

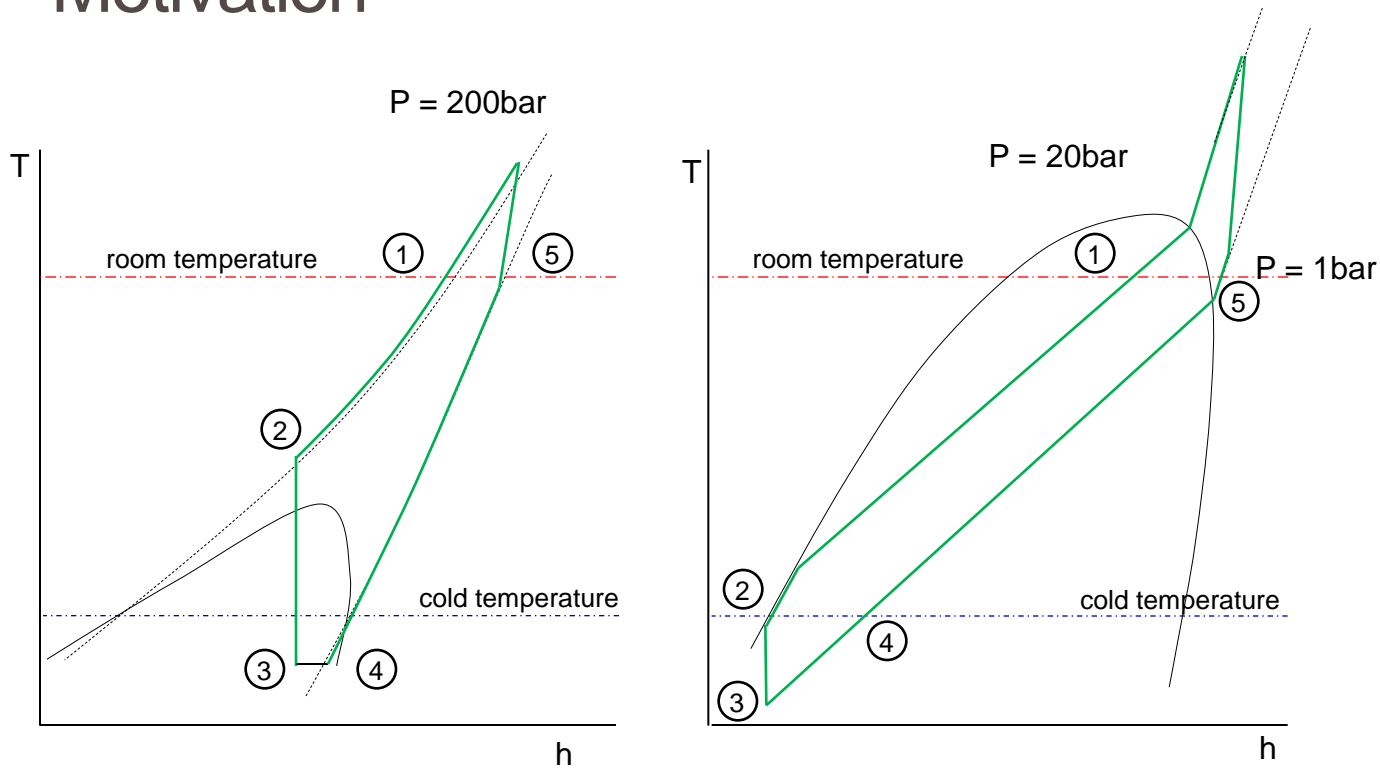
Measurements of convection heat transfer coefficients for hydrocarbon mixtures during boiling in a heated horizontal pipe from 100 K to room temperature



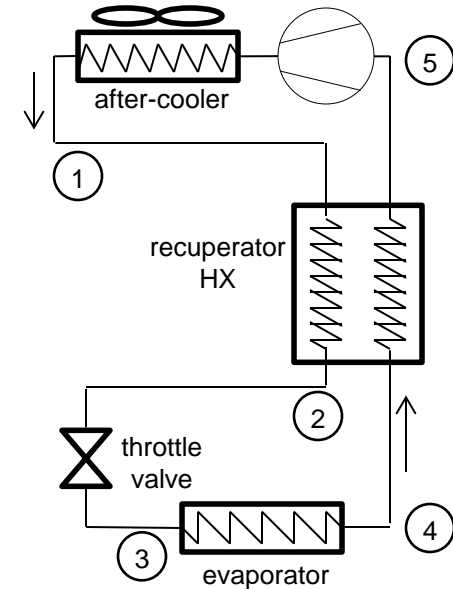
Solar Energy Lab
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Motivation



- MRJT applications: cryosurgical probes, cooling infrared sensors, cryopreservation, liquefaction, biomedical samples, and current leads
- Understand the Thermodynamics of mixture, phase diagrams
- Heat Exchanger - Crucial component and understand the thermal behavior of gas mixtures.

