



MHTLS Cross-flow Heat Exchanger Temperature Performance Data

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Outline

- Purpose of this presentation
- Description of HE-1
- Feed and HTL Run Descriptions
- Temperature Profile Data

Purpose of this presentation

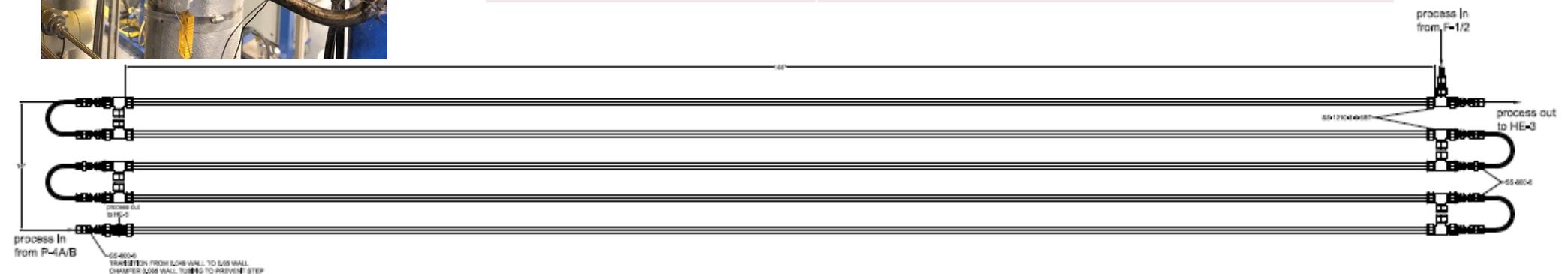
- Provide description and temperature profile data measured on cross flow heat exchanger while processing Wet Waste in hydrothermal liquefaction engineering scale system
- Data can be used to cross-check calculations and modeling of scaled up system.
- This presentation had been processed through PNNL's Information Release Process for the purpose of public dissemination.

Description of MHTLS HE-1 (Cross-flow HX)

- Purpose of Unit: Preheat wet waste slurry feed with hot product stream in the Modular Hydrothermal Liquefaction System.



