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ICE AGE

Renewable cooling energy in breweries

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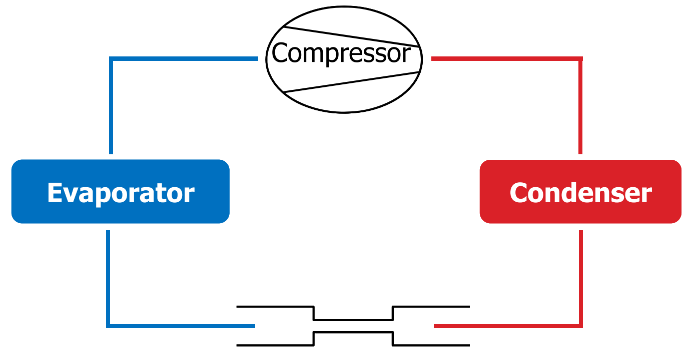
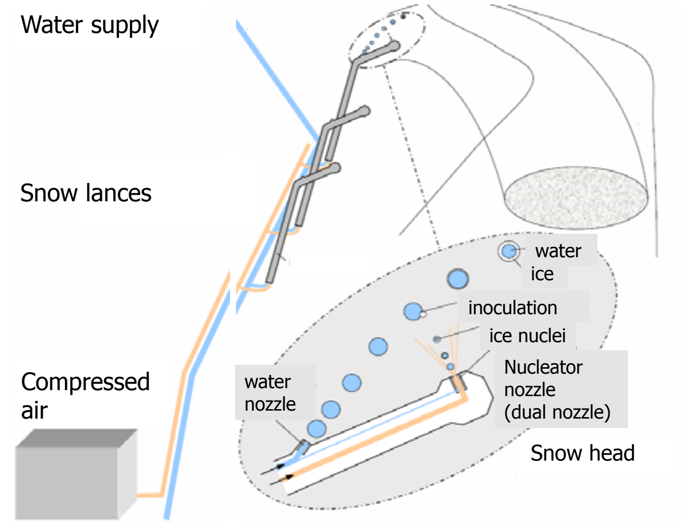
State of the art



Areas, in which cooling is required

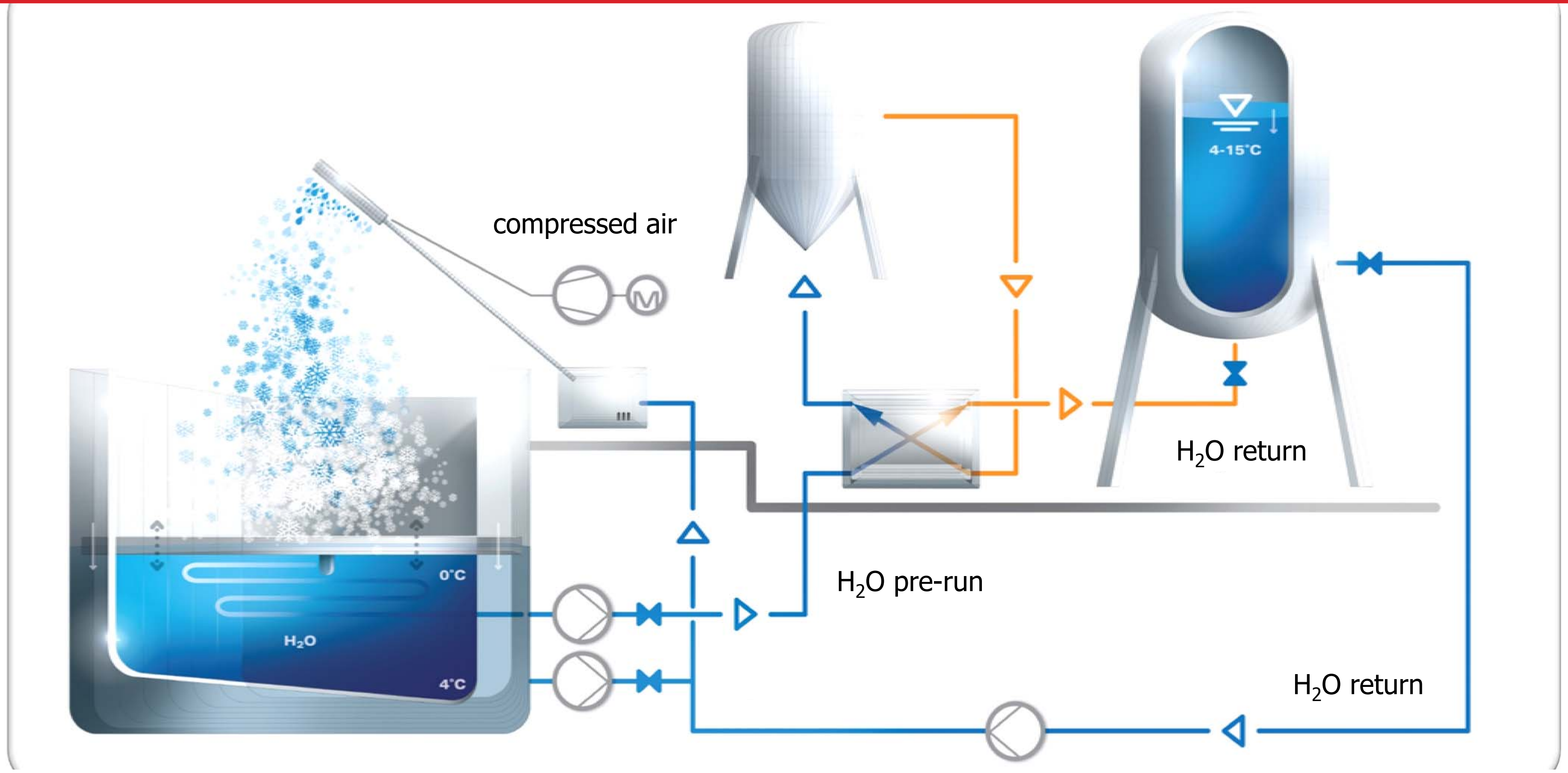
- Hops
- Fermentation
- Ice water
- Storage
- Bright beer tanks
- Space cooling
- Wort cooling
- NH3 pre-cooling
- Glycol pre-cooling
- Condenser cooling (refrigerating machine)

