hour.

7.44 When it is desired to make detergent cakes, the following additional equipment will be needed.

1. A milling machine

2. Plodder

3. Stamping machine.

7.45 Table 17 gives investment for a mini synthetic detergent plant with a capacity of one tonne per day or 300 tonnes per annum.

7.5 Manufacturing Process

7.51 LAB is pumped into a sulphonator into which oleum is introduced. In a matter of about 2 hours, the reaction is completed. The spent acid is separated. The resultant slurry is then taken to a blender where additives perfumes and whiteners are added. Some countries do not allow any phosphates in a detergent powder. The semi solid material is then pumped into a spray dryer. After drying, the product obtained is the synthetic detergent containing about 5% moisture. The powder is then converted into the final product according to a formula that is likely to vary from one manufacturer to the other. . Typical compositions is given in Table 9.

7.52 Table 20 gives personnel required for the operation of a mini synthetic detergent plant.

7.6 Quality Control

7.61 The ISI specifications for Synthetic Detergent powder and Cake are given in Tables 21 and 22 respectively. However, there are large number of units, many in the cottage sector, which do not adhere to this specification. Close control of operations will ensure quality products. The equipment needed for maintenance of quality is very simple, listed in Table 23.

7.7 Environmental Impact

7.71 Synthetic detergent units using linear alkyl benzene, as the starting material and on a small scale do not have any serious environmental problems. Spent acid has to be disposed off by converting into sodium sulphate and selling it to detergent and paper industry or neutralising it with powdered lime stone.

7.72 Cottage units have no environmental problems.

7.8 Detergent Powder Manufacture as Cottage Industry

7.81 There are numerous establishments which manufacture synthetic detergent powders on cottage scale, 10 kgs. per day to any quantity required. There are some modern units in India which manufacture 10,000 to 15,000 tonnes per year. The basic difference between the manufacture of synthetic detergent powder on a cottage scale and that in a large plant is essentially the step from which one starts the manufacture. On a cottage scale one cannot have sulphonation of LAB with oleum. Oleum is difficult to handle and the operation is quite elaborate. The most simple operation on cottage scale will be buying LAB sulphonate called acid slurry and mix it with needed additives, perfume and whitening agent. The mixing could be done in a small blender and the blended material is packed and sold. The packaging material can be very simple like PVC or polythene bags. Some times one need not even print on the bag the name of the detergent or the name of the manufacturer. The choice of technology from the stage from which one decides to manufacture will depend upon individual requirements including the market. In India, there are numerous such operations, with varying outputs.

7.82 Figure 5 gives the flow sheet for the manufacture of detergent in a mini detergent plant and Table 24 gives production costs of synthetic detergent powder in a mini plant.

8.0 AVAILABILITY OF EQUIPMENT

8.1 Equipments needed for mini soap and synthetic detergent plants and cottage sector units are not very complicated. Perhaps a good part of the equipments could be manufactured in many developing countries. For example, in India all equipments needed for such units are being manufactured and supplied. There are many manufacturers who can do this work satisfactorily.

8.2 The Khadi and Village Industries Commission, Bombay which is fully financed by the Government of India has long experience in supplying equipments and establishing cottage industry units.

8.3 It is therefore suggested that if any entrepreneur in a developing country wants to establish mini soap and detergent units and cottage industry units, it is necessary for him to study carefully the requirements of equipments and decide which can be manufactured locally and which needed to be imported. If local facilities are not adequate to manufacture equipments for such units, the whole plant has to be imported. Even then, in some locations, mini soap and detergent units and cottage industry units could be justified.

9.0 DISCUSSION

9.1 SOAP

9.11 Soap is an item which is being manufactured on very small scale to very large scale. In some countries, soap is made in individual households, in cottage units, in mini units, in medium capacity units and in large plants, all of them existing side by side. India is a good example.

9.12 There are advantages and disadvantages of soap manufacture in different sized units. When produced in a large unit, the product has better quality, some times better than what is prescribed in a standard specification. A large plant can cater to a large market producing soap at a relatively cheaper price as compared to smaller units. Also, glycerine produced during saponification of oils and fats can be separated and sold. This will generate additional income for the soap unit, while reducing pollution problems. However, large units require high capital investment, sophisticated machinery and trained personnel. Some developing countries may not have the needed personnel and the large markets. Export of soaps from small developing countries, faraway from market, is a very difficult proposition.

9.13 Mini soap plants of capacity, 600 tonnes per annum of toilet soap and 1000 tonnes per annum of laundry soap suggested in this report can be economically feasible in some countries depending upon their raw material resources, markets, capability to manufacture equipment and import duty structure for raw materials and equipments.

9.14 In a mini unit the production of glycerine is relatively very small and a glycerine recovery unit cannot be recommended on economic grounds. Therefore the unit will have the problem of disposing of spent lye which contains glycerine. However, mini units cater to limited markets with local products, saving foreign exchange and creating local employment, two items in which developing countries are very much interested. In this study, it was found that the production cost of toilet soap is around 0.23 US dollars per cake of 100 gms in a mini toilet soap unit as compared to around 0.2 dollars in a larger unit. However, these costs are of no great relevance in many countries except that they are in the same range. While production cost is higher in a mini unit, the price consumer has to pay can be competitive, if at present soaps are imported in a country, because one has to add to an imported product, freight and handling charges, import duty if any, etc. Also production costs can come down significantly, when toilet and laundry soap manufacture can be integrated in an unit. There is no difficulty in doing this. Therefore, one has to make a recommendation on the basis of study in each case on its merits.

9.15 As mentioned earlier, toilet soap and laundry soap can be manufactured on a cottage scale from 100 kg. per day to any quantity required. The quality of the product in a cottage scale while satisfying some standard specifications may not be comparable to that manufactured in a large unit or even in a mini unit. However, on a cottage scale the industry can be established on a decentralised basis utilising locally available oils and fats and local manpower for satisfying local needs. India has a very well organised cottage soap industry promoted by the Khadi and Village Industries Commission, Government of India. Production costs in the cottage scale are lower than those in the case of large units and mini units, because the equipment is very simple, no mechanical handling of raw materials or products is involved, elaborate control methods do not exist and the whole operation can be done by workers trained for a few days. There is a good case for some developing countries to go in for cottage toilet and laundry soap units, to establish the industry in a decentralised manner providing local employment and saving foreign exchange which may be incurred for import of soap. Hereagain, a case by case study is indicated.

9.2 Synthetic Detergents

9.21 Consumption of synthetic detergents has steadily increased in the world including in developing countries, during the last four decades. Also because soaps require oils and fats, in many cases, edible and needed for human consumption, there is a case for establishing synthetic detergent plants in many developing countries. There are a number of units in developing countries making 10,000 to 15,000 tonnes of synthetic detergent powder per annum. Such large units may not be suitable for certain locations and for some countries. Therefore, a mini unit having 300 tonnes per annum capacity has been suggested in this report. This is technically feasible. However, the production cost is likely to be higher as compared to that in a large unit by about 15 to 20%. However, these costs are also notional because if detergent powder is imported, one has to add freight and handling charges and customs duty. Therefore, a recommendation for the establishment of mini units can be made only on a case to case basis.

9.23 One problem with the manufacture of synthetic detergent powder is with regard to the availability of the starting material, Linear Alkyl Benzene, which is a petrochemical product. Those developing countries which do not have a well developed petrochemical industry will not have any other alternative but to import the raw material. India imports this material. In many other developing countries even other raw materials like oleum, sodium tripoly phosphate, sodium sulphate, sodium silicate, carboxy methyl cellulose, perfume, additives, etc. may have to be imported. A mini synthetic detergent can be justified only when a study indicates that it will be cheaper to import all the raw materials and manufacture the detergents as compared to importing detergents themselves.

9.26 In many locations, synthetic detergent powder industry can be justified as a cottage industry. Such units can manufacture from 20 kg. per day to any quantity required. However, they will not start with linear alkyl benzene but with acid slurry (sulphonate of linear alkyl benzene). Many units in India manufacture varied quantities of synthetic detergent powder starting with acid slurry. This again has to be examined on a case to case basis.

9.25 It could be that importing detergent powder in bulk and packaging it into bags and cartons and/or converting the powder into cakes and selling them could be a profitable endeavour in some developing countries. This will create local employment and auxillary jobs for supply of containers, wrapping papers etc. This again needs a case by case examination.

9.26 While there is no serious environmental problem existing in a synthetic detergent making plant, use of synthetic detergent have posed environmental problems like foaming of water, choking of sewerage pipes etc. Therefore, biodegradable synthetic detergent powders are presently being manufactured in developed countries. Also some countries have banned the use of sodium tri-poly phosphate in synthetic detergents because this chemical promotes growth of weeds like water hyacinth, wherever water gets collected eg. tanks, pools etc. In the plant itself, when fuming sulphuric acid is used, spent acid is a product for disposal. Some times this is converted into sodium sulphate which can be sold to synthetic detergent industry, paper industry etc. If markets for such products are not available, the spent acid has to be neutralised with powdered lime stone and the whole material used as a earth fill wherever this can be done.

9.27. A large number of raw materials in cluding fillers, perfumes and colours, etc, are required for formulation of synthetic detergent powder and cake. Proper storage of these raw materials and inclusion of their cost in arriving at working capital required are indicated. Because of the relatively small amount of raw materials required, storage space will not be very large and containers will easily be available, even locally in many developing countries.