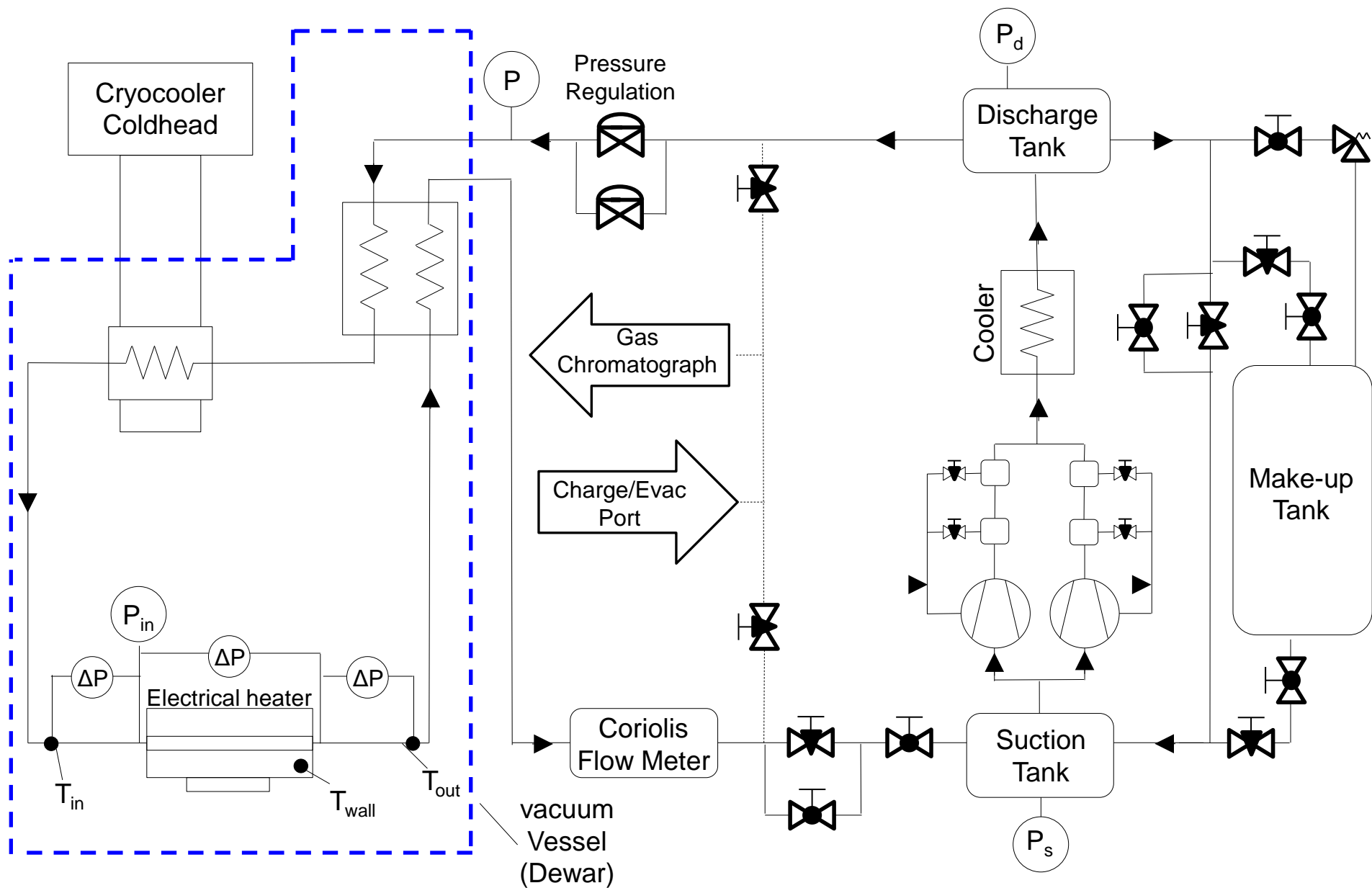


JT:

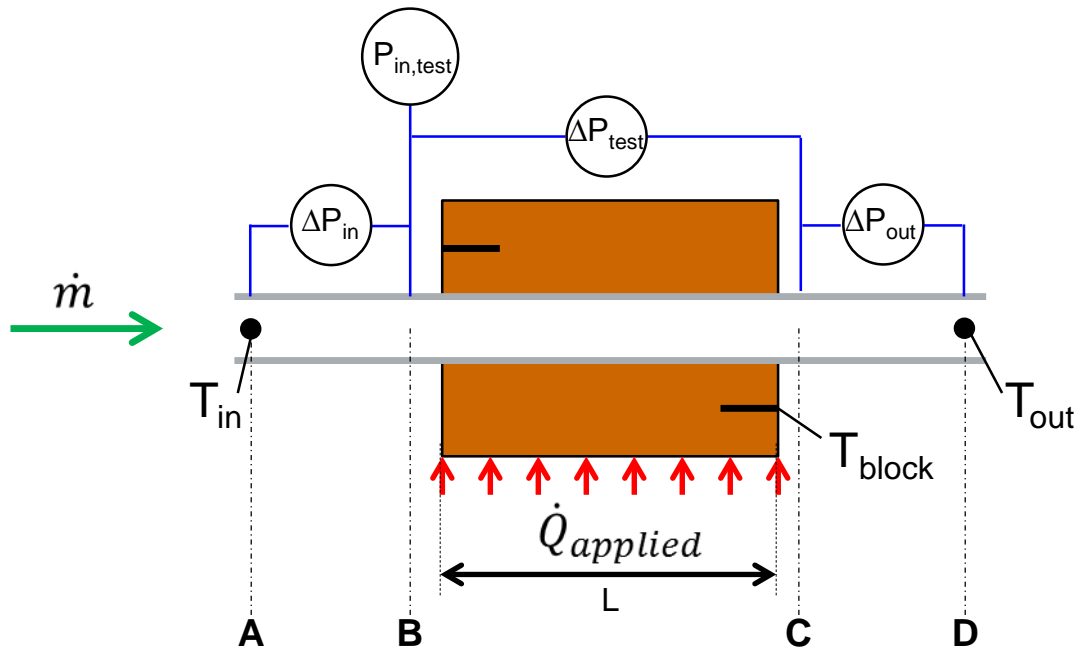
- low thermal efficiency
- low cost
- high reliability
- Scalable to small loads

