CO_2 Removal and Atmosphere Revitalization Systems for Next Generation Space Flight

ARC Air Revitalization Group

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October 28, 2010

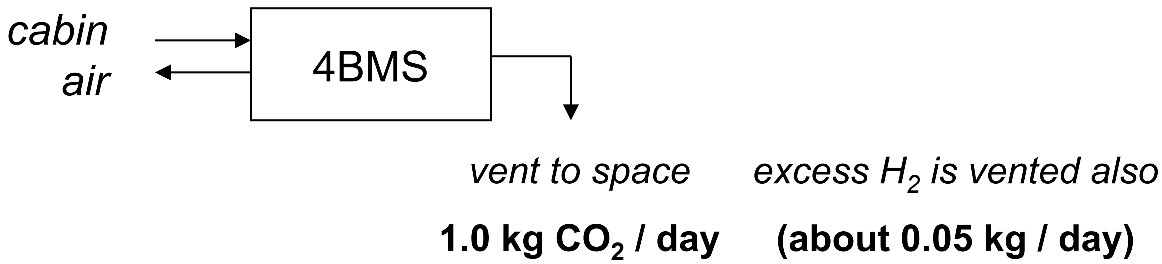
Outline

- Design Objectives of Atmosphere Revitalization
  - Reliability
  - Low Power
  - Loop Closure
- ISS CO2 Removal
- Low Power CO2 Removal System
- Next Generation Atmosphere Revitalization

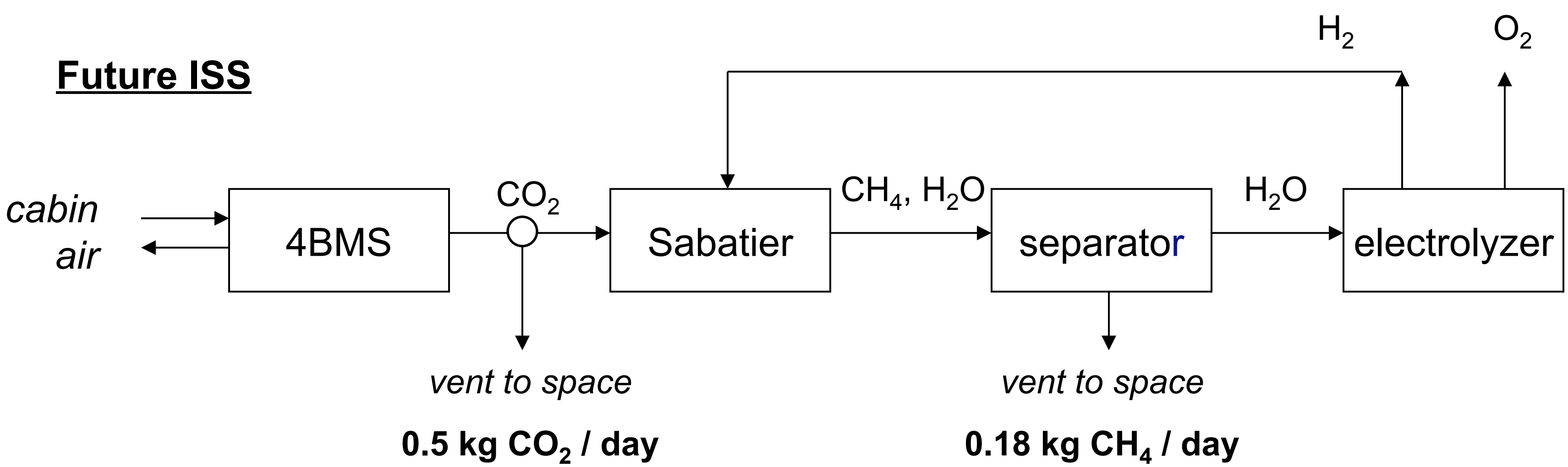
Loop Closure

BASIS:
one Human Equivalent Unit
(1 kg CO_2 generated / day)

