

INDUSTRIAL USES OF GEOTHERMAL ENERGY IN THE USA

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INTRODUCTION

- Industrial applications & agricultural drying
- Few in number in the U.S.
- Large scale operations dominate
 - Gold ore heap leaching
 - Onion dehydration
- Many small scale operations:
 - Milk pasteurization, laundry, beer production, alcohol production and mushroom growing.

ENERGY USE

- Installed capacity = 38 MWt
- Annual energy use = 500 TJ (140 GWh)
- Mainly due to agricultural drying
- Enhanced petroleum recovery using injected geothermal water – NE Wyoming and adjacent states estimated at 8,600 TJ/yr (2,390 GWh) and approx. 250 MWt
 - However, no reliable data available

KLAMATH FALLS GEOTHERMAL BREWERY

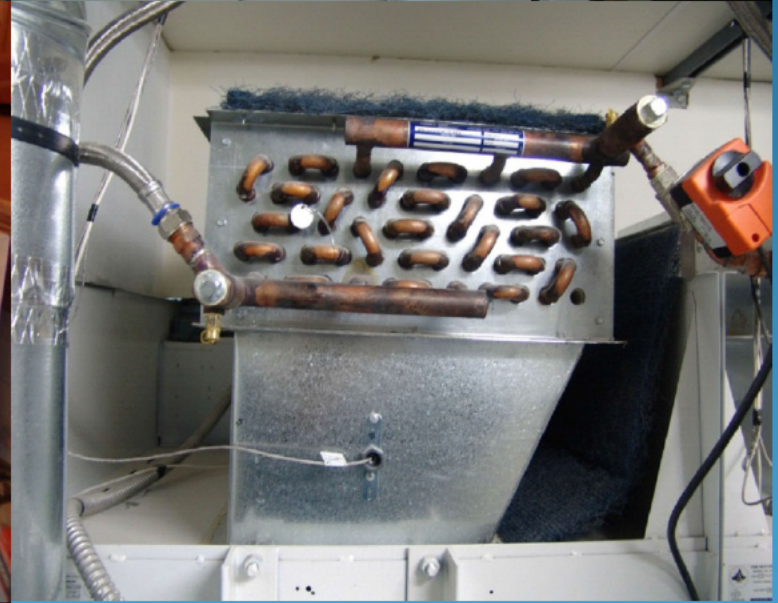
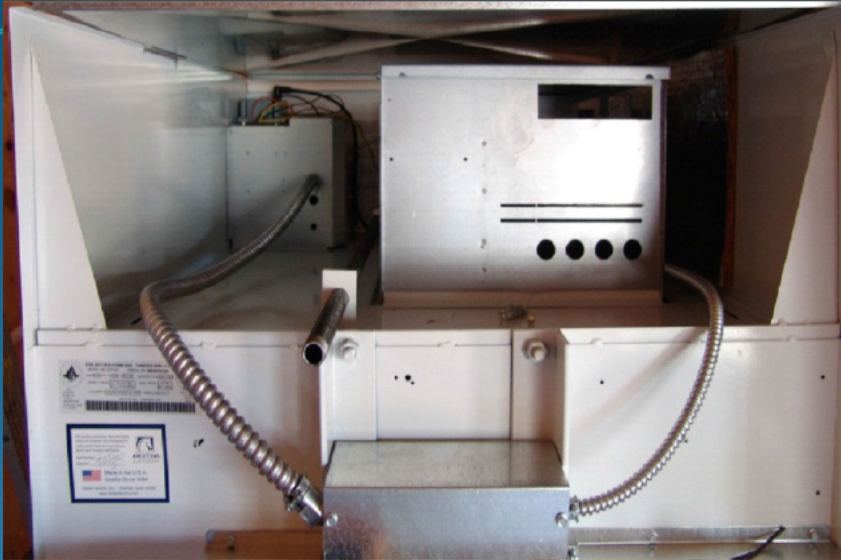


KLAMATH BASIN BREWING CO.

- Replaced the Crater Lake Creamery in 2005
- Now known for making great craft beer.
- The brewery is connected to the city geothermal district heating system
 - Hot water is provided through a heat exchanger for use of hot water in the brewing process, for space heating and for snow melting on the sidewalk
- The brewery uses about 1,700 therms (179 GJ) of geothermal energy a month at a cost of \$1,360 , saving \$1,190 over fossil fuel (peak month usage) – and 430 therms (45 GJ) at a cost of \$344, savings of \$300 (off peak month).

