



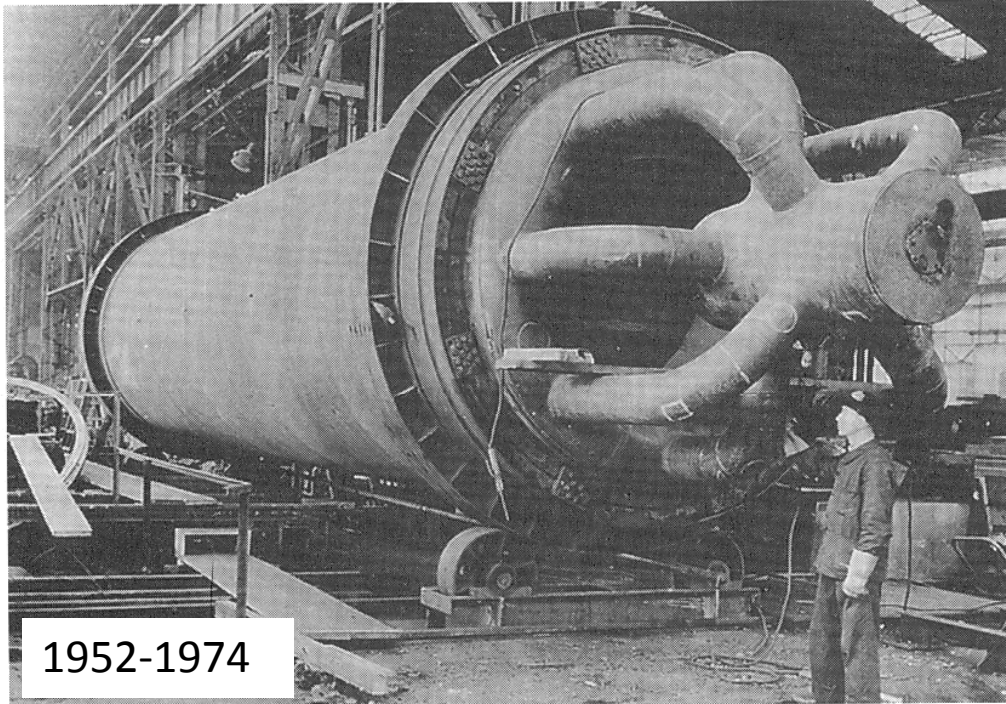
TESTING OF COMPACT RECUPERATORS FOR A SUPERCRITICAL CO₂ BRAYTON POWER CYCLE

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Recuperators Can Be Large



View of a recuperator with plain tubes for a 12 MW installation.

Source: Frutschi, *Closed-Cycle Gas Turbines – Operating Experience and Future Potential*, 2005

Fluid: air-to-air

Heat Transfer Surface: Tubes-Baffled flow

Diameter: 3,100 mm (10.2 ft)

Length: 12,680 mm (41.6 ft)

Output power: 12 MWe

Efficiency: 28 percent

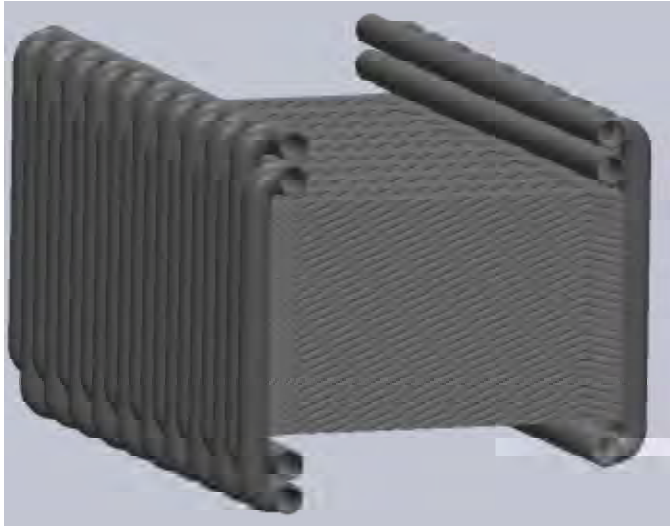
Estimated Capacity of Recuperator:

$(12 \text{ MWe}/0.28) \times (1/2) = \underline{21.4 \text{ MWt}}$

(assuming half of the heat input is from the recuperator)



A Compact Recuperator



Fluid: CO₂-to-CO₂
Heat Transfer Surface: wavy-fin
Size: 32.5x46x55 inches

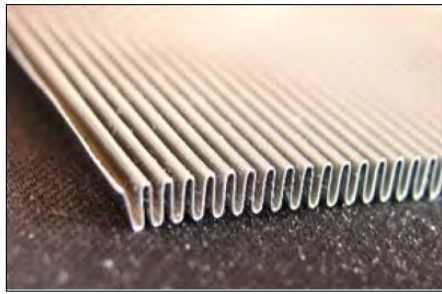
Design Capacity of Recuperator:

18.7 MWt

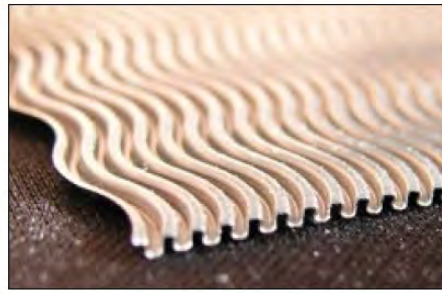
(Pressure Drop: <10 psi)

Heat Transfer Surface

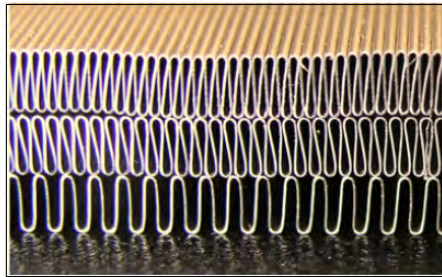
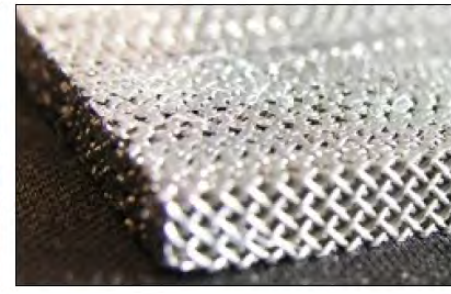
Straight Fin