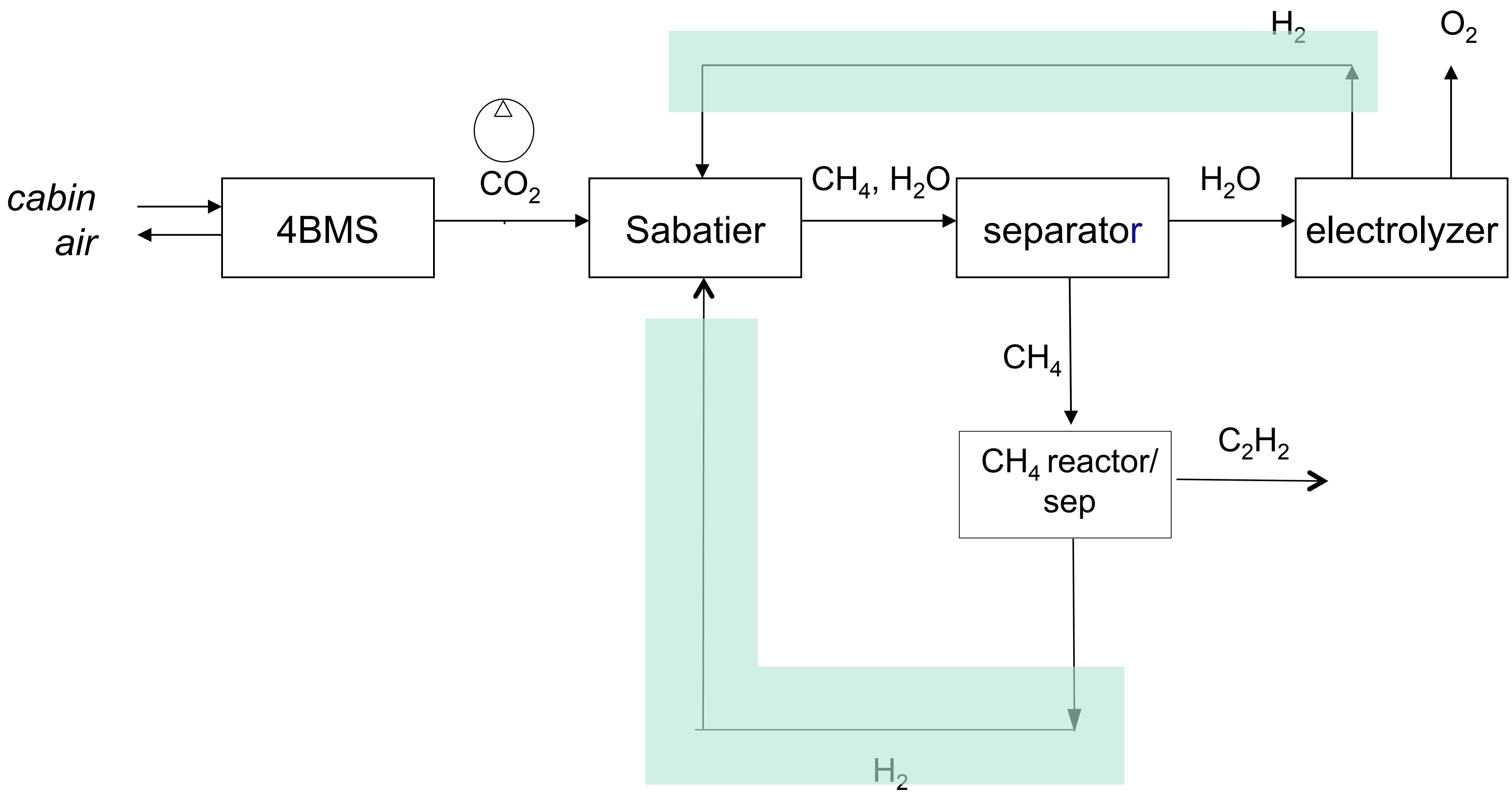
Current ISS



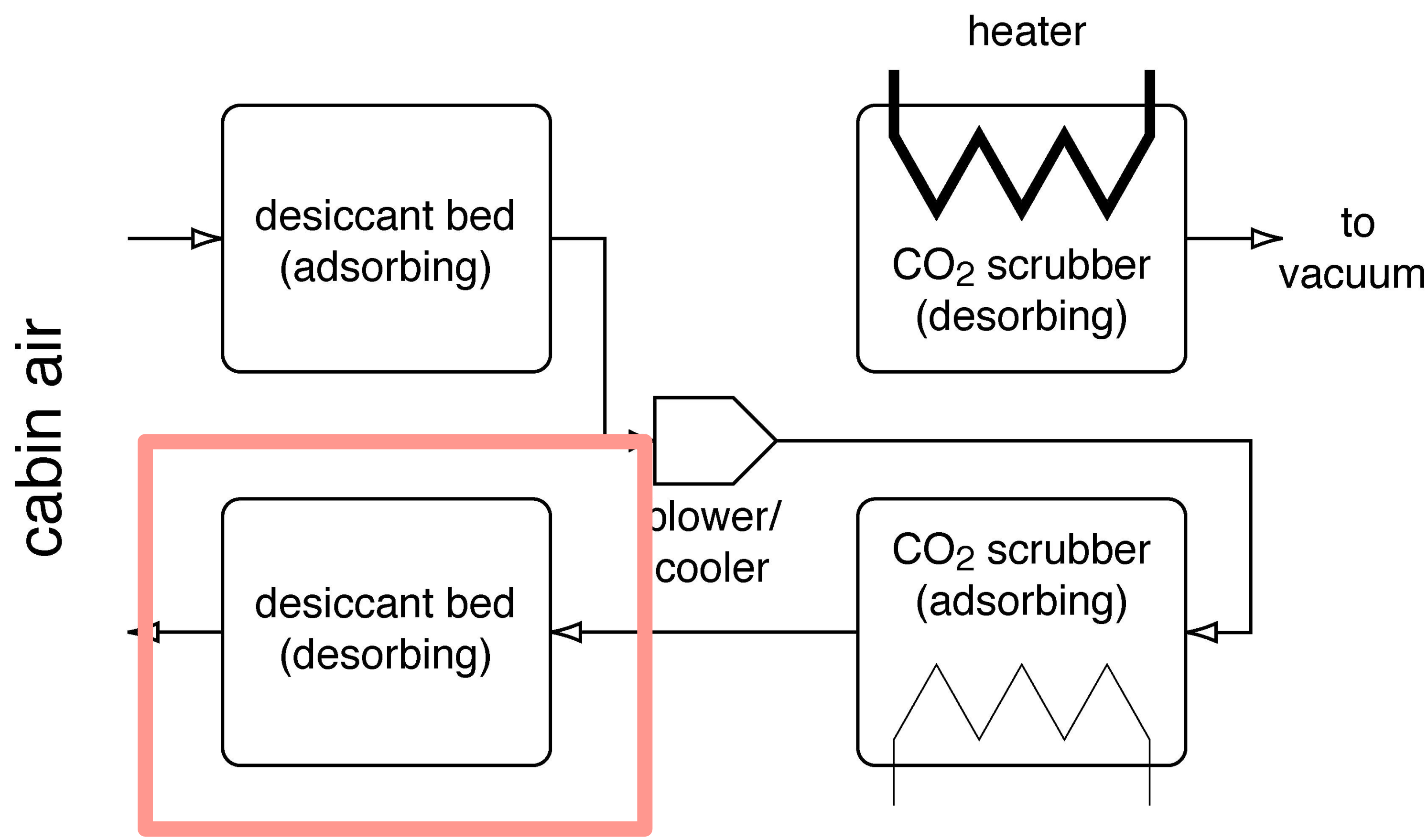
Future ISS



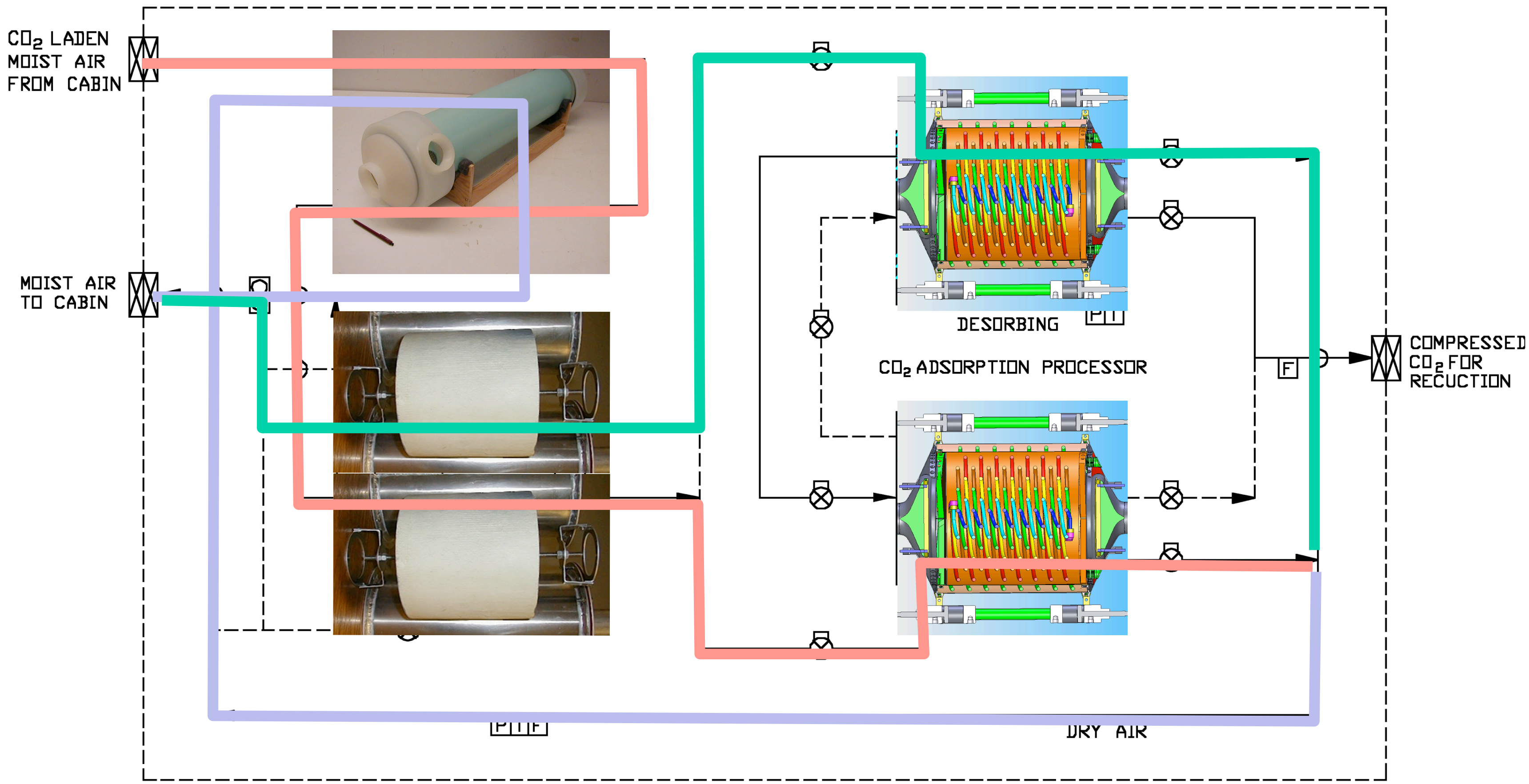
Increased Loop Closure



ISS CO2 Removal



Low Power CO2 Removal - LPCOR

