Thermal and Hydraulic Characterization of supercritical CO_2 flow in Additively Manufactured Pin-fin Heat Sinks

Supercritical CO_2 Power Cycles Symposium

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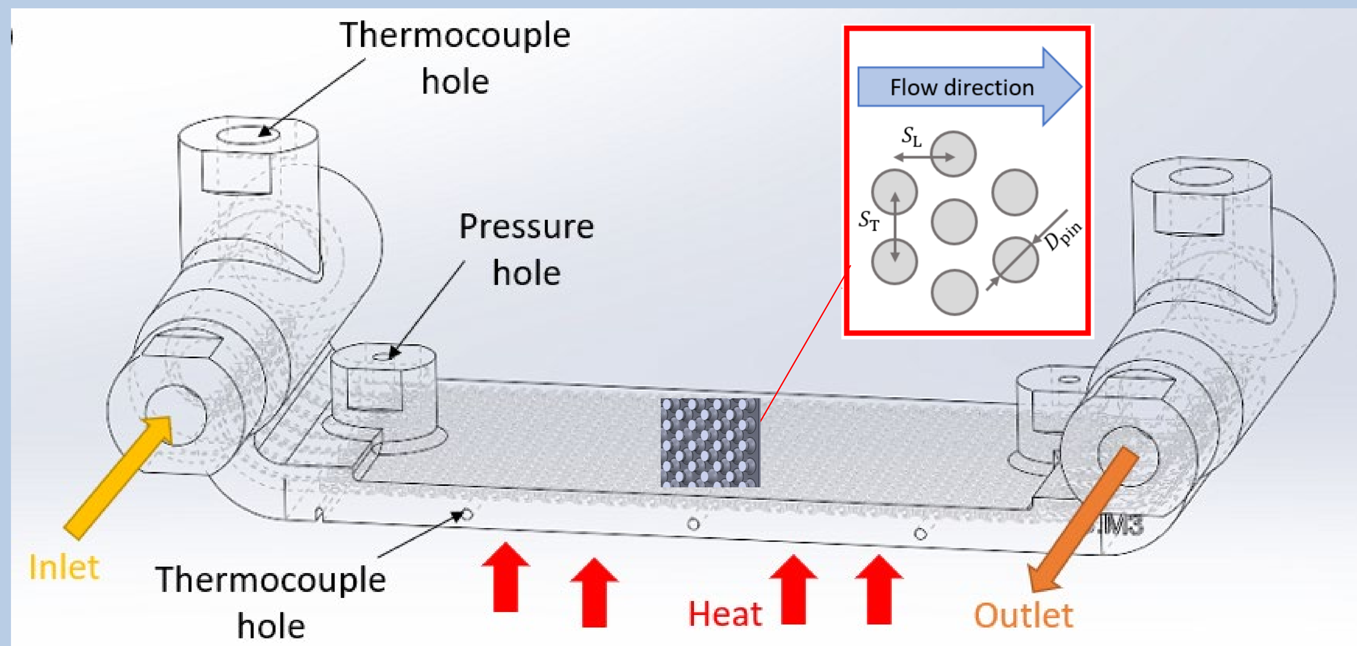
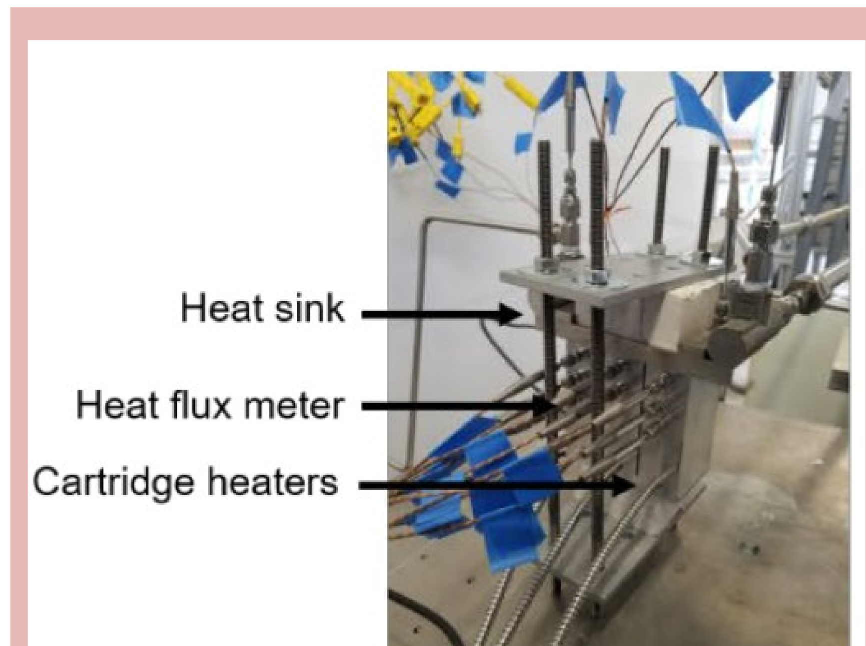


