TECHNICAL BULLETIN

Homogenizer Operation

IN UHT PLANTS

When considering equipment used for processing milk at ultra high temperatures (UHT), one should recognize that the homogenizer is an important part of the system. The homogenizer reduces the size of the fat globules in the milk and prevents creaming of the butterfat. In 1900, long before modern UHT systems, Auguste Gaulin used a homogenizer on bottled, sterilized milk to demonstrate that homogenization could produce a long-shelf-life product able to be kept, for example, on ships over long voyages.

This report will review the operating requirements of the homogenizer in processing UHT milk, and UHT systems will not be described in detail here. However, it is beneficial to review some different UHT methods in very general terms. UHT heating is used to produce an aseptic product that has a long shelf life. Ultra high temperatures and aseptic packaging systems are used for a variety of products such as milk, juices, sauces, creams, ice cream mix, desserts, diced fruit, soups and purees. In general, UHT milk is milk that has been heated to 132°C (270°F) for not less than 1 second and then aseptically packaged. These are the minimum processing conditions. Usually, UHT milk is processed at 130-150°C (266-302°F) with 2 to 8 seconds holding time[1,2].

There are two basic heating arrangements used for milk, **direct and indirect heating**:

1. **Direct heating**: involves heating with culinary steam followed by a vacuum flash cooling to remove added condensate and odors. There are different ways to do this.

   a. Injection: steam is sprayed into the milk in a mixing chamber.

   b. Infusion: milk is sprayed into a steam environment.

      (1) Atomizing the milk into fine droplets and injecting the droplets into the steam.

      (2) Laminar, free-falling film: product falls through a steam chamber as a thin, laminar, free-falling film.

2. **Indirect heating**: "...milk is heated through a heat-conducting barrier, usually stainless steel, which separates the heating agent from the milk."[2] Some examples of indirect heating methods are plate heat exchangers, single tube-in-tube systems and multiple tube-in-tube systems.

Dairy products usually use heating by injection, infusion, tubular heat exchangers or plate heat exchangers. The location of the homogenizer in the process is dictated by the system used (as recommended by the manufacturer of each system). For injection and infusion methods the homogenizer is usually located in the aseptic section of the system, after the heater and hold tube. A double-packing plunger design, providing a sterile barrier, is required on the homogenizer to avoid contaminating the product by exposure of the working area of the plunger to the environment. For laminar, free-falling film the homogenizer is located before the heating section. For indirect heating the homogenizer is usually located in the non-aseptic section of the system before the heater. However, in tubular heat exchangers the homogenizer and one homogenizing valve are located before the heater, and a second aseptic homogenizing valve is located after the heater and cooler. This second homogenizing valve would have a steam barrier (or any other sterilizing medium) between the valve body and actuator.

As stated above, the location of the homogenizer varies with each system, but in the UHT process there may be an advantage to homogenizing after heating.

"Homogenization may be carried out before or after UHT heating. If the latter arrangement is adopted, homogenization will cost more, since the process had to be carried out aseptically. There is, however an advantge in homogenizing after UHT heating, since it prevents or reverses protein—protein and fat globule—protein aggregation. It also retards the formation of sediment of heat precipitated proteins."[3]

Also, from another information source it is stated that…"it is advantageous to homogenize the product after sterilization, since this order provides added heat stability to the protein system."4 Whether or not the homogenizer is before or after the heaters, the milk is homogenized in the same temperature range, usually 70 - 80°C (158 -185°F). Also, in either location the homogenizer is sterilized with the rest of the system and, therefore, experiences high temperatures during sterilization and cleaning. Thus, the homogenizer components must be compatible with high temperatures regardless of its location.

The purpose of homogenization is to reduce fat globule size in the milk; therefore, it is important to discuss the globule size required for the desired shelf life of the milk product. Obviously, a smaller average globule diameter means a lower rate of fat creaming. The mean globule diameter produced will depend on the homogenizing pressure used and geometry of the homogenizing valve. The globule size is also dependent on viscosity of the fat (lower viscosity is better), the source of the milk (season of the year) and the percentage of fat.

The shelf life required for the milk determines what homogenizing pressure should be used. The following table gives the desired shelf life, the average fat globule diameter needed, the maximum globule diameter, and the homogenizing pressures necessary to achieve these parameters using the conventional homogenizing valve and the Micro-Gap® homogenizing valve. For this application most

homogenizers are supplied with a two-stage homogenizing valve. The mean diameters are given in values corresponding to determinations done with the spectroturbidity technique (Gaulin Emulsion Quality Analyzer). Other particle-size analysis methods may give different mean diameters, because of the physics and statistics used for the evaluation. The maximum diameters represent the maximum droplet size, as predicted by statistical calculations. These mean diameters are derived from analyses of actual samples prepared by HTST (high temperature short time pasteurization) and by UHT processes.

The operating pressure is the actual pressure drop through the homogenizing valve (the pressure in front of the homogenizing valve minus the pressure after the homogenizing valve). Therefore, any back-pressure should be considered when determining this value. When a two-stage homogenizing valve is used, the second-stage

SHELF LIFE	MICROMETERS D D (MAX)	CONVENTIONAL PRESSURE/PSI (BAR)	MICRO-GAP PRESSURE/PSI (BAR)
10-12 days	.80 3.0	1800-2000 (124-138)	1200-1400 (83-97)
2 weeks	.75 2.5	2000-2200 (138-152)	1400-1500 (97-103)
2 months	.55 1.5	3000-3500 (207-241)	2100-2500 (145-172)
6 months	.40 1.25	3500-4000 (241-276)	2500-3000 (172-207)

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pressure should be 10 to 15% of the total homogenizing pressure.

If these mean diameters are obtained, it does not mean that no creaming will occur. However, with these homogenization conditions creaming will be slight, and most of the surface cream can be readily mixed back into the milk.

References

1. *Aseptic/Extended Shelf Life Processing Handbook* (Wisconsin: APV Crepaco,)

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3. H. G. Kessler, *Food Engineering and Dairy Technology* (Germany: Verlag A. Kessler, 1981) 163.

4. N. P. Wong et al., eds. *Fundamentals of Dairy Chemistry 3* (New York: Van Nostrand Reinhold, 1988) 755.

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ISSUED: 02/2009 3086-01-08-2008-US