WavyFin



Wire Mesh



Assembly

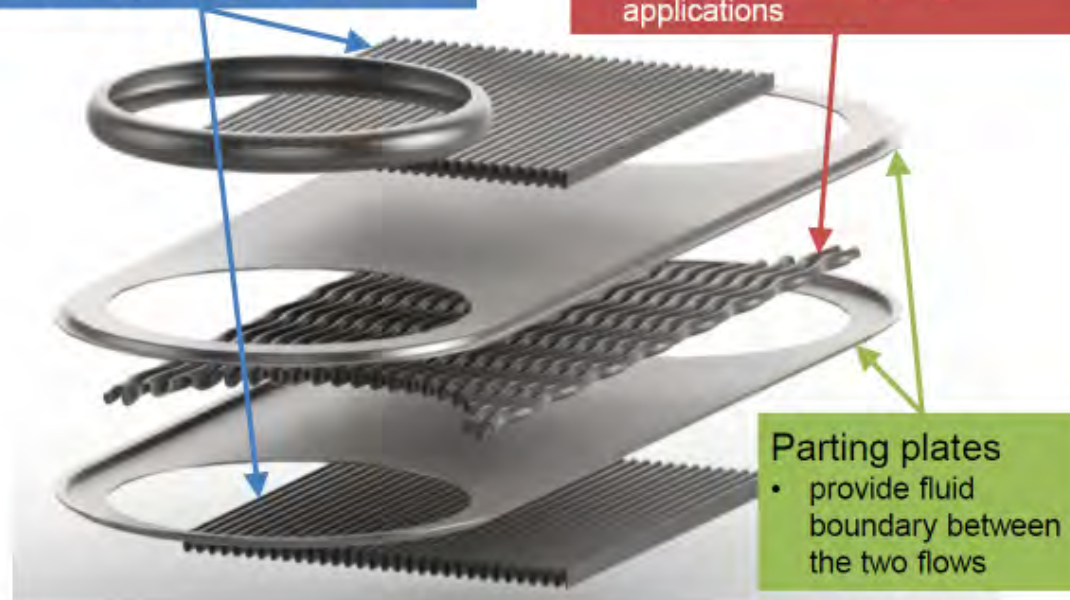
The Plate-Matrix Unit Cell

External low-pressure matrices

- Enhances the heat transfer of the low-pressure fluid as it flows between adjacent unit cells

Internal high-pressure matrix

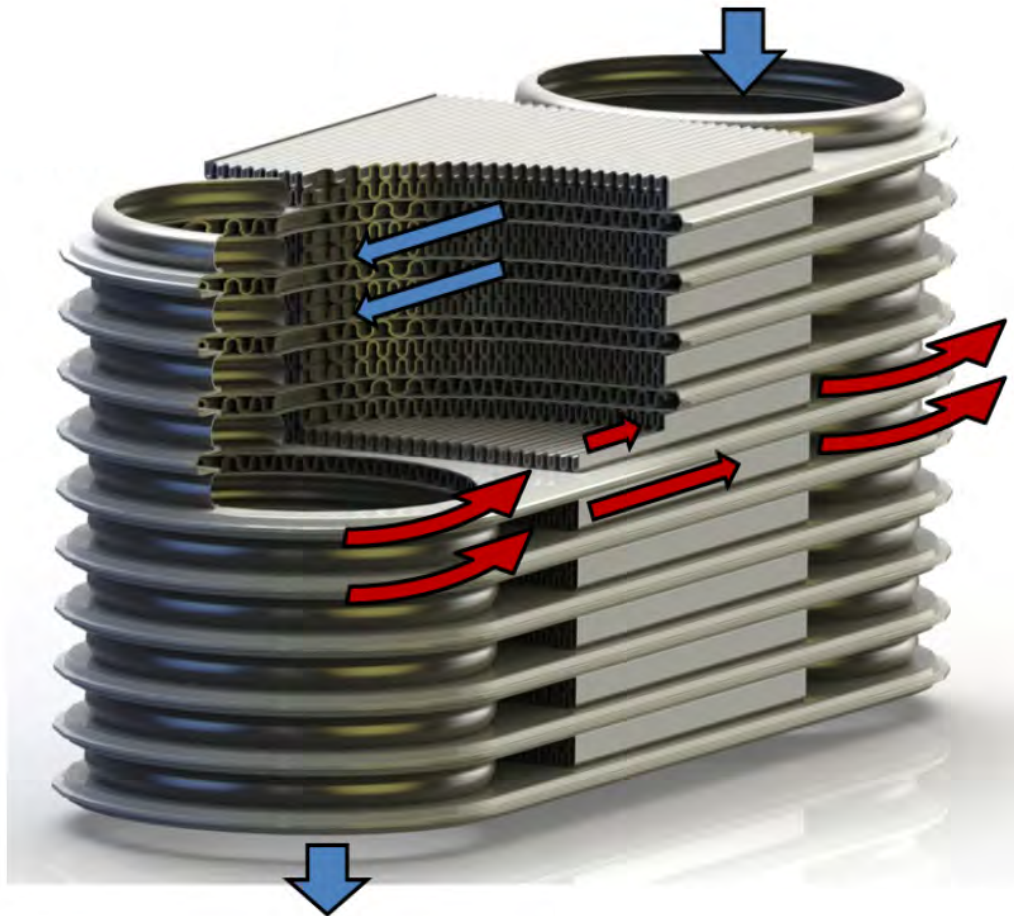
- Enhances the heat transfer of the high pressure fluid as it flows between the two parting plates
- Can serve as structural features for high-pressure (sCO₂) applications