CANBY LAUNDROMAT

- A small community cooperative in northern California (I'SOT) retrofitted gas-fired 55-lb (25 kg) industrial laundry driers to use geothermal water supplied at 150°F (66°C) .
- A plenum was mounted over a larger air-flow vent with a geothermal hot water coil.
- The retrofit average about \$1,800 per drier including the coil, plenum, control valve, fitting and copper supply and return lines.
- Simple payback was under 3 years.



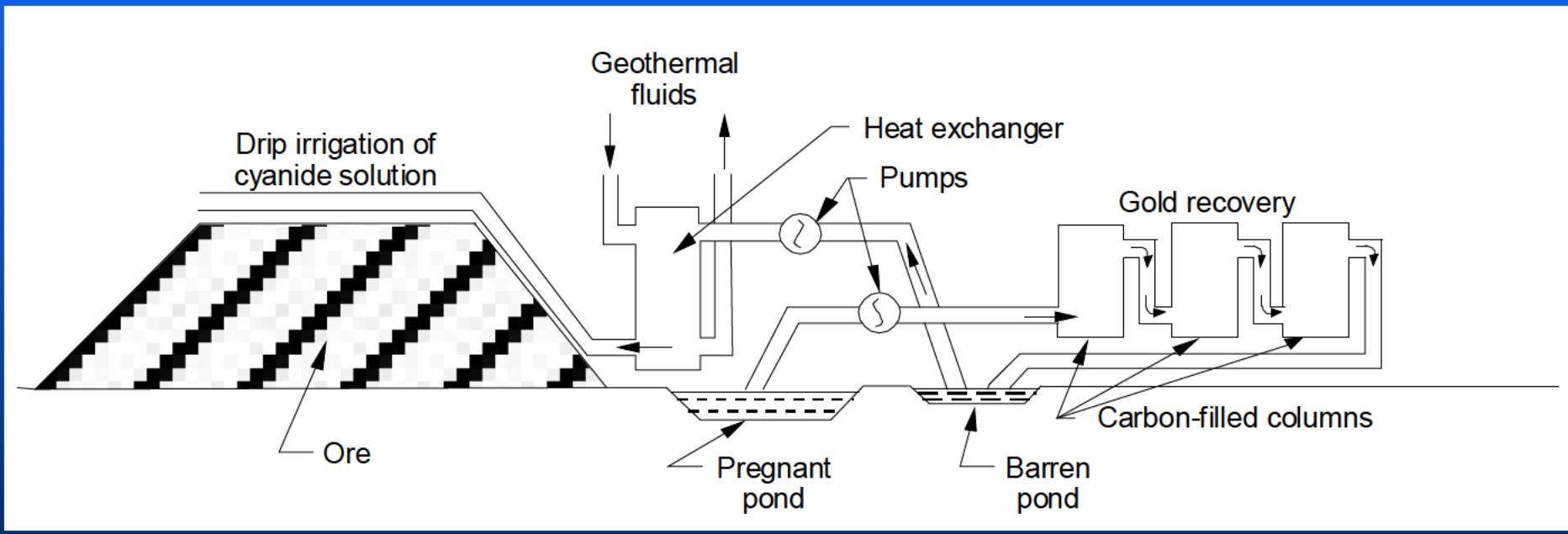
Geothermal heat used in laundry machines – Canby, California

HEAP LEACHING 1

- Used in gold recovery from Nevada mines
- Process consists of dripping a dilute sodium cyanide solution over a crushed ore pile or heap
- The gold, in solution, drains from the heap and extracted by a charcoal process producing a bar of impure gold (doré).
- The cyanide solution is then recycled

HEAP LEACHING 2

- Operation can recover up to 95% of gold
- Also, used for silver extraction
- Under normal circumstances – in Nevada – operation takes place mid-March to late-October (min. production temp. = 4°C - 40°F)
- Using geothermal energy
 - Recovered enhanced by 5 to 17% by accelerating the chemical reaction
 - Year-around operation possible



