SSP Pumps
in the
Soap & Detergent Industry



Inside View

This document has been produced to support pump users at all levels, providing an invaluable reference tool. It includes information on the Soap and Detergent processes and provides guidelines as to the correct selection and successful application of SSP Rotary Lobe Pumps.

Main sections are as follows:

1. Introduction
2. General Applications Guide
3. The Cleaning Process
4. Soap Manufacture
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6. SSP in the Soap and Detergent Process
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1.0 Introduction

Many people are confused about the difference between soap and detergent. Soaps and detergents are not the same thing, although both are surfactants, or surface active agents, which basically mean a washing compound that mixes with grease and water.

Soaps are made of materials found in nature. Detergents are synthetic (although some of the ingredients are natural); they were developed during World War II when oils to make soap were scarce.

There is little doubt that soap is better for your health and the environment than detergents. Detergents are very toxic to fish and wildlife. Nonetheless, a big drawback of washing with soap is that the minerals in water react with those in soap, leaving an insoluble film. This can turn clothes greyish, and the film can leave a residue. Detergents react less to minerals in water and for all practical purposes are the product of choice for laundry.

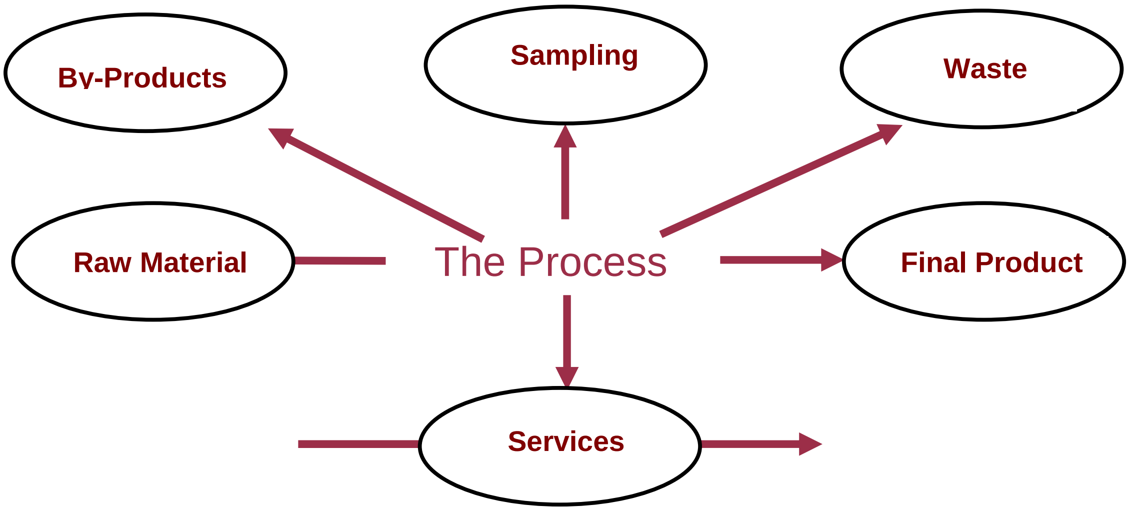
As a recognised market leader in pumping technology SSP Pumps has been at the forefront of supplying rotary lobe pumps to the soap and detergents industry for over 50 years. SSP rotary lobe pumps are to be found in many stages of the soap and detergent manufacturing process, where their reliable low shear flow characteristics offer gentle handling of shear sensitive media and provide long trouble-free service.

