# MILK PASTEURIZATION WITH GEOTHERMAL ENERGY

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## INTRODUCTION

Milk pasteurization with geothermal energy has been viewed by the author in two locations in the world: Klamath Falls, Oregon and Oradea, Romania. The former is no longer in operation; but, the latter has been operating since 1981. A third dairy using geothermal energy has been reported in Iceland (Thorhallsson, 1988) which was established in 1930 to pasteurize milk and evaporate whey to produce brown whey cheese. This dairy merged with another co-op dairy in 1938 and was shut down. A description of the first two of these installations is deemed important, as there is potential for similar installation in other geothermal locations. These two reported savings in energy costs by using geothermal heat; the Klamath Falls installation producing 7,600 L/day (2,000 gals/day) for a savings of $12,000 per year and the Oradea plant producing 70,000 L/day (18,500 gals/day) (winter) and 200,000 L/day (52,800 gals/day) (summer) for a savings of $120,000 per year (saving 800 TOE - tonnes of oil equivalent).

## KLAMATH FALLS, OREGON

Medo-Bel Creamery, in Klamath Falls, Oregon, is the only creamery in the U.S. known to have used geothermal heat in the milk pasteurization process (Lund, 1976, 1996; Belcastro, 1979). The geothermal well, located at the corner of Spring and Esplanade streets, was first drilled in 1945 by the Lost River Dairy. The well was designed by a New York engineering firm to insure maximum heat at the wellhead with a minimum of pumping time. The facility was closed down about 10 years ago due to financial problems.

The 233-m deep (765-ft) well was cased to 109 m (358 ft) with 20-cm (8-inch) diameter casing and to 149 m (489 ft) with 15-cm (6-inch) diameter casing. The original well had an artesian flow of around 1.9 L/s (30 gpm) at the surface of 82°C (180°F) water. Based on a recent profile (1974), the well water varied from 80°C (177°F) at the surface to 98°C (208°F) at a depth of 137 m (450 ft), with the artesian surface at one meter (three feet) below the ground level. The geothermal hot water was pumped directly from the well to the building approximately 15 m (50 ft) away through an overhead line. This overhead line allowed easy maintenance and prevented freezing during cold weather since it was self-draining.

Rather than using downhole heat exchangers as is common in Klamath Falls, the water was used directly in air handling units in each room and in the plate-type pasteurizing heat exchanger (Figure 1). The used hot water was then emptied into the storm sewer where it was later used by industry in the south end of the town for cold weather concreting and space heating.