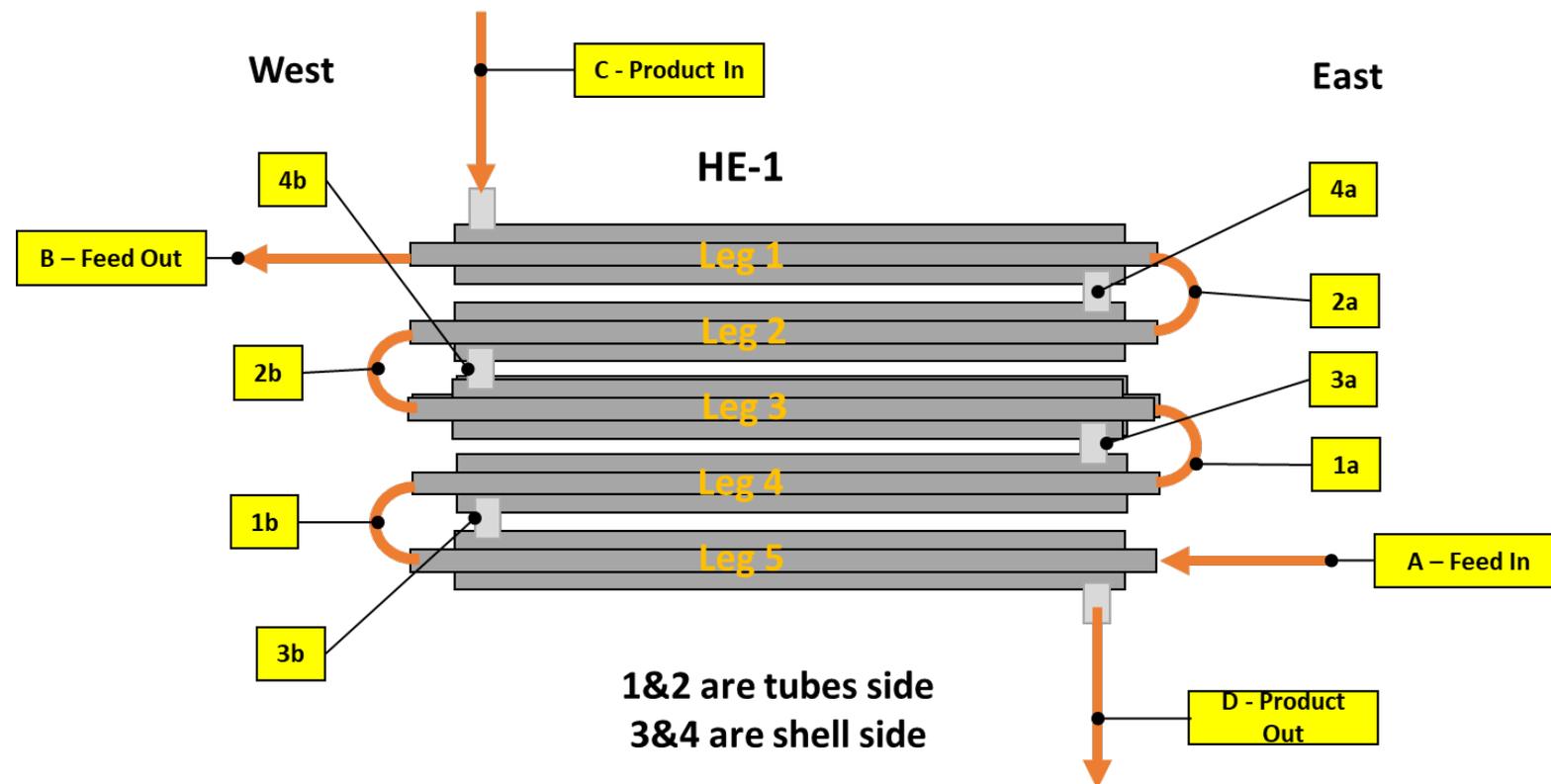
HE-1 Parameters	Value
Design	Tube in tube
Length	60 feet
Material	Swagelok SS316/L
Inner tube	0.375 in. OD, 0.049 in. wall
Outer tube	0.75 in. OD, 0.095 in. wall
U-bend length	5 in.



MHTLS HE-1 Thermocouple placement

- Purpose of Unit: Preheat wet waste slurry feed with hot product stream in the Modular Hydrothermal Liquefaction System.

HE-1, Supplemental Thermocouple Placement



- TCs A, B, C and D are logged by DAS
- All TCs are placed on outside of tubes (skin temperature) and held in place with hose clamp. They are measured by hand-held reader. TC tips are insulated