9.28. Synthetic detergent powder is being manufactured in all sizes of plants - large, medium, small, mini and cottage. Formulae for making detergent powder are available in literature. Also, know-how can be obtained from actual manufacturers and experts who are in a position to give this technology at competitive prices.

10.0 CONCLUSION

10.1 Soap manufacture is a very ancient industry. The industry exists in many countries. The size of factories varies quite a bit, some are very large factories and some tiny.

10.2 Depending upon availability of raw materials, local markets, skills and equipment manufacturing capabilities and nature of taxes, a number of developing countries can establish mini and cottage units for manufacturing toilet and laundry soaps. The output from a unit can vary from a few kilograms to several tonnes per day. This will create local industry, generate local employment and satisfy local markets. A case by case study is indicated before a firm recommendation can be made for any particular location.

10.3 During the last four decades, synthetic detergent powders and cakes have become very important for washing purposes. Increasing quantities are being made and consumed in developed and developing countries. Depending upon market needs, small units of capacity one tonne per day can be established in some developing countries, where suitable conditions exist for such an endeavour. Cottage units for making synthetic detergent powder can be established starting with the import of detergent powder in bulk or acid slurry. Here also a case by case examination is indicated.

10.4 Developing countries can be benefitted by studying this matter in depth and deciding about the establishment of suitable soap and synthetic detergent industry on a small scale.

11.0 REFERENCES

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TABLE 1 = PRODUCTION OF SOAPS AND DETERGENTS IN SELECTED COUNTRIES - 1982

Kg/capita/anmum

Sl. No.	COUNTRY	All Soaps	All Synthetic Detergents	Total
1.	CANADA	1.7	10.1	11.8
2.	U.S.A.	2.5	22.5	25.0
3.	UNITED KINGDOM	3.3	16.3	19.6
4.	WEST GERMANY	2.1	18.6	20.7
5.	BRAZIL	5.6	2.9	8.5
6.	MEXICO	3.7	3.1	6.8
7.	CHINA	1.0	0.6	1.6
8.	INDIA	1.3	0.2	1.5
9.	JAPAN	1.2	7.5	8.7
10.	PAKISTAN	3.0	0.1	3.1
11.	PHILIPPINES	1.7	3.1	4.8
12.	KENYA	1.8	1.3	3.1
13.	NIGERIA	1.1	1.3	2.4
14.	TANZANIA	1.0	0.3	1.3

SOURCE: "The Manufacture of Soaps, other Detergents and Glycerine" - EDGAR WOOLCAT, Published by ELLIS HORWOOD LTD., 1985.

TABLE 2 - PRODUCTION OF SOAPS AND SYNTHETIC DETERGENTS IN INDIA IN THE ORGANISED SECTOR

Thousands of Tonnes

Year	Soaps	Synthetic Detergents
1970	233	31
1976	270	79
1978	340	122
1980	308	179
1982	334	164
1984	371	174
1985	380	190

SOURCE: "Which will wash the Cleanest", The ECONOMIC SCENE, Nov.1986, Pages 73 & 77.

Note: Almost an equal quantities of soaps and detergents are made in India in the socalled "unorganised sector".

TABLE 3 - PER CAPITA CONSUMPTION OF SOAPS AND SYNTHETIC DETERGENTS IN INDIA

YEAR	Toilet Soap	Laundry Soap	Solid Synthetic Detergents
1972	...	0.5	...
1979	...	1.3	0.2
1982	0.1	1.2	0.2

SOURCE: "The Manufacture of Soaps, Other Detergents and Glycerine" - EDGAR WOOLLATT, Published by ELLIS HORWOOD LTD. 1985.

TABLE 4 - INVESTMENTS IN A MINI TOILET SOAP PLANT

600 TURNOVER PER YEAR
(INDIAN CONDITION)

		US $
1.	Land - 0.5 hectares	1200
2.	Borewell - 40 meter depth	1200
3.	Building - 550 sq.m. $80/sq.m.	44000
4.	Soap Kettles - 3 Nos.	7500
5.	Soap frames - 5 Nos. 500 kg. capacity	400
6.	Caustic soda storage tank - 5000 litres capacity	800
7.	Boiler - 1000 kg. of steam per hour at 7 kg/sq.cm. (fuel wood coal or agricultural waste materials)	15000
8.	Electrically heated drying chamber	4000
9.	Drying Trays	1500
10.	Pumps with Motors - 4 Nos.	3200
11.	Soap dies	750
12.	Chipping machine, amalgamator, 3 Roll Milling Machine, duplex plodder, Cutting Machine and Stamper	93000
13.	R.C.C. water tank 5000 litre capacity-1	5000
14.	Electrical Connections(connected load 70KW)	2000
15.	Water pipes, valves and fittings	2500
16.	Laboratory equipment	3000
17.	Furniture and office equipment	3000
18.	Erection & Commissioning @ 3% of cost	6000
19.	Miscellaneous	5000
20.	Interest during construction @ 12% for one year	23526
		222576
	Say	220000

TABLE 5 - INVESTMENT FOR A MINI LAUNDRY SOAP UNIT 1000 TONNES PER ANNUM (INDIAN CONDITION)

		US $
*1.	Land - 0.5 hectares and	1200
	Building - 270 sq. meters at $80 per sq. meter	21600
*2.	Borewell for water - 45 metres	1200
**3.	Soap boiling pans - 4 Nos. each having capacity of 5 tonnes	10000
*4.	Steam jeckelted crutcher (capacity 2 tonnes)	4000
*5.	Caustic soda tank - 1 No. of 5000 litres	800
*6.	Water tanks 1 No. - 25,000 litres	2000
*7.	Centrifugal pumps - 3 No.	2400
**8.	Frames - 10 Nos.	800
9.	Stamping machines - hand operated and dies - 2 Nos.	800
*10.	Boiler with 500 kg. steam per hour capacity - 1 No.	15000
**11.	Electrical connections	500
**12.	Water connections (including valves etc.)	1500
13.	Rack trays and working tables	1000
14.	Erection charges at 3% of investment	3000
15.	Interest charges for 6 months at 12%	6000
16.	Others	5000
	Total	76800
	or say	$ 77,000

* Common for toilet soap unit

** Part common for toilet soap unit.

TABLE 6 - PERSONNEL REQUIRED FOR A MINI SOAP FACTORY - 2 TONS OF TOILET SOAP PER DAY

1.	Manager	..	1
2.	Chemist	..	1
3.	Mechanical Foreman	..	1
4.	Boiler Operator	..	1
5.	Fitters	..	2
6.	Workers	..	20
7.	Lab. Assistant	..	1
	Total	..	27

TABLE 7 - PERSONNEL REQUIRED FOR MINI LAUNDRY SOAP UNIT

1.	Manager ..	1
2.	Foreman ..	1
3.	Fitter ..	1
4.	Boiler Operator..	1
5.	Workers ..	13
	Total	17

TABLE 8 - PRODUCTION COST OF TOILET SOAP IN A MINI UNIT BASIS - 50 TONNES

		U.S. $
A.	Raw materials	
1.	Tallow .. 24.5 tonnes @ $400/tonnes	9800
2.	Coconut oil .. 10.0 tonnes @ $2000/tonnes	20,000
3.	Rosin .. 0.64 tonnes @ $230 /tonnes	147
4.	Caustic soda .. 5.6 tonnes @ $460 /tonnes	2576
5.	Common salt .. 40 tonnes @ $38 /tonnes	1520
6.	Perfume ..1000 kg. @ 30/kg	30,000
7.	Colour and additives - 10 kg. @ $4/kg.	40
8.	Wrapping materials, cartons	16,000
B.	Utilities	
1.	Electricity - connected load 70 k.w. @ 7.7 ¢ per unit.	560
2.	Water - 260 cubic metres @ $5/c.m.	1300
3.	Steam - 50 tonnes $100/tonne	5000
C.	Wages - (27 nos.)	3500
D.	Repairs and Maintenance - @ 2% of cost	366
E.	Interest @ 12%	2200
F.	Interest on working capital @ 15% on requirements for one months of turnover $ 95,000	14250
G.	Depreciation - 10% per annum	1833
H.	Marketing and sales promotion	5000
I.	Others	1000
		$ 115092

Assuming 100 gms. weight for a cake

No. of cakes is 5,00,000

Cost of production per cake - $ <u>0.23</u>

NOTE: Cost of production in a large unit in India is of the order of $ 0.2 per cake of 100 gms.

TABLE 9 - COST OF PRODUCTION OF LAUNDRY SOAP IN A MINI UNIT

65 TONNES

		U.S $
A.	**Raw materials**	
1.	Groundnut oil - 10.5 tonnes @ $1500/tonne	15750
2.	Rice bran oil - 8.75 tonnes @ $ 900/tonne	7875
3.	Coconut oil -14.0 tonnes @ $2000/tonne	28000
4.	Rosin - 1.75 tonnes @ $230 /tonne	402
5.	Caustic soda - 5.6 tonnes @ $460/tonne	2576
6.	Common salt - 40 tonnes @ $.38/tonne	1520
7.	Perfume - 1000 kg. @ $5/kg	5000
8.	Sodium silicate-16.25 tonnes @ $150/tonne	2437
9.	Wrapping materials - wax paper	600
B.	**Utilities**	
1.	Electricity (connected load 50 k.w.) @ 7.7 ¢ /unit	280
2.	Water - 200 c.m. @ $5/c.m.	1000
3.	Steam - 50 tonnes @ $100/- per tonne	5000
C.	Wages (17 men)	1550
D.	Repairs & Maintenance @ 2% of cost	86
E.	Interest @ 12%	513
F.	Interest on working capital @ 15% for one month turnover - $ 75,000	11250
G.	Depreciation - 10%	427
H.	Marketing & sales promotion	2000
I.	Others	1000
		87266

Assuming 250 gms. bars are produced -
No. of bars is 260,000
Cost per bar - $ 0.336

NOTE: The cost of production can come down quite a bit if manufacture of toilet and laundry soaps can be integrated.