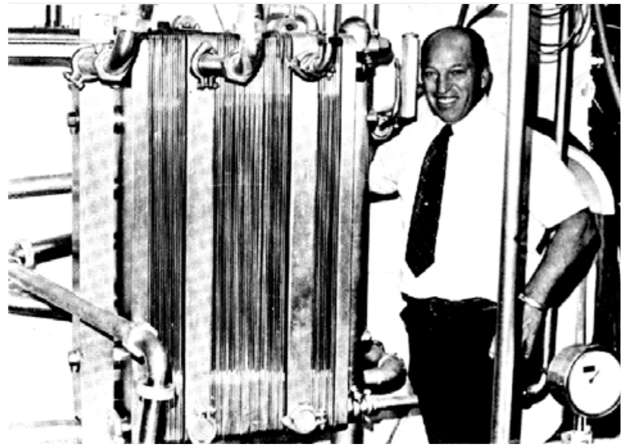

**Figure 1. Owner, Elmer Belcastro, standing next to the plate heat exchanger (pasteurizer).**

The pasteurization process involved pumping up to 6.3 L/s (100 gpm) of geothermal fluid into the building and through a short-time pasteurizer (Cherry Burrell plate heat exchanger of stainless steel construction) (Figure 2). The geothermal water was pumped from the well at 87°C (189°F) into the building and through a three-section plate heat exchanger. The incoming cold milk at 3°C (37°F) was heated by milk coming from the homogenizer in one section of the plate heat exchanger. The milk was then passes to the second section of the plate heat exchanger where the geothermal fluid heated the milk to a minimum temperature of 78°C (172°F) for 15 seconds in the short-time pasteurizer. If the milk temperature dropped below 74°C (165°F), the short-time pasteurizer automatically recirculated the milk until the required exposure as obtained. Once the milk was properly pasteurized, it was passed through the homogenizer and then pumped back through the other side of the first section of the plate heat exchanger where it was cooled to 12°C (54°F) by the incoming cold milk. It was finally chilled to 3°C (37°F) by cold water in the third section of the plate heat exchanger, where the milk went into the cartons with no chance of cook on. This insured both flavor and longer shelf life. As an added bonus, the outgoing heated milk was cooled somewhat by passing it by the incoming cold milk and the cold milk was in turn heated slightly by the outgoing milk. Milk was processed at a rate of 0.84 L/s (800 gal/hr), and a total of 225,000 kg (500,000 lbs) were processed each month. Some steam was necessary in the process to operate equipment; thus, geothermal water was heated by natural gas to obtain the required temperature. Geothermal hot water was also used for other types of cleaning.

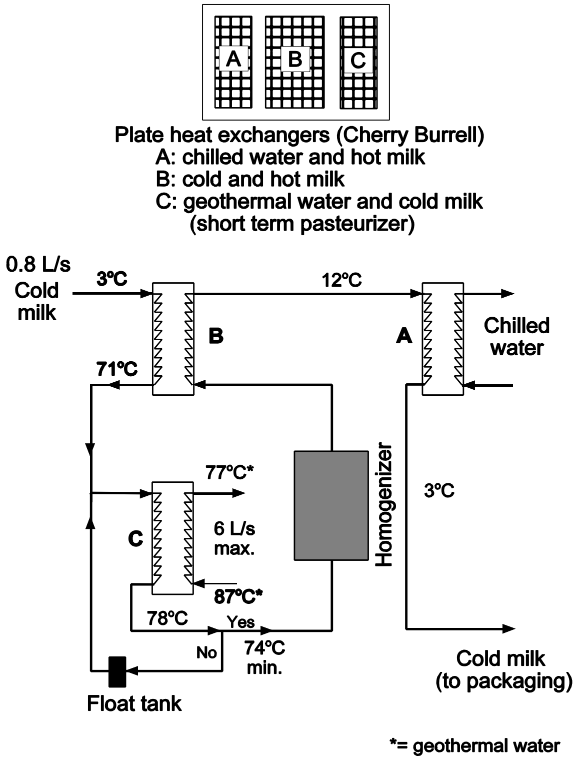


**Figure 2. Medo-Bel milk pasteurization flow diagram.**

In addition to the milk pasteurizing, some batch pasteurizing of ice cream mix was carried out by geothermal heat. A 950-liter (250-gallon) storage tank was used to mix geothermal hot water and process steam to a temperature of 121°C (250°F). This heat was then used to pasteurize the ice cream mix at 63°C (145°F) for 30 minutes. This was the original milk pasteurizing method used at the creamery.

The geothermal water had slightly over 800 mg/L (ppm) dissolved solids of which approximately half were sulfate, a quarter sodium and a tenth silica. The pH of the water was 8.8. Minimum corrosion was evident in the well, requiring the jet pump to be replaced only once in the 30-year period (1974). The original pump was rated at 0.7kW (one hp) and a new pump was rated at 5.6 kW (7.5 hp). The corrosion had also been minimum in the area heaters and did not affect the stainless-steel plate heat exchanger. Corrosion was substantial in the pipelines.

The annual operational cost of the system was negligible. However, the savings amounted to approximately $1,000 per month as compared to conventional energy costs. Geothermal hot water was also used to heat the 2,800 $m^2$ (30,000 $ft^2$) building, which amounted to a substantial savings during the winter months.

## ORADEA, ROMANIA

Oradea, a city of almost half a million people, is located in northwestern Romania next to the Hungarian border. There is considerable use of geothermal energy in the area including at Felix Spa just outside of town, district heating systems for a portion of the city and for the university, greenhouses, a lumber drying facility, swimming pools and pasteurizing all the milk for the city. The district heating systems will be discussed in another article in this issue.