Heat sink design based on creep life for full-scale HX

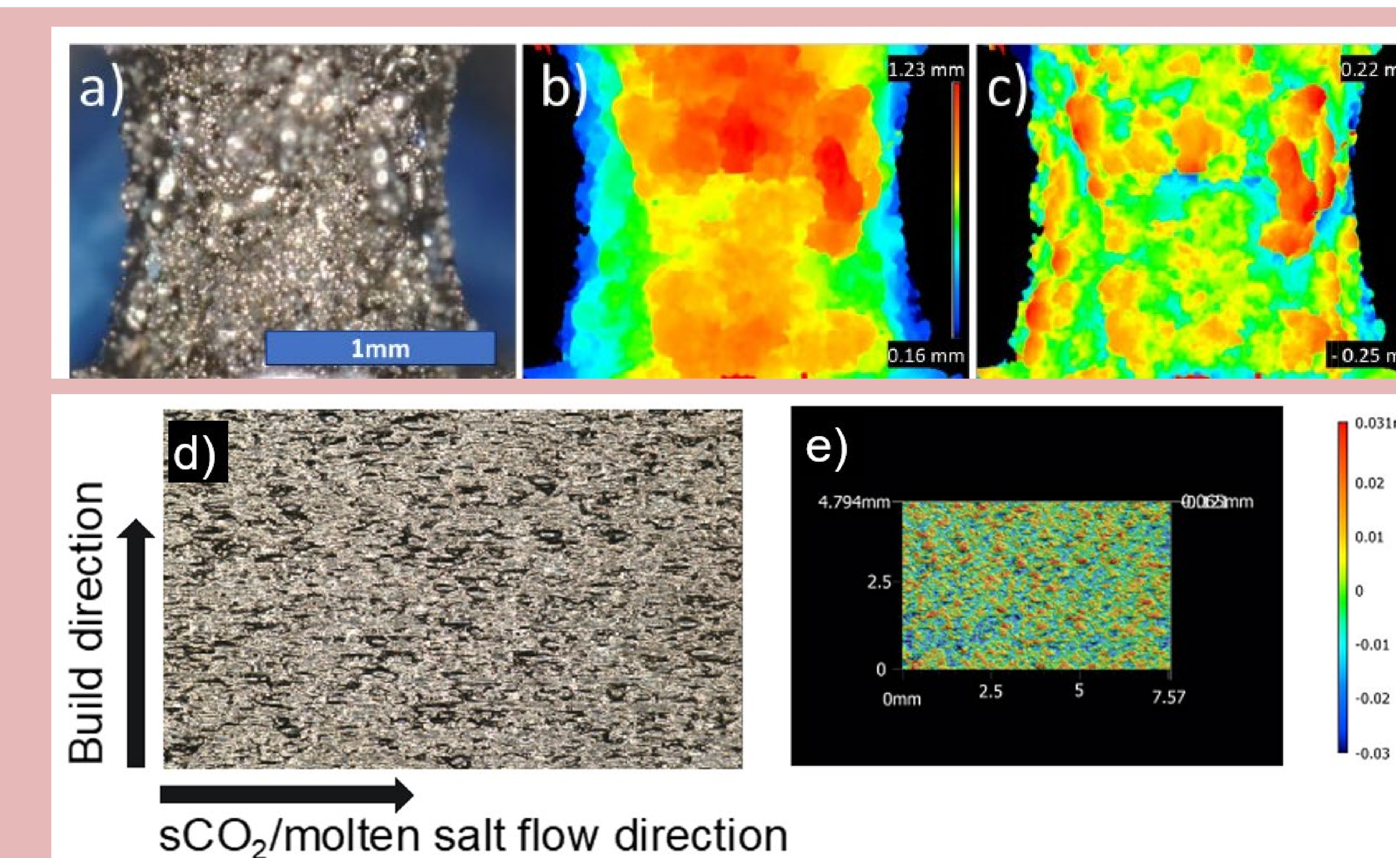
Motivation and Objectives:

- AM monolithic structure advantage for heat exchanger (HX) design
- Development of correlations for sCO2 flow in pin arrays for efficient heat exchanger design
- Study of AM-induced surface roughness effect on heat transfer and pressure drop



	Baseline	v1	v2	v3	v4
Design cross-section					
Printed cross-section	Build				
Aspect ratio, $\alpha = \frac{Height}{Diameter}$	Flow, Build				
Aspect ratio, α	1.64	0.73	2.73	1.64	1.64
Pitch ratio $\beta_{T,L} = \frac{S_{T,L}}{Diameter}$					
Transverse pitch ratio, β_T	2.43	1.49	2.43	3.82	2.43
Longitudinal pitch ratio, β_L	2.11	1.29	2.11	3.31	3.04

Experimental testing with system pressure up to 120 bar and inlet T_{sCO_2} up to 300°C

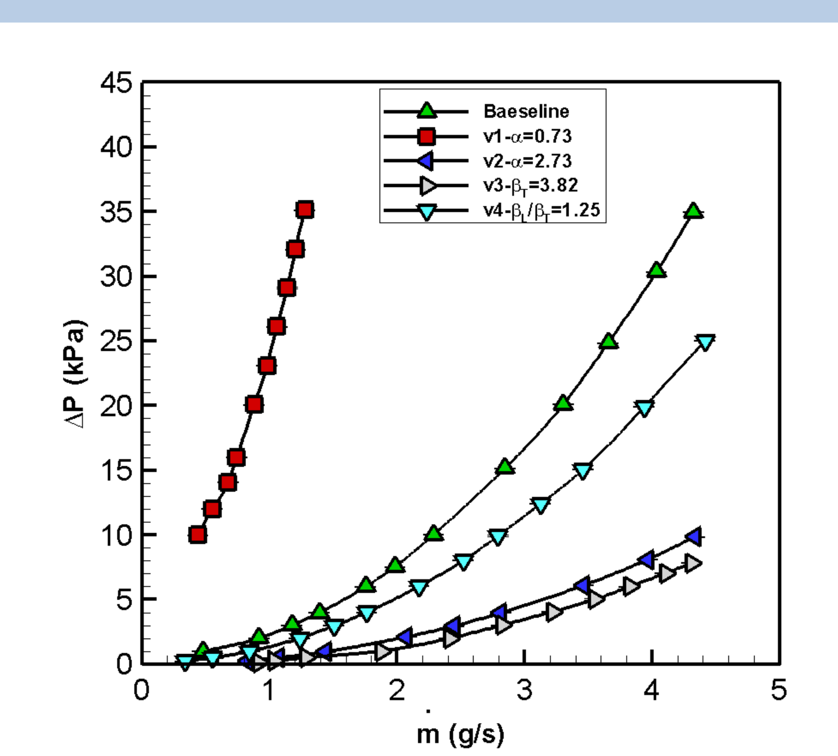


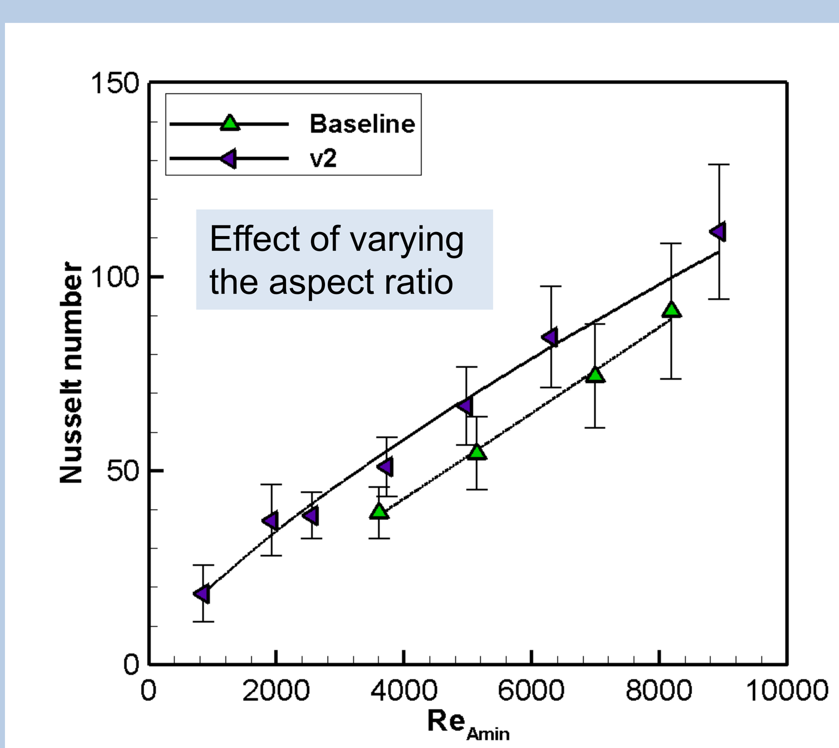
Printing and roughness characterization

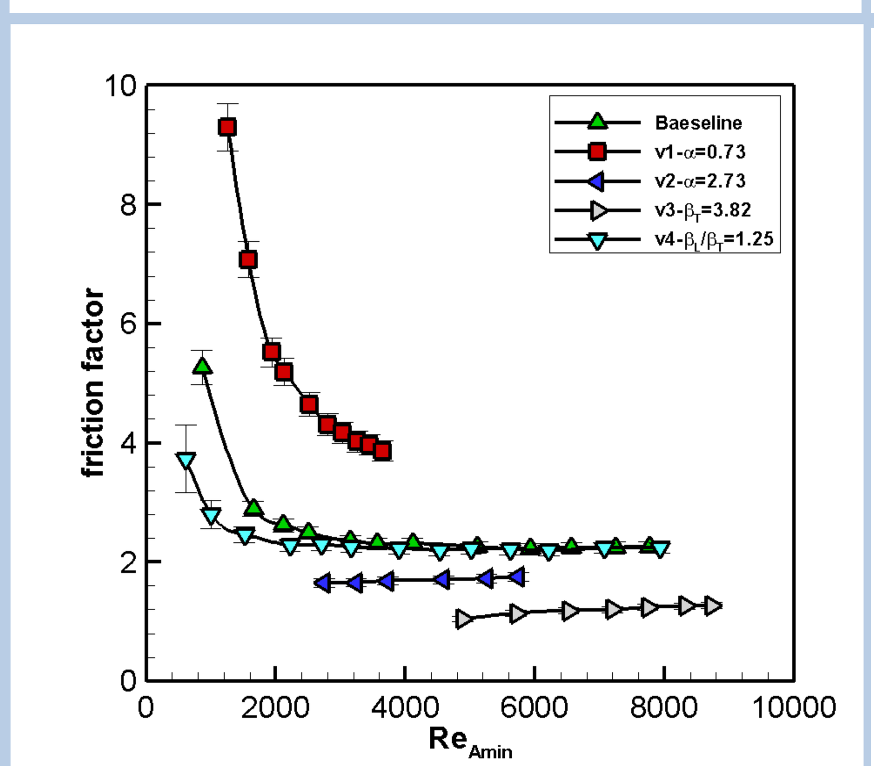
a-c) Downskin pin surface
d-e) Vertical wall surface