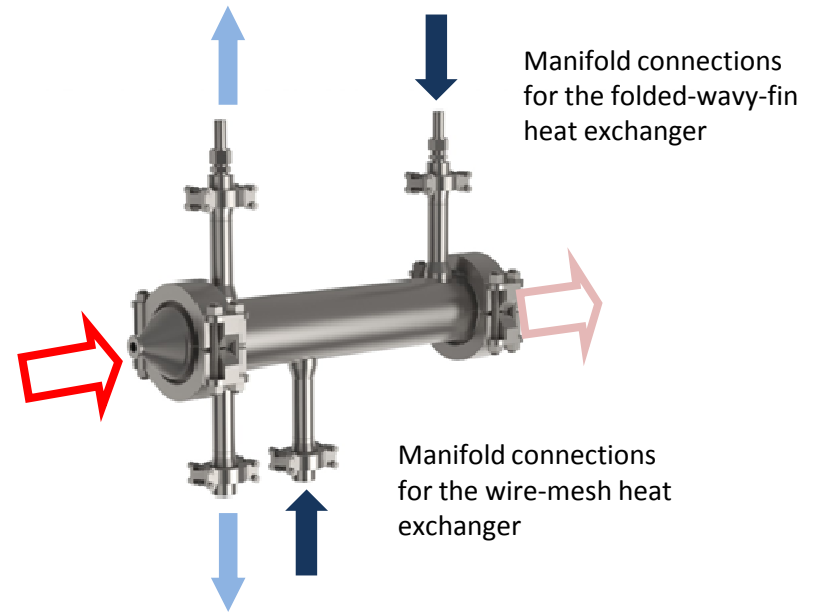
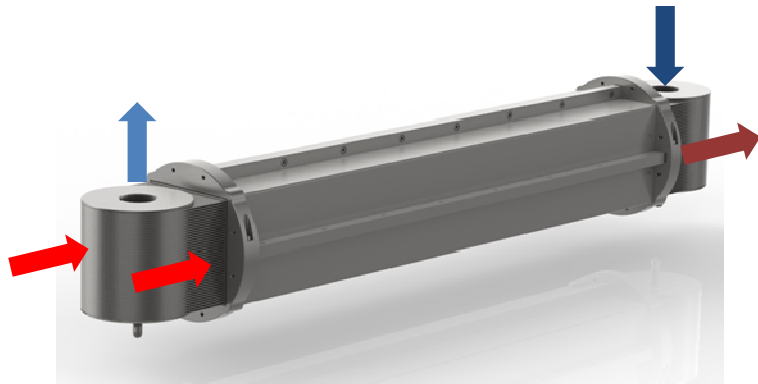
Parting plates

