ADPI Intelligence
Volume II
Issue 1

Production of Low Spore Milk Powder - July 2014

Exported milk powder is often purchased by customers intending to use the powder in recombining plants to produce UHT dairy products for the local market. These customers demand "low spore" milk powders, as residual spores and the enzymes within them may cause product defects such as off flavors and gelation – all leading to product spoilage.

Customer's specifications typically include limits for Thermophilic (113F to 158F) spores <1,000 cfu/g, but tighter specifications with maximum limits of <500 cfu/g, <100 cfu/g and even <50 cfu/g are becoming more and more common. Additionally, customers have also started to add specifications for Mesophilic (68F to 113F) spores.

How can a milk powder manufacturer produce and supply product that meets or exceeds their customer's spore specifications?

It starts with the raw materials - the raw milk off the farm and lactose / milk permeate used in production of Skim Milk Powder (SMP) and Whole Milk Powder (WMP). The maximum target for raw milk Thermophilic and Mesophilic spore counts should be <10 cfu/ml with a goal of typically <5 cfu/ml. Work with your milk producers and field staff to ensure that good GMP practices are followed in the barns and milk sheds. Similarly, the lactose / milk permeate ingredients used to protein standardize SMP and WMP need to be low spore - <100 cfu/g.

In the plant, spores will develop and grow in parts of the plant where the process parameters are within the critical temperature range (68F to 158F) and where biofilm forms. Biofilm forms on heating surfaces such as regenerative plate and tubular heat exchangers, and on equipment with holdup volumes, large surfaces and low flow such as separators and within the evaporator. The biofilm develops over time, so there's a lag period before the spore count starts to increase; but once it does, the growth is exponential. It is important to note, that the development of the biofilm and thus spore growth will happen, so the applied process techniques first aim to delay and interrupt the biofilm formation / spore growth and then kill or remove any developed spores.

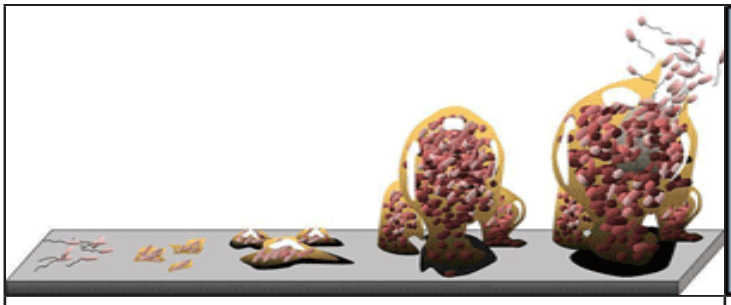

Fig 1 – Biofilm Formation – Phases: 1) Attachment, 2) Maturation, 3) Dispersion

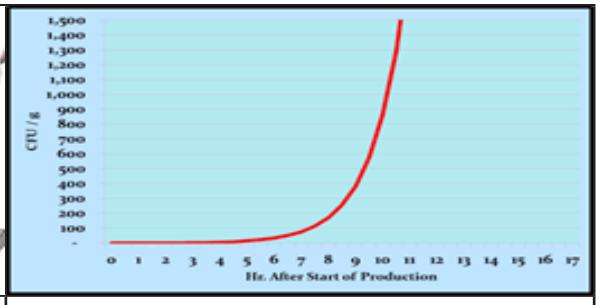

Fig 2 – Typical Spore Growth Curve

A typical US Nonfat Dry Milk (NDM) powder plant is designed for energy efficiency with a regenerative pre-heater, vapor and steam tubular heaters on the evaporator, and hot milk separator(s). These are all areas that where biofilms will develop.

