

The logo for SPX, with 'SP' in black and 'X' in green, followed by a registered trademark symbol.

SPX[®]

A horizontal teal bar containing the text 'Reduced and Low Fat Spreads' in white, sans-serif font.

Reduced and Low Fat Spreads

A horizontal teal bar containing the text 'White Paper' in white, sans-serif font.

White Paper

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➤ Gerstenberg Schröder®

EXECUTIVE SUMMARY

Food companies today are like other manufacturing businesses not only focusing on the reliability and quality of the food processing equipment but also on various services which the supplier of the processing equipment can deliver. Apart from the efficient processing lines we deliver, we can be a partner from the initial idea or project stage to the final commissioning phase, not to forget the important after-market service. SPX Flow Technology has Gerstenberg Schröder installations in more than 110 countries around the world.

INTRODUCTION TO SPX FLOW TECHNOLOGY

VISION AND COMMITMENT

SPX's Flow Technology segment designs, manufactures and markets process engineering and automation solutions to the dairy, food, beverage, marine, pharmaceutical and personal care industries through its global operations.

We are committed to helping our customers all over the world to improve the performance and profitability of their manufacturing plant and processes. We achieve this by offering a wide range of products and solutions from engineered components to design of complete process plants supported by world-leading applications and development expertise.

We continue to help our customers optimize the performance and profitability of their plant throughout its service life with support services tailored to their individual needs through a coordinated customer service and spare parts network.

CUSTOMER FOCUS

SPX Flow Technology develops, manufactures and installs modern, high efficient and reliable processing lines for the food industry. For the production of crystallized fat products like margarine, butter, spreads and shortenings SPX offers Gerstenberg Schröder solutions which also comprise process lines for emulsified food products such as mayonnaise, sauces and dressings.

INTRODUCTION TO SPREADS

During the last decades, low fat spreads have become very popular in the Western World due to an increasing awareness in the population in respect to minimizing the fat intake. Back in the late 60's, the first margarines with a fat content reduced to approximately 40% were produced. Thus, these products contained 50% of the normal fat content and consisted of only fat, water, salt, emulsifier, flavor, vitamins and preservatives. These products showed poor melting and flavor release properties due to very tight water-in-oil emulsions. This tight emulsion was required in order to have the needed stability.

In general, margarine contains minimum 80% fat, and products with a fat content of less than 80% are called spreads. Low fat spreads have approx. 40% and reduced fat spreads contain typically 60% fat.

In the early 80's, 40% fat products containing very high amounts of milk solids were marketed in the US. These products exhibited, however, very poor microbiological stability. Consequently, these products did not have the 4 to 6 months' shelf life that other spreads have and were therefore withdrawn from the market.

Today, higher quality products containing less fat, usually with milk proteins and stabilizer systems, are being produced with great success in many countries. However, the great demand for low fat food products has been and still is a big challenge for the food industry, since a number of low fat products require development of new technologies and processes.

SPREADS PRODUCTION

In general, like production of ordinary margarine the production of spreads can be divided into the following parts:

- Preparation of the water phase and fat phase
- Emulsion preparation
- Pasteurization
- Crystallization
- Filling
- Remelt

The emulsion consists of a fat phase and a water phase. Minor ingredients such as emulsifiers, salt, preservatives or additives, color, flavor and vitamins are dispersed in the phases according to solubility. Consequently, the raw materials used in the emulsion preparation prior to processing of spreads can be divided into

a fat phase and a water phase. The major ingredients in the fat phase, the fat blend, normally consist of a blend of different fats and oils in order to achieve a defined solid fat content curve. In regard to reduced fat products, the fat phase constitutes less than 60% of the total emulsion. Reduced fat spreads are usually formulated from the same oil blends as those used for the manufacture of the corresponding soft table margarines, however these products contain less than 60% fat.

Minor ingredients such as emulsifier, lecithin, flavor and color are dissolved in the fat phase before emulsification. Lecithin is not used in 40% spreads since it destabilizes the emulsion.