2.0 General Applications Guide

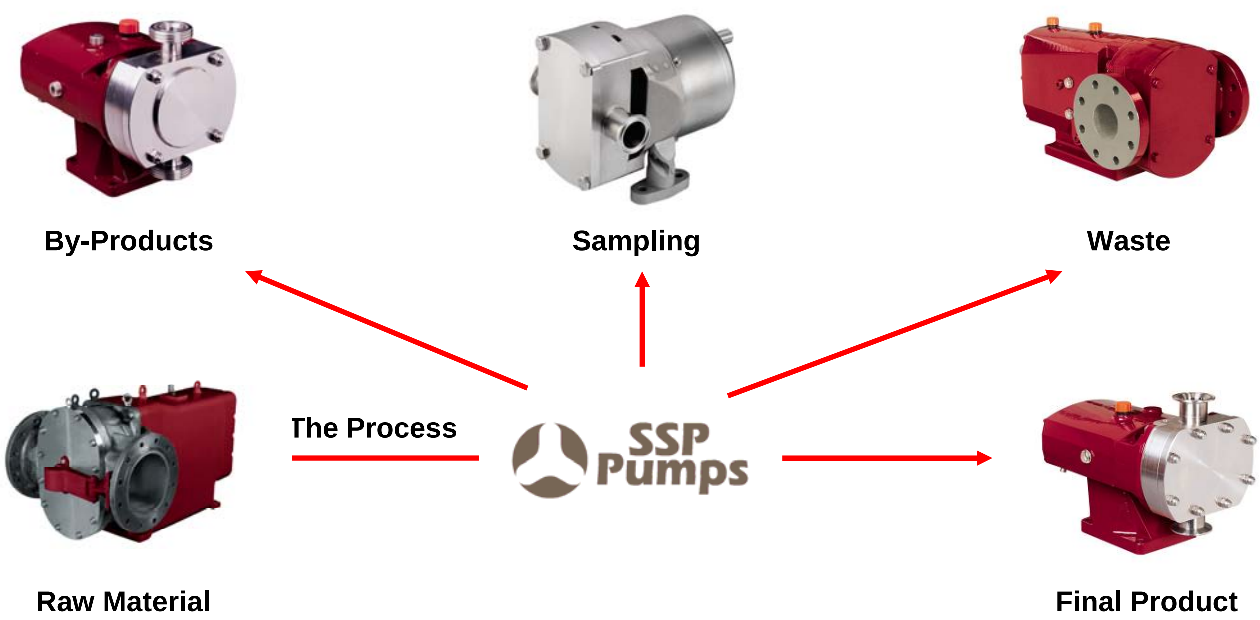
This section gives an overview of the pump ranges currently available from SSP Pumps and which particular pumps to apply within various application areas in the Soap and Detergents Industry.

Within the various soap and detergent industry processes many opportunities exist for utilising SSP rotary lobe pumps, not only for the final product but other processes such as by-products, sampling and waste.

Walk the Process



Opportunities



Within the soap and detergents industry typical application areas for SSP Pumps are to be found in:

- Blending
- Drying
- Mixing
- Recovery
- Separation
- Transfer

The table below indicates the typical pumped media found and which pump series can be generally applied:

Media Handled	**Pump Series**			
	S	**X**	**L**	**A**
Dishwash Liquid	✓	✓	✓	✓
Dodecyl Benzene Sulphonic Acid	✓	✓	✓	✓
Fabric Conditioner	✓	✓	✓	-
Fatty Acid	✓	-	✓	-
Lye	✓	-	✓	✓
Neat Soap	✓	-	✓	✓
Sodium Lauryl Ether Sulphate	✓	✓	✓	✓
Surfactants	✓	✓	✓	-

3.0 Understanding the Cleaning Process

Soaps and detergents are substances that, when dissolved in water, give it the ability to remove dirt from surfaces such as the human skin, textiles, and other solids. The seemingly simple process of cleaning a soiled surface is, in fact, complex, and consists of the following physical-chemical steps:

1. Wetting of the surface and, in the case of textiles, penetration of the fibre structure by wash liquor containing the detergent. Detergents (and other surface-active agents) increase the spreading and wetting ability of water by reducing its surface tension, that is, the affinity its molecules have for each other in preference to the molecules of the material to be washed.

2. Absorption of a layer of the soap or detergent at the interfaces between the water and the surface to be washed and between the water and the soil. In the case of ionic surface-active agents (see section 5.0), the layer formed is ionic (electrically polar) in nature.

3. Dispersion of soil from the fibre or other material into the wash water. This step is facilitated by mechanical agitation and high temperature; in the case of toilet soap, soil is dispersed in the foam formed by mechanical action of the hands.

4. Preventing the soil from being deposited again onto the surface cleaned. The soap or detergent accomplishes this by suspending the dirt in a protective colloid, sometimes with the aid of special additives. In a great many soiled surfaces the dirt is bound to the surface by a thin film of oil or grease. The cleaning of such surfaces involves the displacement of this film by the detergent solution, which is in turn washed away by rinse waters. The oil film breaks up and separates into individual droplets under the influence of the detergent solution. Proteinic stains, such as egg, milk, and blood, are difficult to remove by detergent action alone. The proteinic stain is non-soluble in water, adheres strongly to the fibre, and prevents the penetration of the detergent. By using proteolytic enzymes (enzymes able to break down proteins) together with detergents, the proteinic substance can be made water-soluble or at least water-permeable, permitting the detergent to act and the proteinic stain to be dispersed together with the oily dirt. The enzymes may present a toxic hazard to some persons habitually exposed.