- provide fluid boundary between the two flows

Flow Configuration



Validate



Testing

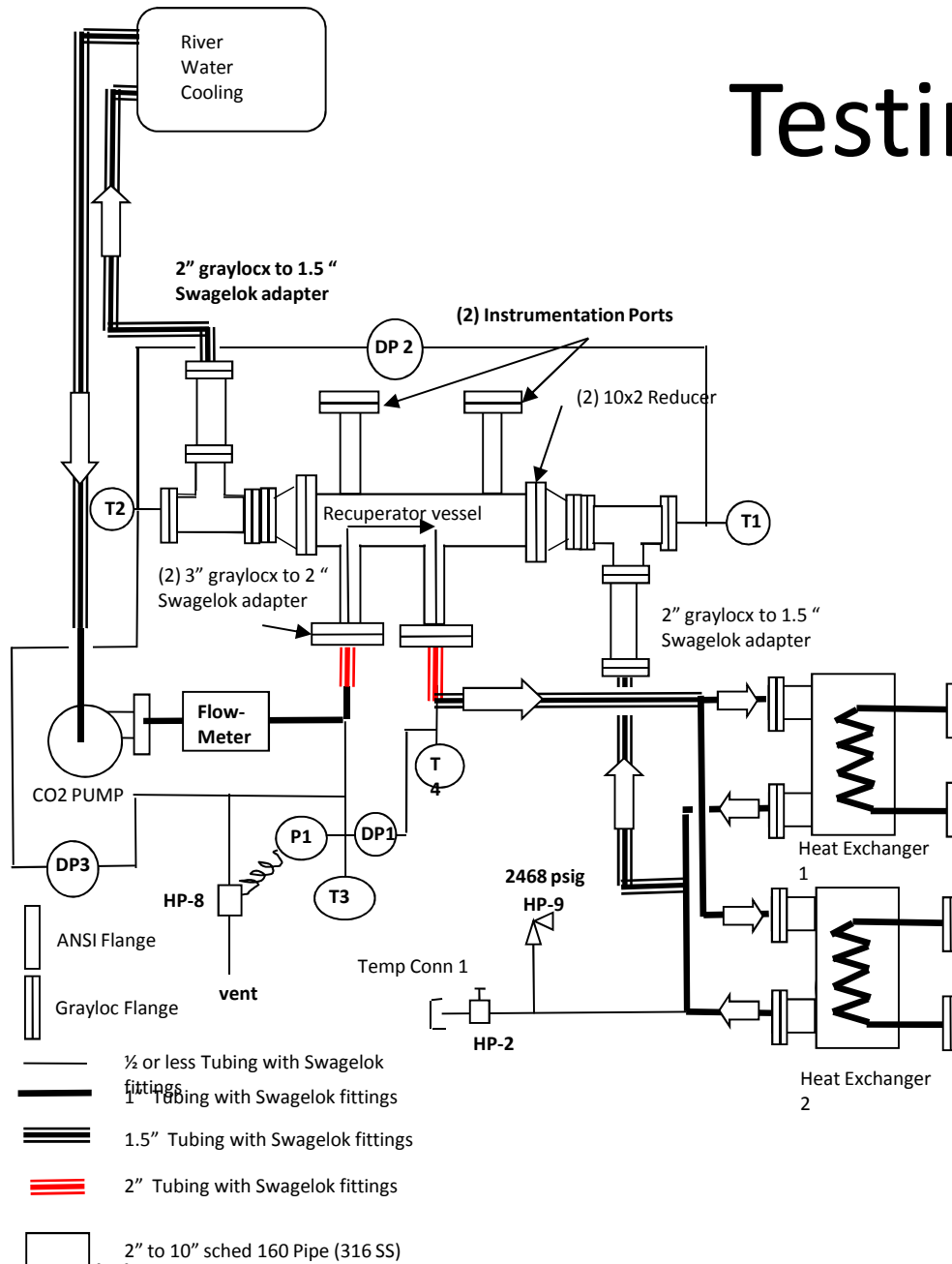
Testing Conditions:

Heat Input/Rejection 20-90 kW_t

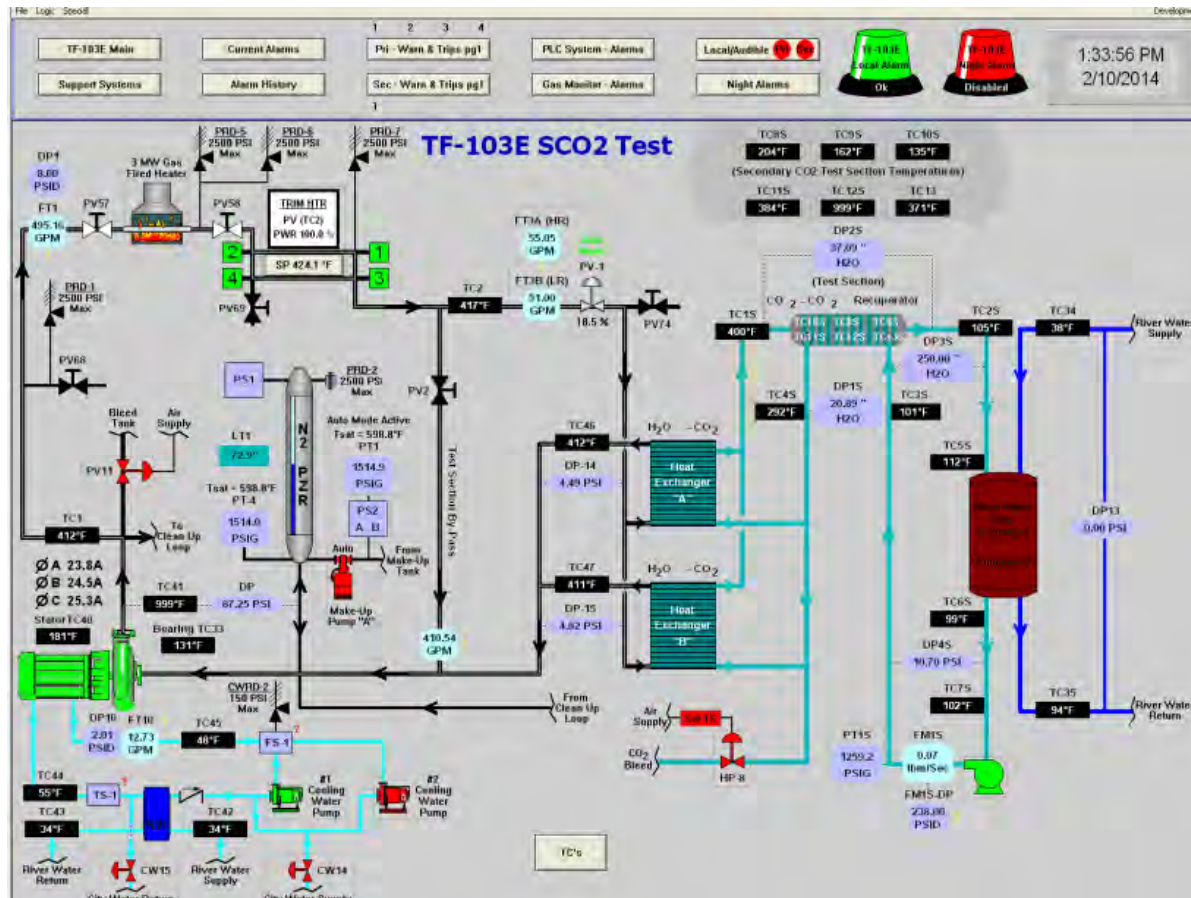
Pressure: ≈1,200-1,500 psi

Temperature: ≈300-500°F

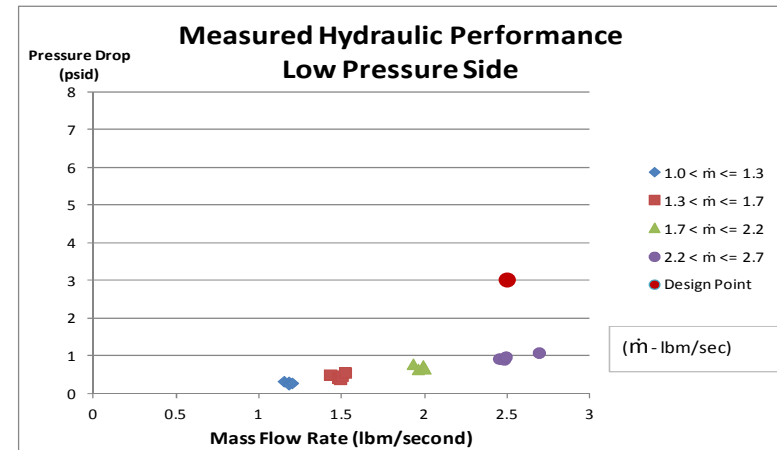
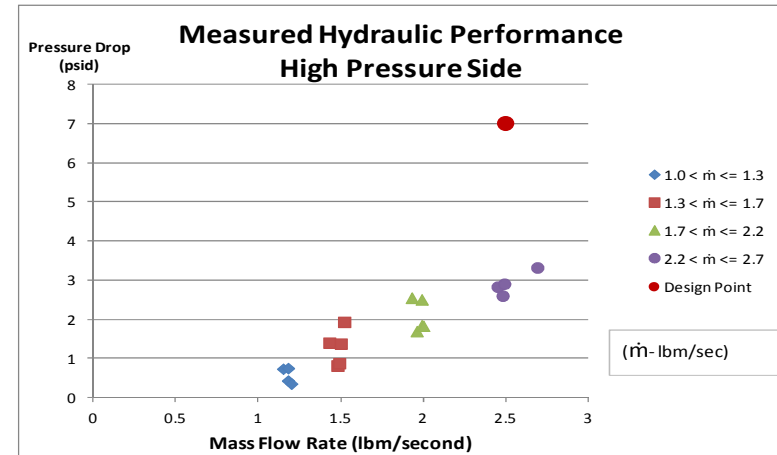
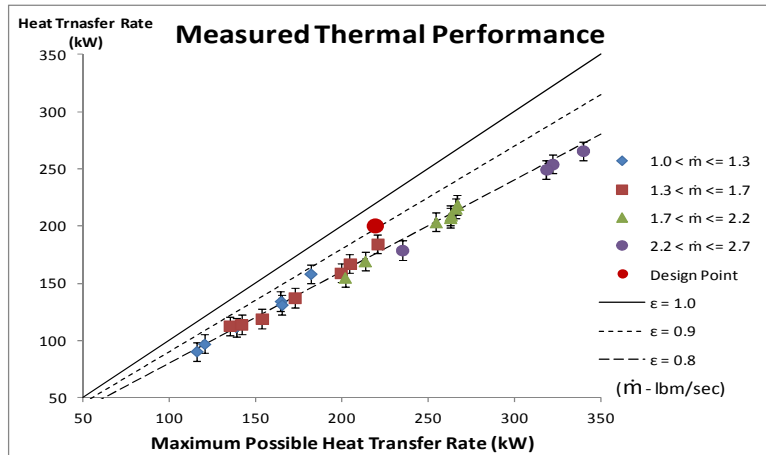
Flow rate: ≈2-3 lbm/second



Testing