Emulsifiers are surface-active compounds and are used to reduce the interfacial tension between the water and the fat phase, usually monoglycerides or mixtures of mono- and diglycerides. The emulsifier stabilizes the liquid emulsion before crystallization to secure a homogeneous product and to achieve a finely dispersed and stable water distribution in order to improve the microbiological keeping properties in the spreads.

Fat-soluble flavor and color, butter flavor and β -carotene, respectively, are added to achieve products which taste and look like butter. In addition, β -carotene has pro-vitamin A activity.

For reduced and low fat spreads, the water phase has a great influence on the finished product in regard to taste and mouth-feel. It mainly consists of water in which the minor ingredients are dissolved. Apart from salt and preservative, whey powder, skimmed milk powder or other types of milk can be added. Due to the high water content, a stabilizer system is needed in the case of spreads in order to have the necessary stability in the final crystallized product. Water-soluble flavor and color can also be added, but are primarily used in low fat spreads.

Salt is added primarily to improve taste, but also to prevent growth of micro-organisms. In frying margarine, salt helps to prevent spattering.

Preservatives often used in reduced fat spreads are benzoates and sorbates. They are most active at a pH around 4.5, which makes the advantage of adding them doubtful due to the fact that pH in low fat margarine emulsions is often close to neutral.

Milk proteins have an o/w emulsifying effect, which means that they work against the w/o emulsifier system of the margarine or spread and thus de-stabilise the margarine emulsion. However,

this enhances the flavour release and thus milk proteins are added to the emulsion when producing spreads to influence the taste.

Stabilizers can be added in order to make the low fat emulsion more stable. There is a large variety of stabilizers, such as hydrocolloids, on the market. The water binding capacity and organoleptic properties have to be considered when choosing stabilizer or stabilizer systems.

Alginates, pectin and carrageenans have a good water binding effect and gives stable emulsions. These stabilizers are today widely used either alone or as mixtures.

In the case of low fat spreads, the water phase and the oil should have similar temperature and should be combined slowly when forming the emulsion. Additionally, it is very important that the emulsion is properly agitated to ensure homogeneity. However,

care should be taken not to incorporate air during emulsification. SPX Flow Technology has developed special tanks to fulfil these demands. Prior to entering the crystallization equipment, the emulsion is pasteurized, preferably in a scraped surface heat exchanger (SSHE).

Low fat emulsions have been found to be sensitive to in-line pressure and cooling rate. If too extensive chilling takes place early in the process, the shearing forces might become too large and the emulsion might break. Therefore, low fat products should be produced by high-liquid, low SFC profile blends to minimize this problem. Usually a lower throughput is used when producing low fat spreads than when producing corresponding 80% margarine.

Formulation A represents a 40% fat spread without protein and without stabilizer, whereas formulation B shows a 40% fat spread containing protein and stabilizer.

RECIPES

		FORMULATION A, % OF THE EMULSION	FORMULATION B, % OF THE EMULSION
FAT PHASE	EMULSIFIER(S)	0.5-1.5	0.5-1.5
	B-CAROTENE	4 PPM	4 PPM
	FLAVOR	0.15	0.15
FAT BLEND	30 PARTS INTERESTIFIED BLEND OR HYDROGENATED OIL 41°/42°C	UP TO 40%	UP TO 40%
	70 PARTS LIQUID VEGETABLE OIL		
WATER PHASE	WATER	UP TO 60%	UP TO 60%
	SALT	0.5-2	0.5-2
	FLAVOR	0.02	0.02
	WHEY POWDER	-	0.5-1.5
	STABILIZER	-	0.5-2

