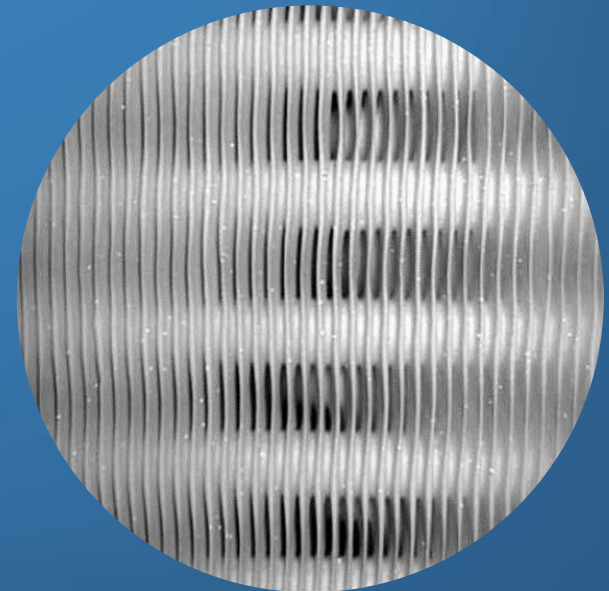
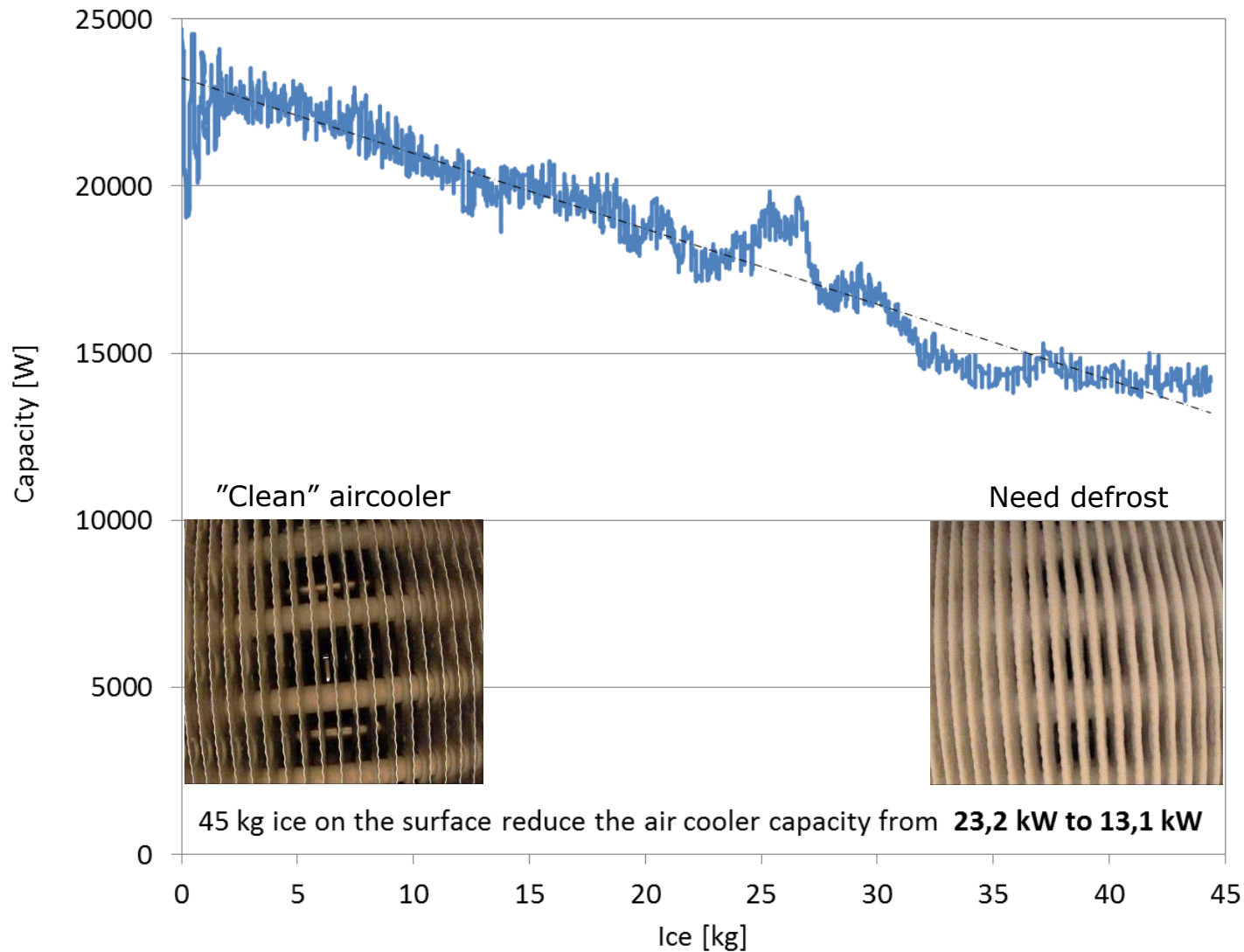