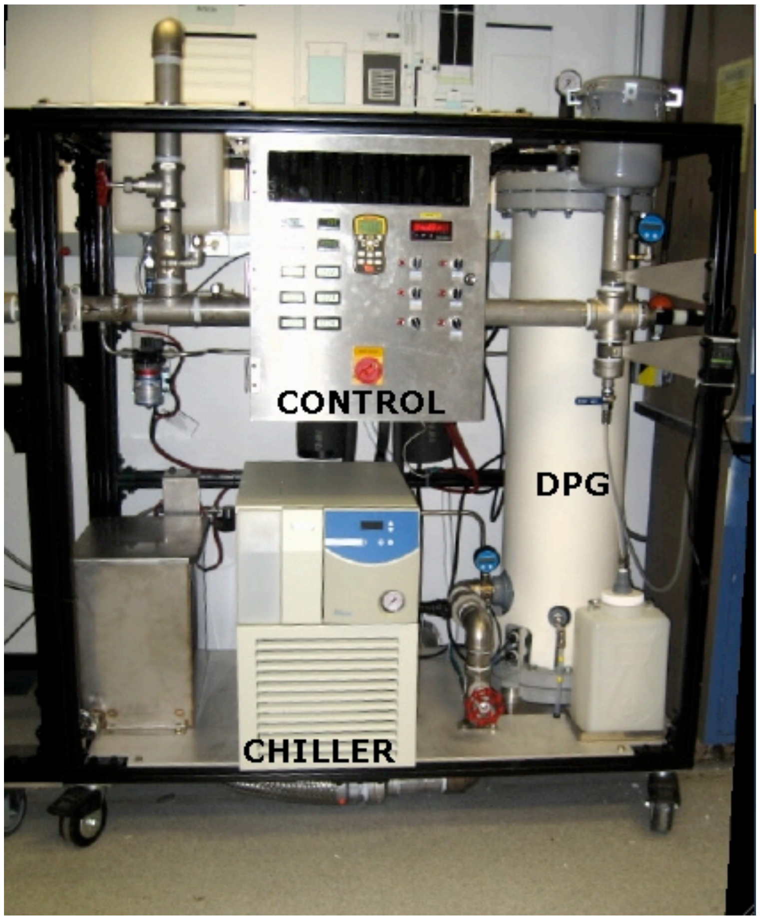


- Passive membrane drying technology for low power
- Structured residual dryers for low power and reliability
- Integrated CO_2 capture and compression for loop closure and low power