Heap leaching flow diagram with geothermal

HEAP LEACHING 3

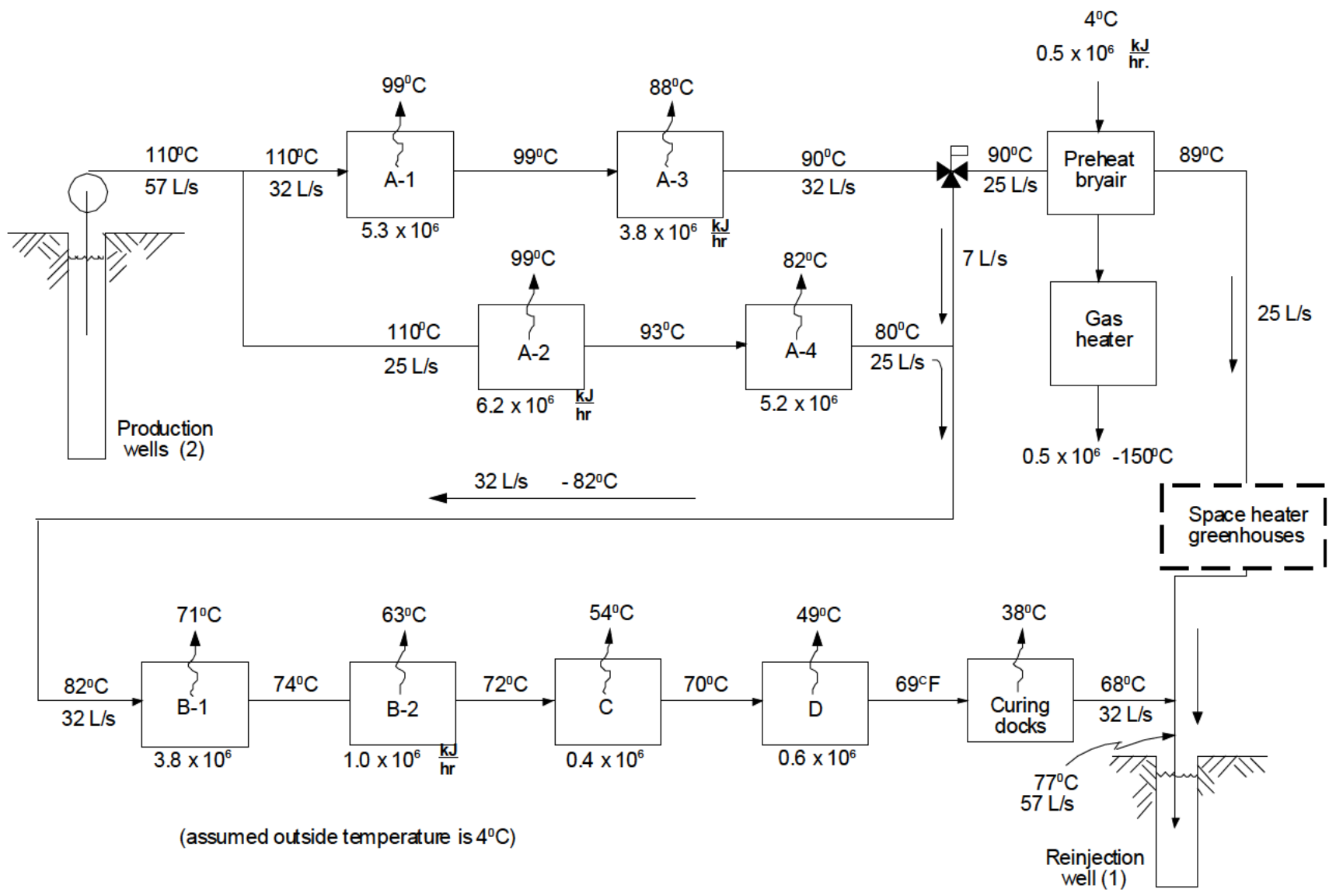
- Two mines in Nevada have used geothermal
- Round Mountain
 - 86,000 tonnes (95,000 tons) of ore/day
 - 1g/tonne (0.035 oz/ton) = 21,000 kg (46,000 lbs) of gold in 2001
 - Geothermal @ 82°C and 69 L/s (180°F and 1,100 gpm)
 - 14.1 MWt and 208 TJ/yr (57 GWh)



