Thermosiphon pre-design

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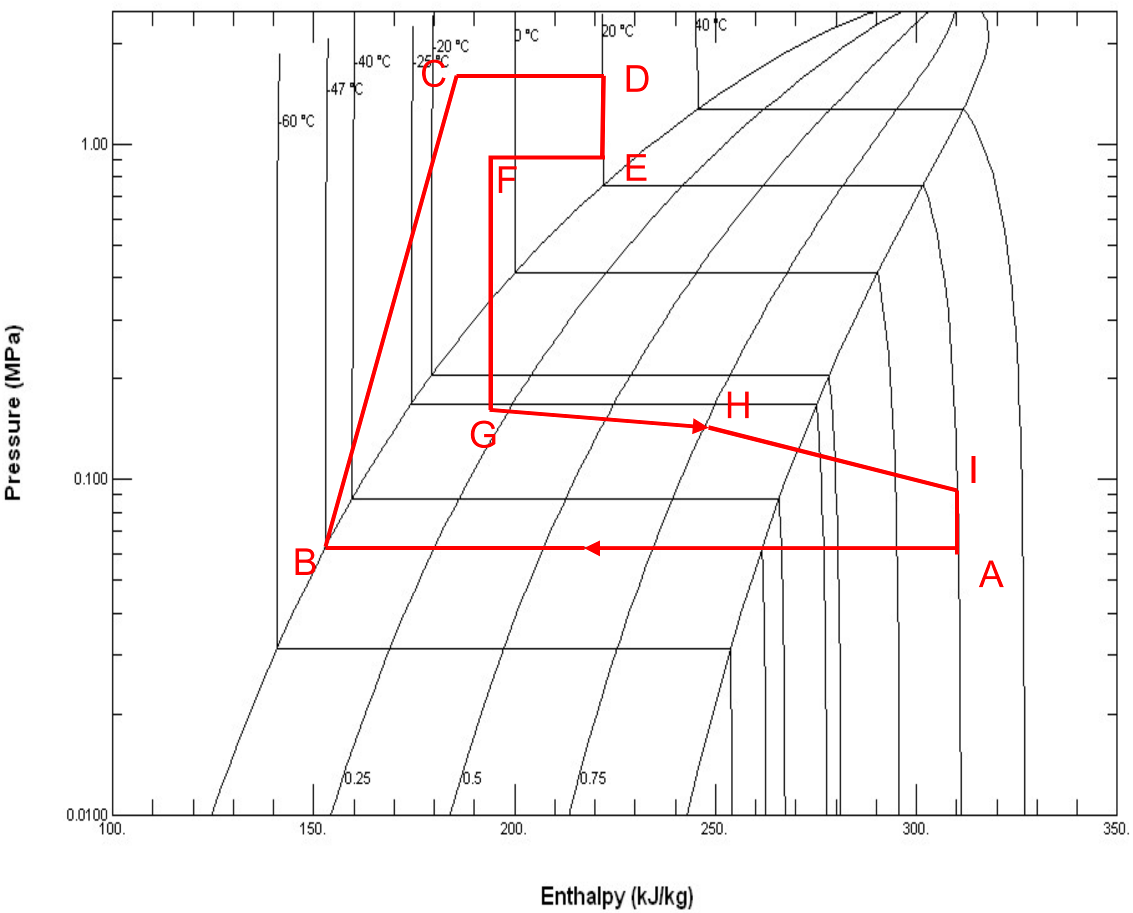
Gravity-driven Cooling Concept

- Natural circulation of the fluid:
  - Condensation temperature/pressure must lower than evaporation temperature/pressure
- No working components in the main circuit
  - Less probability of occurrence of leaks
  - No significant vibrations on the system
  - Low maintenance operations
- Access to refrigeration units at the surface
- No limit for the Evaporation Temperature:
  - Suction pressure of the compressors is not a limit anymore -> possibility of reaching lower evaporation temperatures