Specifications

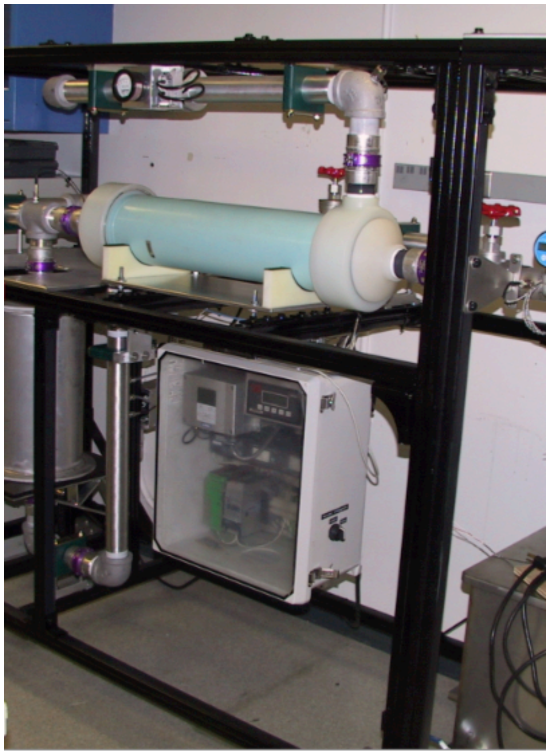
PARAMETER	SPECIFICATION
Crew-size	4 (max)
CO_2 concentration	2600 ppm (average)
Cycle Time	60 minutes
Flow rate: process air inlet	850 slm
Temperature: process air inlet	8-10°C
Dewpoint: process air inlet	8°C
CO_2 delivery pressure	133 kPa
Adsorbent Cooling Method	process air and rack air for additional cooling

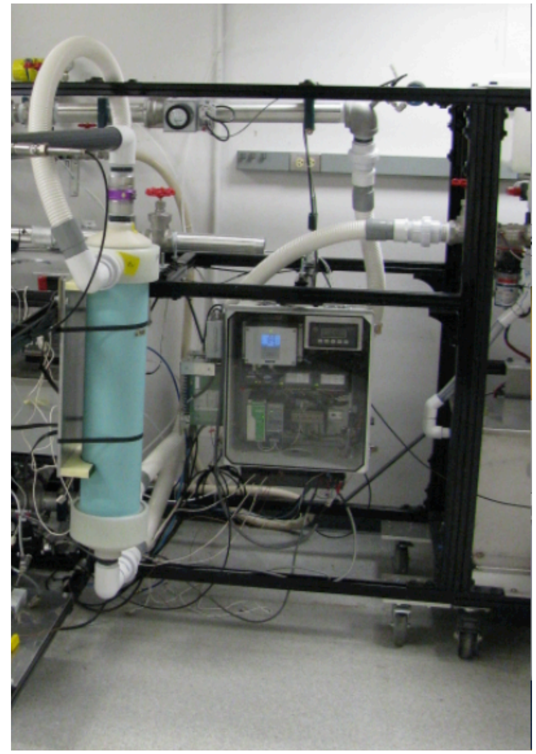
Test Stand



- Test platform for evaluation/ characterization of AR components
- Air Flow range : 0-1275 slm
- Air Temperature : 5°C-20°C
- Air Dewpoint : 5°C-20°C
- Air Relative Humidity : 35%-100%
- Supplemental Air Flow Range: 0-1416 slm
- Supplemental Air Flow Dewpoint: -70°C

Dryer Orientation



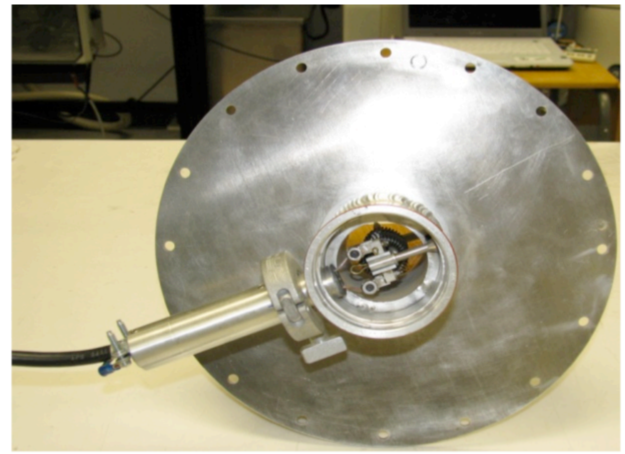


- Tube flow - 850 slm, Shell flow - 722 slm (85% of tube flow), Inlet DP - 8°C
- 70% water-removal efficiency in horizontal orientation
- 81% water-removal efficiency in vertical orientation

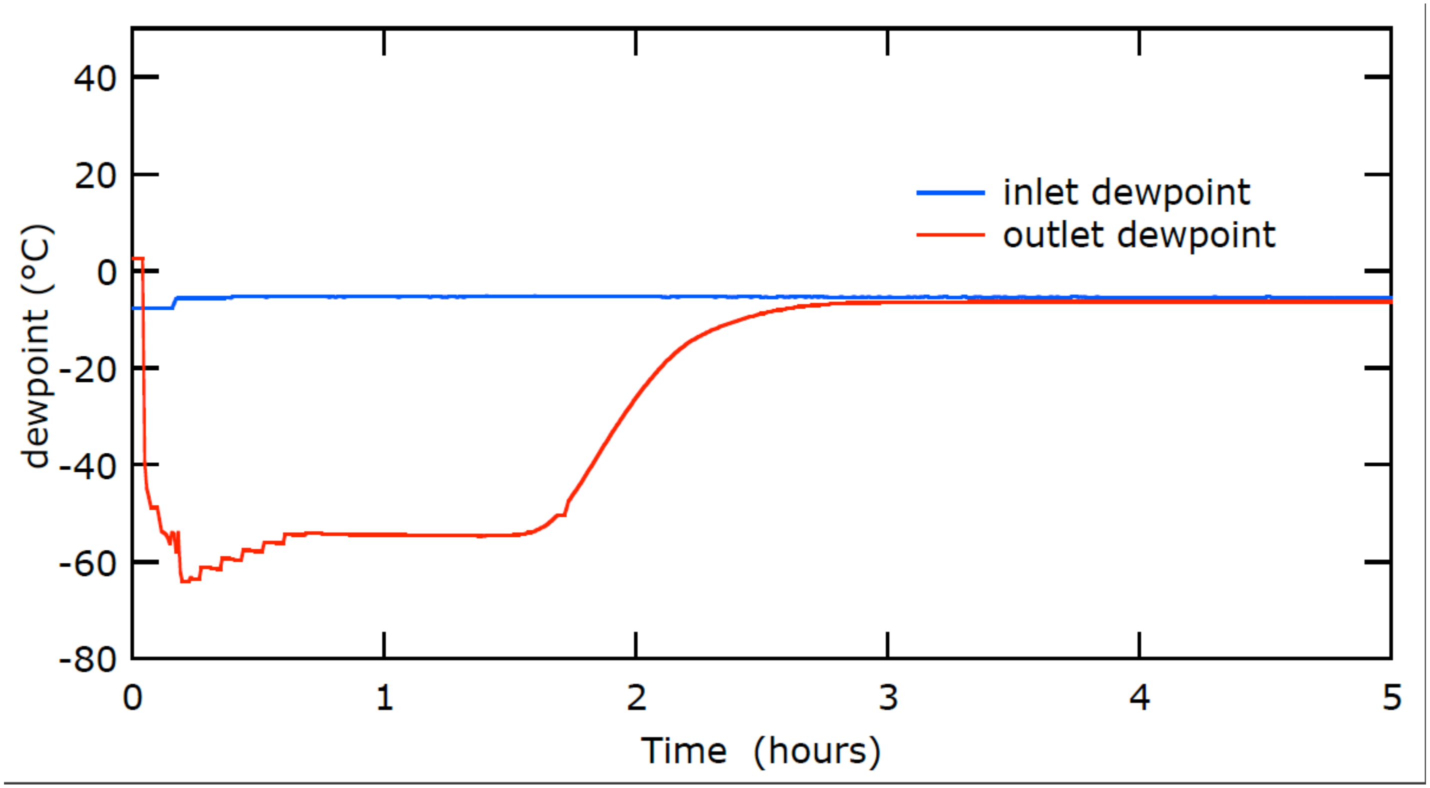
Efficient Heating – In-line vs. proximal