TABLE 10 - INDIAN STANDARD SPECIFICATION FOR TOILET SOAP

IS: 2888 - 1983

Characteristics	Requirement		
	Grade 1	Grade 2	Grade 3
i) Total fatty matter percent by mass, min.	76.0	70.0	60.0
ii) Rosin Acid, percent by mass. of total fatty matter, Max.	3.0	7.0	7.0
iii) Free caustic alkali as sodium hydroxide (NaOH), percent by Mass, Max.	0.05	0.05	0.05
iv) Matter insoluble in alcohol, percent by mass, Max.	2.5	5.0	6.0
v) Chlorides (as Sodium Chloride), percent by mass, Max.	1.50	1.50	1.50
vi) Free carbonated alkali, percent by mass, Max.	1.0	1.0	1.0

TABLE 11 - INDIAN STANDARD SPECIFICATION FOR LAUNDRY SOAP

IS : 285 - 1974

Characteristics	Requirements for	
	Type 1 (pure Soaps)	Type w (built soaps)
i) Total fatty matter, percent by mass, Min.	62.0	45.0
ii) Rosin acids, per-cent mass of total fatty matter, Max.	15.0	15.0
iii) Unsaponified fatty matter, percent by mass, Max.	0.5	0.5
iv) Free caustic alkali, as sodium hydroxide (NaOH), percent by mass max.	0.1	0.2
v) Matter insoluble in alcohol, percent by mass, Max.	2.5	20.0
vi) Titre of total fatty acids, °C, Min.	33	-
vii) Glycerol, percent by mass, Max.	1.0	-

TABLE 12 - <u>LABORATORY EQUIPMENTS REQUIRED IN MINI SOAP PLANT</u>

1. Laboratory Furniture comprising of Work Table (10 feet by 4 feet) with an imbedded sink

2. One Chemical Balance and one Rough Balance

3. Glassware

   Beakers, Flasks, Test Tubes
   Distillation apparatus
   Leibig Condenser
   Hot air oven
   Spirit lamps
   Retort stands, clamps etc.
   Funnels
   Reagent bottles
   Water bath
   Glass tubing, rubber tubing etc.

4. Refractometer

5. Polarimeter

6. Chemicals

7. Hot plates

Total cost .. US $ 5,000

TABLE 13 - EQUIPMENT AND INVESTMENT FOR A TOILET SOAP UNIT AS A COTTAGE SCALE

300 Kg. per day or 100 tonnes/annum

			Cost US $
1.	Soap boiling pan	..	1150
2.	Boiler with water softener and water tank	..	2800
3.	Accessories for boiler and pan	..	500
4.	Drier	..	1500
5.	Basin	..	150
6.	Trolley type moulds - 6 Nos.	..	400
7.	Caustic Lye tank	..	100
8.	Cutting table	..	50
9.	Chipping machine	..	400
10.	Balance and weights	..	50
11.	Amalgamator, Milling Machine and Plodder	..	2700
12.	Stamping Machine	..	400
13.	Die Set	..	50
14.	Electrical work of installation	..	250
15.	Laboratory equipment and Miscellaneous	..	500
			$ 11,000

Note: 1. Cost of land and building not included - Building area - 200 sq. metres.

2. Employment - 15 persons (in India). May vary according to circumstances.

TABLE 14 - COST OF PRODUCTION OF TOILET SOAP ON COTTAGE SCALE

			For 1000 Kg. U.S. $
1.	Oils and Fats	..	965
2.	Chemicals	..	169
3.	Perfumes	..	245
4.	Colour	..	10
5.	Wrapping paper	..	70
6.	Packing boxes	..	30
7.	Labour	..	35
8.	Fuel and Electricity	..	15
9.	Depreciation	..	5
10.	Interest	..	7
11.	Repairs and maintenance	..	2
12.	Cost of administration	..	4
			1557

Cost per Kg. - US $ 1.557

NOTE: 1. Based on prices in India in 1986

2. One U.S. Dollar equal to Rs.13/-.

TABLE 15 - EQUIPMENT AND INVESTMENT FOR A LAUNDRY SOAP UNIT ON A COTTAGE SCALE

			100 tonnes per annum
			US $
1.	Conical boiling pan	2	1400
2.	Basins	2	300
3.	Cooling moulds	8	600
4.	Slab Cutter	1	20
5.	Cutting table	1	150
6.	Stamping machine	1	150
7.	Chipping machine	1	100
8.	Stirrer	2	30
9.	Drying racks	6	120
10.	Die sets	2	120
11.	Balance and weights	1 set	300
12.	Caustic dye tank	1	200
13.	Miscellaneous		200
		US $	3690

NOTE: 1. Cost of land of building not indicated. Space required - 150 sq. mts.

2. Employment - 10 (in India) Can vary depending on circumstances.

TABLE 16 - PRODUCTION COST OF LAUNDRY SOAP IN A COTTAGE UNIT - 1200 KG.

		US $
1.	Oils and Fats	965
2.	Chemicals	169
3.	Filler (sodium silicate)	30
4.	Perfume	10
5.	Packing boxes	30
6.	Labour	30
7.	Fuel and electricity	15
8.	Depreciation	2
9.	Interest	5
10.	Repairs and Maintenance	2
11.	Cost of Administration	3
		$ 1261

Cost per kg. - $ 1.051

Note: 1. Band on prices in India in 1986

2. One US Dollar equal to Rs.13/-

TABLE 17 - INVESTMENT FOR A MINI SYNTHETIC DETERGENT PLANT

300 tonnes capacity per annum
(under Indian conditions)

		U.S. $
1.	Land - 0.5 hectares	1200
2.	Borewell - 40 metres deep	1200
3.	Building - 270 sq.m. at $ 80 per sq.m.	21600
4.	Jacketted sulphonator - 1000 litres 1 (lead lines or stainless steel SS 316)	
5.	Separators - 1000 litres - 2 Nos. (lead lines or stainless steel SS 316	
6.	Storage tank for linear alkyl benzene -1 (capacity 10 tonnes)	
7.	Spent acid storage tank - 10 metric tonnes (mild steel) - 1	
8.	Oleum storage tank - mild steel - 15 tonnes capacity - 1	28000
9.	Pumps - @ centrifugal pump - 2 Nos. (each of 1.5 k.w. (a) gear pump - 1 No. of 2 k.w. (b) oleum pump - 1 No. of 2 k.w.	
10.	Troughs - 1.5 mts. x 1.5 mts. x 0.3mts-12 (fibre reinforced plastic)	
11.	Shifter - 1.2mm x 0.8 mm - 6	
12.	Bag ceiling machine - 3 Nos.	6000
13.	Shovels - 5 Nos.	
14.	Laboratory equipment - $ 5000	
15.	Boiler - 1 500 kg. - 1 No.	10000

Extra equipment for cake making

1.	Sigma mixer with stainless steel lining-1	
2.	3 roll mill - 1	
3.	Plodder with stainless steel lining - 1	58,500
4.	Cutting & stamping machine - 1	
5.	Trollys - 4	
	Total for the cake unit	131,500
		or
		say $132,000

TABLE 18 - INVESTMENT IN A COTTAGE DETERGENT POWDER UNIT

100 KG/DAY

Basis - Starting from acid slurry (Under Indian Conditions)

	US $
Building - 90 sq.m. @ $80/sq. m.	7200
1. Troughs - 1.5 m x 1.5 m x 0.3 m - 6 Nos.	2000
2. Trolleys - 2 Nos.	
3. Sifters - 1m x 0.7m - 3 Nos.	
4. Bag scaling machines - 2 Nos.	
5. Shovels - 6 Nos.	
Total	$ 9200

Note: 1. All operations are manual

2. No electrical equipment involved

3. Production cost largely depends on cost of materials

4. 3 men are adequate to do this job

5. No laboratory equipment is required.

TABLE 19 - TYPICAL COMPOSITION OF A SYNTHETIC DETERGENT POWDERS*

A. Full Phosphate	wt %
Alkylbenzene sulfonate	5-10
Nonionics	2-6
Soap	2-6
Sodium tripolyphosphate	20-35
Sodium perborate	10-25
Perborate activator	2-3
Synthetic polymer	0-2
Phosphonate salt (as acid)	0.2-0.4
Proteolytic enzymes	0.2-0.4
Carboxymethylcellulose	1-2
Optical brighteners	0.1-0.3
Perfume	0.1-0.3
B. Phosphate Free	
Alklybenzene sulfonate	5-10
Nonionics	4-6
Soap	2-6
Zeolites	10-20
Sodium carbonate	5-15
Sodium nitriilotriacetate	0-5
Sodium perborate	20-30
Synthetic polymer	0-3
Phosphonate salt (as acid)	0-0.8
Proteolytic enzyme	
Carboxymethylcellulose	1-2
Optical brighteners	0.1-0.3
Perfume	
Silicates	4-8
Sodium sulfate-water	q.s.