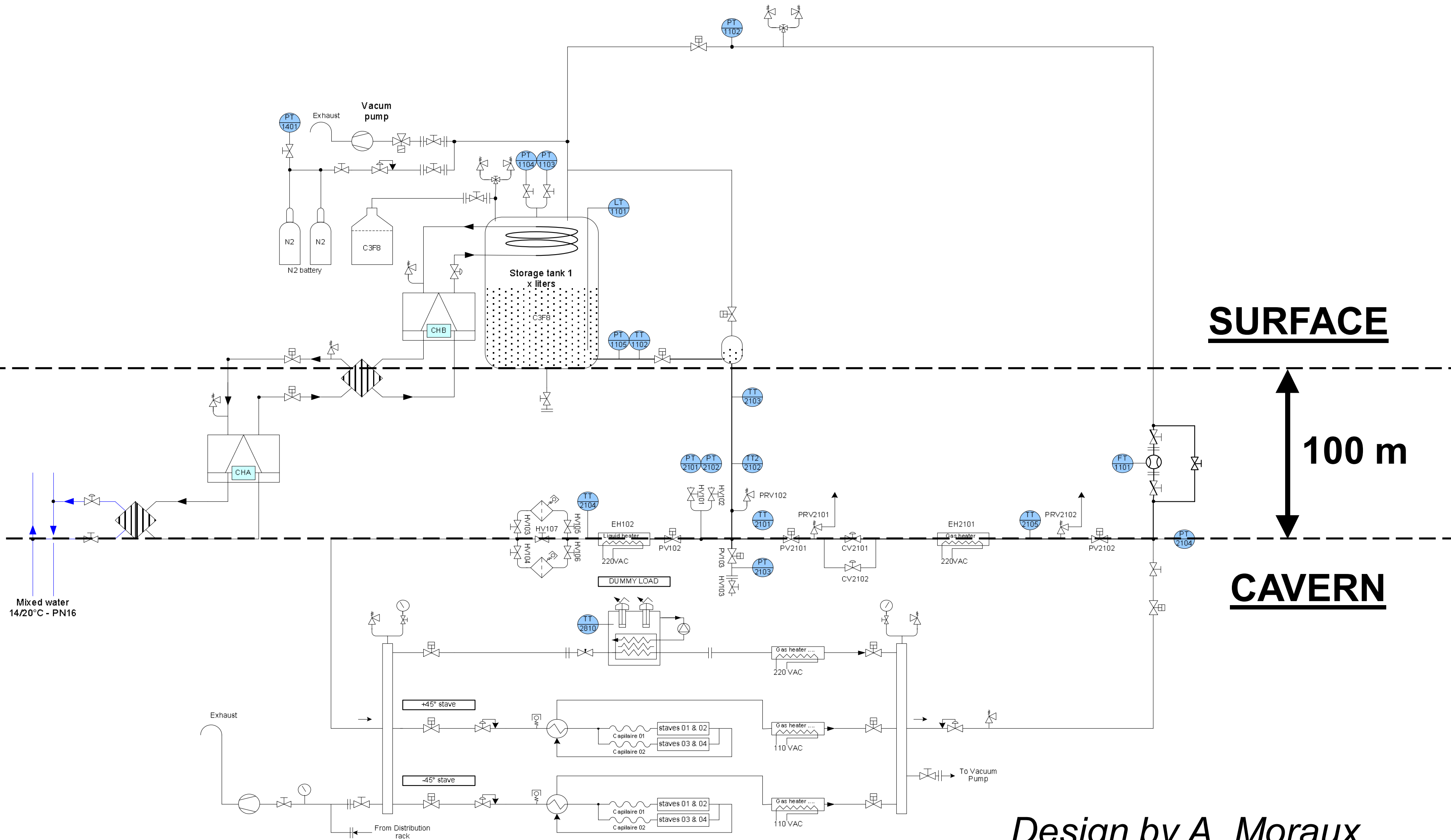
Preliminary design and parameters

- Thermodynamic Cycle Example for C3F8 with Sub-Cooling



- A-B : Condensation
- B-C : Hydrostatic dP
- C-D : Heat Exchanger
- D-E : Pressure Regulation
- E-F : Sub-Cooling
- F-G : Capillary Expansion
- G-H : Evaporation
- H-I : Heater
- I-A : Back-Pressure regulation