Desiccant

Air Pre-Heater

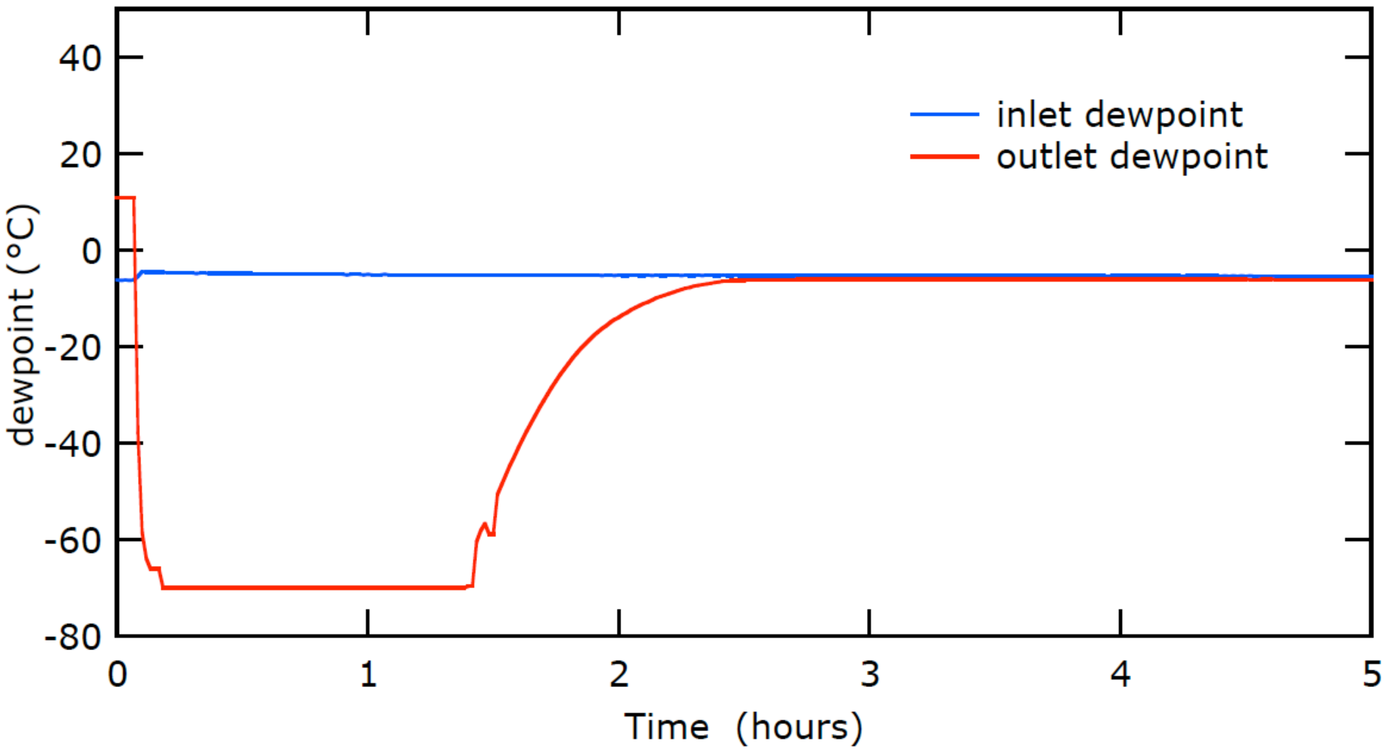


In line



inlet dewpoint
outlet dewpoint
dewpoint (°C)
40
20
0
-20
-40
-60
-80
0
1
2
3
4
5
Time (hours)