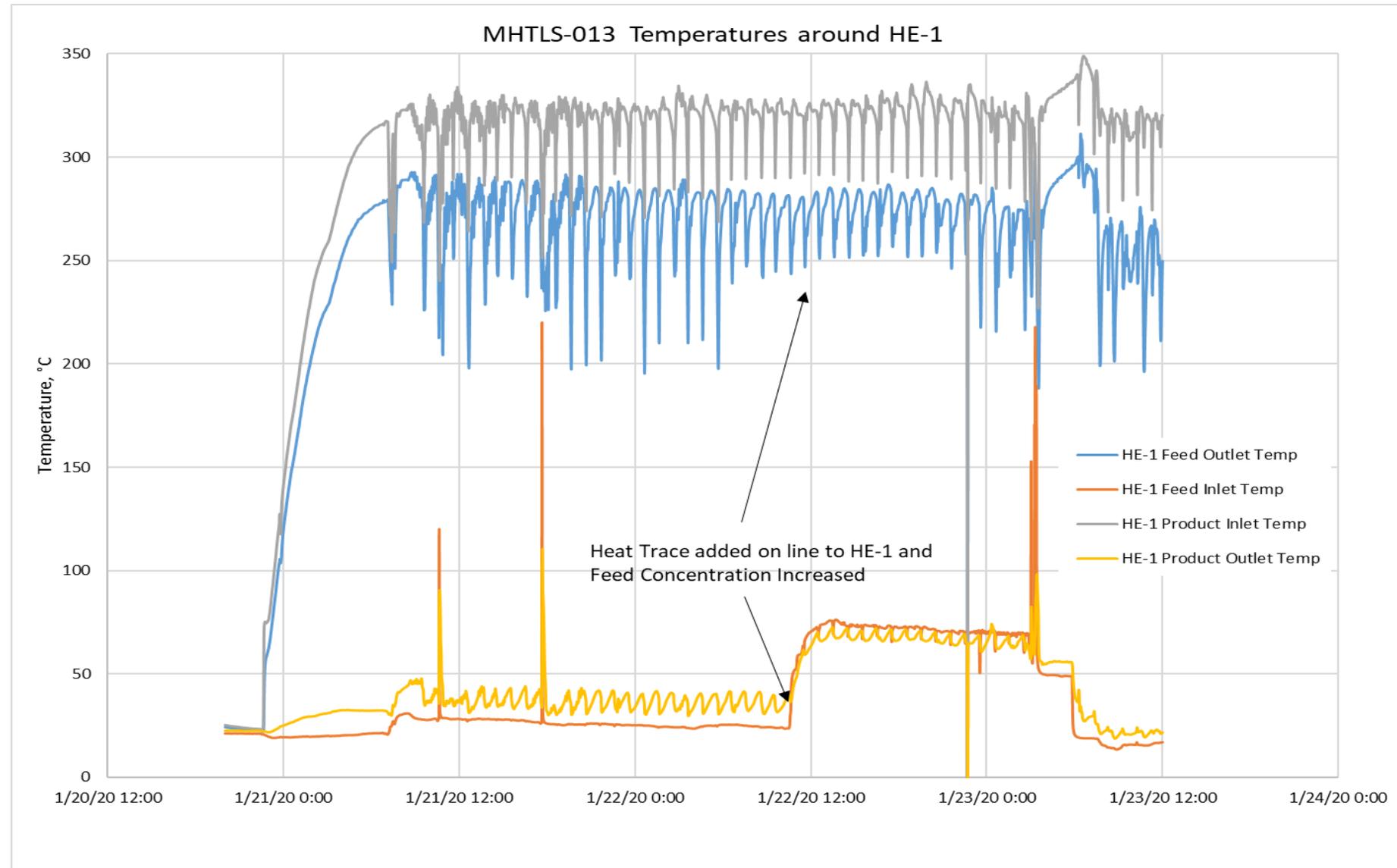
Wet Waste Feed Properties/Run Parameters

Parameter	Unit	MHTLS-13	MHTLS-15	MHTLS-17
Feed		Primary Sludge	66/34 Pri/Sec	Food Waste
Total Solids in Feed	wt%	15.3%	15.4%	17.1%
Ash in Dry Feed	wt%	25.6%	22.2%	7.7%
Ash in Slurry Feed	wt%	3.9%	3.4%	1.3%
AF Solids in Slurry Feed	wt%	11.4%	12.0%	15.8%
Average Feed density	g/ml @20C	1.05	1.05	1.02
Feed Rate	Kg/h	12.6	12.6	12.2
Product Rate	Kg/h	11.0	11.0	10.6