MRJT:

- higher thermal efficiency
- low cost AC compressor



Test section & measured parameters



New Test section

stainless steel pipe (304)

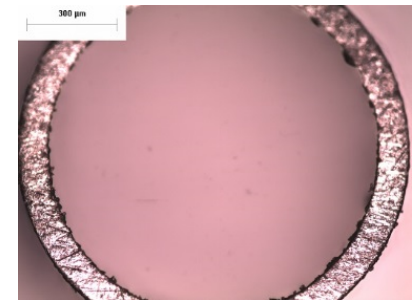
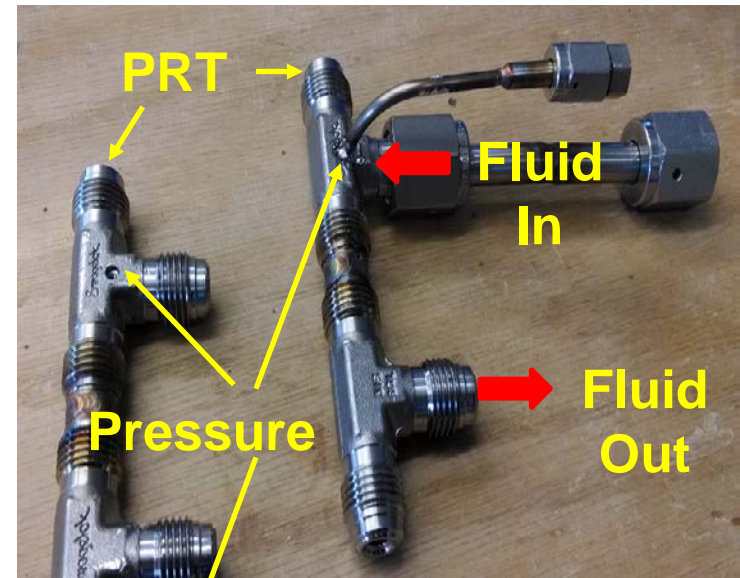
inner diameter	ID	mm	1.53
Outer diameter	OD	mm	1.82
Wall thickness	th	mm	0.15

Copper block

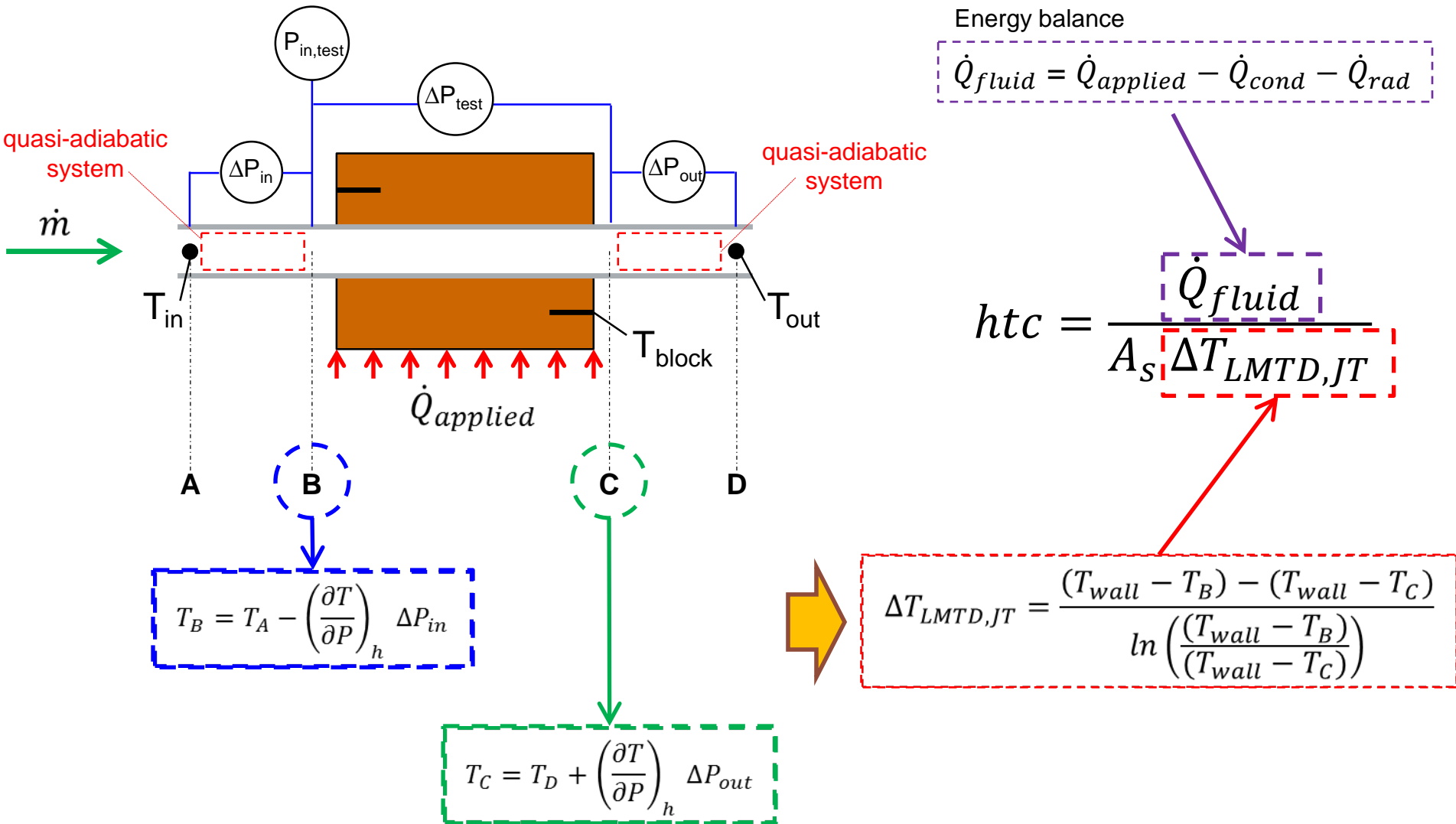
Location PRTs	D_{PRTs}	mm	9.53
Outer diameter	D_{block}	mm	19.05
Length	L	mm	52.50