Proximal



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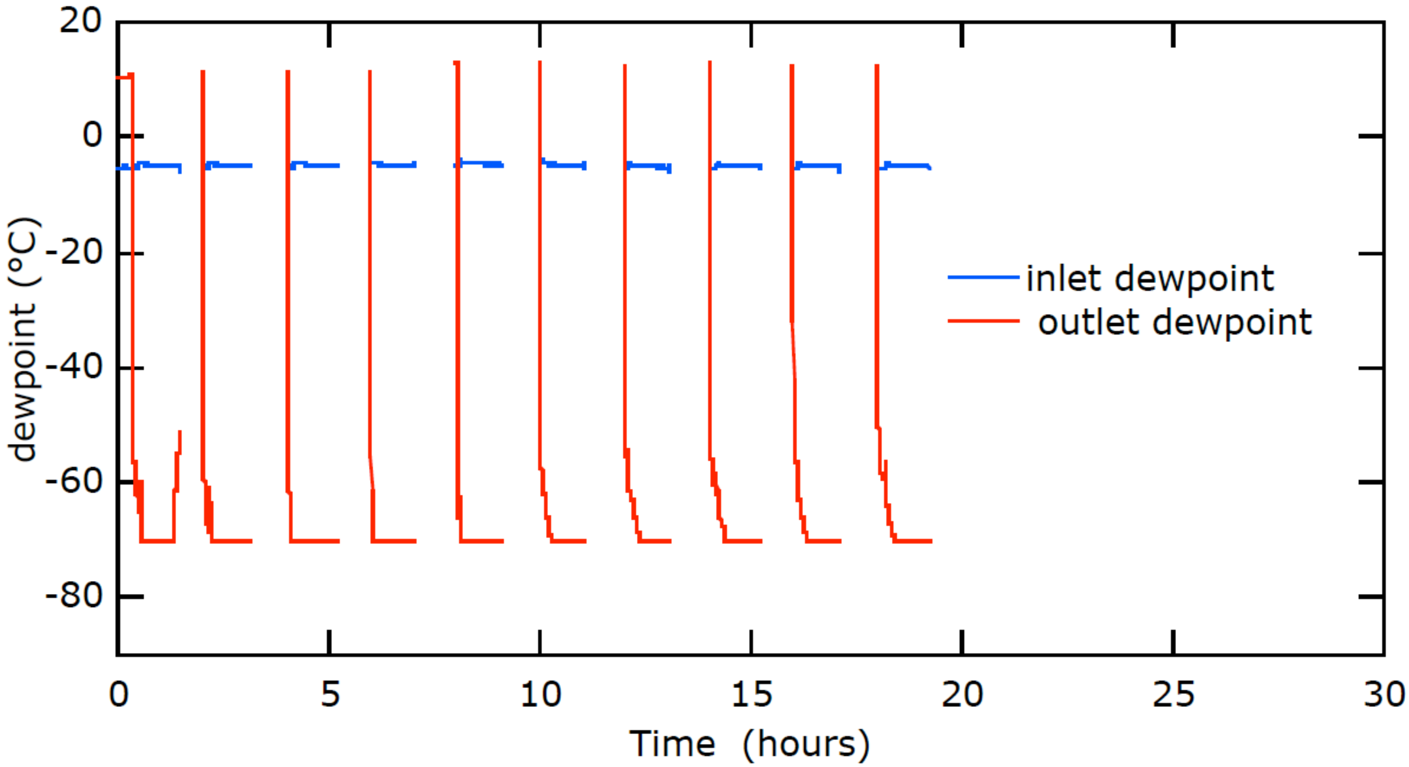
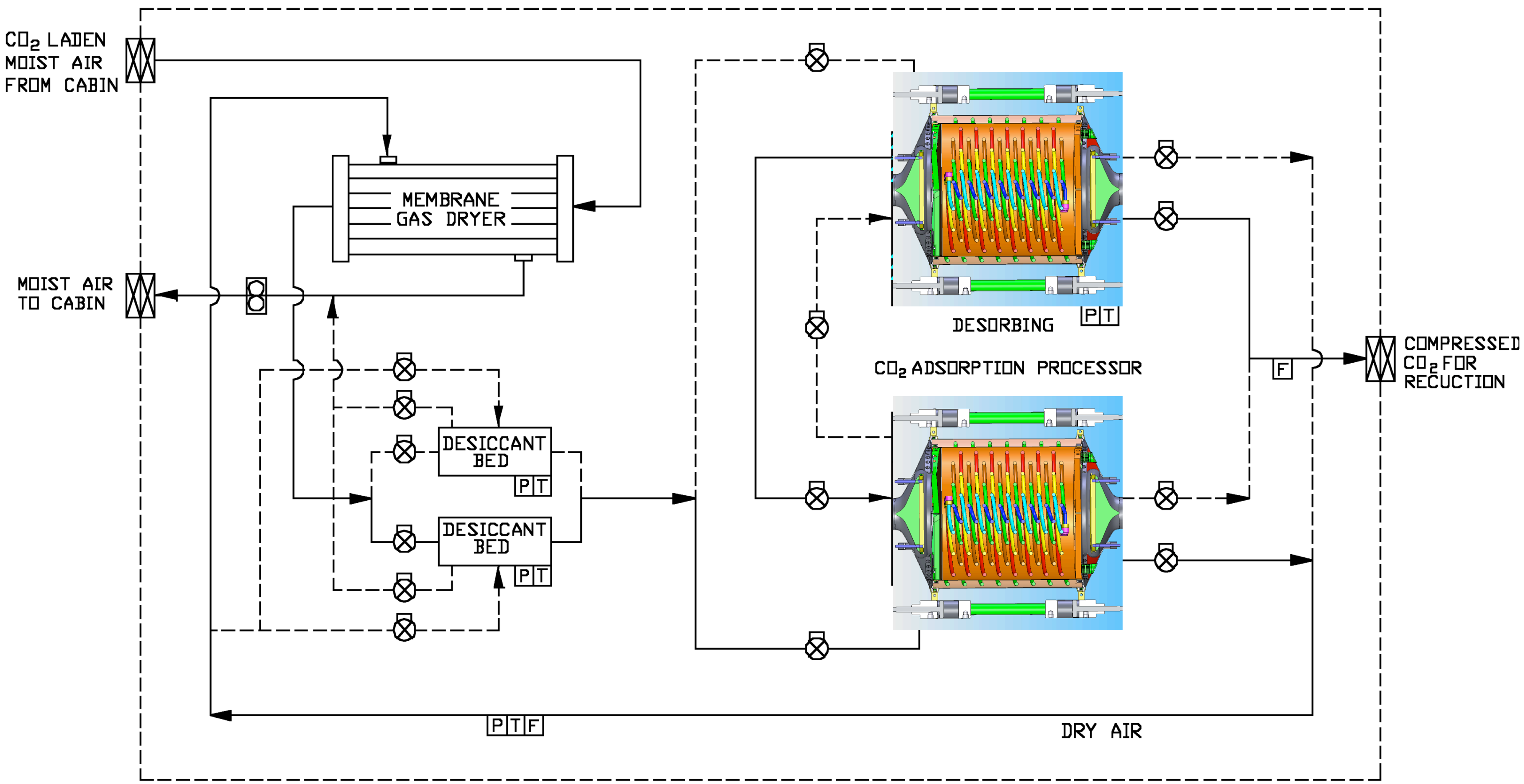