If detached oil droplets and dirt particles did not become suspended in the detergent solution in a stable and highly dispersed condition, they would be inclined to flocculate or grow together into aggregates large enough to be re-deposited on the cleansed surface. In the washing of fabrics and similar materials, small oil droplets or fine, de-flocculated dirt particles are more easily carried through interstices in the material than are relatively large ones. The action of the detergent in maintaining the dirt in a highly dispersed condition is therefore important in preventing retention of detached dirt by the fabric.

In order to perform as detergents (surface-active agents), soaps and detergents must have certain chemical structures: their molecules must contain a hydrophobic (water-insoluble) part, such as fatty acid or a rather long chain carbon group, such as fatty alcohol's or alkylbenzene. The molecule must also contain a hydrophilic (water-soluble) group, such as - COONa, or a sulfo group, such as - OSO3Na or -SO3Na (such as in fatty alcohol sulfate or alkylbenzene sulfonate), or a long ethylene oxide chain in non-ionic synthetic detergents. This hydrophilic part makes the molecule soluble in water. In general, the hydrophobic part of the molecule attaches itself to the solid or fibre and onto the soil, and the hydrophilic part attaches itself to the water.

The first detergent (or surface-active agent) was soap. In a strictly chemical sense, any compound formed by the reaction of a water-insoluble fatty acid with an organic base or an alkali metal may be called a soap. Practically, however, the soap industry is concerned mainly with those water-soluble soaps that result from the interaction between fatty acids and alkali metals. In certain cases, however, the salts of fatty acids with ammonia or with triethanolamine are also used, as in shaving preparations, for instance.

4.0 Soap Manufacture

The most widely used process of soap manufacture is the saponification of fats and oils. This method involves heating fats and oils and reacting them with a liquid alkali to produce soap and water (neat soap) plus glycerine, and is fully described in 4.2.

4.1 Raw Materials and Additives

The major raw materials for soap manufacture are fat and alkali. Other substances, such as optical brighteners, softeners, and abrasives are often added to obtain specific characteristics.

Alkali

Sodium hydroxide is used as the saponification alkali for most soap now produced. The soap formed is a ‘hard’ soap. Soap may also be manufactured with potassium hydroxide (caustic potash) as the alkali. These soaps are more soluble in water than sodium soaps and in concentrated form they are called soft soap, generally used for some liquid hand soaps and shaving creams.

Fats and Oils

Fatty raw materials for soap manufacture include animal and vegetable oils and fats or fatty acids, as well as by-products of the cellulose and paper industry, such as rosin and tall oil. These raw materials can be split into four different groups according to the properties of the soap products they yield:

1. Hard fats yielding slow lathering soaps include tallow, garbage greases, hydrogenated high-melting-point marine and vegetable oils, and palm oil. These fats yield soaps that produce little lather in cold water, more in warm water; are mild on the skin; and cleanse well. This is the leading group of fats used in the international soap industry, with tallow the most important member.

2. Hard fats yielding quick-lathering soaps include coconut oil, palm-kernel oil, and babassu oil. These fats are not very sensitive to electrolytes, such as salt; thus, they are suitable for manufacture of marine soap, which must lather in seawater. This is the second most important group of soap fats, with coconut oil the most used.

3. Oils yielding soaps of soft consistency, such as olive oil, soybean oil, and groundnut (peanut) oil are most important here, and linseed and whale oils also belong to the group, as do some semi-drying or drying oils. Because these oils readily undergo changes in air or light or during storage, soaps made from them may become rancid and discoloured.

4. Rosin and Tall Oil with Rosin being used in laundry soap, less expensive toilet soaps, and specialty soaps in various industries and Tall oil mainly being used in liquid soap.

Optical Brighteners

Now an integral part of all washing powders, optical brighteners are dyestuffs absorbed by textile fibres from solution but not subsequently removed in rinsing. They convert invisible ultraviolet light into visible light on the blue side of the spectrum, causing the fibre to reflect a greater proportion of visible light and making it appear brighter. Furthermore, since the tone of the extra light reflected is on the blue side of the spectrum, this blue-violet tinge will complement any yellowish present on the fibre to make it look whiter as well as brighter.