* From Reference 7.

TABLE 20 - PERSONNEL FOR A SYNTHETIC DETERGENT POWDER/CAKE UNIT (ONE TONNE PER DAY)

1.	Manager	..	1
2.	Chemist	..	1
3.	Foreman	..	1
4.	Fitter	..	1
5.	Workers	..	10
	Total		15

TABLE 21 - INDIAN STANDARDS SPECIFICATION FOR SYNTHETIC DETERGENT POWDER

IS : 4955 - 1982

Characteristics	Requirements for			
	Grade 1	Grade 2	Grade 3	Grade 4
i) Active ingredient, percent by mass, Min.	19.0	16.0	10.0	12.0
ii) Total Phosphates expressed as Sodium tripolyphosphate calculated from P_2O_5 content, percent by mass Min.	19.0	15.0	9.0	-
iii) Sodium Tripolyphosphate (STPP) percent by mass, Min.	9.5	7.5	4.5	-
iv) pH of 1 percent solution 27°C	9.0 to 11.0	9.0 to 11.0	9.0 to 11.0	9.0 to 11.0
v) Matter insoluble in water, percent by mass, Max.	1.0	1.0	2.0	2.0

TABLE 22 - INDIAN STANDARDS SPECIFICATION FOR SYNTHETIC DETERGENT BAR

IS: 8180 - 1982

Characteristics	Requirements for			
	Grade 1	Grade 2	Grade 3	Grade 4
i) Active detergent (as sodium salt of alkyl benzene sulphonic acid), percent by mass, Min.	18.0	15.0	10.0	12.0
ii) Total phosphates as STPP, calculated from P_2O_5, percent by mass, Min.	17.0	10.0	6.0	-
iii) pH of 1 percent solution at 27°C	9.0 to 11.0	9.0 to 11.0	9.0 to 11.0	9.0 to 11.0

TABLE 23 - LABORATORY EQUIPMENT FOR A SYNTHETIC DETERGENTS PLANT - MINI UNIT 1 TONNE PER DAY

1. Furnitures and fittings
2. Glass ware - flasks, beakers, bottles, funnels, test tubes, burettes etc.
3. Hot air oven
4. Steam bath
5. Hot plates
6. Balance and weights.

Total cost .. US $ 5000

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TABLE 24 - PRODUCTION COST OF SYNTHETIC DETERGENT POWDER/CAKE

Basis - 10 tonnes (under Indian Conditions)

		US $
(a)	Raw Material	
1.	Linear alkyl Benzene 2.5 tonnes at $ 1950 per tonne	4875
2.	20% oleum 2.5 tonnes at $ 155 per tonne	387
3.	Caustic soda 0.2 tonnes at $ 460 per tonne	92
4.	Sodium tripoly phosphate - STP 350 kgs. at $1200 per tonne	420
5.	Sodium sulphate 300 kgs. at $123 per tonne	104
6.	Carboxy mithyl cellulose 25 kgs. at $ 500 per tonne	13
7.	Sodium Silicate 75 kgs. at $ 154 per tonne	11
8.	Optical whitener 2 kgs. at $3000 per tonne	6
9.	Others	20
10.	Packing material	550
(b)	Utilities	
1.	Electricity 20 k.w. connected load	60
2.	Water 10 cubic metres at $5 per c.m.	500
3.	Steel 20 tonnes at $100 per tonne	2000
(c)	Wages - for 13 men	600
(d)	Repaires and maintenance 2% if investment	40
(e)	Interest at 12%	240
(f)	Interest on working capital - 15% for one month production	1750
(g)	Depreciation at 10%	200
(h)	Marketing and sales promotion	2000
(i)	Others	1000
	Production cost for 1 kg. $ 1.5	14918

In a large unit the cost could be down by about 15%.

	US $
Production cost of cakes (1 lakh)	
1. Interest depreciation maintenance and additional equipment	390
2. Additional materials (soaps, gums colder etc.	2000
	2390