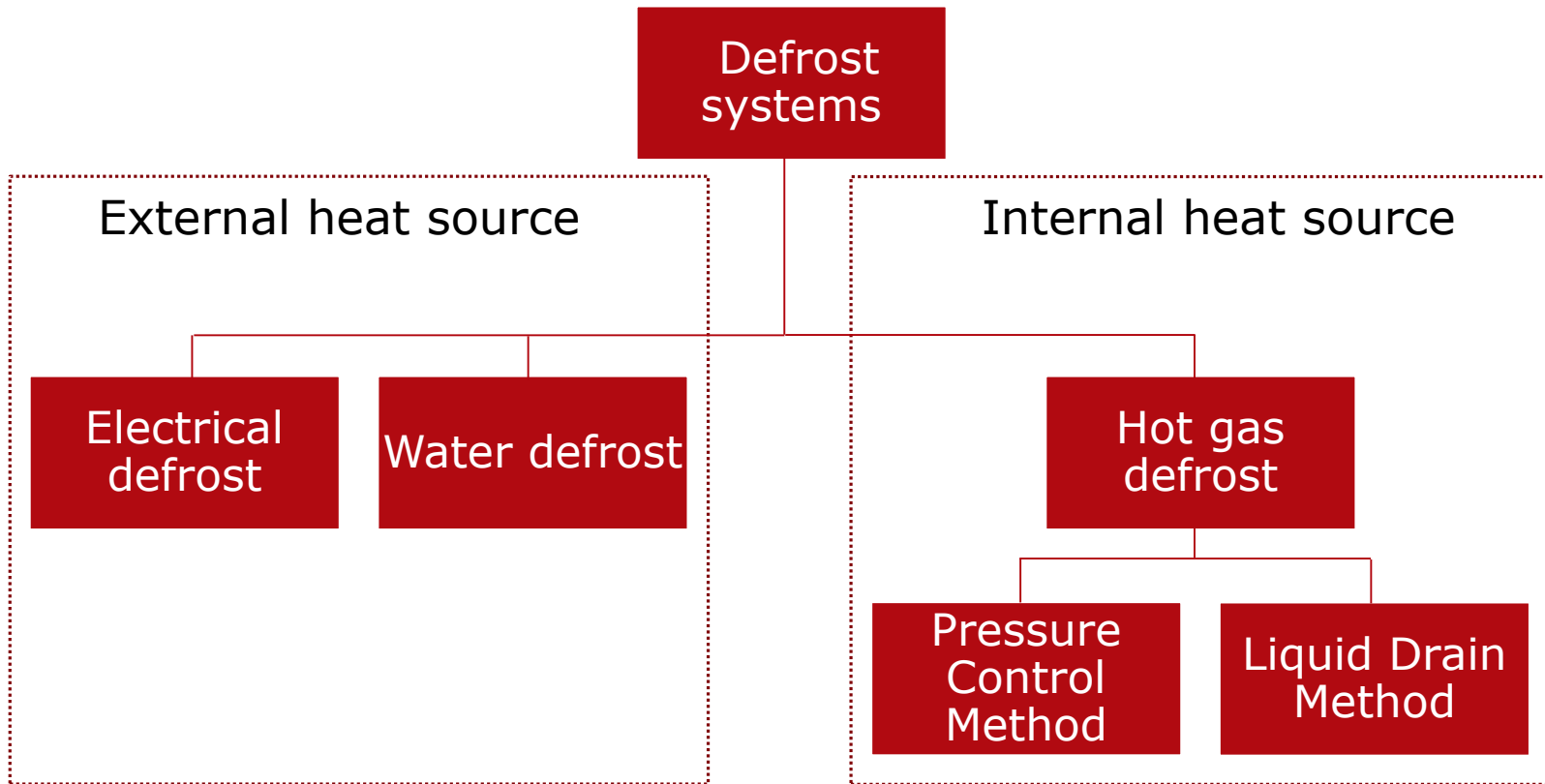
Hot gas defrosting techniques



Air cooler performance vs. ice build-up on surface

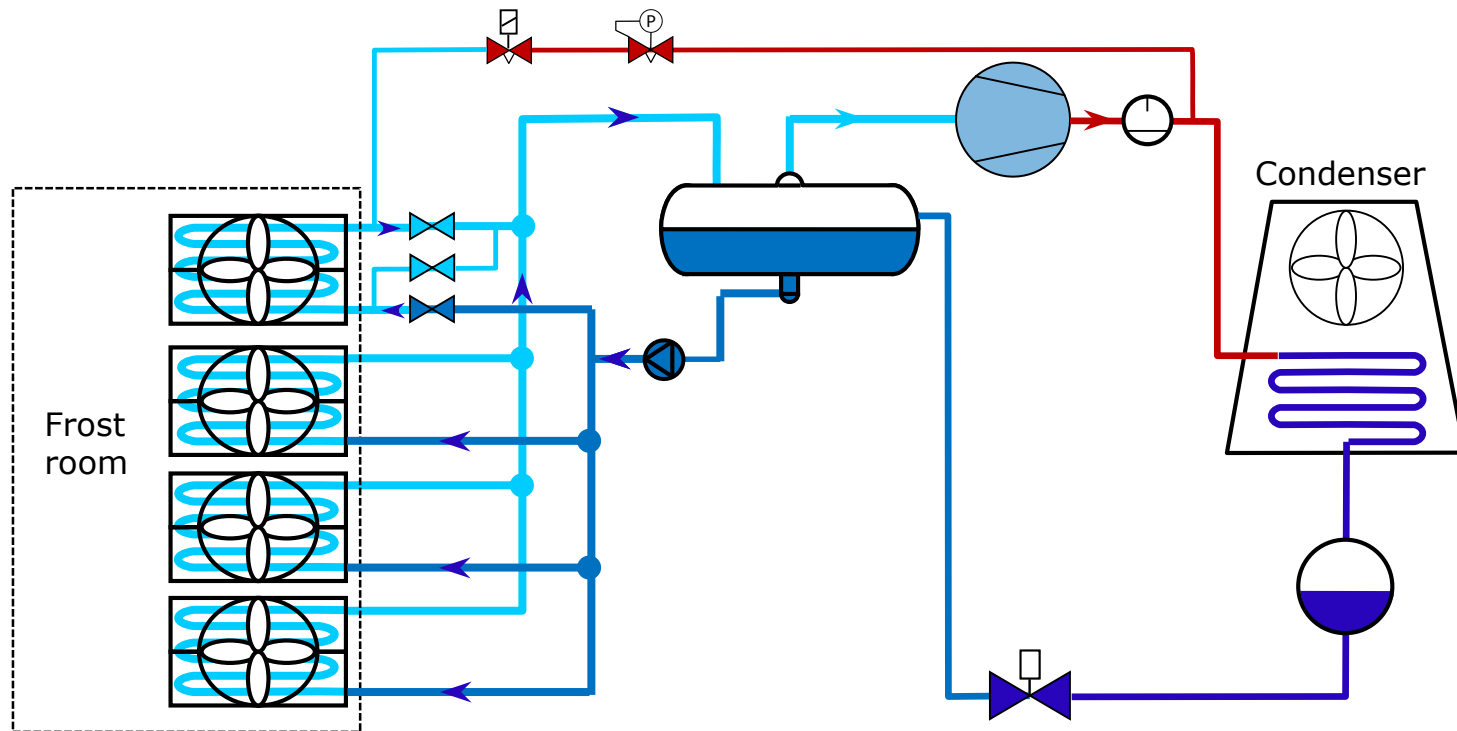


Defrost methods for industrial systems



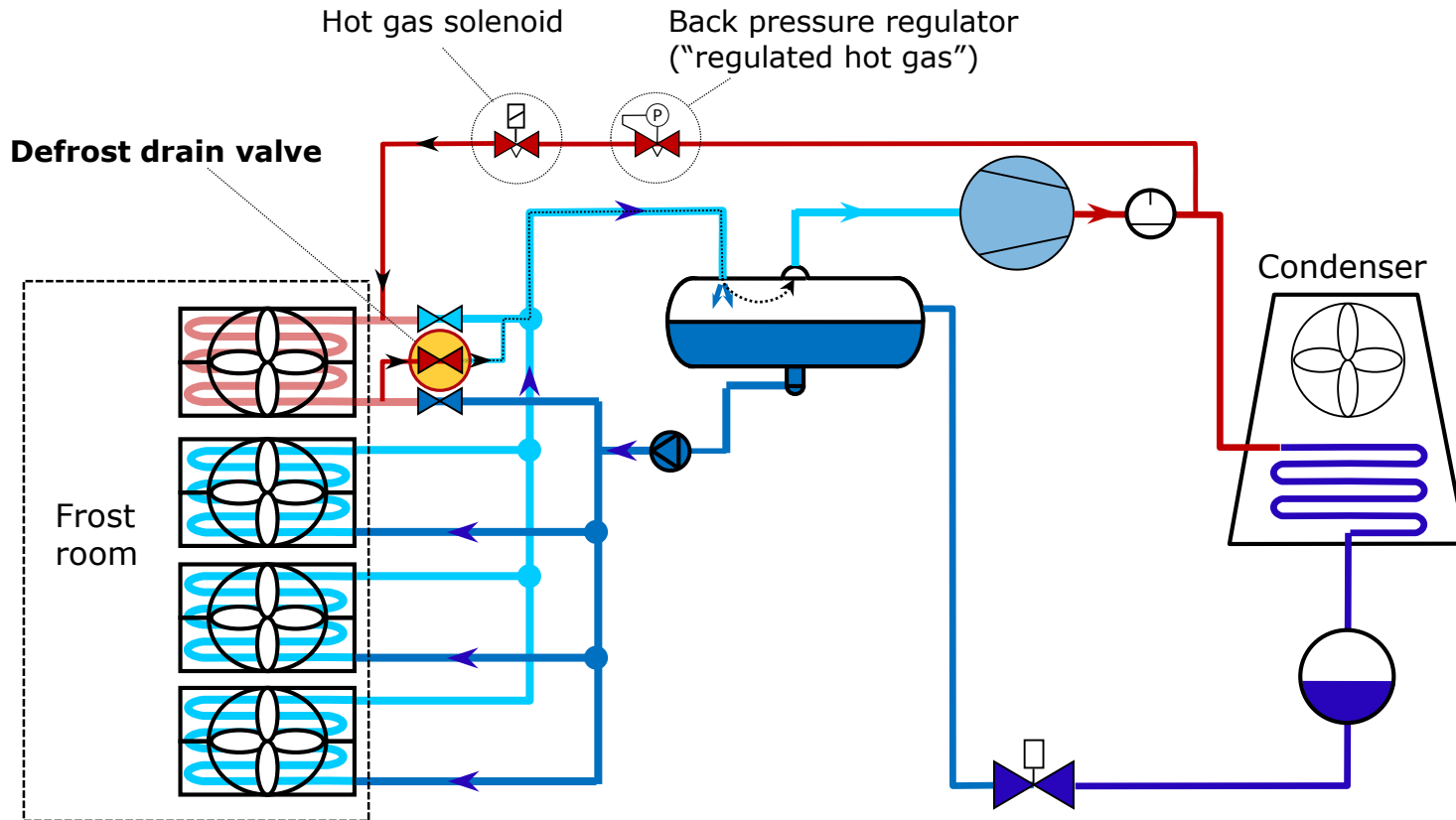
Hotgas defrosting principle

Freezing Mode



Hotgas defrosting principle

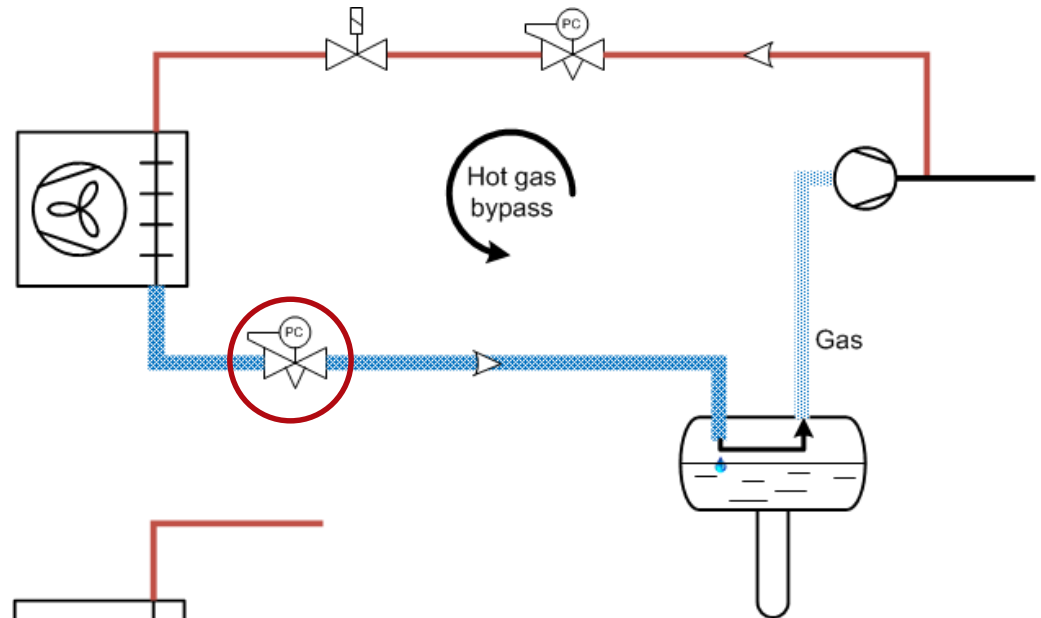