- 60-minute adsorption/desorption cycles
- Average power for desiccant regeneration – 250 W

Low Power CO2 Removal - LPCOR



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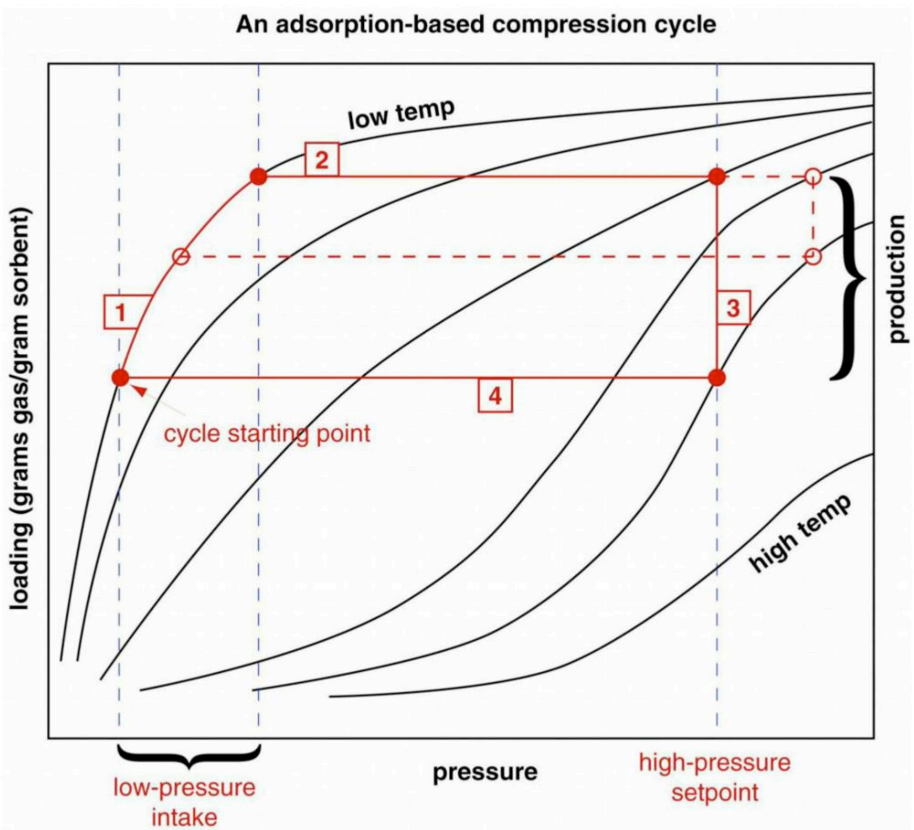
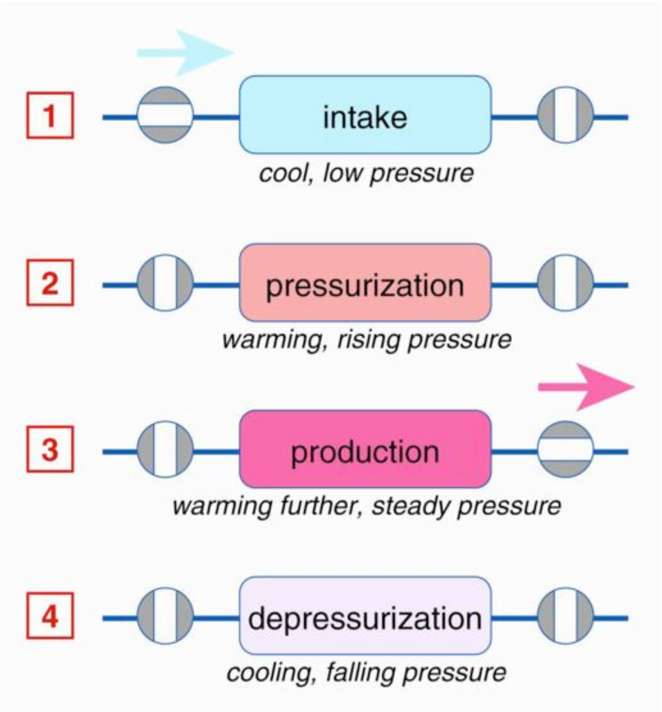
2-Stage Compressor

- Built-in inlet and outlet valves with integrated valve actuation assembly
- Concentric design with stage 1 embedded inside of stage 2
- Coiled heater assembly for uniform heating of each stage