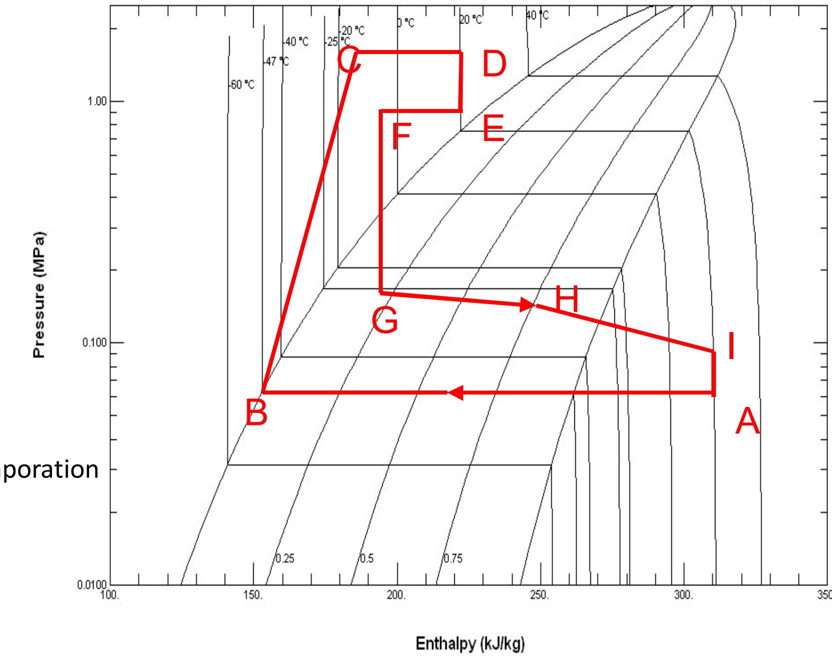
Preliminary design and parameters



Design by A. Moraux

Preliminary design and parameters

- A-B : **Condensation** – $dh = h$ (at $T_{condensation}$) – h (at $T_{return\ lines}$)
  - Definition of the Condensation Power
- B-C : **Hydrostatic** – $dP > P_{transfer\ lines}$ ($T_{transfer\ lines}$) – $P_{return\ lines}$ ($T_{return\ lines}$)
  - Definition of minimum height
- C-D : **Heat Exchanger** – $dh = h$ (at T_{in}) – h ($T_{supply\ lines}$)
  - Definition of HX power
- D-E : **Pressure Regulation** – Pressure Regulator Cv
  - Regulation of mass flow
- E-F : **Sub-Cooling** – $dh = h$ (T_{evap} at T_{cond}) – h (X_{in})
  - Definition of HX Power for sub-cooling
- F-G : **Capillary pressure drop** – $dP = P_{pressure\ regulator} - P_{evaporation}$
  - Definition of capillary length
- G-H : **Evaporation** – dP_{stave}
  - Definition of dP at the stave
- H-I : **Heater** – $dh = h$ (X_{out}) – h ($T_{transfer\ lines}$)
  - Definition of Heater power
- I-A : **Back-Pressure regulation** – Pressure Regulator Cv
  - Regulation of Evaporation Temperature



Preliminary design and parameters

- Application example for the IBL detector and Distribution Racks at USA 15:
  - Required mass flow = 36g/s
  - Evaporation temperature = -40C
  - Supply and return lines Temperature = 20C
  - Altitude difference ≈ 100m
- Definition of the main components:
  - Minimum height O.K.: 16 bar > dP (P_{cond} = 7.57 bar ; P_{evap} = 0.87 bar)
  - liquid line = DN25 -> dP= 16 bar ; Vapor line = DN50 -> dP = 90 mbar
  - Condensation Temperature < -42.5 C (P_{cond} < 0.87 bar – 90mbar)
  - Condenser Power > 5.94kW (*dh* = 165kJ/kg; m = 36g/s)
  - Heat Exchanger Power > 1.44kW (dh = 40kJ/kg; m = 36 g/s)