- A : Test section approach (T_{in} is measured 2 PRTs)
- B : Actual inlet to the active portion (P is measured)
- C : Actual outlet
- D : Test section departure (T_{out} is measured 2 PRTs)

Current Test Section

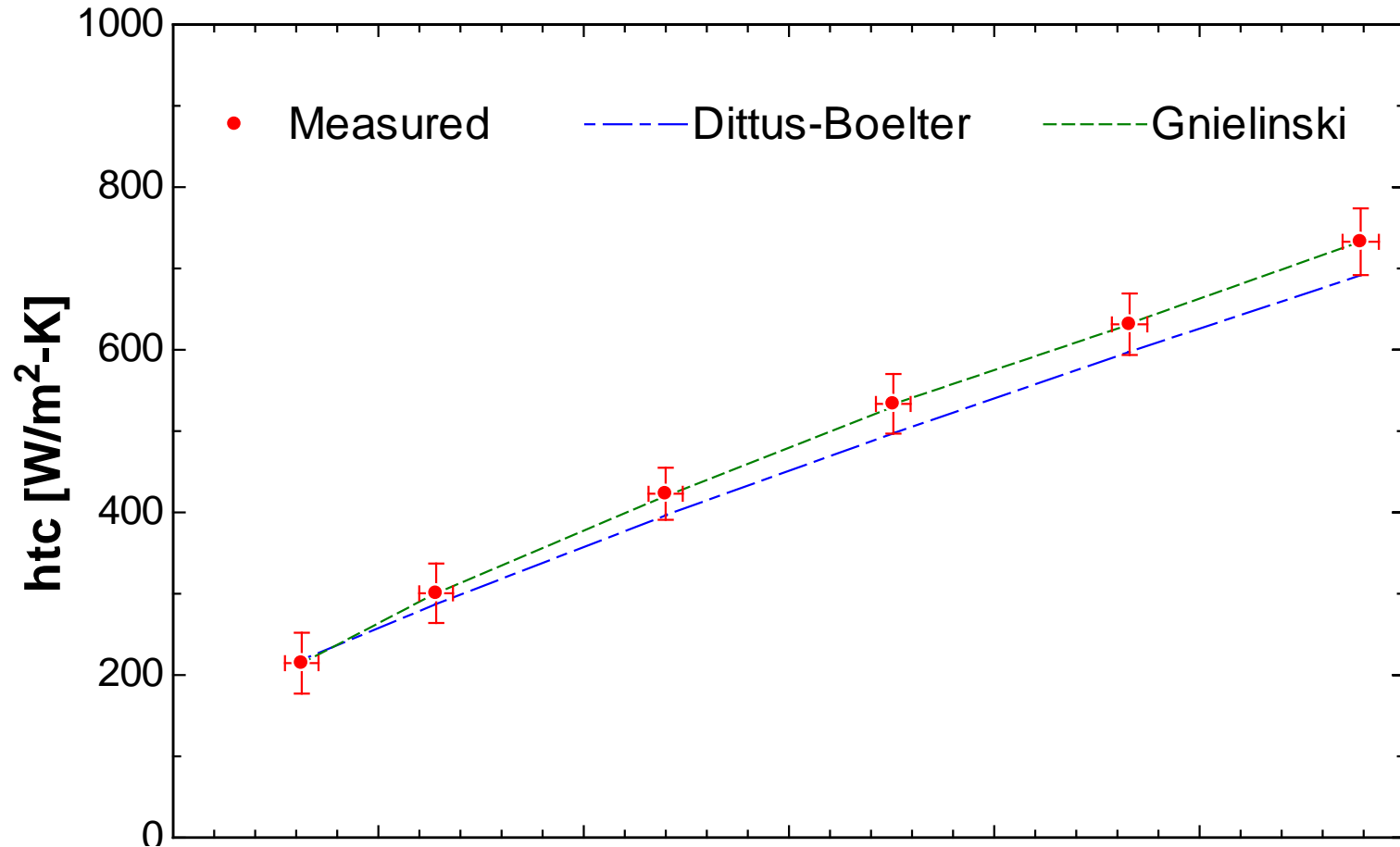


Data reduction



Test facility validation

- Heat transfer coefficient for pure single phase nitrogen



Results

Run	Mixture	Charge composition	P kPa	G kg/s-m ²	q" kW/m ²	T @ x=0 K	T @ x=1 K