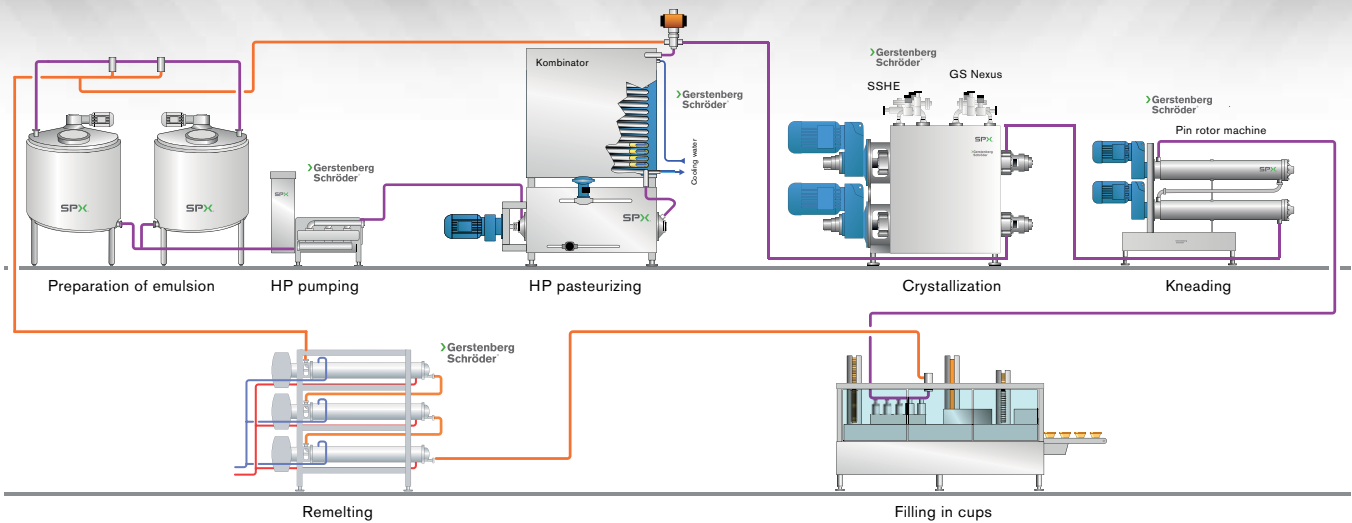
However, depending on the composition of the emulsion and especially the water phase, low fat emulsions can be more or less stable. Stable, viscous emulsions are easy to crystallize. Relatively low cooling temperature can be applied and the product can be produced like normal table margarine.

In most cases when producing low fat spreads, a w/o emulsion is made from the beginning, but if the composition is such that it gives an unstable emulsion, it can be an advantage to start with an o/w emulsion. If an o/w emulsion is made from the beginning, it is necessary to make a phase inversion by the inverter during the crystallization process. The inverter has to be placed after the

first chilling tube in order to make the phase inversion before the emulsion has become too crystallized.

Typically the emulsion is continuously pumped from the buffer tank through either a plate heat exchanger (PHE), a low pressure SSHE, the GS Consistator® or high pressure SSHE, the GS Kombinator, for pasteurization prior to entering the crystallization line.

For some very stable low fat emulsions the PHE can be used for pasteurization. For the low fat versions for which the emulsion is expected to exhibit a relatively high viscosity and is specifically sensitive to shear and for heat-sensible emulsions



High pressure pasteurization solution with GS Kombinator 250 SHCW.

(e.g. emulsions with high protein content), the GS Consistator® system as a low pressure solution or the GS Kombinator 250 SHCW as a high pressure solution is recommended as shown in the process drawing.

The pasteurization process has several advantages. It ensures inhibition of bacterial growth and growth of other micro-organisms and thus improves the microbiological stability of the emulsion. Pasteurization of only the water phase is a possibility, but pasteurization of the complete emulsion is preferred since the pasteurization process of the emulsion will minimise the residence time from pasteurized product to filling or packing of final product. Also, the product is treated in an in-line process from pasteurization to filling or packing of the final product and pasteurization of any rework material is ensured when the complete emulsion is pasteurized.



GS Kombinator 250 SHCW for high pressure pasteurization.

In addition, pasteurization of the complete emulsion ensures that the emulsion is fed to the crystallization line at a constant temperature achieving constant processing parameters, product temperatures and product texture. Furthermore, occurrence of pre-crystallized emulsion fed to the crystallization equipment is prevented when the emulsion is properly pasteurized and fed to the high pressure pump at a temperature 5-10°C higher than the melting point of the fat phase.

A typical pasteurization process will after preparation of the emulsion at 45-55°C include a heating and holding sequence of the emulsion at 75-85°C for 16 sec. and subsequently a cooling process to a temperature of 45-55°C. The end temperature depends on the melting point of the fat phase: the higher the melting point, the higher the temperature.