Sequestering or Chelating Agents

EDTA (ethylenediamine tetra acetic acid) or its sodium salt has the property of combining with certain metal ions to form a molecular complex that locks up or chelates the calcium ion so that it no longer exhibits ionic properties. In hard water, calcium and magnesium ions are thus inactivated, and the water is effectively softened.

Abrasives

Water-insoluble minerals such as talc, diatomaceous earth, silica, marble, volcanic ash (pumice), chalk, feldspar, quartz, and sand are often powdered and added to soap or synthetic detergent formulations.

4.2 Soap Production Processes

Several techniques are employed in making soap, most of which involve heat. Processes can be either continuous or on a batch basis.

Boiling Process

This is still widely used by small and medium sized producers with its main objective being to produce neat soap in a purified condition, free from glycerine. Neat soap being the starting material for making bars, flakes, beads, and powders. The boiling process is conducted in a series of steps called changes and occurs in the kettle.

Step 1: Melted fats are placed in the kettle and boiled with caustic soda solution being gradually added. With the saponification reaction now taking place, the mass gradually thickens or emulsifies as the caustic soda reacts with the fat to produce both soap and glycerine.

Step 2: The glycerine is separated from the soap by being treated with brine. Contents of the kettle separate into an upper layer that is a curdy mass of impure soap, and a lower layer that consists of an aqueous salt solution with the glycerine dissolved in it. The slightly alkaline salt solution, termed spent lye, is extracted from the bottom of the kettle and subsequently treated for glycerine recovery.

Step 3: The grainy, curdy mass of soap remaining in the kettle after the spent lye has been removed contains any un-saponified fat (usually traces that have escaped reaction during saponification) plus dirt and colouring matter present in the original oils. During this step, called strong change, strong caustic solution is added to the mass, which is then boiled to remove the last of the free fat.

Step 4: The final stage, called pitching and settling, transforms the mass into neat soap and removes dirt and colouring matter. After the strong change, the soap may be given one or more salt-water washes to remove free alkali, or it may be pitched directly. Pitching involves boiling the mass with added water until a concentration is attained that causes the kettle contents to separate into two layers. The upper layer is neat soap, of almost constant composition for a given fat (about 70%soap, 30% water); the lower layer, called nigre, varies in soap content from 15% to 40%.

Continuous Soap Making - the Hydrolyser Process

The boiling process is very time consuming with settling taking days. To produce soap in quantity, huge kettles must be used. For this reason, continuous soap making has largely replaced the old boiling process. Most continuous processes today employ fatty acids in the saponification reaction in preference to natural fats and oils.

These acids do not contain impurities and produce water instead of glycerine when they react with alkali. Hence, it is not necessary to remove impurities or glycerine from soap produced with fatty acids. Furthermore, control of the entire process is easier and more precise. The fatty acids are proportionally fed into the saponification system either by flowmeter or by a metering pump. The final adjustment of the mixture is usually made by use of pH meter (to test acidity and alkalinity) and conductivity-measuring instruments.

The continuous hydrolyser process begins with natural fat that is split into fatty acids and glycerine by means of water at high temperature and pressure in the presence of a catalyst, zinc soap. The splitting reaction is carried on continuously, usually in a vertical column 15 metre or more in height. Molten fat and water are introduced continuously into opposite ends of the column; fatty acids and glycerine are simultaneously withdrawn. Next, the fatty acids are distilled under vacuum to effect purification. They are then neutralized with an alkali solution such as sodium hydroxide (caustic soda) to yield neat soap. The entire hydrolyser process, from natural fat to final marketable product, requires a few hours, as compared with the four to 11 days necessary for the old boiling process. The by-product glycerol is purified and concentrated as the fatty acid is being produced.

Cold and Semi-boiled Methods
In the cold method, a fat and oil mixture, often containing a high percentage of coconut or palm-kernel oil, is mixed with the alkali solution. The mass is mixed and agitated in an open pan until it begins to thicken. Then it is poured into frames and left there to saponify and solidify.

In the semi-boiled method, the fat is placed in the kettle and alkali solution is added while the mixture is stirred and heated but not boiled. The mass saponifies in the kettle and is poured from there into frames, where it solidifies. Because these methods are technically simple and because they require very little investment for machinery, they are ideal for small factories.