Total production cost ..	2390
	14918
	17390

Cost per cake $ 0.17

Fig. 1. Flow Sheet for the Manufacture of Toilet Soap in a Mini Unit

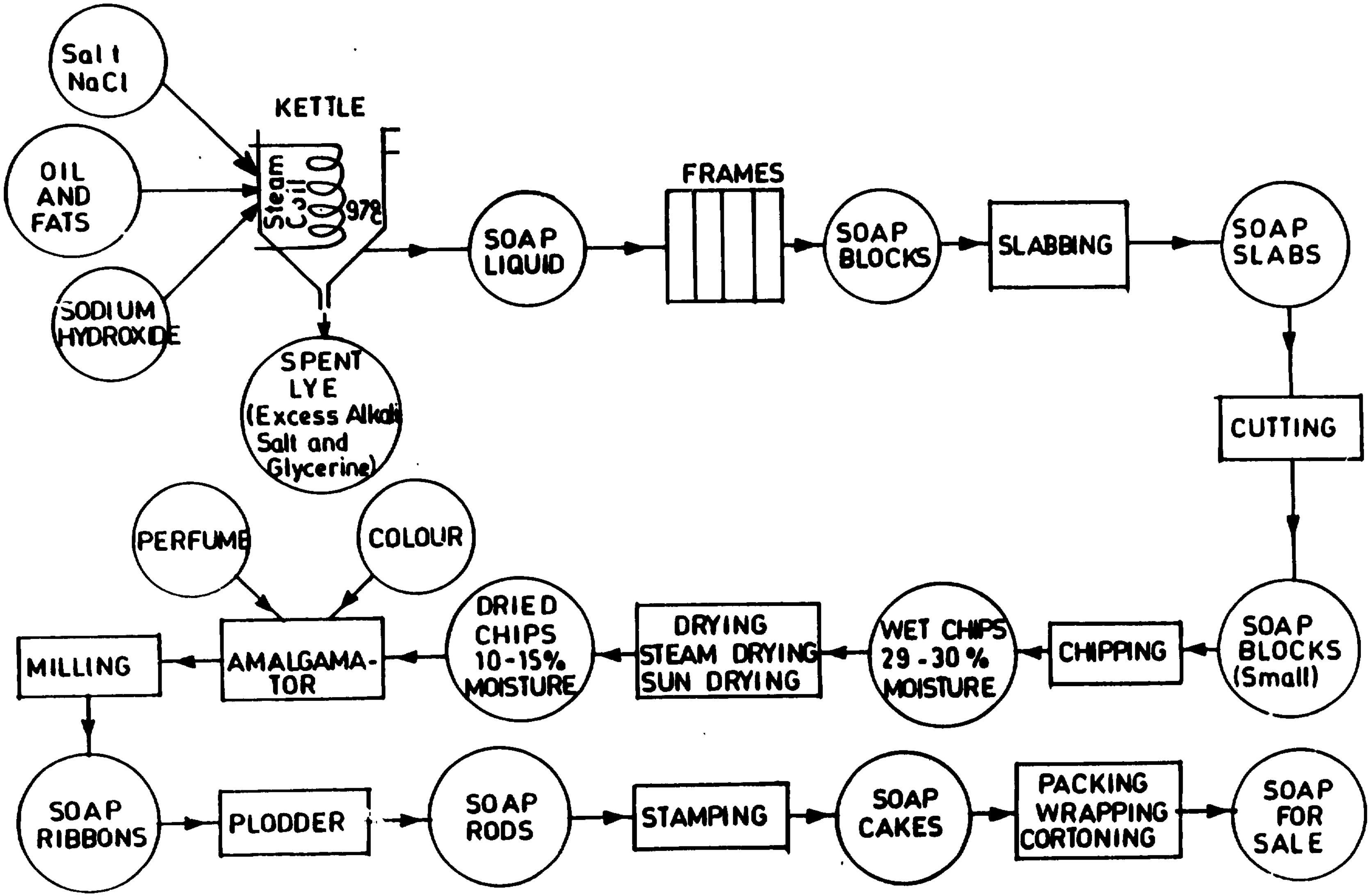


Fig. 2. Flow Sheet for the Manufacture of Laundry Soap in a MINI UNIT

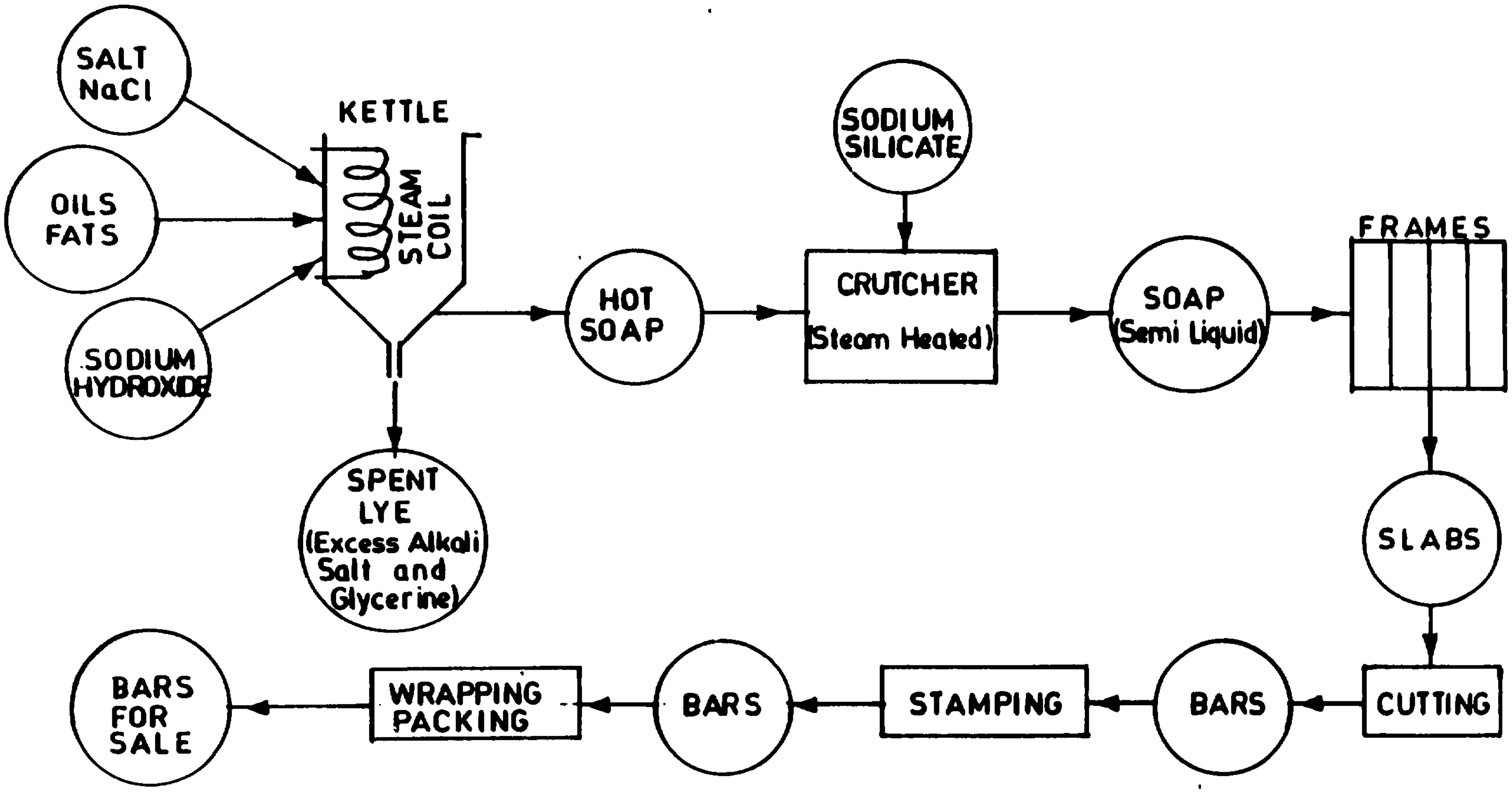


Fig. 3. – Flow sheet for the manufacture of Toilet soap on a COTTAGE SCALE

Notes :- 1. All machines are small
2. All transport operations between stages, manual.