Defrost Mode



Pressure Controlled vs Liquid Drain

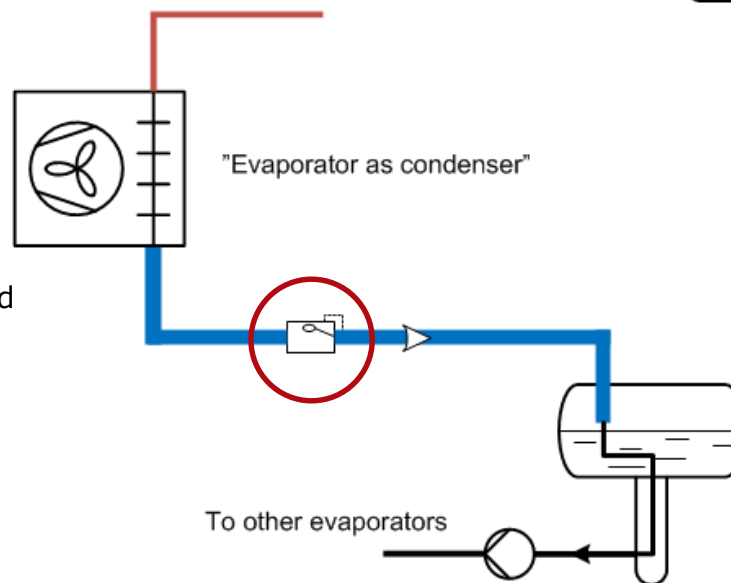
- **Pressure Controlled**

- Increasing amount of gas is bypassed as defrost progresses

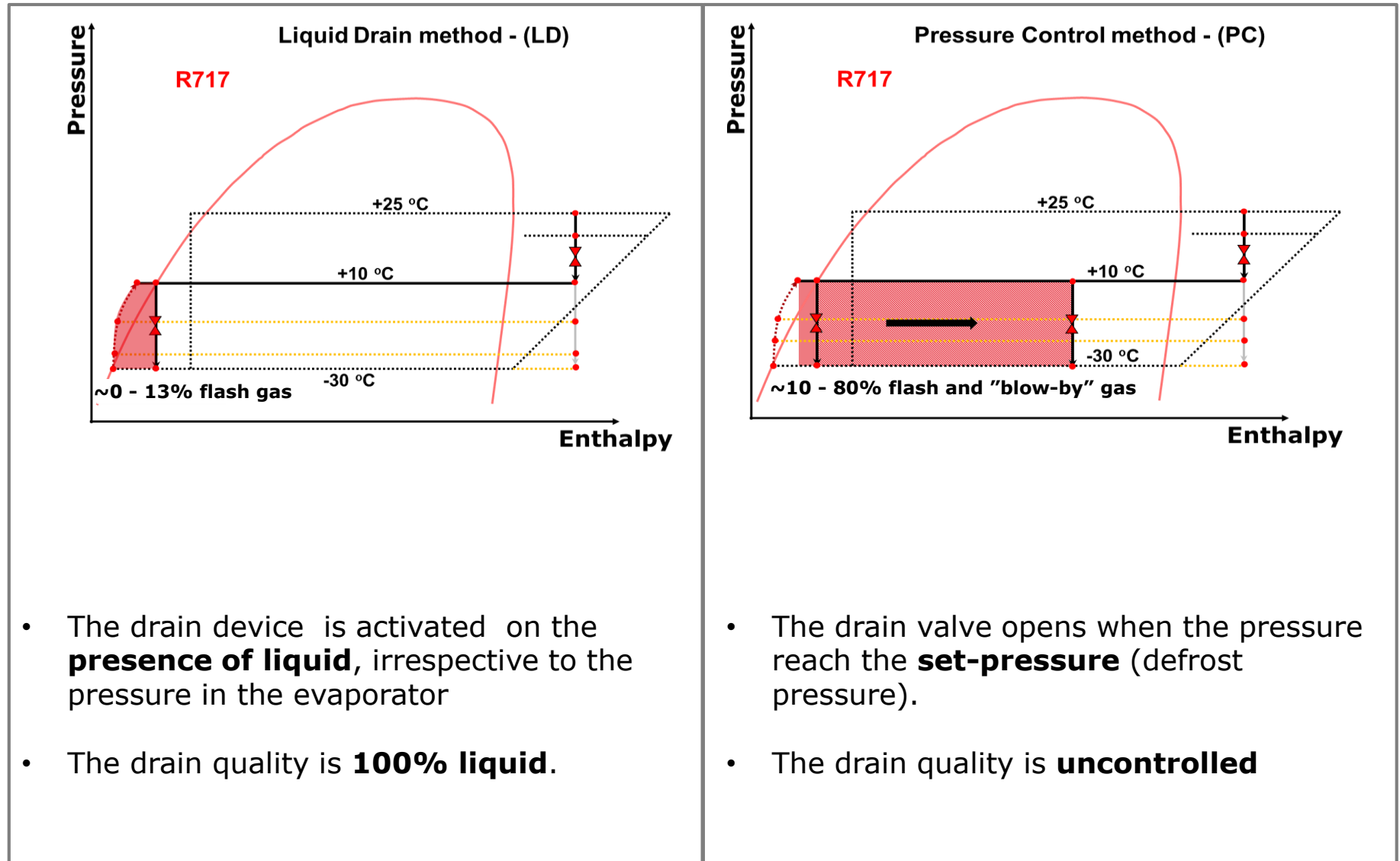


- **Liquid Drain**

- Float valve just returns liquid to separator
- ...minor gas bypass necessary though bleed