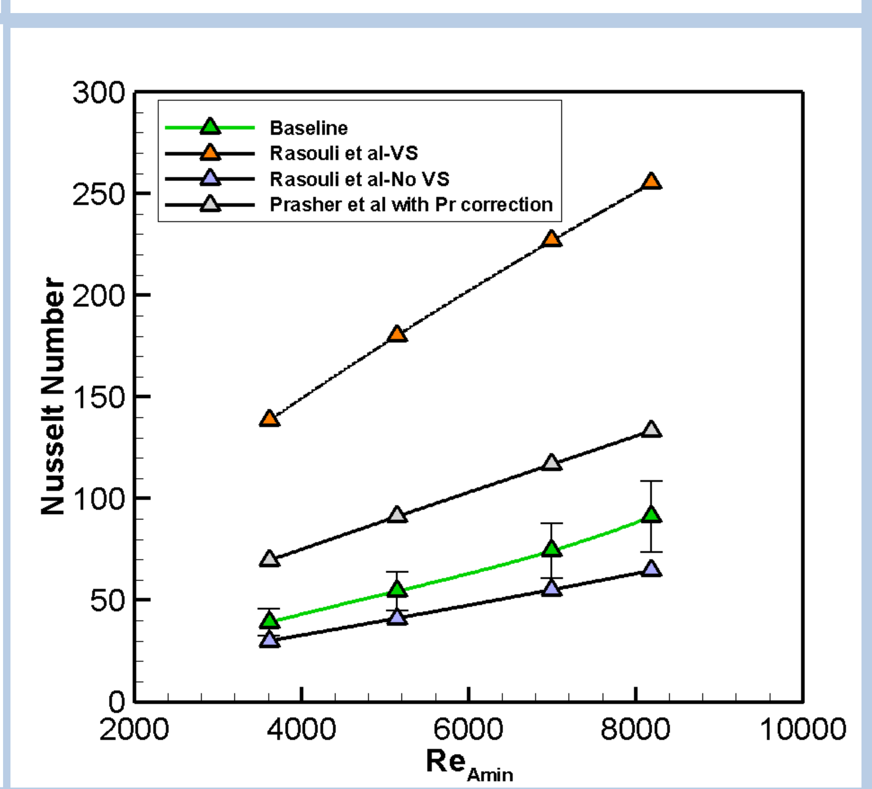
Abrasive Flow Machining (AFM)

Heat sink	Surface	Sa (µm)	Sz (µm)	Standard deviation of Sa (µm)	Standard deviation of Sz (µm)
Before AFM	Internal wall	11.8	239.8	1.1	157.7
After AFM	Internal wall	9.5	159.8	1.0	115.6