The milk factory shares a well used by the lumber drying facility and to heat 100 apartments and several swimming pools (Figure 3). The 3000-meter (9,800-ft) deep well produces 105° to 110° C (221° to 230°F) water at 30 L/s (480 gpm) - "the best well in town." A total of 6 MWt is produced for these facilities. The timber drying facility uses 0.5 L/s to 1.0 L/s (8 to 16 gpm) to produce 50° C (122°F) air to dry 150 $m^3$ (63,600 board-feet) of lumber in 3 bins (Figure 4) for a period of two weeks to one month for each load. The product is oak which is exported for furniture manufacturing at the rate of about 5,000 $m^3$ (2.1 million board-feet) per year.

**Figure 3. Swimming pool and apartments, Oradea.**

**Figure 4. Timber drying facility, Oradea.**

The milk factory has been using geothermal energy for milk pasteurization since 1981. It supplies all the milk to the city and produces 70,000 L/day (18,500 gal/day) in the winter and 200,000 L/day (52,800 gal/day) in the summer for a savings of about $120,000 per years (800 TOE savings). The raw milk is trucked in daily from surrounding farms (Figure 5). The geothermal fluids is first passed through a series of shell-and-tube heat exchangers which provides secondary water for heating the factory. This secondary water is then passed through plate heat exchangers (Figure 6) to pasteurize the milk. The geothermal fluid is also used to preheat air to produce milk powder. The milk powder requires 300°C (572°F) air for drying (Figure 7). The peak geothermal use for all processes is 17 L/s (270 gpm).

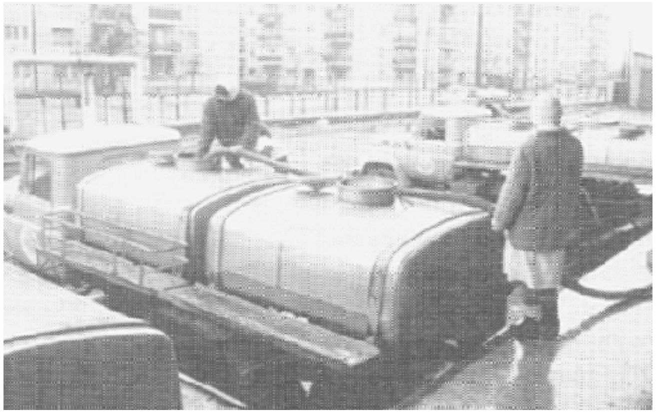

**Figure 5. Milk delivery, Oradea.**

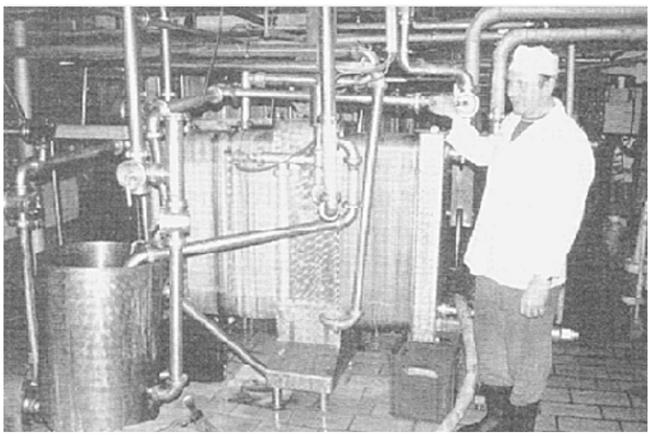

**Figure 6. Plate heat exchanger for milk pasteurization.**

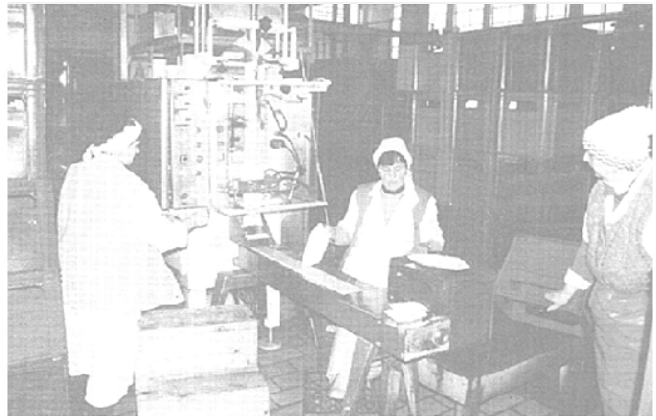

**Figure 7. Powdered milk packaging.**

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