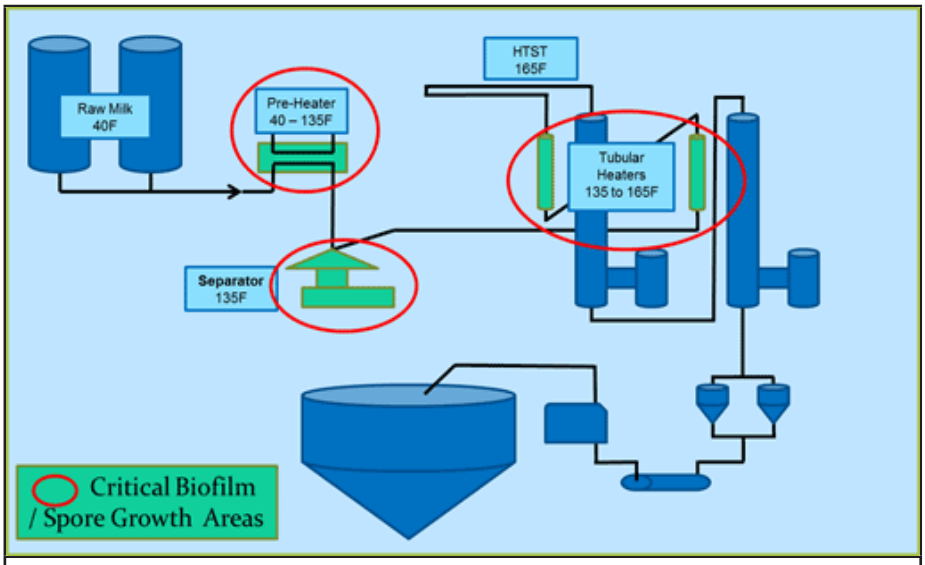

Fig 3 – Typical US NDM / SMP plant

In designing a low spore modified plant, the hot milk separator(s) are replaced with cold milk separators to stay below the critical temperature range and dual regenerative heat exchangers are installed allowing for switching after 9-11 hours of operation and thus avoiding the steep part of the growth curve.

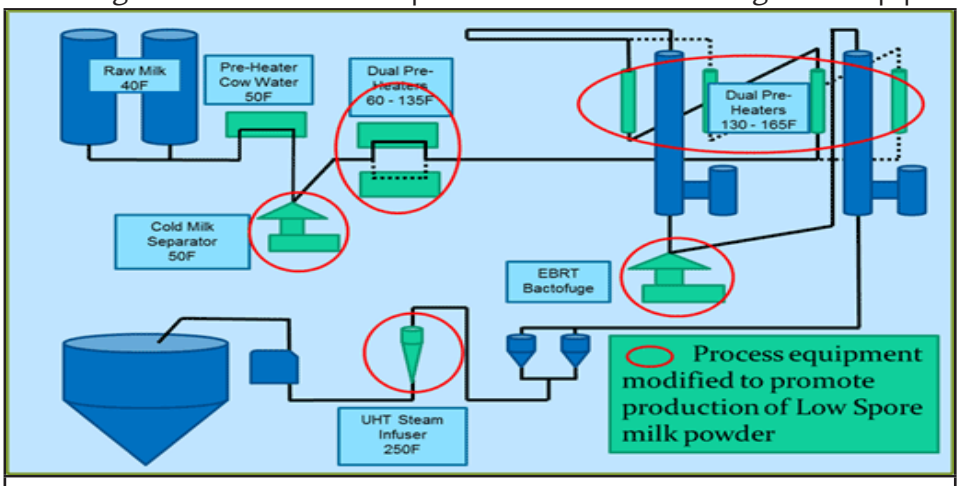

Fig 4 – Low Spore Designed Modified NDM / SMP plant

Additional available process technologies include:

1) Mid-wash of the all wet process equipment: separators, heat exchangers and evaporator
2) UHT treatment – designed to kill any developed cells and spore – of the evaporator concentrate prior to drying
3) Bactofugation (Evaporator Bacterial Removal Technology) within the evaporator to remove any developed spores from the milk stream
4) The application of multiple evaporators to reduce the process time and avoid the log growth curve.

Besides excellent quality raw milk and plant equipment designed for low spore production, the plant must be operated and managed in such a manner that production of low spore powder is promoted. This includes maintaining effective and efficient CIP systems, using a Preventative Maintenance program which includes routine gasket replacement to keep the plant in top operational shape, and maintaining production schedules that avoid excessively long production runs even occasionally. Excessive, long production runs will produce high spore count powder, which then in turn will contaminate the whole dry side of the plant from the bag houses through the powder storage silos to the packaging machine.

In summary, to produce Low Spore milk powder, you need:

a) High quality ingredients – raw milk and Lactose / Milk Permeate
b) Process equipment designed for low spore powder production
c) Excellent CIP and active Preventative Maintenance programs
d) Operational and management excellence - low spore commitment and mindset

The author Bjorn Sorensen is a member of the ADPI Center of Excellence as well as the owner of Dairy Industry Consultants and an associate engineer with Pacific Process US. He has over 35 years of experience in dairy product production, plant operations and technology. With his past positions at HOCO (Arla Foods), Vermont Whey, Golden Cheese, Glanbia Foods, Darigold and Land O'Lakes, Mr. Sorensen has led the expansion of several plants including green field sites, the development of new product lines and streamlining manufacturing processes using lean manufacturing principles. In his current position, Mr. Sorensen provides consulting services specializing in process technology, business plan development, management, staff training and product mix optimization.

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