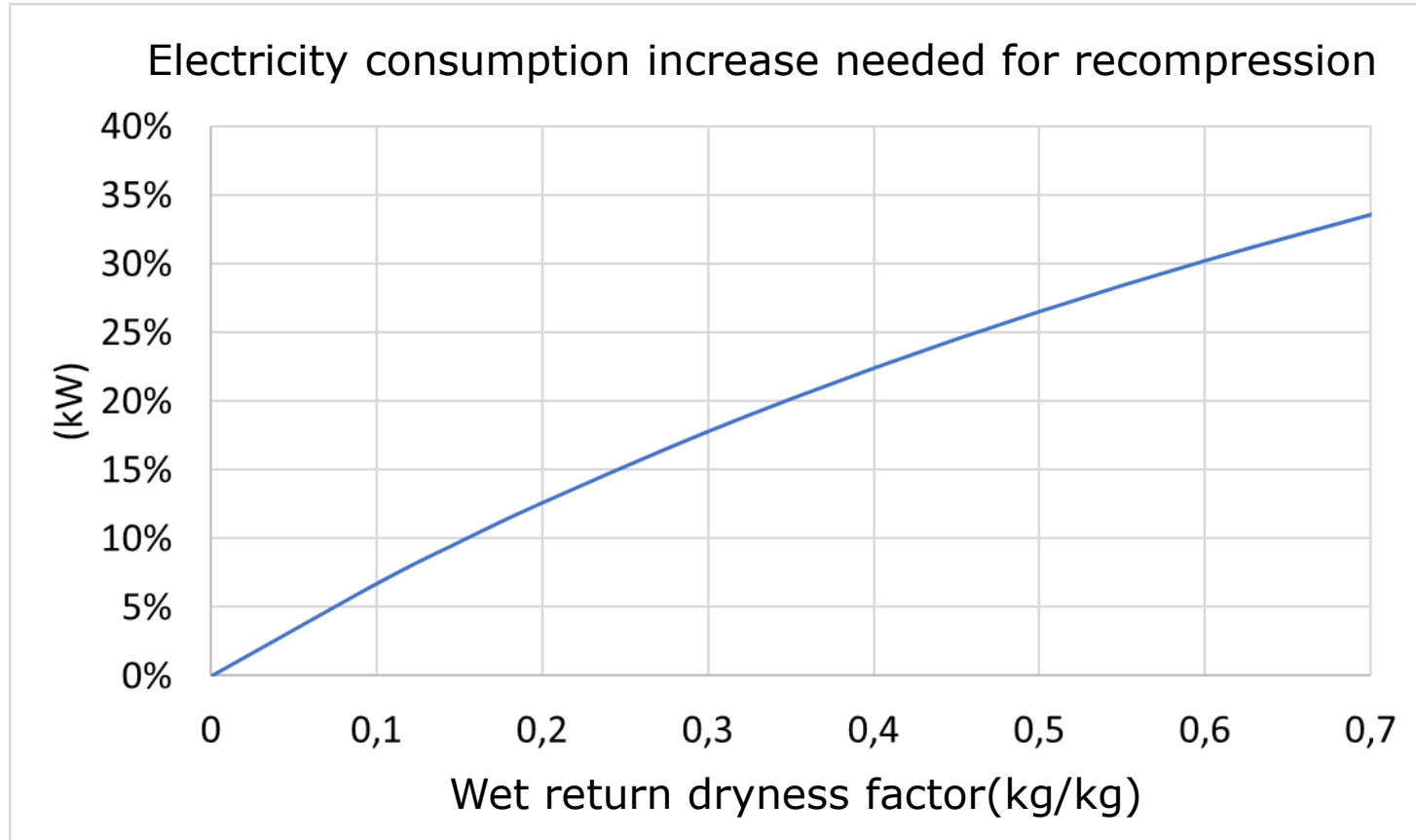
Pressure Controlled vs Liquid Drain



- The drain device is activated on the **presence of liquid**, irrespective to the pressure in the evaporator
- The drain quality is **100% liquid**.

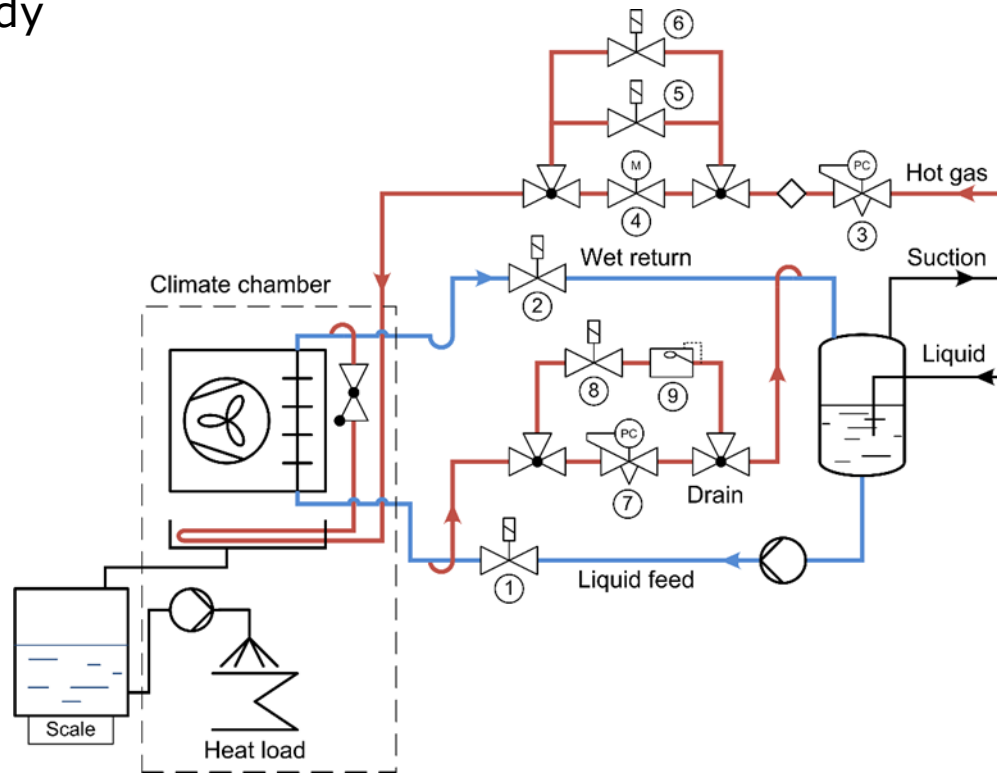
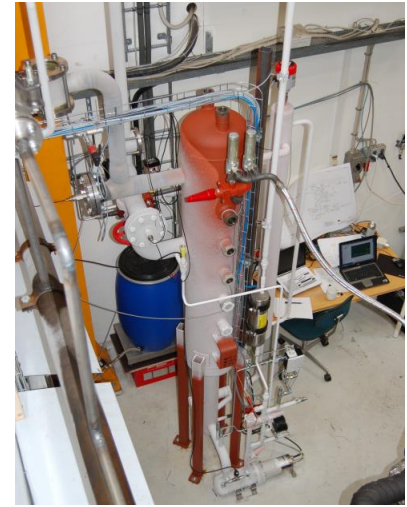
- The drain valve opens when the pressure reach the **set-pressure** (defrost pressure).
- The drain quality is **uncontrolled**

Pressure Controlled vs Liquid Drain



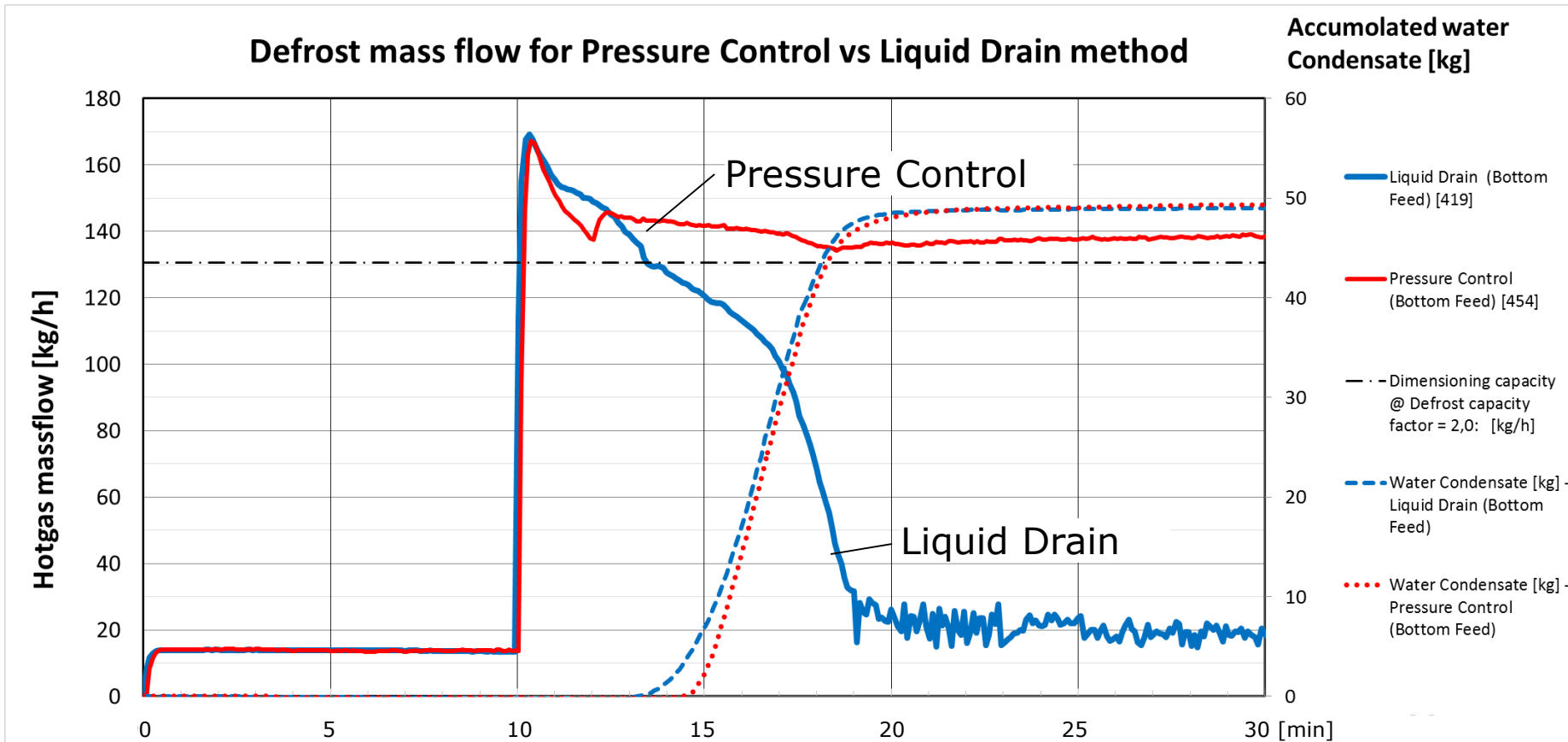
Defrost test

- Laboratory tests / measurements at DTI
- Defrost simulation tool
- Test on Industry applications
- Literature study