Finishing Operations
Finishing operations transform the hot mass coming from the boiling pan or from continuous production equipment into the end product desired.

For laundry soap, the soap mass is cooled in frames or cooling presses, cut to size, and stamped. If soap flakes, usually transparent and very thin, are to be the final product, the soap mass is extruded into ribbons, dried, and cut to size.

For toilet soap, the mass is treated with perfumes, colours, or superfatting agents, vacuum dried, then cooled and solidified. The dried solidified soap is homogenized (often by milling or crushing in stages to produce various degrees of fineness).

Medicated soaps are usually toilet soaps with special additives such as chlorinated phenol, xylenol derivatives, and similar compounds, added to give a deodorant and disinfectant effect.

5.0 Detergents

A detergent is a chemical compound that cleans. In the sense that a soap cleans things, it can be considered a detergent. However, chemists generally make a distinction between soaps and detergents, since soaps are salts of carboxylic acids, and detergents are sulphate or sulphonate salts.

The basic constituent of detergents, both liquid and powder form, fabric conditioners, washing up liquid and all related products, are surfactants i.e. surface acting agents. Detergents (and other surfactants) increase the spreading and wetting ability of water by reducing its surface tension. In order to perform as detergents, they must have certain chemical structures: their molecules must contain a hydrophobic (water-insoluble) part, such as fatty acid or a rather long chain carbon group, such as fatty alcohol's or alklybenzene. The molecule must also contain a hydrophilic (water-soluble) group, such as in fatty alcohol sulphate or alkylbenzene sulphonate, or a long ethylene oxide chain in non-ionic synthetic detergents. This hydrophilic part makes the molecule soluble in water. In general, the hydrophobic part of the molecule attaches itself to the solid or fibre and onto the soil, and the hydrophilic part attaches itself to the water.

Surfactants are classified by their ionic (electrical charge) properties in water:

- Anionic (negative charge)
- Non-ionic (no charge)
- Cationic (positive charge)
- Amphoteric (either positive or negative charge)

- **Anionic Detergents**
  The anionic detergents are used extensively in most detergent systems, such as dishwash liquids, laundry liquid detergents, laundry powdered detergents, car wash detergents, shampoo's etc.
  The common anionic detergents can be placed into the following main groups:
  a) Alkyl Aryl Sulphonates
  Linear alkyl benzene sulphonate would be the highest quantity used of any detergent in the world, and the alkyl aryl sulphonates as a group would represent more than 40% of all detergent used. They are cheap to manufacture, very efficient, and the petroleum industry is a starting point for the base raw material. The most important alkyl aryl condensate is DDB (dodecyl benzene). DDB is sulphonated to DDBSA (dodecyl benzene sulphonic acid), and this in turn is used as a detergent base, where it is neutralised with a base, such as sodium hydroxide, monoethanolamine, triethanolamine, potassium hydroxide, etc.
  b) Long Chain (Fatty) Alcohol Sulphates
  Made from fatty alcohol's, and sulphated, these are used extensively in laundry detergents. They can be produced with varying carbon chain lengths.
  c) Others
  These are the olefine sulphates and sulphonates, alpha olefine sulphates and sulphonates, sulphated monoglycerides, sulphated ethers, sulphosuccinates, alkane sulphonates, phosphate esters, alkyl isethionates, and sucrose esters.

- **Cationic Detergents**
  These have poor detergency, and are used more for germicides, fabric softeners, and specialist emulsifiers. You cannot mix cationic and anionic detergents together, as it causes precipitation. The cationic detergents invariably contain amino compounds. The most widely used would be the quaternary ammonium salts, such as cetyl trimethylammonium chloride, a well known germicide.

- **Non-ionic Detergents**
  The vast majority of all non-ionic detergents are condensation products or ethylene oxide with a hydrophobe. This group of detergents is the single biggest group of all detergents.

- **Amphoteric Detergents**
  These have the characteristics of both anionic detergents and cationic fabric softeners. They tend to work best at neutral pH, and are found in shampoo's, skin cleaners and carpet shampoo.