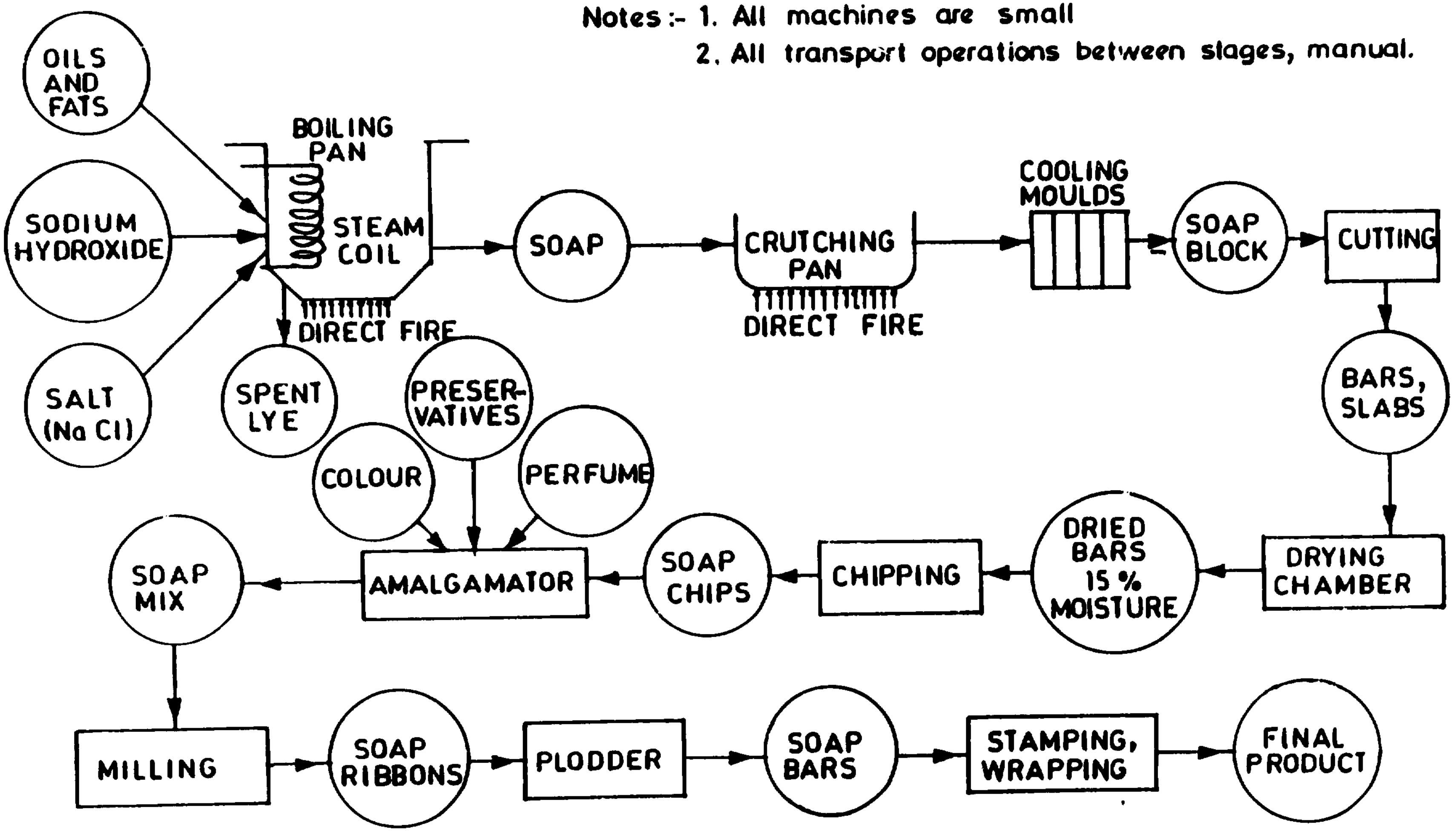


Fig. 4 _ Manufacture of Laundry Soap on COTTAGE SCALE

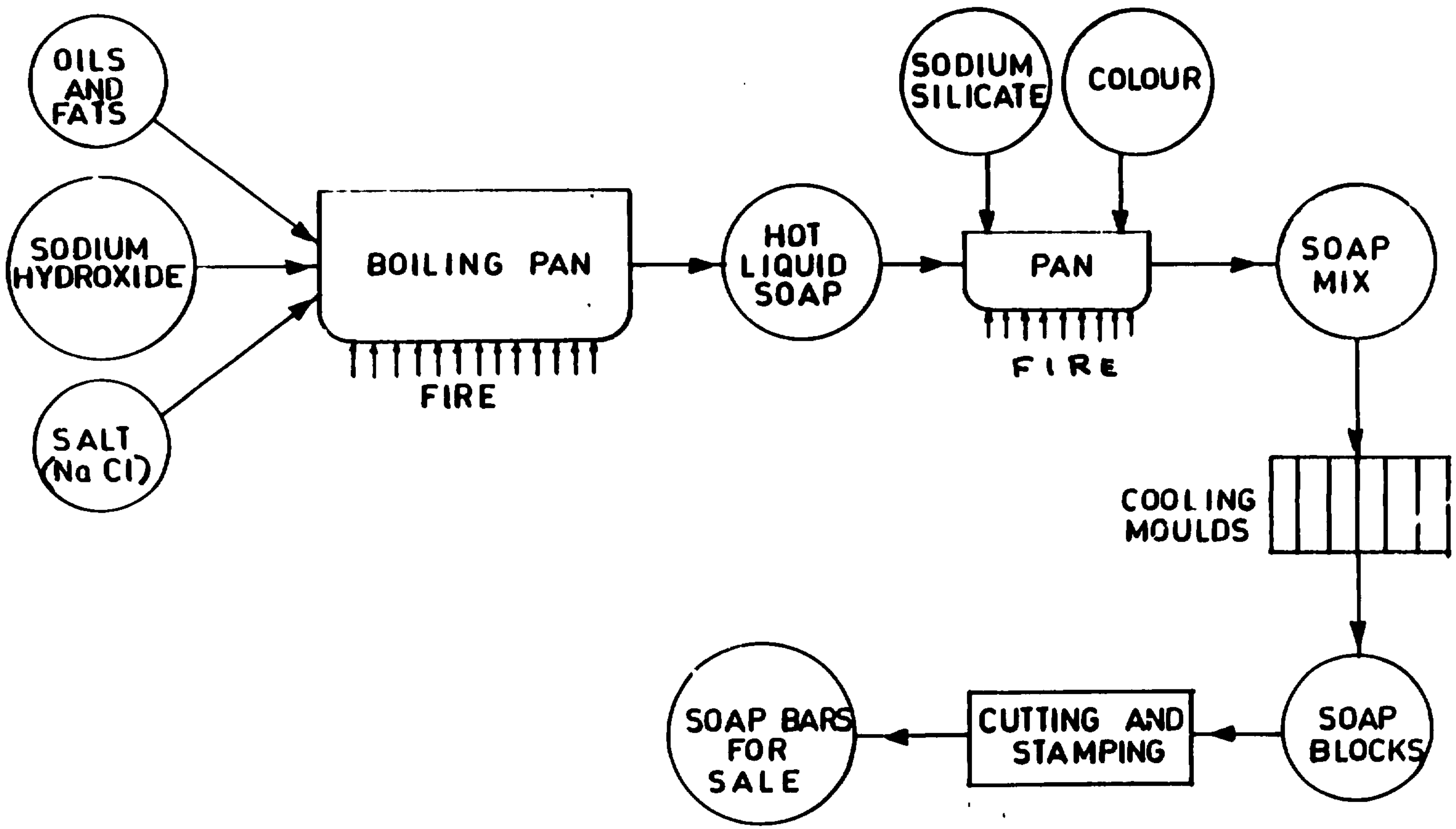


Fig. - 5A - Flow sheet for the Manufacture of Synthetic Detergent

MINI UNIT

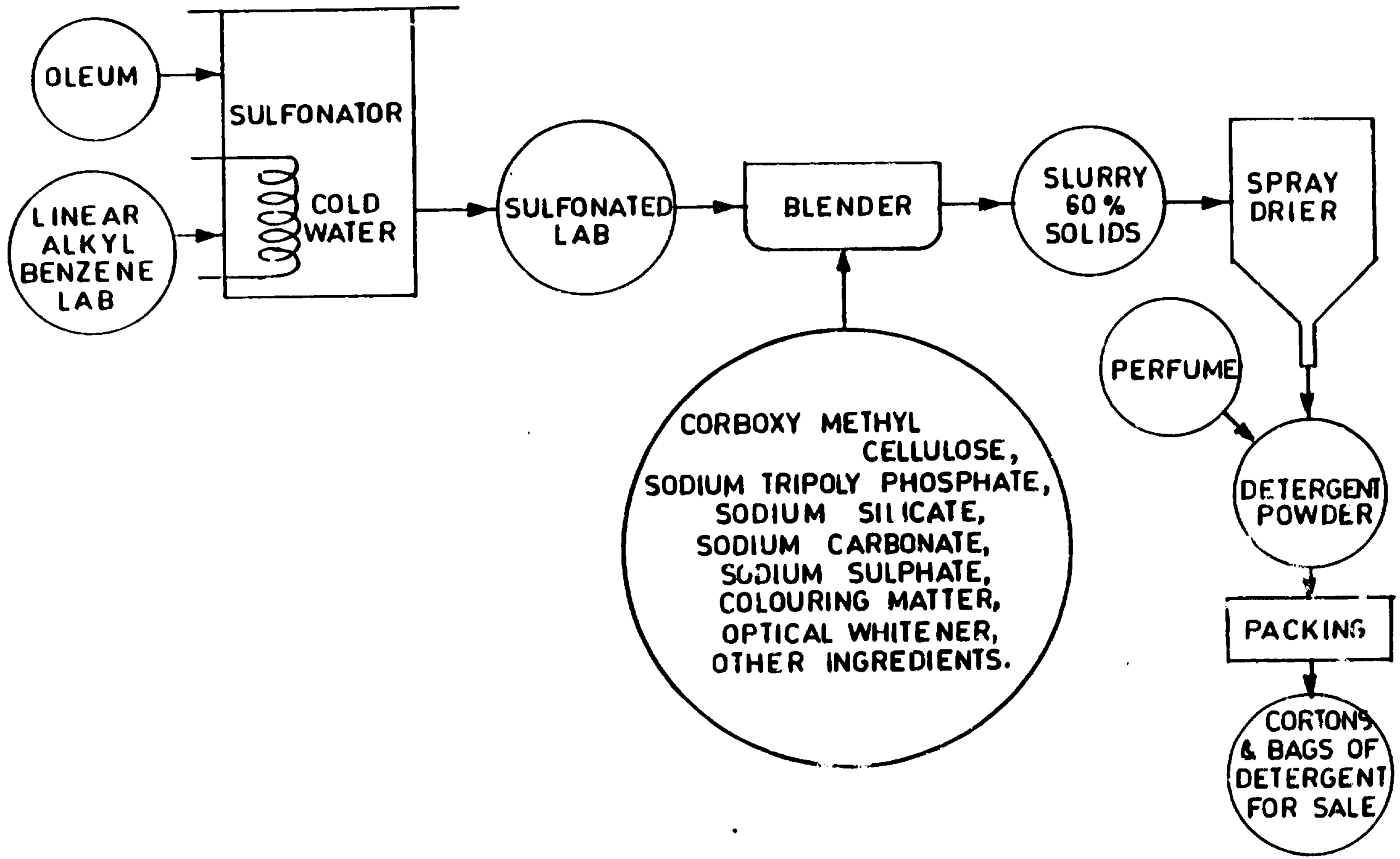


Fig. 5B- Flow sheet for the Manufacture of Detergent Cake

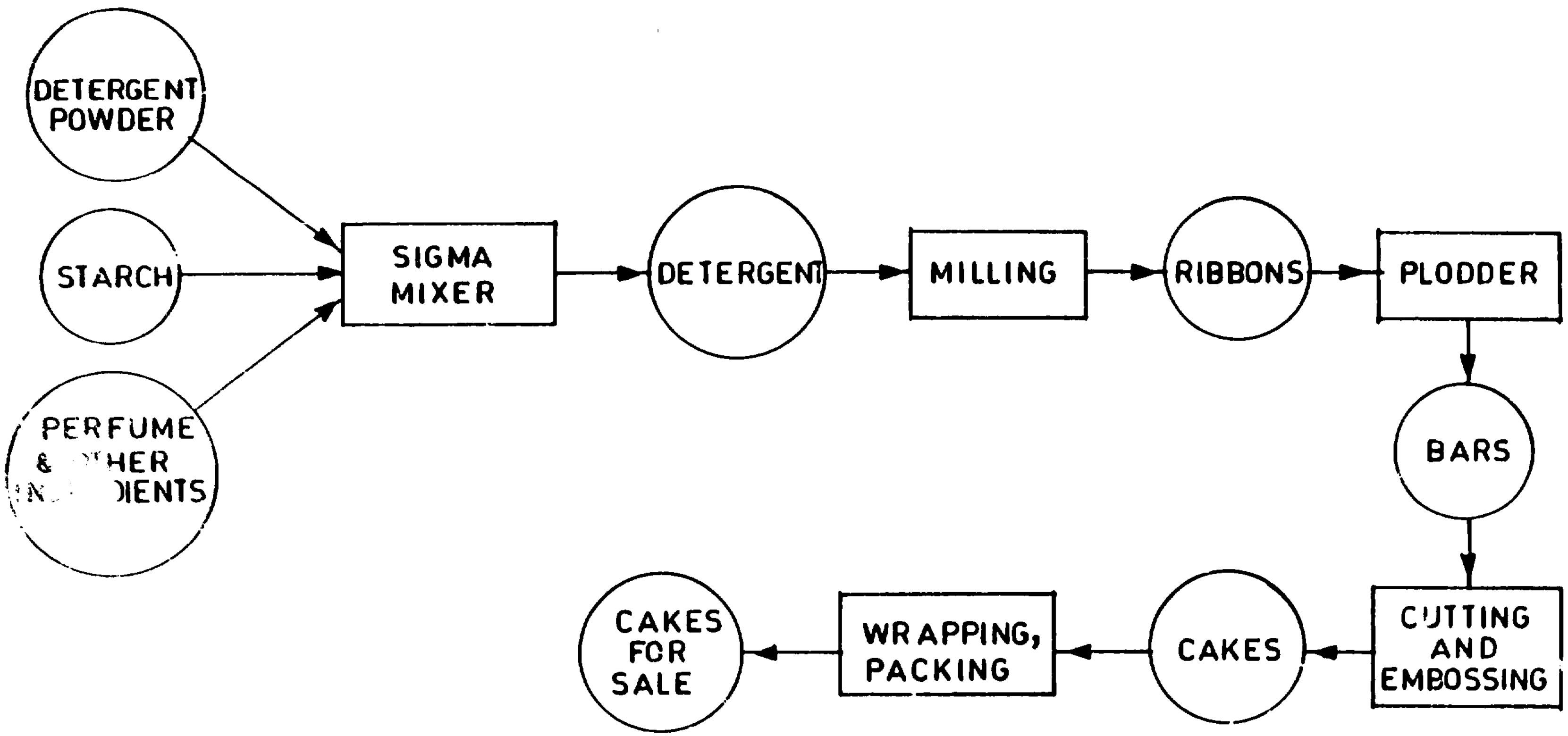
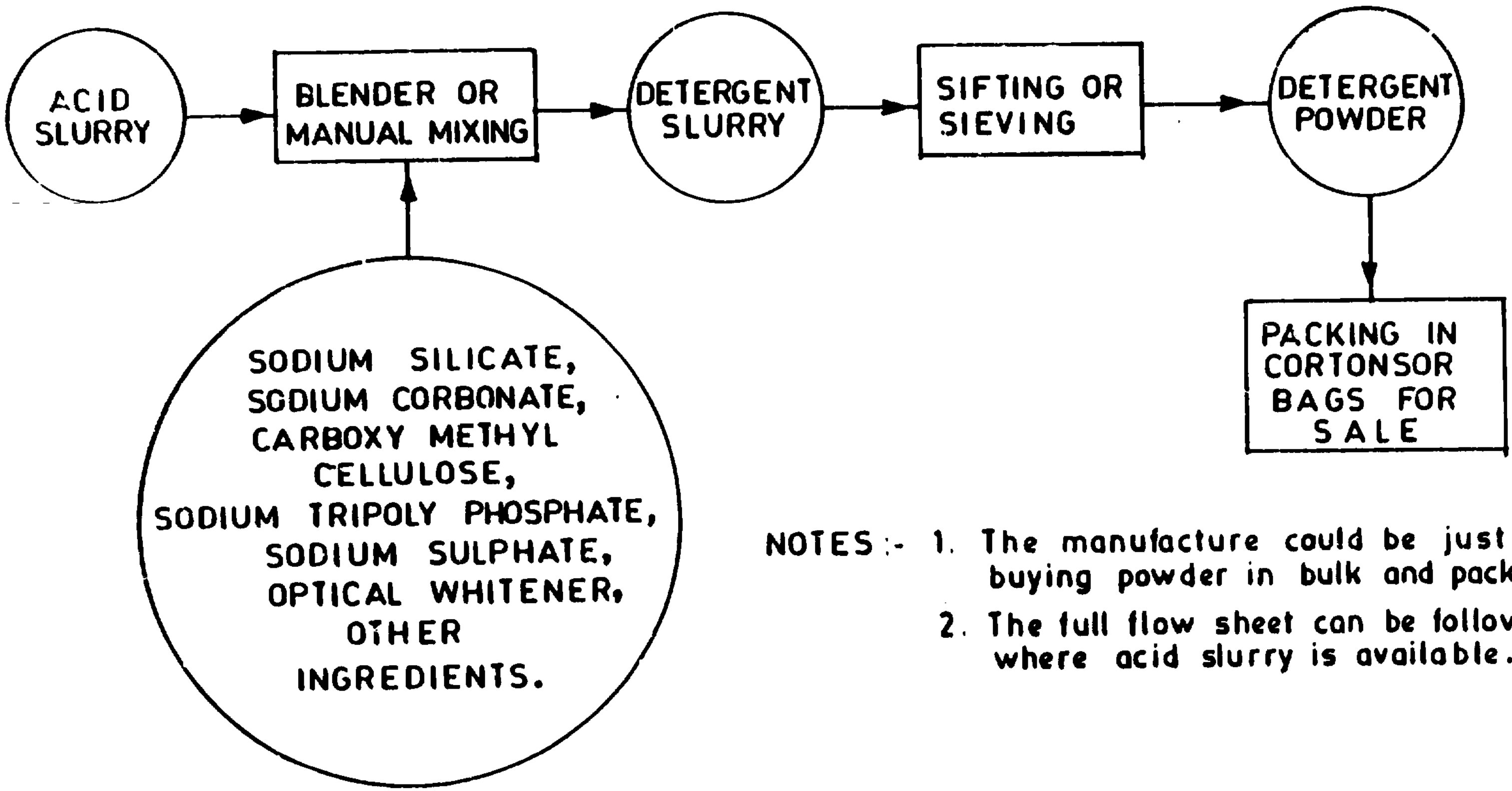


Fig. 6 - Manufacture of Synthetic 'etergent Powder on COTTAGE SCALE



NOTES :-
1. The manufacture could be just buying powder in bulk and packaging.
2. The full flow sheet can be followed where acid slurry is available.

ANNEXURE 1*

HISTORY

Although the origin of soap is shrouded in the mists of antiquity, it is generally accepted that some form of primitive saponification was first developed in almost pre-historic times : the eastern portion of the Mediteranian. Soap is one of the oldest chemical substances known. Only in the 19th century, following introduction of the Leblanc process for Soda Ash manufacture, soap became much cheaper and its use very common.

SOAP MAKING OPERATIONS

The basic reaction of soap making is quite simple. It consists of reacting oil or fat with an alkali to produce soap and glycerol.

$$\begin{array}{l} CH_2OCOR \\ CHOCOR \\ CH_2OCOR \\ \text{Oil or Fat} \end{array} + 3\ NaOH \text{ --- } 3\ RCOONA = \begin{array}{l} CH_2\ OH \\ CH\ \ OH \\ CH_2\ OH \\ \text{Glycerol} \end{array}$$

Alternatively, it is also made from fatty acid route as follows:

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* Material from Reference No.6.

CH_2OCOR

Splitting at high temp. & Pressure

$$\text{CHOCOR} \xrightarrow[H_2O]{} C_3H_5(OH)_3 + \text{RCOOH (fatty acids)}$$

CH_2OCOR

Oil or fat

$$\text{R-COOH (Fatty acid)} \xrightarrow[NaOH/Na_2CO_3]{} \text{RCOONa (Soap.)}$$

The following steps are involved in manufacturing of soap with the above two routes.

ROUTE I : SOAP FROM OILS

Steps

1. Pre-treatment of oils
2. Blending of oil & fats
3. Saponification
4. Soap drying
5. Soap finishing and packaging

ROUTE II : SOAP FROM FATTY ACIDS

Steps :

1. Pretreatment of oils
2. Splitting of oils & fats
3. Distillation of fatty acids
4. Blending of fatty acids
5. Continuous saponification using fatty acids
6. Soap drying
7. Soap finishing and packaging.

ROUTE I : SOAP FROM OILS

Step 1. <u>Pretreatment of oils</u>

Refining of oils and fats for use in the soap industry is to remove resinous and mucilagenous matter is removed by acid treatment, silicate wash, salt wash, hot water wash etc. in one or more combinations where in such mucilagenous matter gets coagulated effecting good separation.

Next step would be the removal of colouring matter by physical or chemical bleaching. Physical bleaching involves bleaching with various kinds of activated earths, acidic, alkaline or naturally and chemical bleaching involves treatment with air, hydrogen Peroxide, chlorine, potassium chlorate and other organic oxidising agents. The choice of a particular type of treatment depends on the type of oil or fat under question. The Indian soap industry has had to use many of the non-traditional oils like Rice bran oil, rubber seed oil, maize oil, neem oil, Karanja oil, tobacco seed oil etc. which necessarily require one or other pretreatment steps. A process of purification or refining involving less number of steps with lower treatment losses would be to the advantage of the processing industry.