1	CH ₄ - C ₂ H ₆ - C ₃ H ₈	0.45/0.35/0.20	270	150	56.7	132.0	217.2
2	CH ₄ - C ₂ H ₆ - C ₃ H ₈	0.45/0.35/0.20	270	150	85.2	132.0	217.2
3	CH ₄ - C ₂ H ₆ - C ₃ H ₈	0.41/0.37/0.22	270	250	56.7	133.3	221.4
4	CH ₄ - C ₂ H ₆ - C ₃ H ₈	0.44/0.36/0.20	780	150	56.7	157.8	246.6
5	CH ₄ - C ₂ H ₆ - C ₃ H ₈ - N ₂	0.34/0.30/0.19/0.17	780	150	56.7	102.2	241.1
6	CH ₄ - C ₂ H ₆ - C ₃ H ₈ - N ₂	0.25/0.22/0.15/0.38	780	150	56.7	102.7	235.8

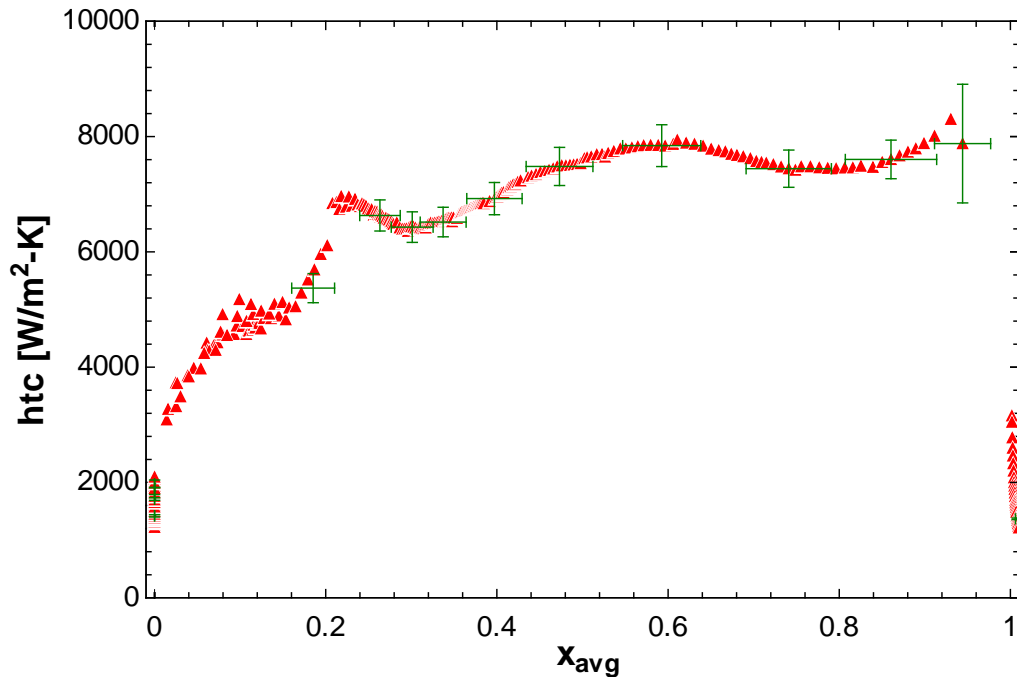
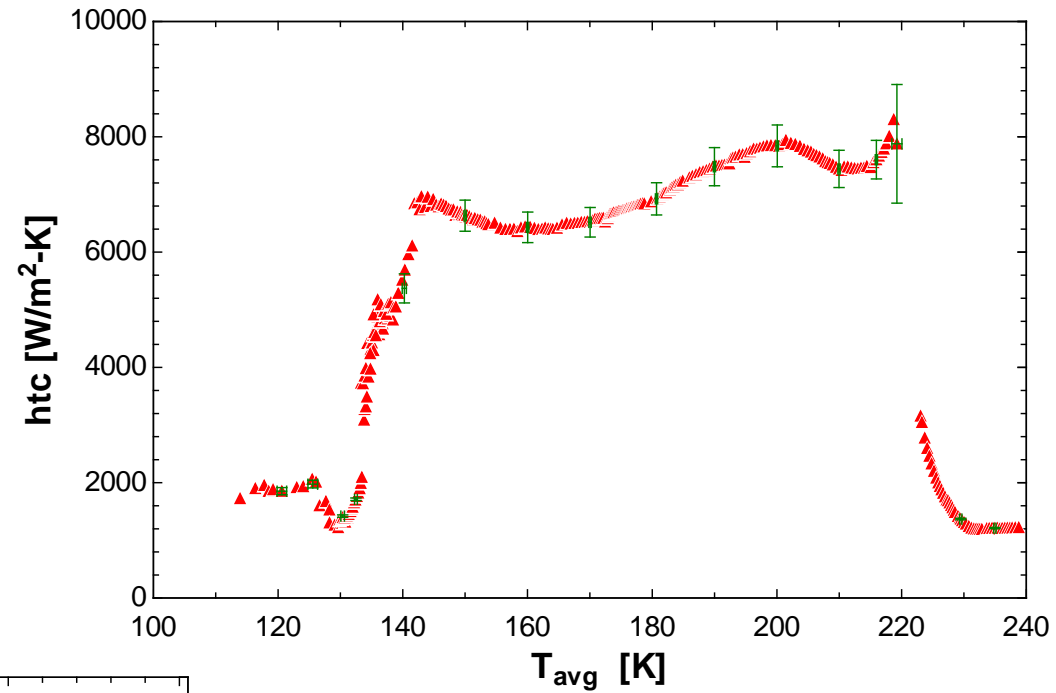
Results