The emulsion is pumped to the crystallization line by means of a high pressure plunger pump (HPP). The crystallization line for the production of margarine and related products typically consists of a high pressure SSHE which is cooled by ammonia or Freon type cooling media. Pin rotor machine(s) and/or intermediate crystallizers are often included in the line in order to add extra kneading intensity and if placed at the end of the line before the cup filler, a correct filling consistency is ensured.

The heart of the crystallization line is the high pressure SSHE, the GS Nexus, the GS Kombinator or the GS Perfector, in which the warm emulsion is super-cooled and crystallized on the inner surface of the chilling tube. The emulsion is efficiently scraped off by the rotating scrapers, thus the emulsion is chilled



SSHE units from the GS brand: GS Nexus and GS Kombinator.

and kneaded simultaneously. When the fat in the emulsion crystallizes, the fat crystals form a three-dimensional network entrapping the water droplets and the liquid oil, resulting in products with properties of plastic semi-solid nature.

The crystallization process, the processing conditions and the processing parameters have a great influence on the characteristics of the final spread product. When designing a crystallization line, it is important to identify the characteristics of the products planned to be manufactured on the line. To secure the investment for the future, flexibility of the line as well as individually controllable processing parameters are necessary, since the range of products of interest might change with time as well as raw materials.

Typically, a spread line is running at lower capacity than a corresponding 80% fat margarine; the line could be decreased to 50% of the capacity rate at which an 80% product is being produced.

The configuration of the process differs from producer to producer but often a cooling to pin to cooling or cooling to pin configuration is used. The chilling and kneading intensity in the SSHE and the pin rotor machine, respectively, depends on the type of product. As a general rule, less intensive chilling is applied when especially low fat spreads are made. The residence time in the pin rotor machine varies unfortunately also from spread to spread but 1-2 minutes is a normal interval.

When the product leaves the last chilling section or pin rotor machine it is ready for filling. The filling temperature is normally higher for low fat products than for the corresponding 80% fat products since the emulsion is more viscous. If the filling temperature is too low, the final product may become crumbly with water leakage as it is filled or later spread on bread.

If the product at filling is out of scope in regard to the specifications, it will be diverted to the remelting system, melted and added to the buffer tank for re-processing. Different remelting systems are available but the most used systems are PHE or low pressure SSHE, e.g. the Consistator®.

EVALUATION

In regard to reduced fat and low fat spreads, these products have to exhibit the same characteristics as traditional soft table margarine and other 80% fat spreads. In other words, the eating properties should be similar to those of full fat margarines in terms of mouth-feel and flavour release. In addition, the products should be spreadable directly from the refrigerator.

The stability of the samples can be described by a spreadability test. This test involves spreading of the sample with a knife on cardboard, and the following rating system can be used:

- **5 points:** describes a highly stable and very smooth sample.
- **4 points:** describes a stable sample that tends to separate when worked intensively.
- **3 points:** describes a sample that separates when worked.
- **2 points:** describes a sample that separates immediately.
- **1 point:** describes a sample that separates during processing - free water is visible.

Water droplet size and distribution can be analyzed by Nuclear Magnetic Resonance, NMR, using Minispec from Bruker, Germany. The most important parameter in characterizing any emulsion is the size distribution. Two emulsions may have the same average droplet size and yet exhibit quite dissimilar behavior because of differences in their distribution of diameters. Stability of the emulsion is one of the phenomena influenced by both relative size and size distribution. Size is an individual droplet property, but the property of one droplet is not an interesting value in the overall emulsion evaluation. The real interest is the entire size distribution of the emulsion.

SUMMARY

There is no doubt that reduced and low fat spreads are going to stay on the market in future. However, further developments concerning stabilizer systems, emulsifier systems and perhaps processing are still of interest in order to produce even better reduced and low fat spreads which have the same characteristics as full fat spreads in regard to use, taste, mouth-feel and keeping properties.



ABOUT SPX

Based in Charlotte, North Carolina, SPX Corporation (NYSE: SPW) is a global Fortune 500 multi-industry manufacturing leader. For more information, please visit www.spx.com.

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