Operating Principle of TSAC

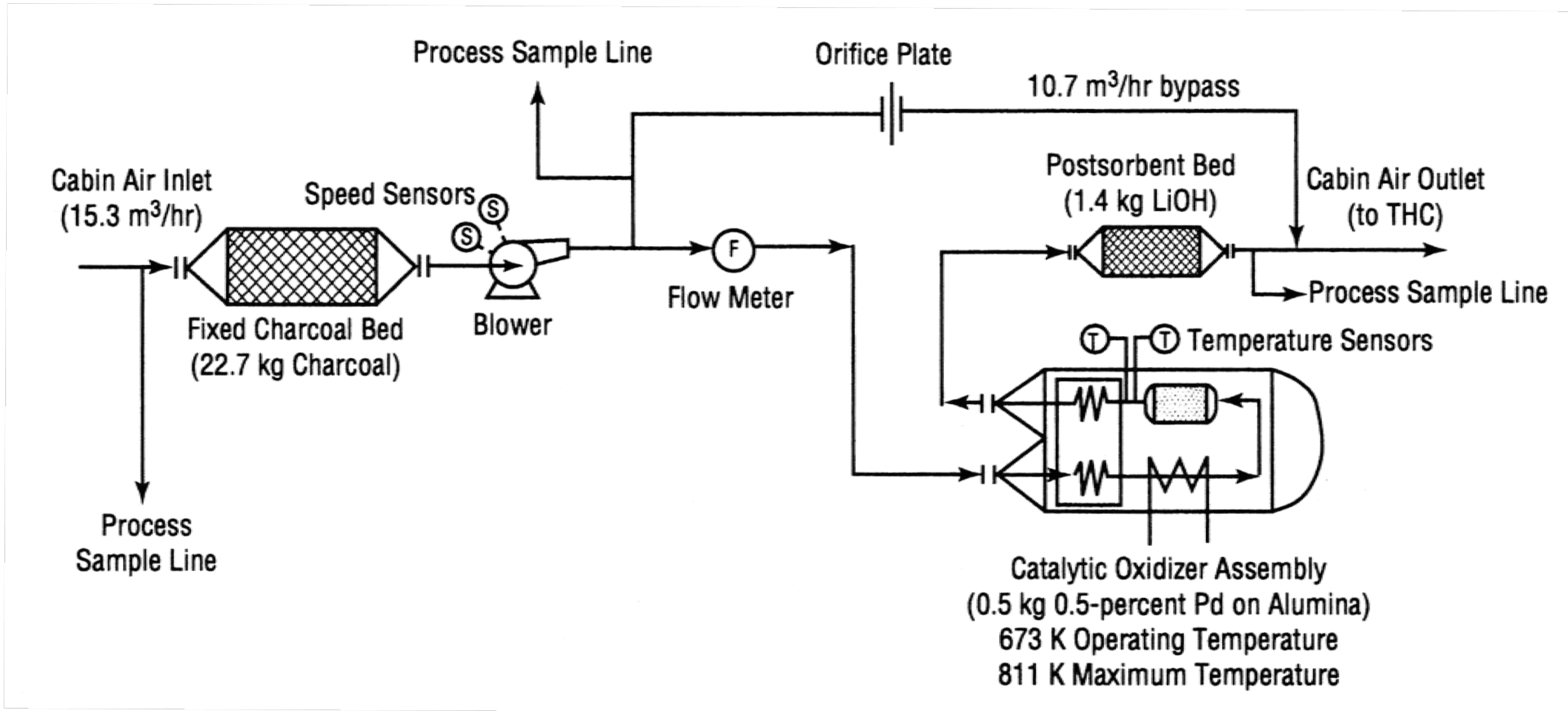




Adsorption vs. Mechanical Compressor

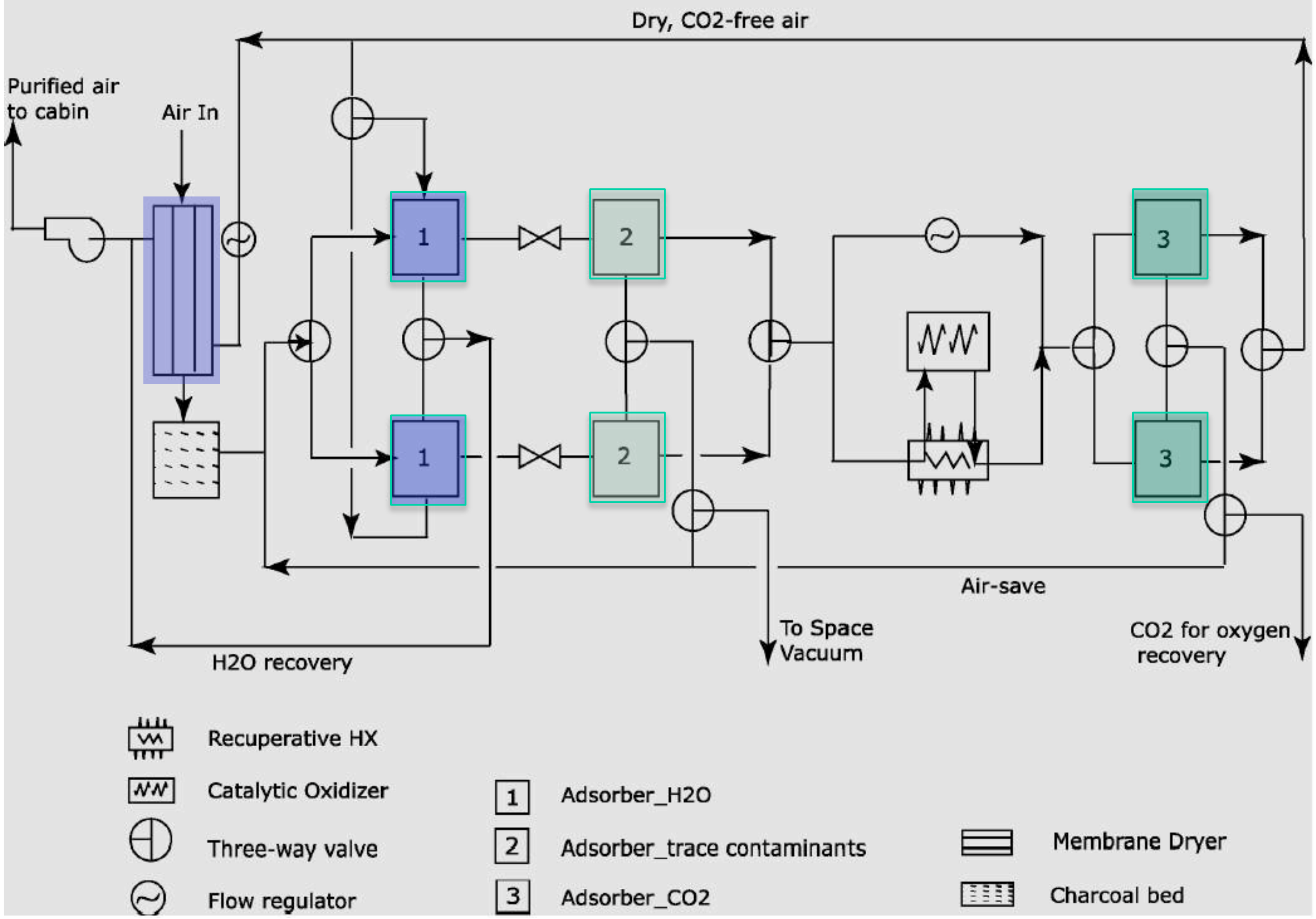
- No rapidly moving parts
- No vibration
- Proven reliability and sustainability

ISS CO_2 and TCCS - separate loops



Next Generation

- Combine CO_2 and TC functions
- Structured sorbents for low pressure drop and longevity



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- **QUESTIONS**