Hydrocarbon mixture (Run 3)

$$G = 150 \text{ kg/s-m}^2$$

$$q'' = 56.7 \text{ kW/m}^2$$

$$P = 780 \text{ kPa}$$

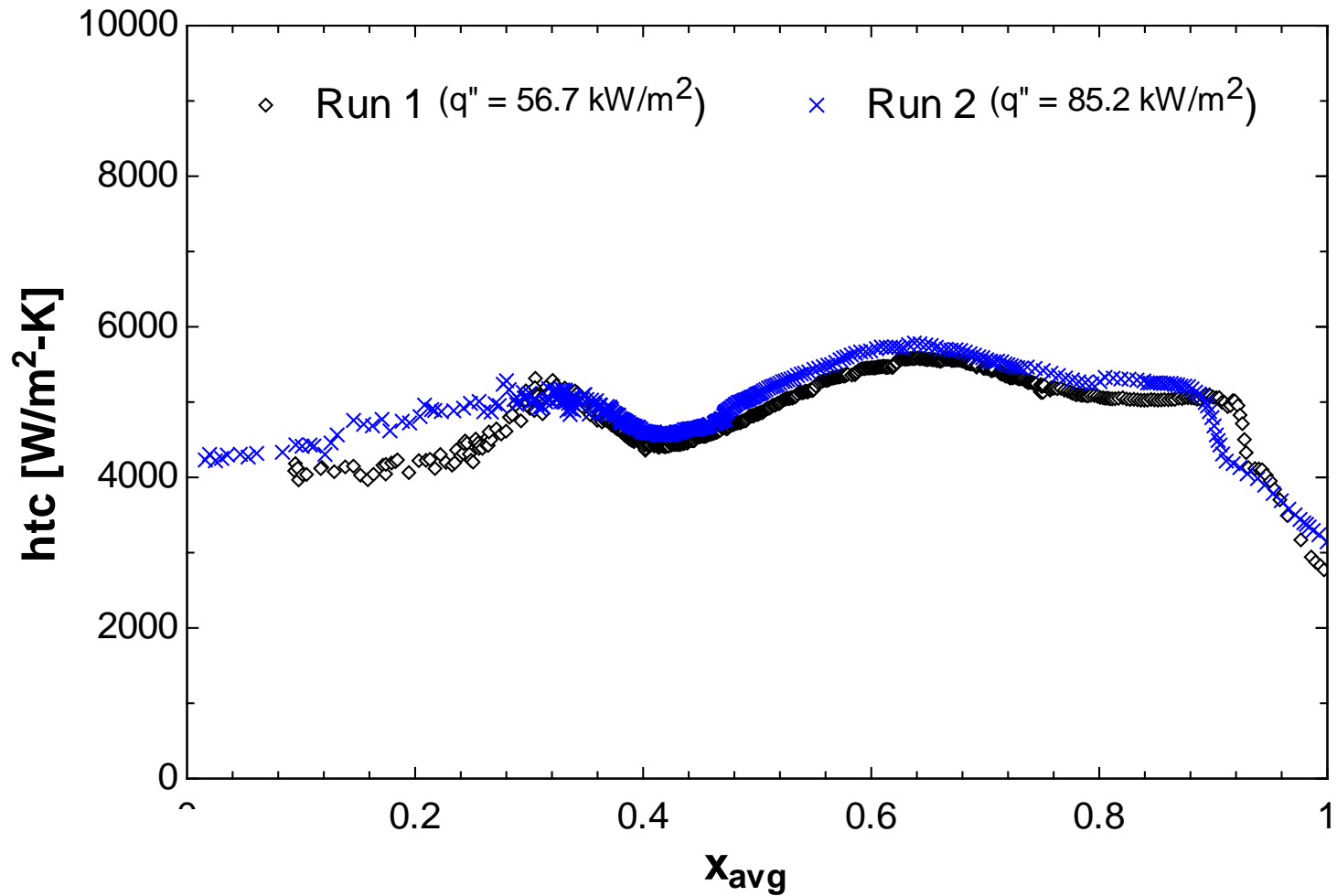


Results

Hydrocarbon mixture