Round Mountain, Nevada

AGRICULTURAL DRYING 1

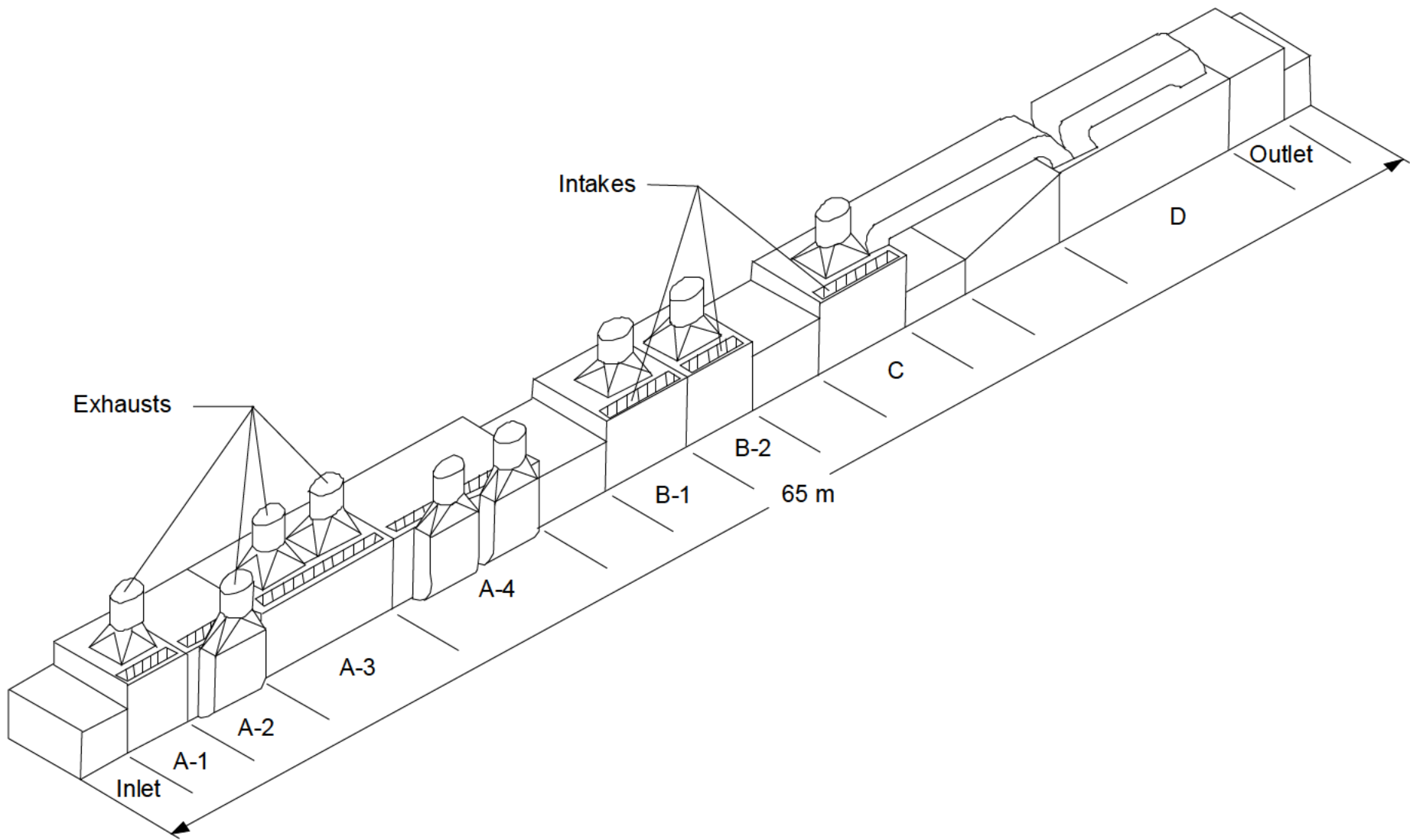
- A large geothermal onion and garlic dehydrator is located in NW Nevada
- This unit can each process 4.5 to 6.8 tonnes (10,000 to 15,000 lbs) of wet onions/hr – drying them from 80% to 5% moisture (output = 0.9 to 1.4 tonnes/hr – 2,000 to 3,000 lbs/hr)
- 35 MJ/kg used (15,000 Btu/dry lb) = 208 TJ/yr (58 GWh) (100 billion Btu/yr) over 150 days period
- Product used in soups, baked goods, salt, & seasoning as powders to slices



(assumed outside temperature is 4°C)