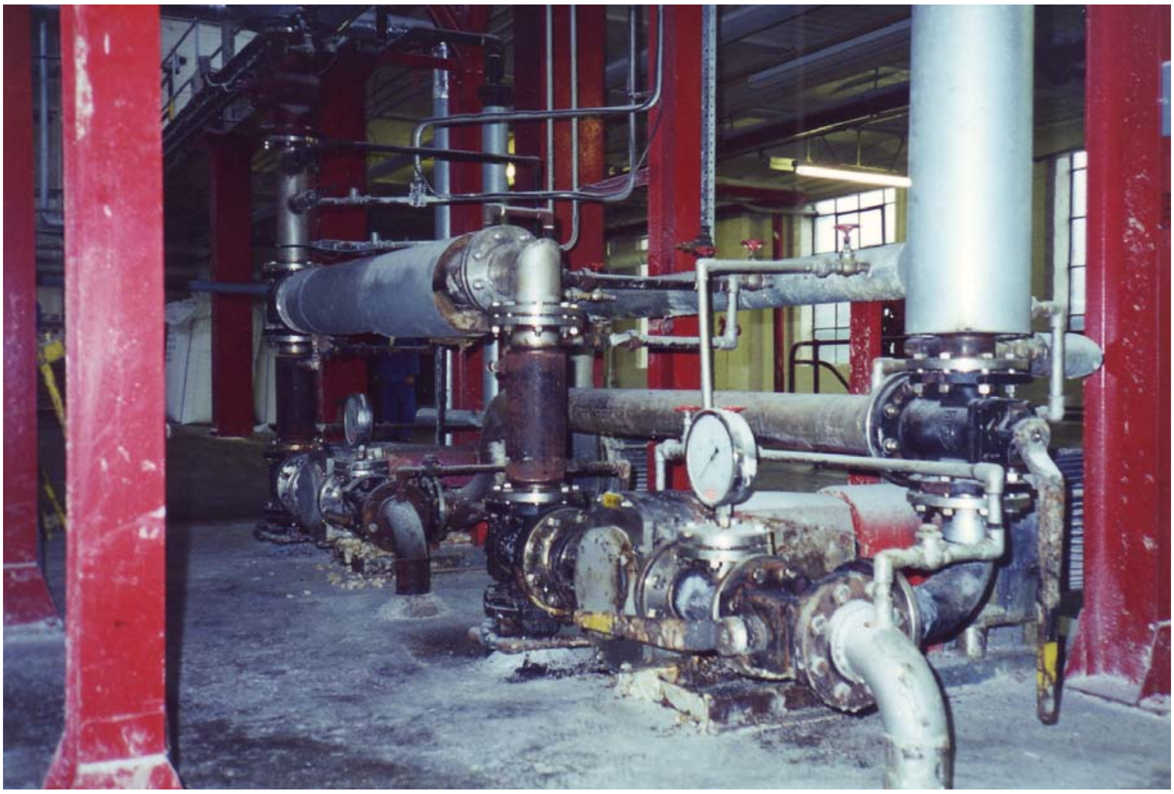
6.0 SSP in the Soap and Detergent Process

The major interest of SSP rotary lobe pumps in the soap making process lies within application areas as follows:

- Blending (Tallow)
- Recovery (Lye)
- Separation (Neat Soap and Nigre)
- Drying (Fatty Acid)
- Mixing (Perfume, Colour and Other Additives)