Removal of volatile and odouriferous substances would form a part of pre-treatment intended primarily for the removal of traces of constituents that give rise to flavours and odours. Such products include lower volatile fatty acids, oxidised fatty acids, aldehydes, ketones etc. The process involves treatment of oil and fat by super heated steam in a vacuum. In fact it is a form of steam distillation that removes from the oil these constituents which are volatile under the imposed conditions of high vacuum and temperature. The de-odcurisation would be necessary whenever the fat charge is of very poor quality and also when oils like fish oil forms part of fat charge which contain nitrogenous compounds with offensive cdours.

Step 2 Blending of oils & fats

In nature, there is no single oil or fat which can straight away be converted into soap of optimum characteristics such as hardness, latherability, wear-out characteristics, keeping quality etc. To achieve this, different oils and fats have to be blended in a select fashion to have a mixture which on conversion to soap, would give all the desired properties mentioned above. The normal practice is to blend fats containing oleates/sterates/palmitates with oils or fats containing laurates. The proportion is decided by the characteristics such as Iodine value, titre value, INS-factors etc.

of the mixture and of course on the composition of fatty acids which is the latest trend.

Step 3 Saponification

A. Batch Saponification Process

Saponification is carried out in an insulated cylindrical tanks, made of mild steel and having concial bottom known as kettles. The appropriate quantity of fat charge is taken in kettle and heated by open steam when alkali is added along with brine solution and water. Depending on fat charge, about 14 to 15 per cent Caustic alkali is required for complete saponification. After complete saponification, mixture is allowed to settle for 24-40 hours, when soap nigre and lye separate in distinct layers. Lye is sent for glycerine recovery and nigre to the next kettle for reuse. The soap contains about 30-40 per cent moisture at this stage.

B. Continuous saponification process

The advantages of this process are greater flexibility in control of chemical reactions, better control of physical properties of soap, better recovery of glycerol and better steam utility i.e. almost one-third quantity of steam as compared to open soap boiling in kettles. An other advantage is that the time required for soap making by CSP is much less than by the kettle boiling process thus reducing inventory. Above all, a better quality soap is obtained in this process.

The raw materials namely oils and fats, caustic soda, salt solution and water stored in overhead tanks are taken in appropriate proportions and sent to the saponification autoclave by means of a seven piston pump and three piston pump and a double dosing piston pump. The amount of material entering the autoclave is dependent directly on the stroke length of the pistons.