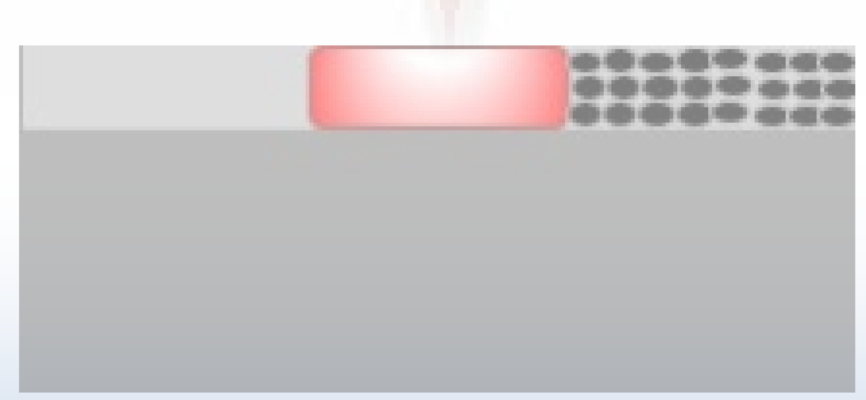




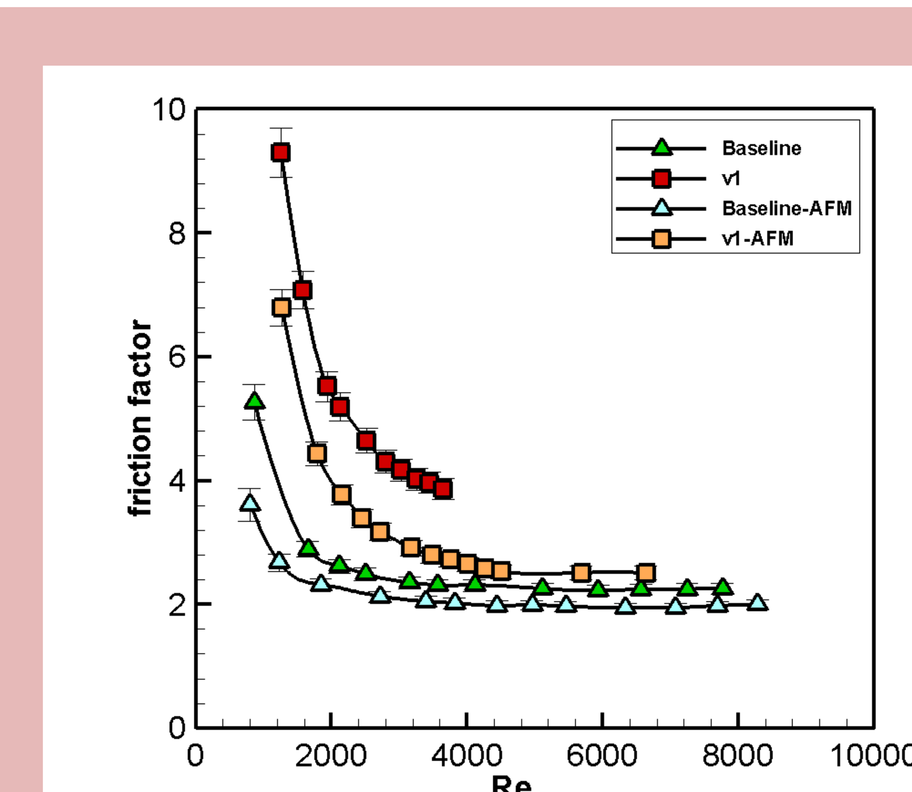


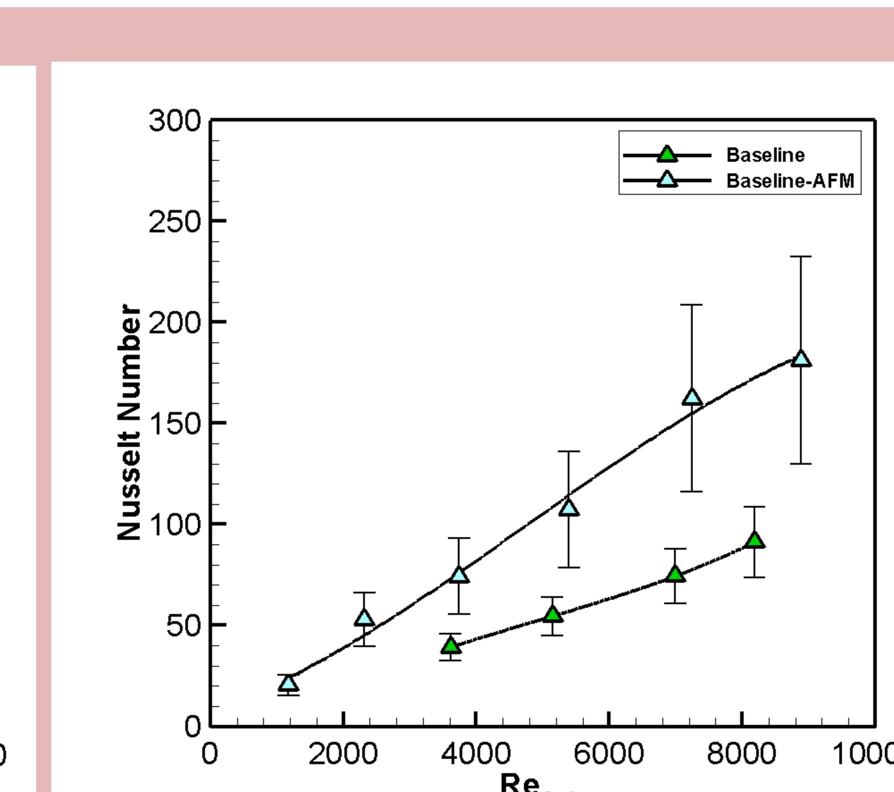


Heat transfer and pressure drop results



Experiments results before and after AFM





Conclusions:

- The impact of AFM is seen in pressure drop and heat transfer
- Need for heat transfer and pressure drop correlations with effect of surface roughness

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