$G = 150 \text{ kg/s-m}^2$

$P = 270 \text{ kPa}$

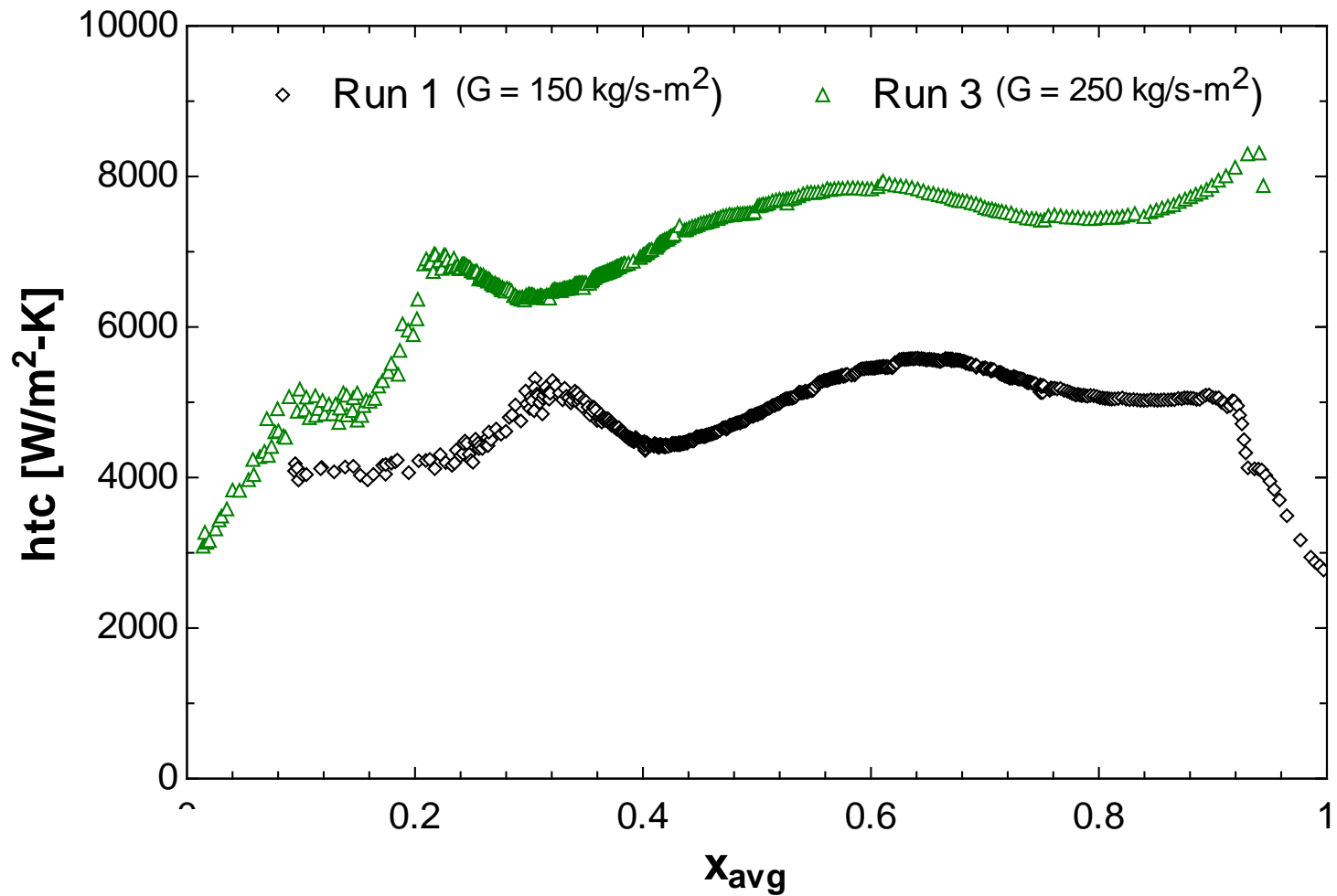


Results

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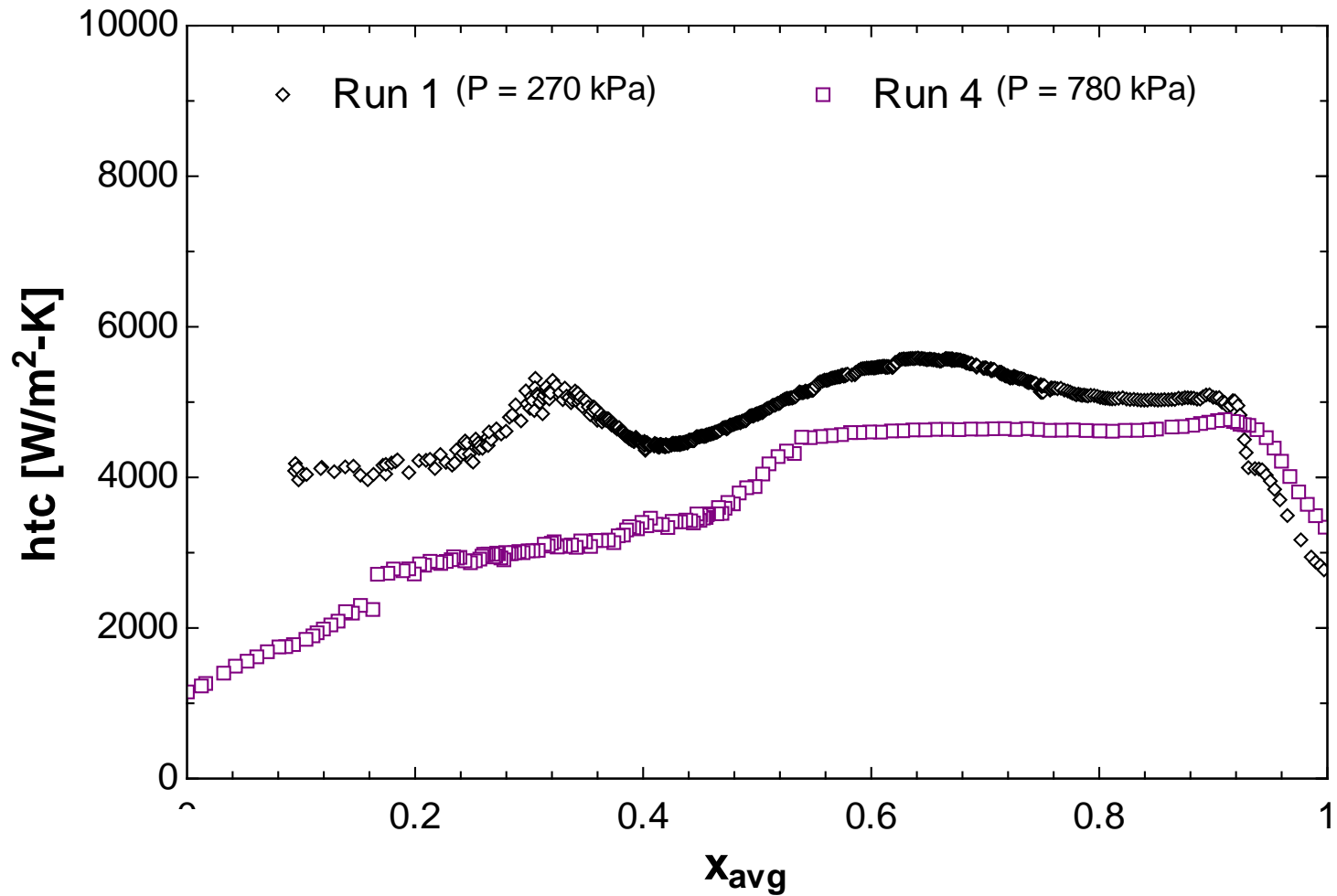