Snow lance



Source: Fa. Bächler, Schweiz

Possible procedure



Key figures of a snow-making system (here 10 snow lances)

1. Water pressure

7.54 L/s water → 27.1 m³/h water
→ 45.2 m³/h snow (600 kg/m³)

7.38 bar increase of pressure
7.50 kW power consumption

2. Compressed air (~ at 29 °F)

Flow rate per snow-making system
→ 45 L/min. → 0.75 L/s
→10 snow lances → 600 L/min

8.0 bar compressed air
4.5 kW power consumption

3. Total energy demand for operating point (at ~ -29 °F, 600 kg/m³)

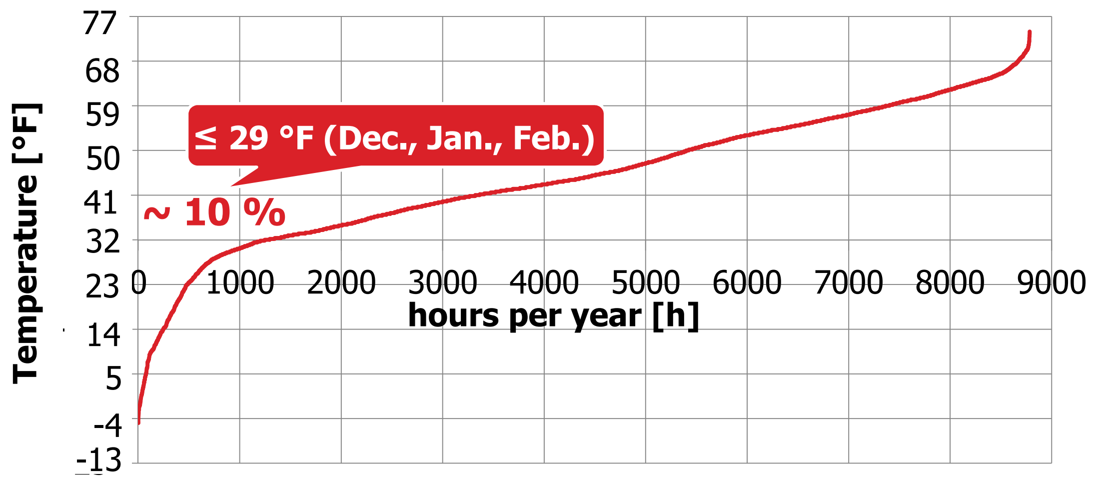
$$\frac{45.2 \text{ m}^3\text{/h of snow}}{7.5 \text{ kW (water)} + 4.5 \text{ kW (air)}} = 3.77 \text{ m}^3 \text{ of snow per kWh,el.}$$

Refrigerating capacity vs. electrical energy

With change of state of aggregation (= with snow)	Usual refrigeration plant
Refrigerating capacity 3.77 m³/kWh, el. x 600 kg/m³ x 335 kJ/kg = 757,770 kJ/kWh, el. → COP = 210.3 i.e. 210 kWh of cold for 1 kWh of electricity	Refrigerating capacity literature value → COP = 3.0 to 4.2 i.e. 4.2 kWh of cold for 1 kWh of electricity

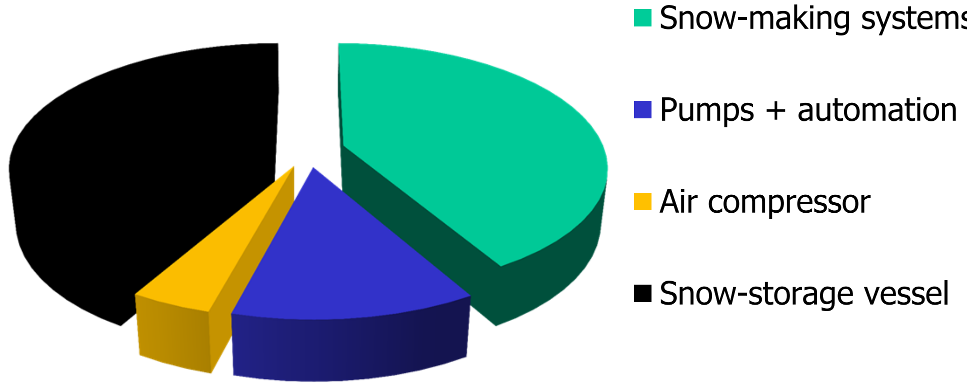
→ 50 – 70 times of the usual refrigeration plant

Wet bulb temperature for snow production [°F]



In 2012 approximately 10 % of the hourly values in South Germany were ≤ 29 °F, which corresponds to the wet bulb temperature required for a snow lance.

Investment costs



Other scenarios

- Instead of 10 snow-making systems only 5 snow-making systems, i.e. double snow-producing time
- Instead of 10 snow-making systems only 2 snow-making systems,
- i.e. 5-fold snow-producing time
- Cooling of the water via evaporation for a faster production of snow

ZIEMANN CIMC ENRIC