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Laboratory defrost test

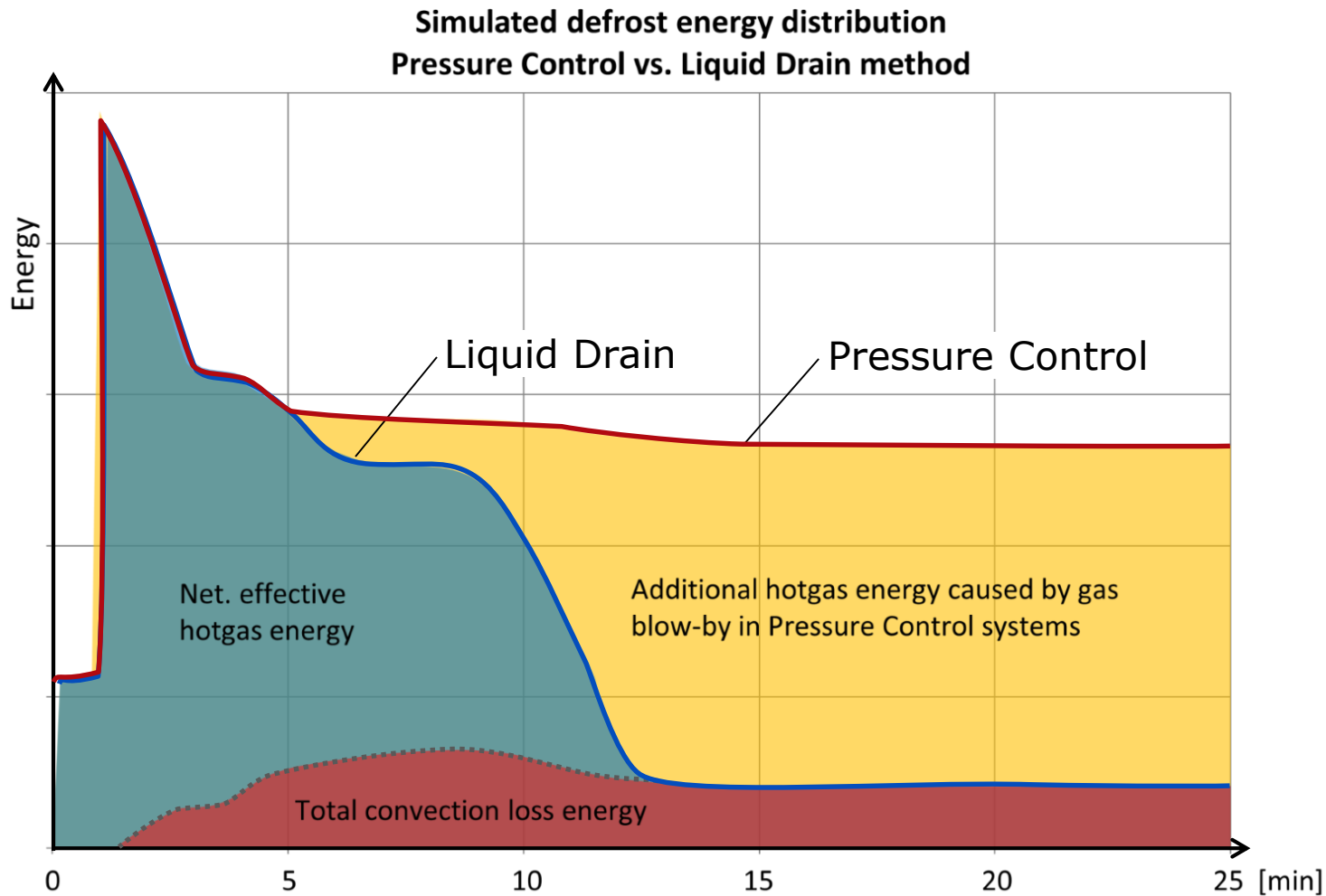


Laboratory defrost test shows significant saving potential on a new “modern” air-cooler, with Liquid Drain defrost vs. Pressure Controlled defrost

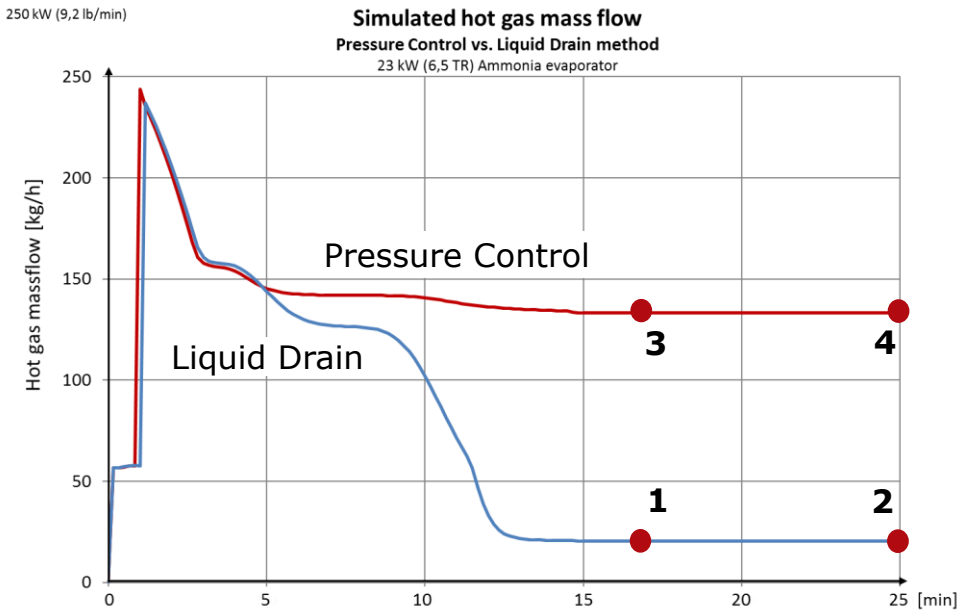


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Defrost energy – Pressure Control vs. Liquid Drain