Results

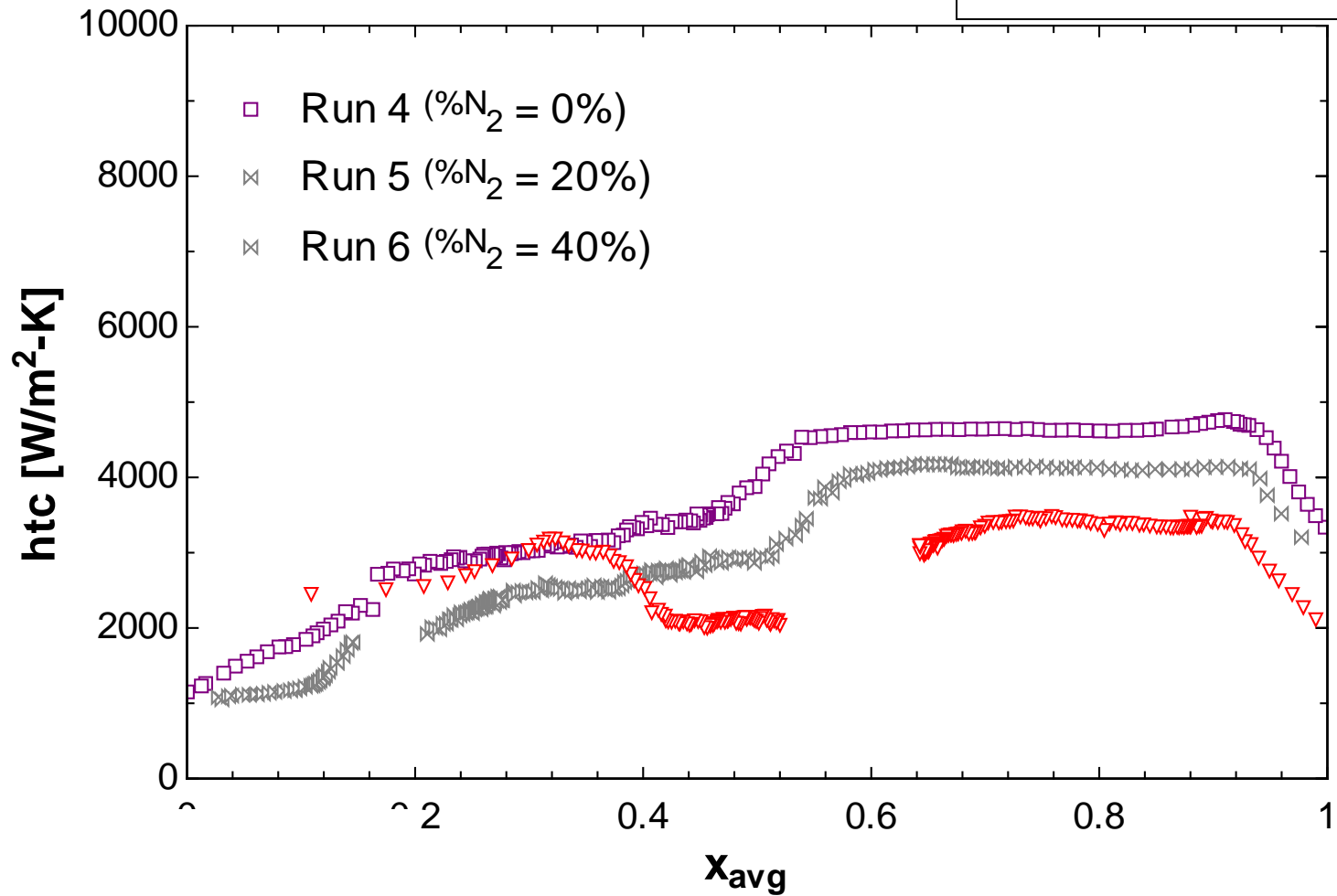
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Results

Hydrocarbon mixture $G = 150 \text{ kg/s-m}^2$ $q'' = 56.7 \text{ kW/m}^2$ $P = 780 \text{ kPa}$ 

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