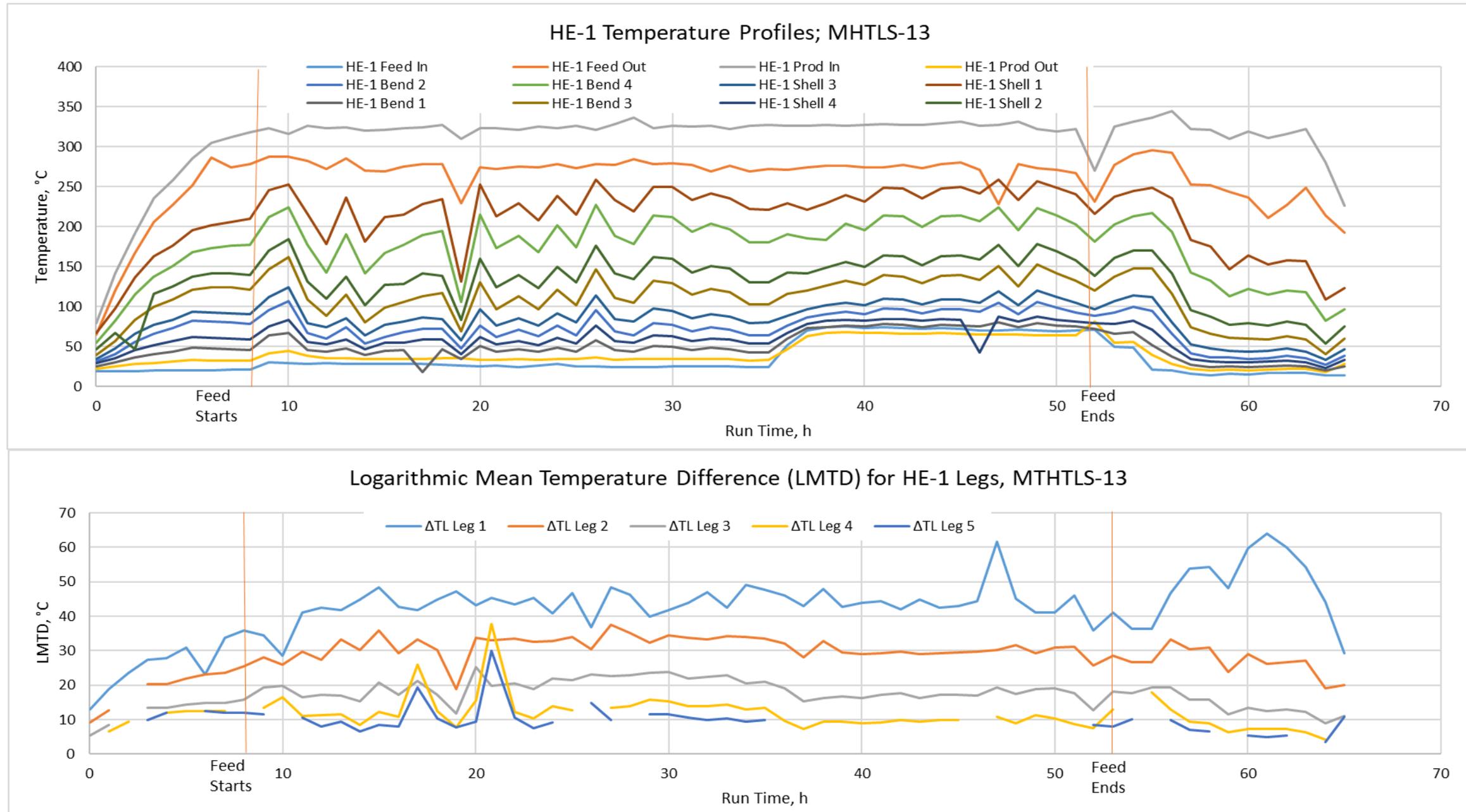
HE-1, Logarithmic Mean Temp Difference (LMTD)

	LMTD MHTLS-13, °C		LMTD MHTLS-15, °C		LMTD MHTLS-16, °C	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
ΔT_L Leg 1	44	5	47	9	36	5
ΔT_L Leg 2	31	3	37	6	25	4
ΔT_L Leg 3	19	3	23	4	17	2
ΔT_L Leg 4	12	5	16	3	11	2
ΔT_L Leg 5	11	7	8	4	9	2