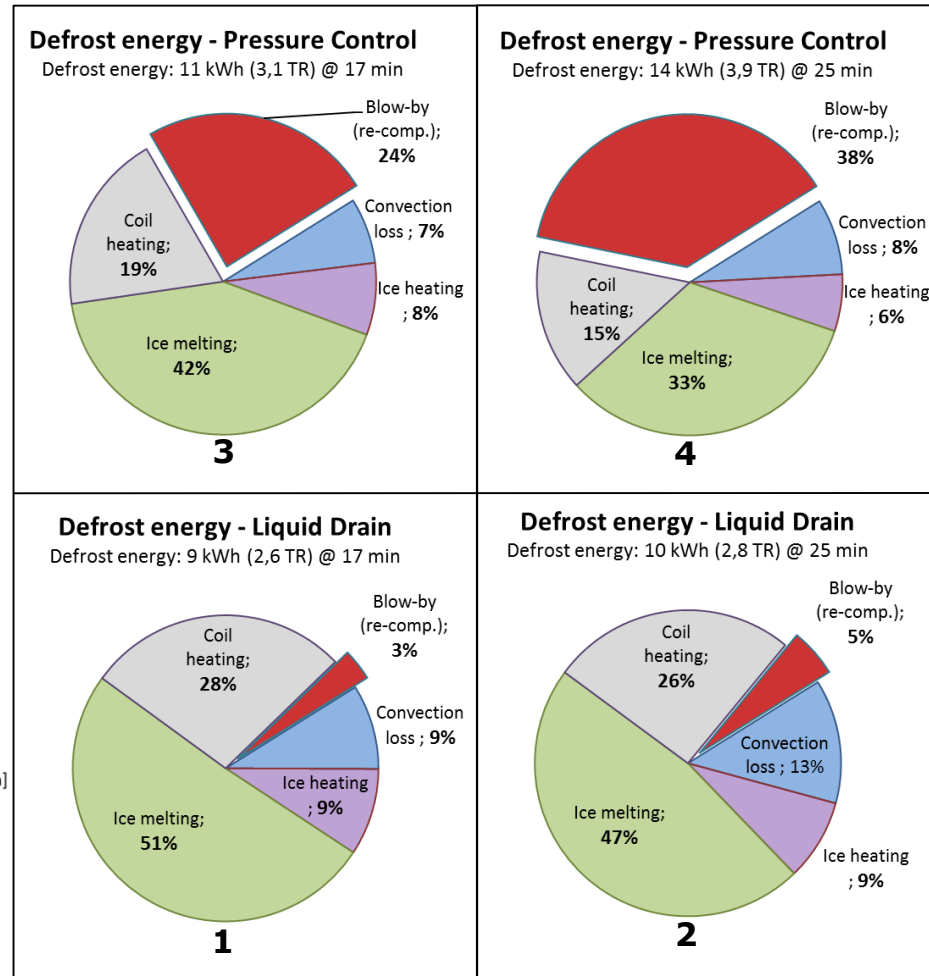


Defrost energy – Pressure Control vs. Liquid Drain



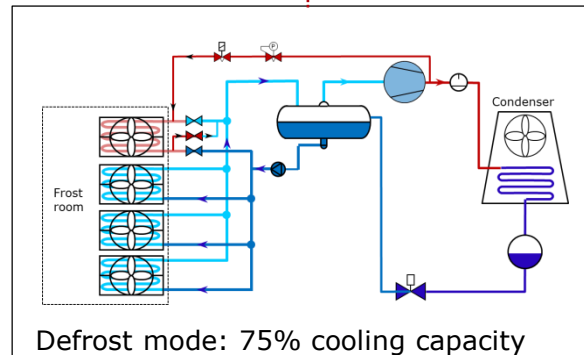
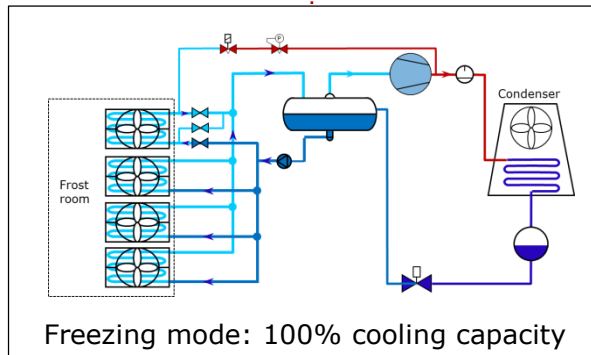
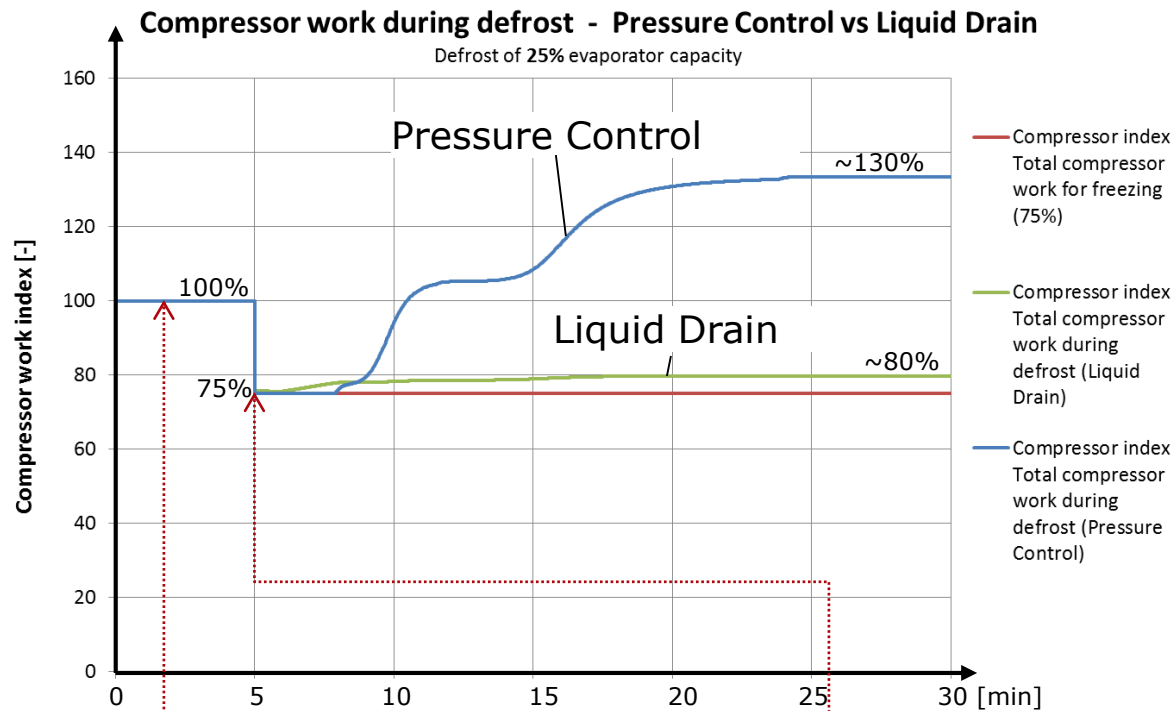
Time: 17 min

Time: 25 min



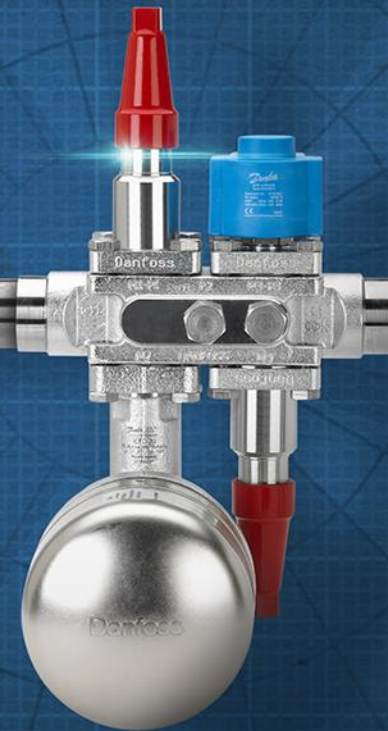
Compressor work during defrost - Pressure Control vs Liquid Drain