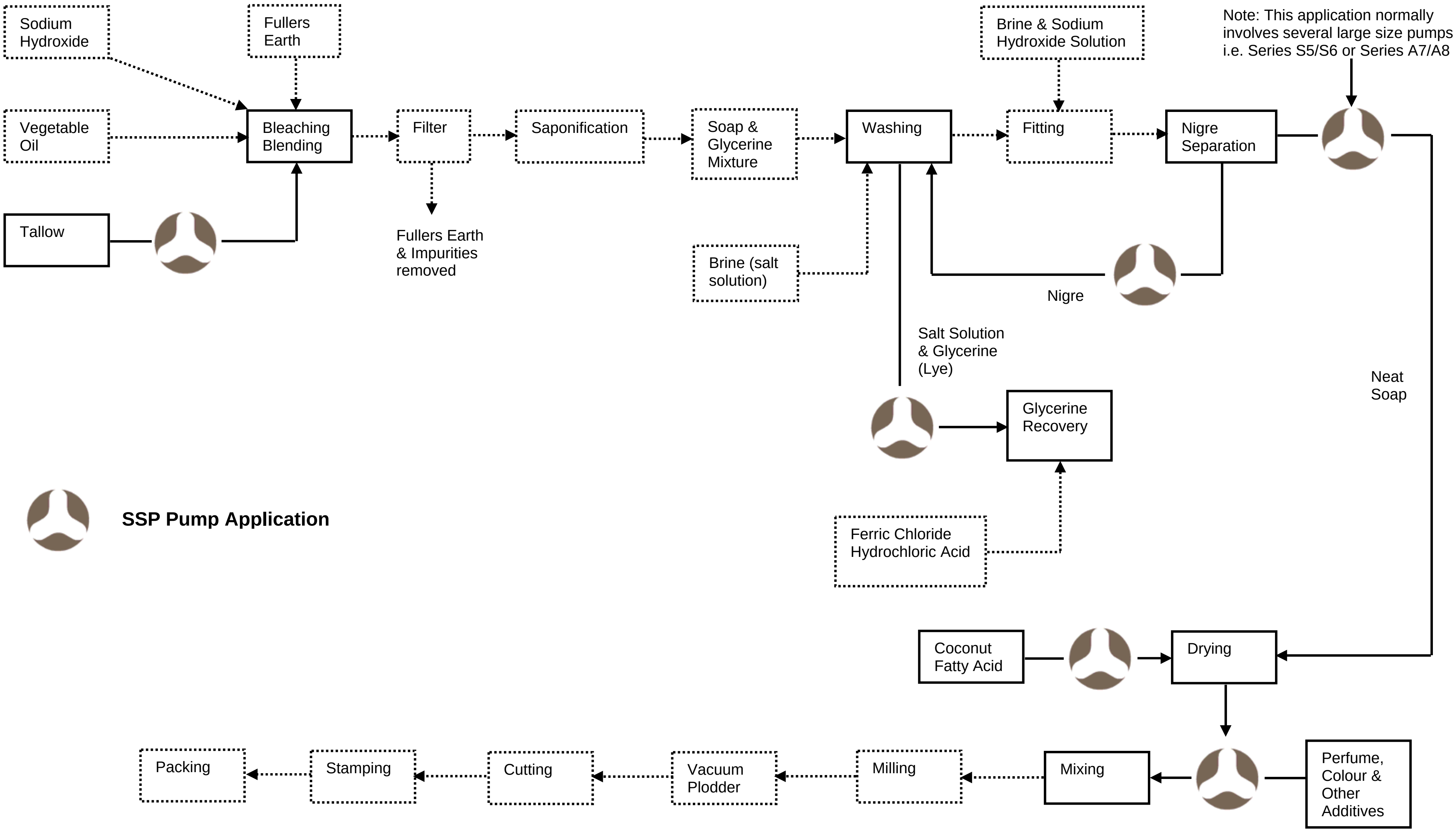
SSP rotary lobe pumps can be used in most applications where either progressing cavity or gear pumps are used.

Series S5 pumps handling neat soap in a major UK soap making plant



The following diagram shows where typically SSP rotary lobe pumps can be found in the soap making process.

SSP Pumps in the Soap Making Process



6.1 The SSP Advantage

SSP Rotary Lobe Pumps offers significant advantages over other pump technologies such as, Progressing Cavity and Gear pumps, as follows:

- **Cost effective easy maintenance**
  Low running and maintenance costs and easy access to the pumphead minimising downtime, results in a reduced lifecycle cost (LCC).

- **Low shear pumping**
  Minimal damage to extremely shear sensitive pumped media.

- **Indefinite dry running capability**
  Avoiding pump components shedding into pumped media.

- **Easy re-start**
  Low breakout torque following machine stoppages.

- **Ability to pump abrasive media**
  Non-contacting design of the pumphead ensures that abrasive particles do not cause excessive wear.

- **Compact design**
  Occupies considerably less floor space than other pump technologies.