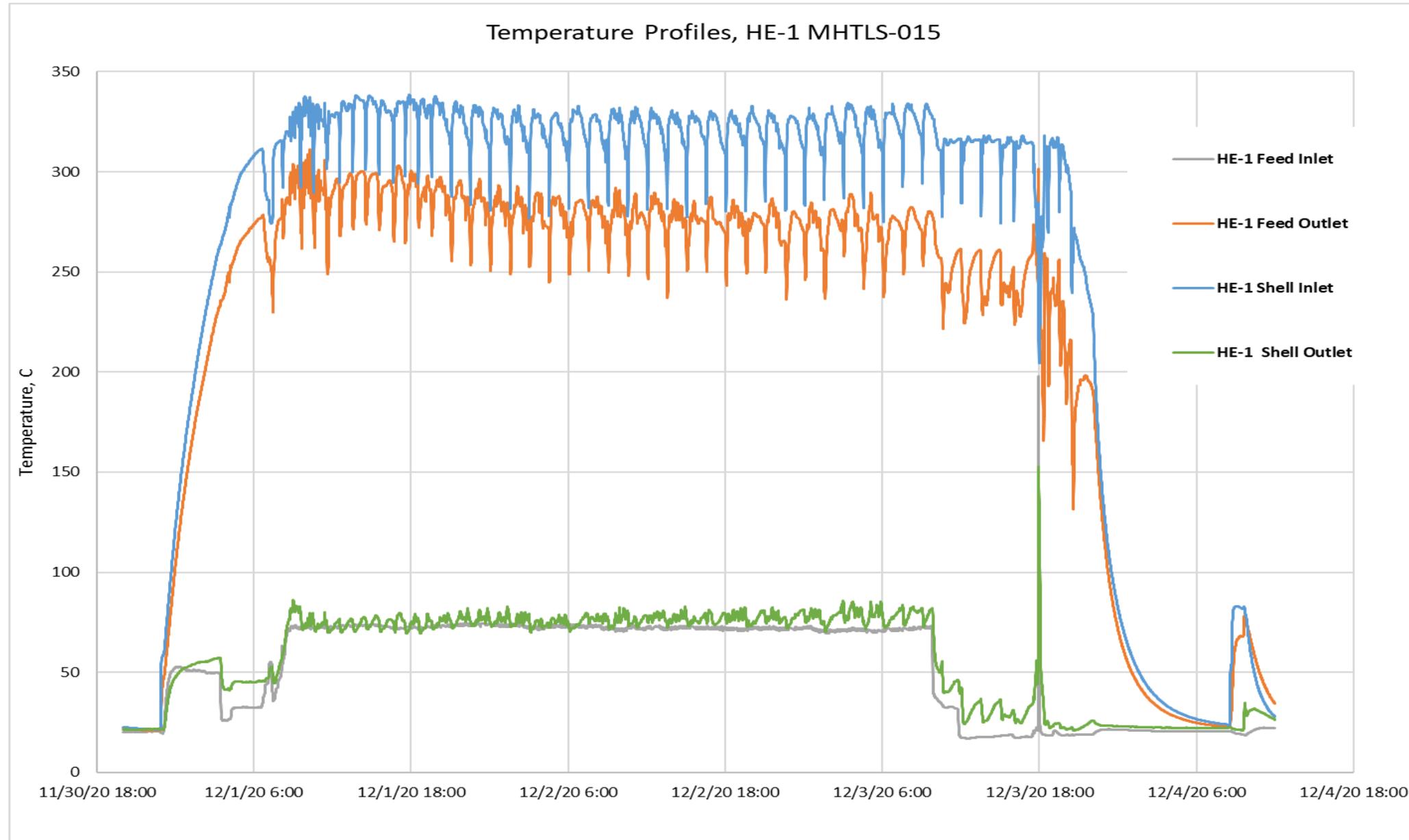
MHTLS-13 HE-1 Data Collected by DAS



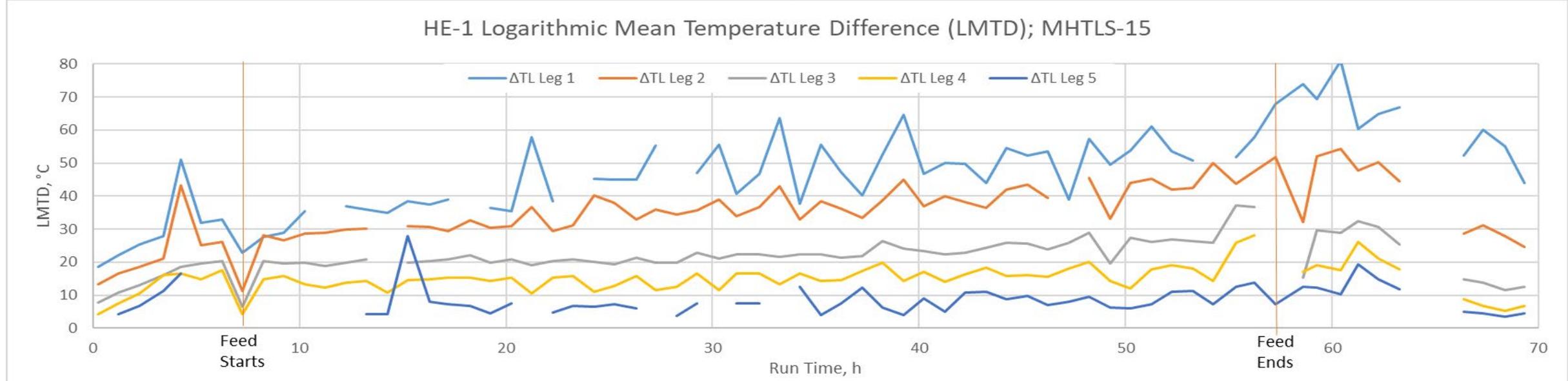