Defrost of 25% evaporator capacity



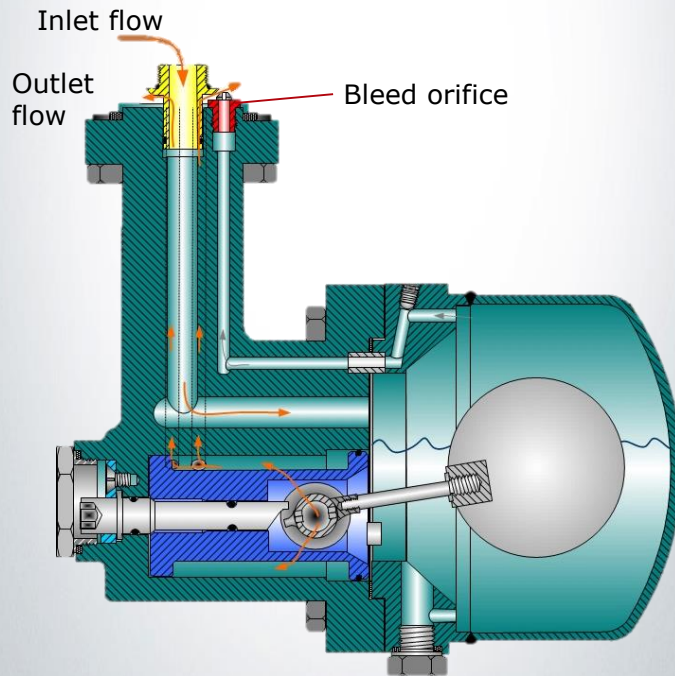
The Formula for Efficiency

Danfoss ICFD
Defrost Module



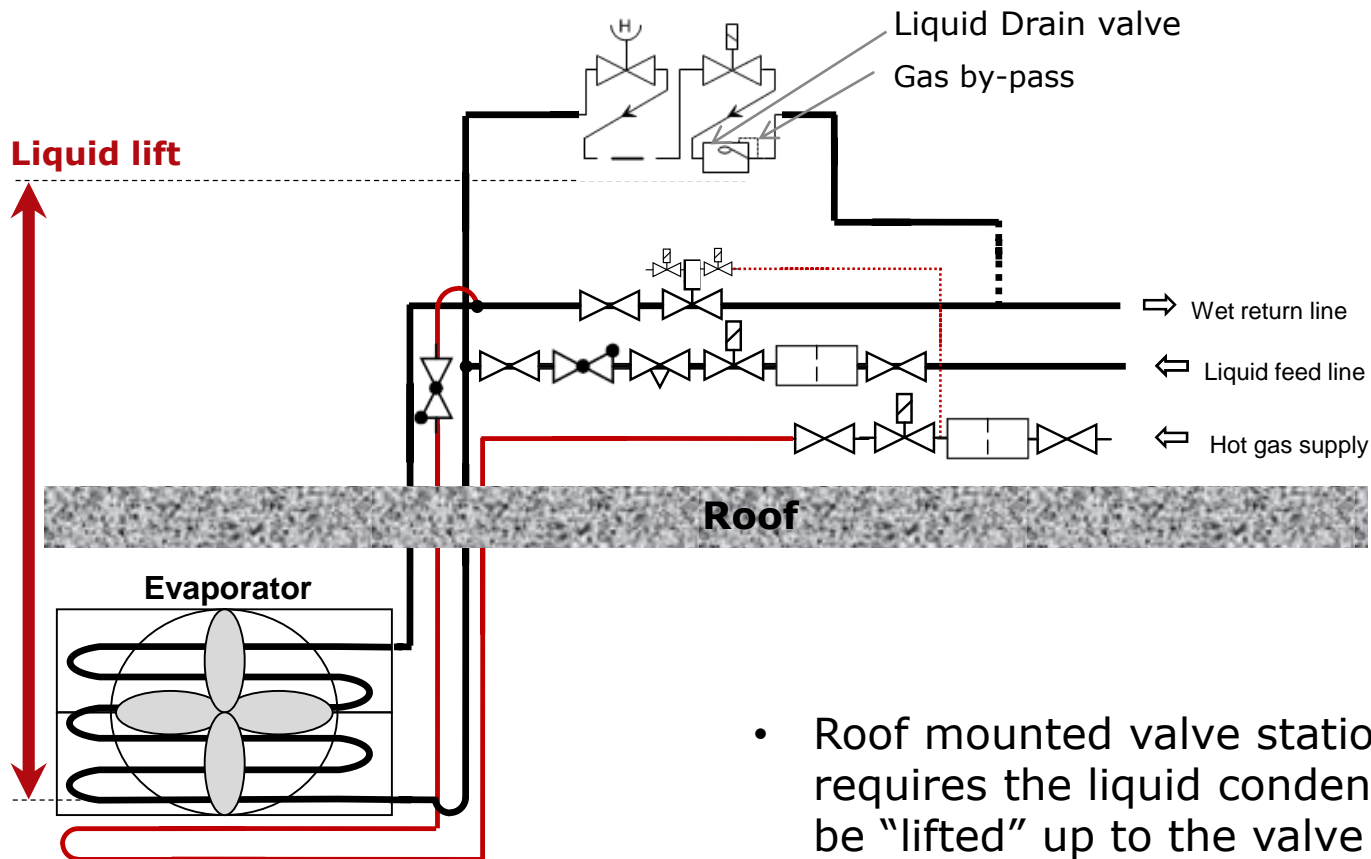
Working principle:

ICFD - How it works



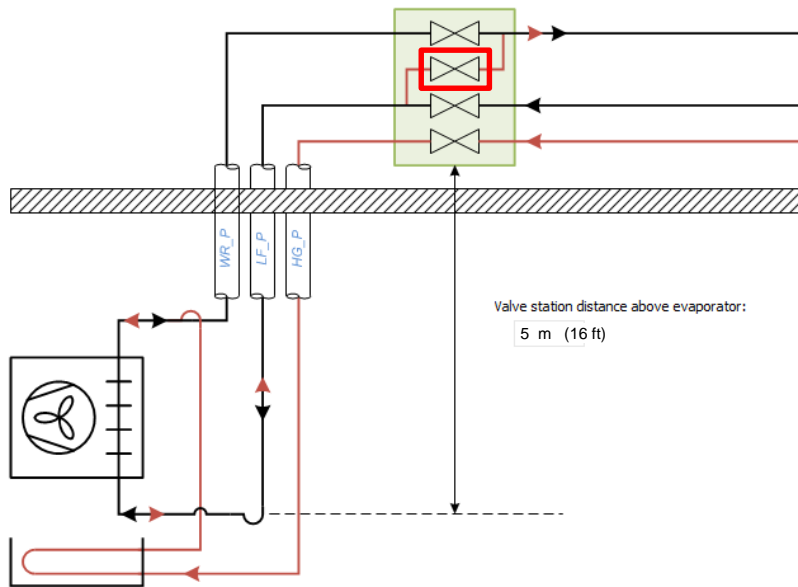
- The design is based on a mechanical float, and the operational mechanism is developed to operate at a very high pressure differential.
- Only allows liquid to pass through – no blow-by gas can bypass
- Provides an automatic capacity adjustment during operation with proportional opening for the necessary amount of liquid – no settings required
- Has a very high capacity compared to its size due to its unique pressure balanced design
- Possible to manage a liquid lift without any additional bypass valves thanks to a built-in bleed function
- **Patent pending** (functionality and design principle of including drain valve into valve station)

Roof mounted valve station (Liquid Drain -ICF)



- Roof mounted valve stations requires the liquid condensate to be “lifted” up to the valve station (liquid riser)
- Liquid risers reduce drain capacity

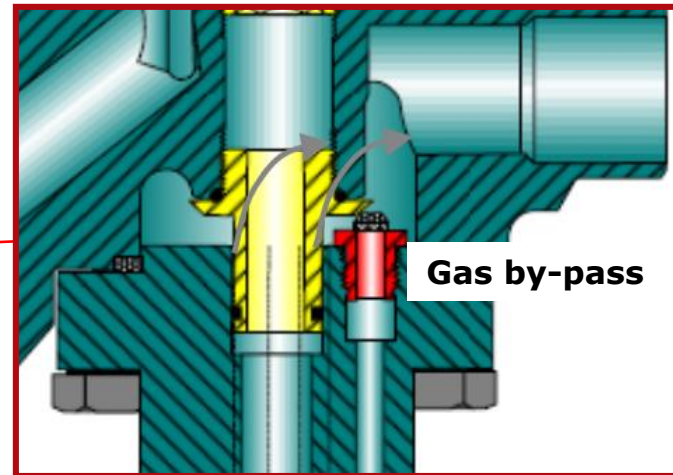
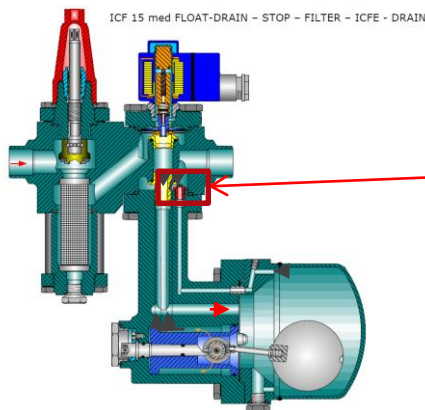
Roof mounted valve station (Liquid Drain -ICF) Gas by-pass orifice