Folded Wavy-Fin Results



Prototype demonstrated thermal-hydraulic performance.

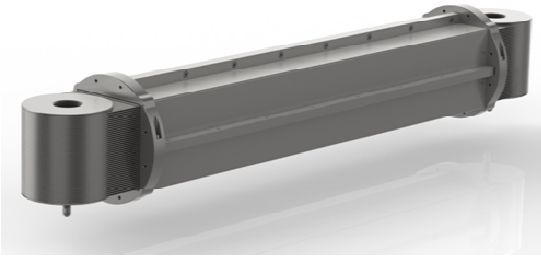


Future

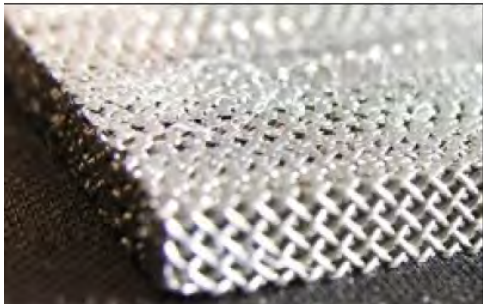
WavyFin



$\beta=3,300-4,500 \text{ m}^2/\text{m}^3$



Wire Mesh



$\beta=7,000-8,000 \text{ m}^2/\text{m}^3$