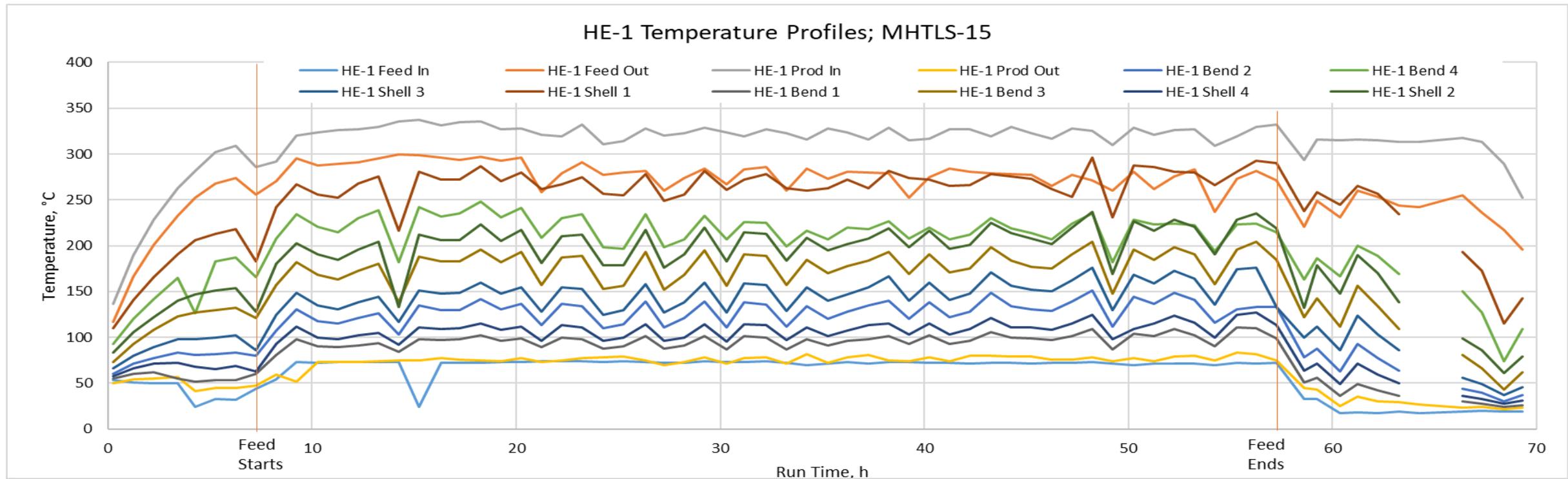
Temperature Profile and LMTD from MHTLS-13