The saponification autoclave is the most important part of this plant. It is made out of stainless steel SS 316 and the temperature inside is maintained at around 130°C with the help of steam coils. Steam being provided at a pressure of ½ to 1 kg. per cm^2. The product that is base soap along with water and other impurities pass to a cooler where a temperature of 80°C is maintained with the help of cold water. Here complete saponification takes place. Then the soap lye and glycerine pass through a series of static separators where the lye gets separated and the soap is sent to a fitting vessel or to kettle where fitting operation is done, as usual.

Step 4 <u>Soap drying</u>

Neat soap is removed by inserting a skimmer pipe through the upper crust of solidified soap and pumping out the soap to the soap drying plant or atomiser. The soap is sprayed as tiny droplets in the automiser, where due to vacuum and temperature, moisture is driven away and the soap comes out of atomiser via a plodder in the form of noodles.

Step 5 <u>Soap Finishing operation</u>

The soap noodles produced in the soap drying plant are collected in intermittent silos by chain conveyors and from here the soap is lifted to overhead silos using pneumatic conveyors.

There are a number of such silos corresponding to the number of finishing lines. From these silos soap is taken by gravity through a pre-set automatic weighing device into an amalgamator. To the soap in the amalgamator, opacifiers, optical whiteners, colours, perfumes, preservations and special ingredients are added and mixed well by rotating blades. The mass is transferred to a milling machine. The milled soap mass is again fed into a duplex plodder and the soap bar obtained from the plodder is cut into billets in a T.V. cutter. The billets are fed into automatic stamping machine where the billet is stamped into soap cake of desired shape, weight and embossing name of the product. The speciality of our stamping machines is the circulation of chilled water at - 20°C in the die box which results in a glossy finish to the cake and also avoids sticking of the soap to the die which is a production hindrance in ordinary stamping machines. While oil is used to avoid sticking of soap to the dies in ordinary stamping machines but the residual odour of white oil on soap is not desirable and this problem does not arise in case of sophisticated stamping machines.

The stamped cakes are sent to automatic ACMA wrapping machines which are capable of packing around hundred cakes per minute. The cakes are then filled into corrugated board boxes and sent to stores.

ROUTE II- SOAP FROM FATTY ACIDS

Step I Pre-treatment of oils

Pre-treatment here consists of only removing resinous and mucilagenous matter by acid treatment such as Phosphoric, Sulphuric acid etc. silicate treatment, water wash etc. Bleaching and deodorida-tion steps are not necessary here since fat is split and distilled to remove the impurities.

Step 2 Splitting of oils & fats

The splitting plant is based on continuous ope-ration and consists of 3 autoclaves in succession. The fat is fed from the bottom of first autoclave and water from top of third autoclave both of which move in opposite direction. The fat from the first autoclave over-flows to the second and enters the bottom of second autoclave and then to the third and it is fully converted to fatty acids when it comes out of third autoclave. Similarly, the water fed from the third autoclave overflows to the second and then to the first, all from top and when it comes out of the first autoclave, it is enriched in glycerine.

The pre-treated or purified oils pass through coarse and fine filters and are then pre-heated in a pre-heater and enters the autoclave at about 125°C. Water from the storage tank is pumped to the top of the third autoclave through a pre-heater, and enters at around 115°C. Steam at 30 kg/cm^2 is injected which results in instantaneous splitting of oil or fat by hydrolysis. The hot fatty acids are led into expansion cooling apparatus where water is cooled and heat exchange takes place. From here the fatty acids are emptied into settling tanks.

Sweet water coming from first autoclave also passes through expansion cooling apparatus and then to settling tanks. The sweet water is purified by lime treatment to separate dissolved fatty acids. This is evaporated in a double effect evaporator where crude glycerine of 80-88 per cent strength is obtained. This is subjected to distillation and the distilled glycerine is bleached using activated carbon to get water white refined glycerine.

Step 2 Distillation of Fatty Acids

The crude fatty acids obtained as above are subjected to distillation and the operating details are summarised as follows:

The crude fatty acids are pre-heated in a pre-heater to a temperature of 140°C-150°C and from here enters into the deaerator-drier, operating under vacuum of around 6 mm of Hg where they are freed from moisture. From here the fatty acids enter the autoclave which are heated at the expense of vapours of distilled fatty acids. These then pass into the distillation chamber proper. The distiller is of Labrynth type and is provided with two heating systems, i.e. by steam for a quick pre-heating and by a dia-thermic fluid circulated in a closed circuit which is designed to bring the fatty acid to distillation temperature. The temperature of distillation chamber is maintained at 230-240°C under vacuum of 3 to 5 mm Hg. The distiller is a long vessel having plates arranged lengthwise.

The main function of these plates is to provide a specific path for the entering fatty acids. The diathermic fluid coils are along this path and thus distillation occurs. The cyclone separator at the top of the distiller condenses vapours of fatty acids which fall back into the distiller. The vapours of fatty acids pass into the condensors which are maintained at around 56°-60°C by cooling water circulation and the fatty acids are collected in receivers and from here they are pumped to storage tanks of FRP make. The FRP tanks are necessary since fatty acids are corrosive in nature.

The black residue, 'Pitch' leaving the distiller is discharged continuously through a special control unit and is collected in pitch receiver. From here it is sent to storage tank. If the TFM content in pitch is high, it is taken for re-splitting and distillation.

Step 4 Blending of Fatty Acid

The purpose of blending of oils and fats is already explained above and blending of fatty acids is done on the same principle as blending of oils. Here the blending can be done either before distillation or after distillation.

Step 5 Saponification

Continuous saponification is recommended when fatty acids are used as feed stock, since the CSP is made out of stainless steel and there is no iron infiltration into the soap. If fatty acids are charged into the soap, if fatty acids are charged into kettle, iron would enter into fatty acids, since kettles are of mild steel make and this could cause the problem of rancidity in soap and shelf life of soap is affected. The operating parameters and other details of CSP operation almost remain the same as the one described above for oil charges. The only difference is that there is no glycerine recovery here since glycerine would have already been separated during fat splitting operation.

Step 6 Soap drying

It is the same as described earlier above in Route I.

Step 7 Soap finishing

This is also similar to the description made in Route I above.

D) SOAP FROM FATTY ACIDS

When fatty acids are used as feed stock, saponification may be effected with sodium carbonate. A nearly saturated soda ash solution is brought to a boil in the soap kettle and the fatty acids are added gradually allowing sufficient time between additions for carbon-dioxide to escape without the batch foaming out. After neutralisation the batch is boiled with an excess of Caustic soda to saponify the small amount of neutral unsplit fat. This treatment corresponds to the strong change in ordinary soap boiling. Subsequently the batch is finished as usual.

E. PRECAUTIONS TO BE TAKEN IN CASE OF FATTY ACID CHARGE

Whenever fatty acids are used, precautions have to be taken to see that all the lines are of stainless steel make since fatty acids cause corrosion resulting in leakage and replacement of lines. Apart from this whenever fatty acids are used sufficient quantities of chelating agents like Sodium EDTA, NTA and sometimes anti-oxidants have to be used to prevent soap from rancidity and deterioration which often happens due to the presence of metallic impurities in soap.

F. PLANT AND EQUIPMENT REQUIRED FOR TOILET SOAP MANUFACTURE

A large number of developing countries are in a position to manufacture all or part of equipments needed for a soap factory. For example, countries like India can make all the equipments needed. However, it may not be possible for some developing countries to make all the equipments. In such cases, an assessment has to be made as to what equipments could be made locally and what have to be imported. Perhaps, in some cases it may be worthwhile to import the entire plant.

G. PERFUMERY & PACKAGING

Perfuming and packaging of toilet soaps and even laundry soaps are important operations in making the soaps attractive to the consumers. This has to be done in such a way that the perfume is liked by the consumers and the packaging attracts their attention.

Here also, many developing countries have capability to do the same. However, in some cases, import of packaging materials and perfumes may be necessary.

H. MARKETING

Marketing has to be tailored to the needs of each country. depending upon the quantity of soap manufacture, types of soaps and local market conditions. Strategy has to be developed in each case and implemented.

I. CONCLUSION

The process of making toilet soaps has undergone a metamorphosis over the years starting from cold to semi-boiled process and then to full boiling in kettles; thereafter through jet saponification to continuous saponification processes. The soap boilers' skill so essential in the earlier years has given way to automatic controls. Continuous processes have brought down the costs of steam for boiling as well as inventories of materials. The fatty acids route for toilet soaps has widened the choice of raw materials and improved quality. Drying of soap under vacuum has replaced the earlier tray drier or band driers. Chilled water circulation in stamping dies has improved finish of the soap cakes while automatic wrapping machines have improved efficiency in packaging. There is further scope to reduce energy inputs in toilet soap making through steps such as elimination of soap drying by continuous saponification yielding 78 per cent TFM noodles etc. As cost of fatty oils increase, there is need to look into the possibility of using suitable non-soapy detergents in toilet soaps. The trend towards more expensive speciality toilet soaps is already seen. With the steady improvement in incomes and living conditions of the people in general and the entry of more multi-nationals and large companies some of whom are new to the soap business, the stage is set for an exciting future for the toilet soap industry.