Series S5 pump handling detergent in Finland

A comparison of Rotary Lobe, Progressing Cavity and Gear pump technologies strengths and weaknesses is given below:

Pump Technology	**Lobe - traditional**	**Lobe - elastomeric**	**Progressing Cavity**	**Gear**
<u>Strength</u>				
Ability to pump abrasive media	✓	✓	✓	
Compact size	✓	✓		✓
Easy maintenance	✓			
Easy re-start	✓	✓		
Low capital investment		✓	✓	✓
Low energy consumption	✓	✓		
Low shear pumping	✓			
Reduced lifecycle cost (versus others compared)	✓			
Reduced lifecycle cost (versus Progessing Cavity)	✓	✓		
Single seal required			✓	✓
Growing presence and acceptance	✓	✓		
High efficiency			✓	✓
Large global presence			✓	
Robust construction	✓	✓		
Suction capability			✓	✓
Traditional concept			✓	
Wide current acceptance			✓	
Wide range of displacements	✓		✓	
<u>Weakness</u>				
Ability to pump abrasive media				✓
Capital cost	✓			
Dry running capability		✓	✓	
High spares cost			✓	
Large size (versus others compared)			✓	
Material compatibility		✓	✓	
Pulsation	✓	✓		
Pumped media contamination			✓	✓
Two seals required	✓	✓		
Whole life cost			✓	✓
Limited presence		✓		✓
Limited range of displacements		✓		
Still gaining acceptance	✓	✓		
Suction capability	✓			

Bold typeface shows attributes that are considered relevent in this industry.
Grey typeface shows attributes that are considered not relevent in this industry.

7.0 Pump Selection and Application Summary

This section gives information as to pump selection for different pumped media found in the Soap and Detergents Industry.

It should be noted that the information given in this section is for guidance purposes only - actual pump selection should be verified by our Technical Support after the provision of full pumped media and duty details.

Soap and Detergents Applications Summary

Viscosity applicable in pump
low = <50 cP
med = 50 - 1000 cP
high = >1000 cP

Pump Speed
low = <100 rpm
med = 100 - 350 rpm
high = >350 - max rpm pump speed

Media	Viscous Behaviour Type	Viscosity	Speed	Pump Series	Sealing	Elastomer Compatiblity	Comments
ANIONIC SURFACTANTS (DOB 113, HLAS)	Pseudoplastic	med	med	S, X, L	Single Flush	NBR, EPDM, FPM, PTFE	If low concentration this can be Newtonian
ANTI-FOAMING AGENTS	Pseudoplastic	high	med	S, L, A	Single	EPDM, FPM	
DISHWASH LIQUID	Pseudoplastic	med	med	S, X, L, A	Single	FPM, PTFE	If low concentration this can be Newtonian
FABRIC CONDITIONER	Pseudoplastic	low	high	S, X, L	Single	FPM, PTFE	
FATTY ACID	Newtonian	low	high	S, L	Single	FPM, PTFE	
HDL (HEAVY DUTY LAUNDRY DETERGENT)	Pseudoplastic	med	med	S, L	Single Flush	FPM	
CATIONIC SURFACTANTS (ARMEEN, ARQUAD, HEQ)	Newtonian	med	med	S, X, L	Single Flush	FPM, PTFE	
LES (LAURYL ETHER SULPHATE) 27%	Pseudoplastic	low	high	S, X, L, A	Single	FPM	
LES (LAURYL ETHER SULPHATE) 70%	Pseudoplastic	med	med	S, X, L, A	Single Flush	FPM	
LIQUID DETERGENT	Pseudoplastic	med	med	S, X, L	Single	FPM, PTFE	
LYE	Newtonian	low	med	S, L, A	Single Flush	EPDM, PTFE	
NEAT SOAP	Pseudoplastic	low	med	S, L, A	Single Flush	EPDM, PTFE	
NIGRE	Pseudoplastic	low	med	S, L, A	Single Flush	EPDM, PTFE	
NON-IONIC SURFACTANT (SYNPERONIC	Newtonian	med	med	S, X, L	Single Flush	EPDM, FPM, PTFE	
POLYVINYL ALCOHOL	Pseudoplastic	med	med	S, L, A	Single Flush	EPDM, FPM, PTFE	
POLYVINYL PYRROLIDONE	Pseudoplastic	med	med	S, X, L	Single Flush	NBR, EPDM, FPM, PTFE	
SHAMPOO	Pseudoplastic	med	med	S, X, L	Single	FPM, PTFE	
SODIUM POLYACRYLATE (NARLEX)	Newtonian	med	med	S, X, L	Single Flush	EPDM, FPM	
SULPHONIC ACID	Newtonian	med	med	S, X, L, A	Single Flush	FPM, PTFE	

Note: Where single seal is shown for Sealing, it is on the proviso that the pump is cleaned out after each use.

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