AGRICULTURAL DRYING 2

- Single-line, continuous-belt dryer use
 - 3.8 m (12.5 ft.) wide
 - 58 to 65 m (190 to 215 ft.) long
 - 3 to 4 sections (A to D) – 96 to 74°C (205 to 165°F)
 - Processing 4.5 to 6.8 tonnes/hr (10,000 to 15,000 lbs/hr) of wet onions
 - Using 2,450 m³/hr (86,500 ft³) of air
 - 42 GJ/hr (4.3 million Btu/hr)
 - Onions 5 cm to 2 m (2 in. to 6 ft.) deep
 - Bryair desiccation unit required in final stage





MILK PASTEURIZATION 1

- Medo-Bel Creamery in Klamath Falls, Oregon used geothermal heat in milk pasteurization for about 50 years
- 233-m (765 ft.) deep well @ 87°C @ 6.3 L/s (189°F and 100 gpm)
- Used a 3-section plate heat exchanger
- Minimum temperature needed: 78°C (172°F) for 15 seconds in short term pasteurizer

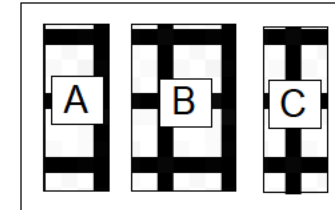