Gas by-pass orifice

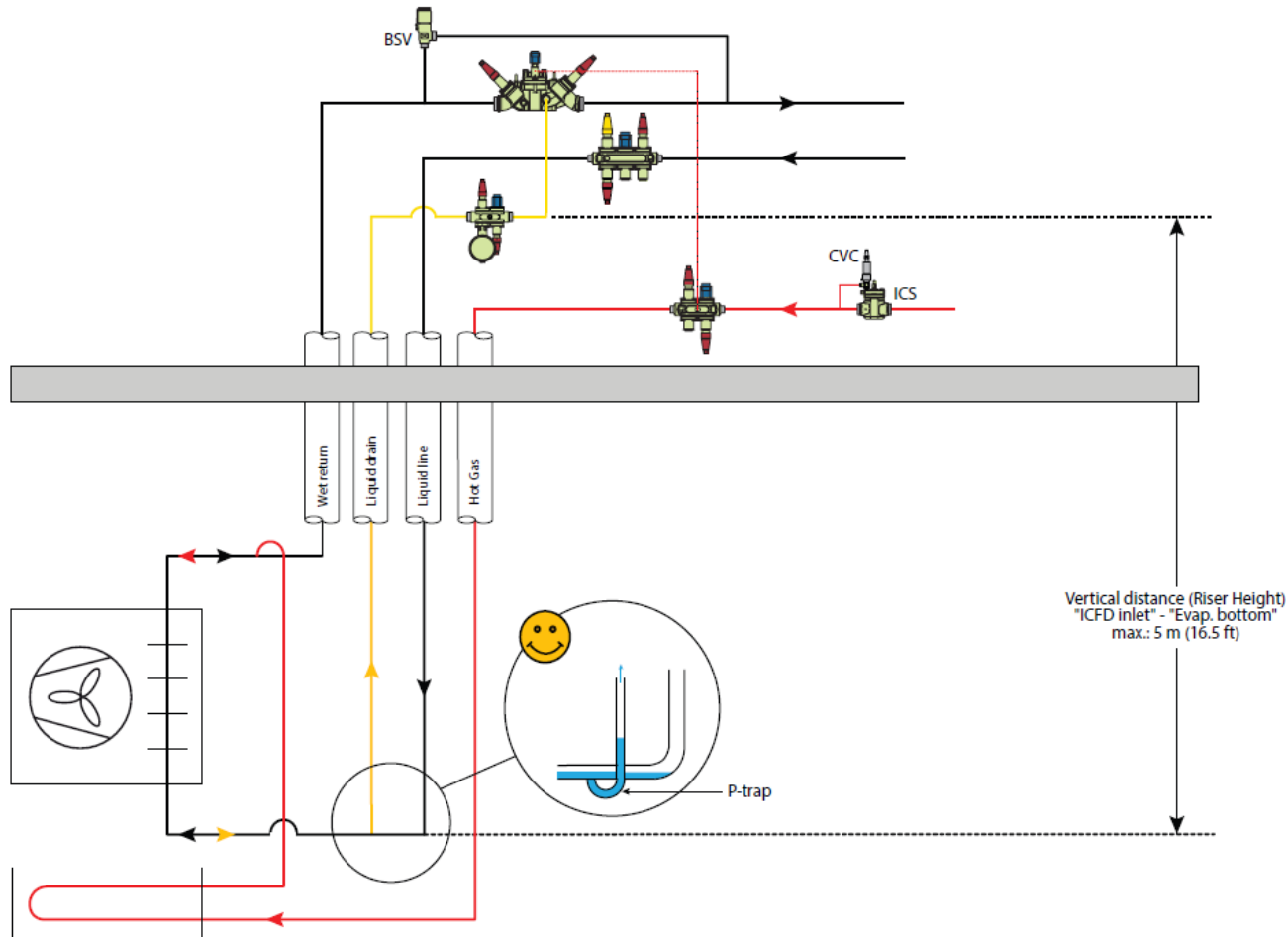
A gas by-pass orifice with a flow coefficient of approximately 5-7 % of the Kv-value of the expansion device (float valve), is normally sufficient.

The gas by-pass is a loss, but the mass flow for gas is typically around 1/10 of the liquid mass flow => Loss \approx 0,5%



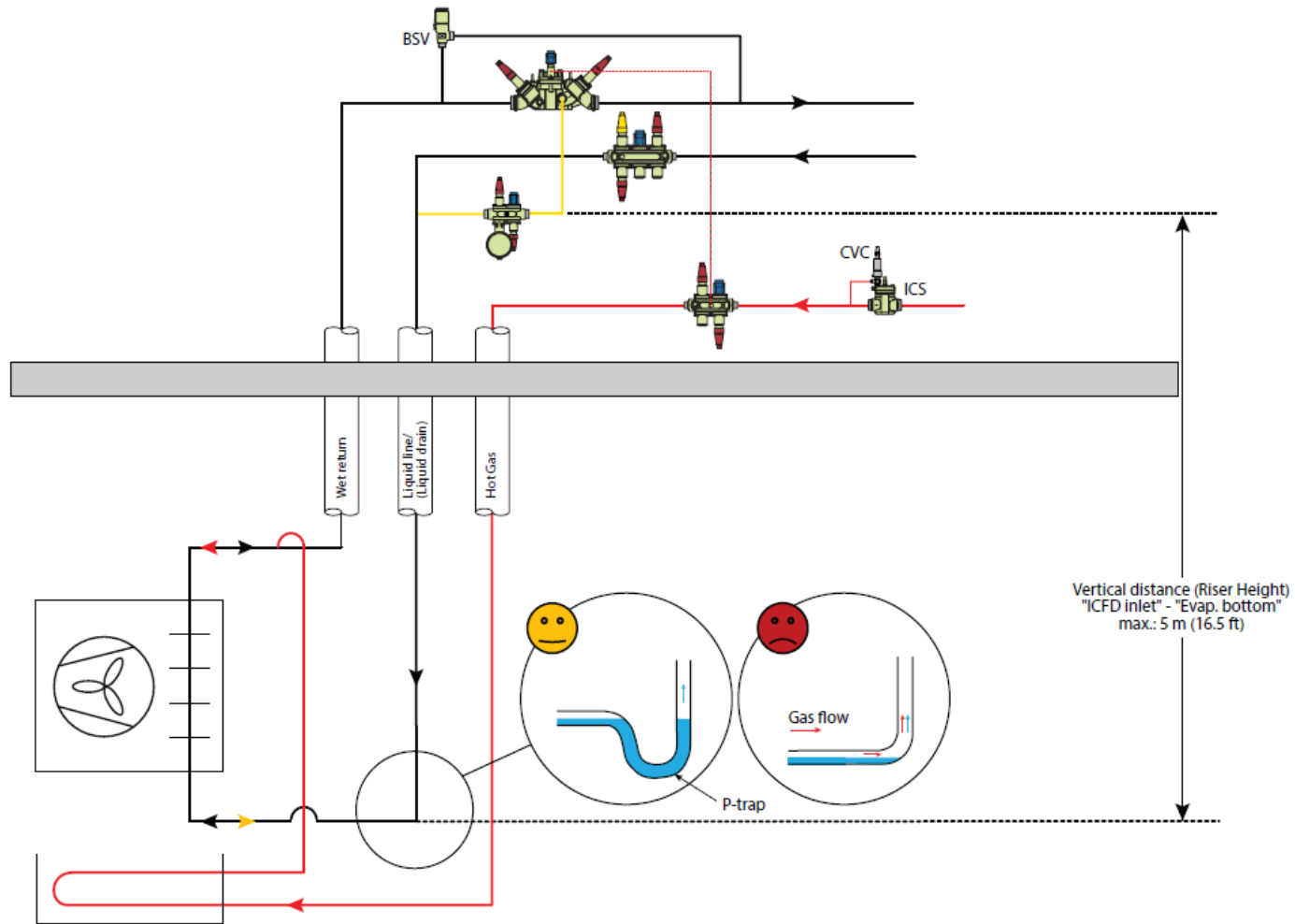
Liquid riser in systems with Liquid Drain systems

Best option: Optimized liquid velocity and volume



2 Always install P-trap

Liquid riser in systems with Liquid Drain systems

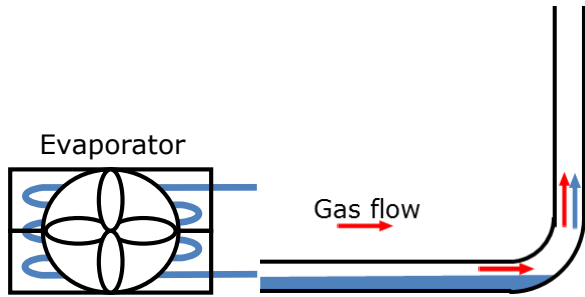


3 Always install P-trap

Liquid riser in systems with Liquid Drain systems

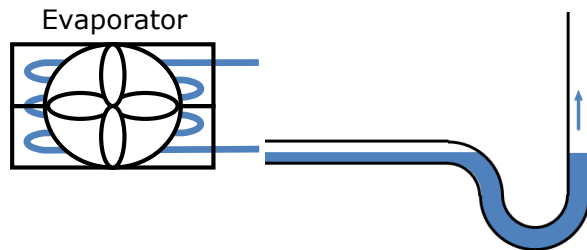
Riser design

Feature



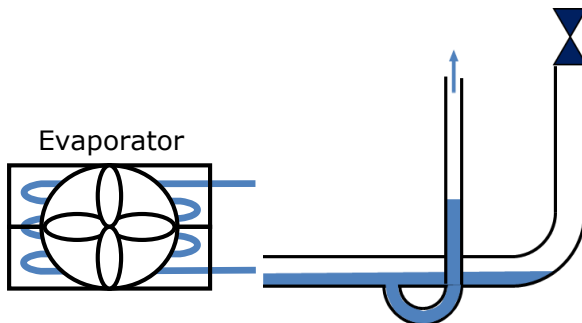
Condensate drain line with riser **without P-trap**

- **No** P-trap increase risk of gas "blow-by" (increased gas re-compression and increased defrost duration)



Common Liquid feed / condensate drain line with riser **with P-trap**

- P-trap minimize gas "blow-by" (loss) in liquid drainer.



Separate riser with P-trap in condensate drain line

- Separate riser enable optimizing riser pipe diameter.
- P-trap minimize gas "blow-by" (loss) in liquid drainer.