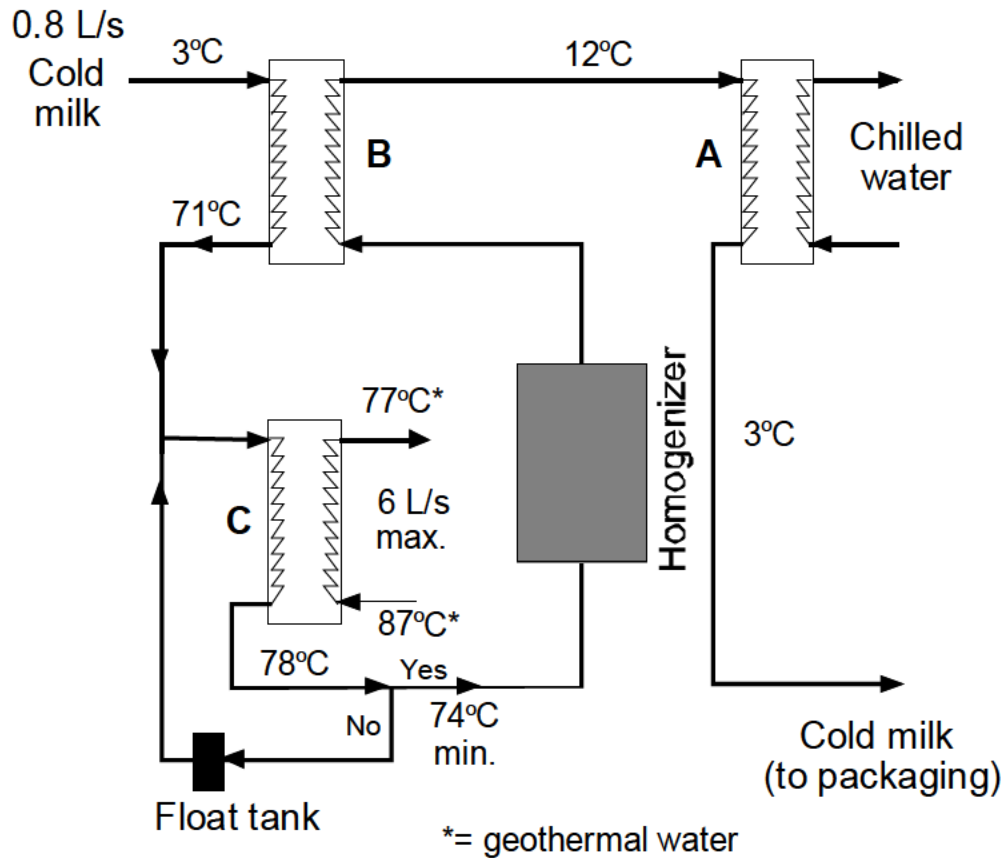
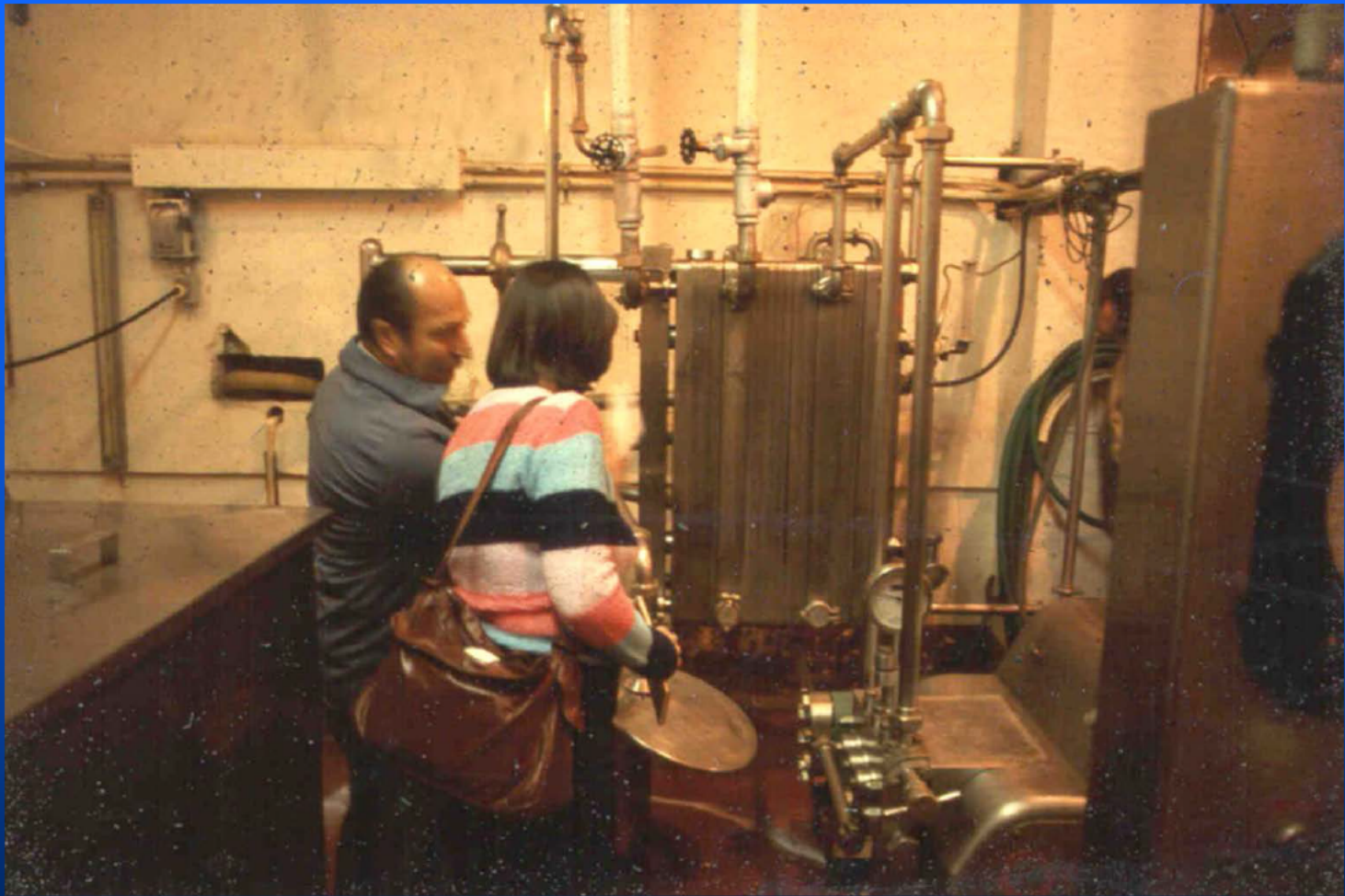


Plate heat exchangers (Cherry Burrell)
 A: chilled water and hot milk
 B: cold and hot milk
 C: geothermal water and cold milk
 (short term pasteurizer)

Medo-Bel pasteurization flow diagram



Medo-Bel Creamery with plate heat exchanger

SUMMARY

- Industrial use dominated by large facilities (onion dehydration, and heap leaching)
- Small industrial uses include: laundries, beer production, mushroom growing, mineral water processing, and an industrial park in Hawaii (experimental work)
- Enhanced petroleum recovery in NE Wyoming using injected geothermal water – no reliable data
- Total as high as 100 MWt and 2,000 TJ/yr (555 GWh) + 250 MWt and 8,600 TJ/yr (2,390 GWh)
- Today 38 MWt and 500 TJ/yr (140 GWh)

THANK YOU