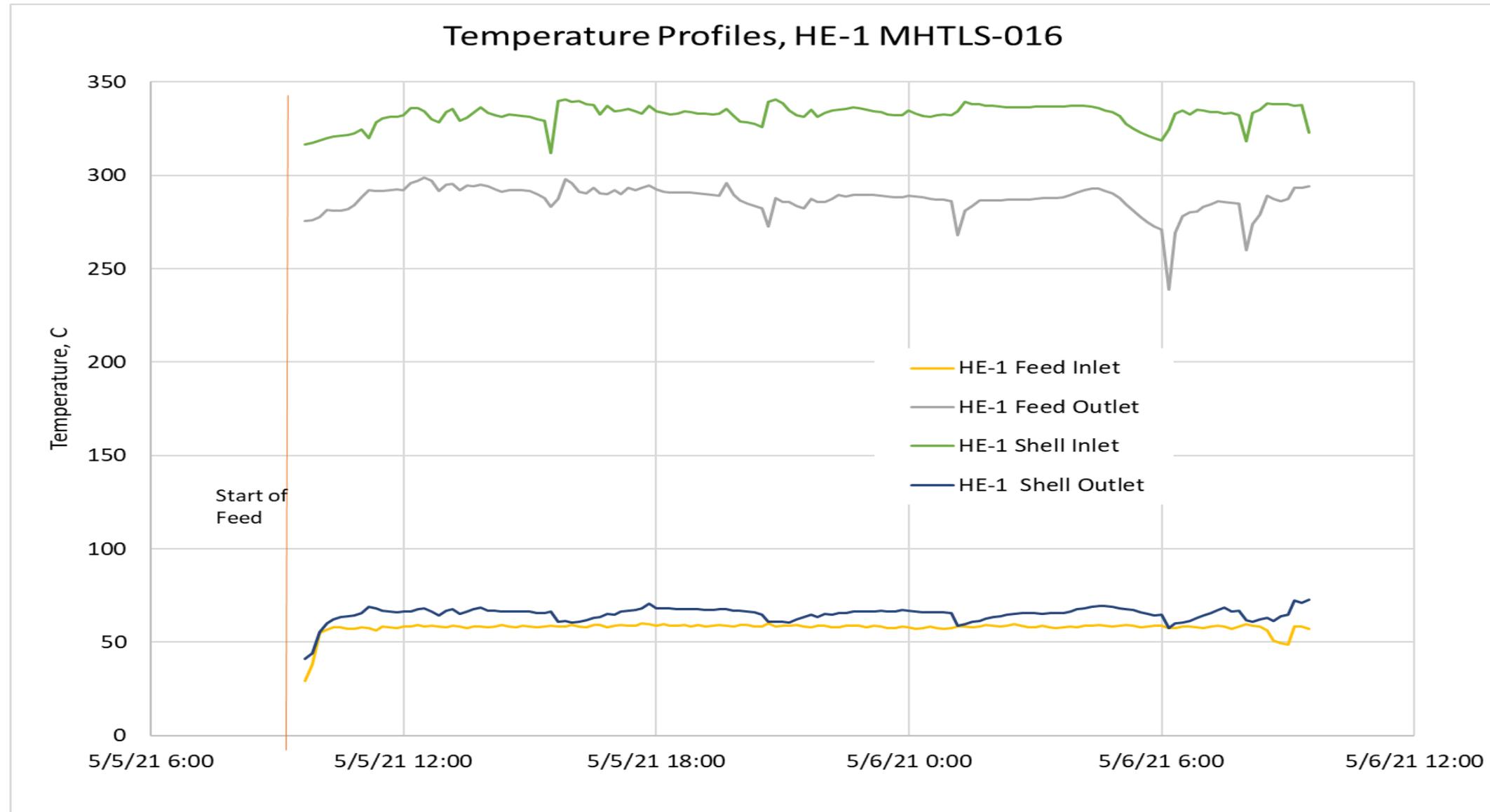
MHTLS-15 HE-1 Data Collected by DAS



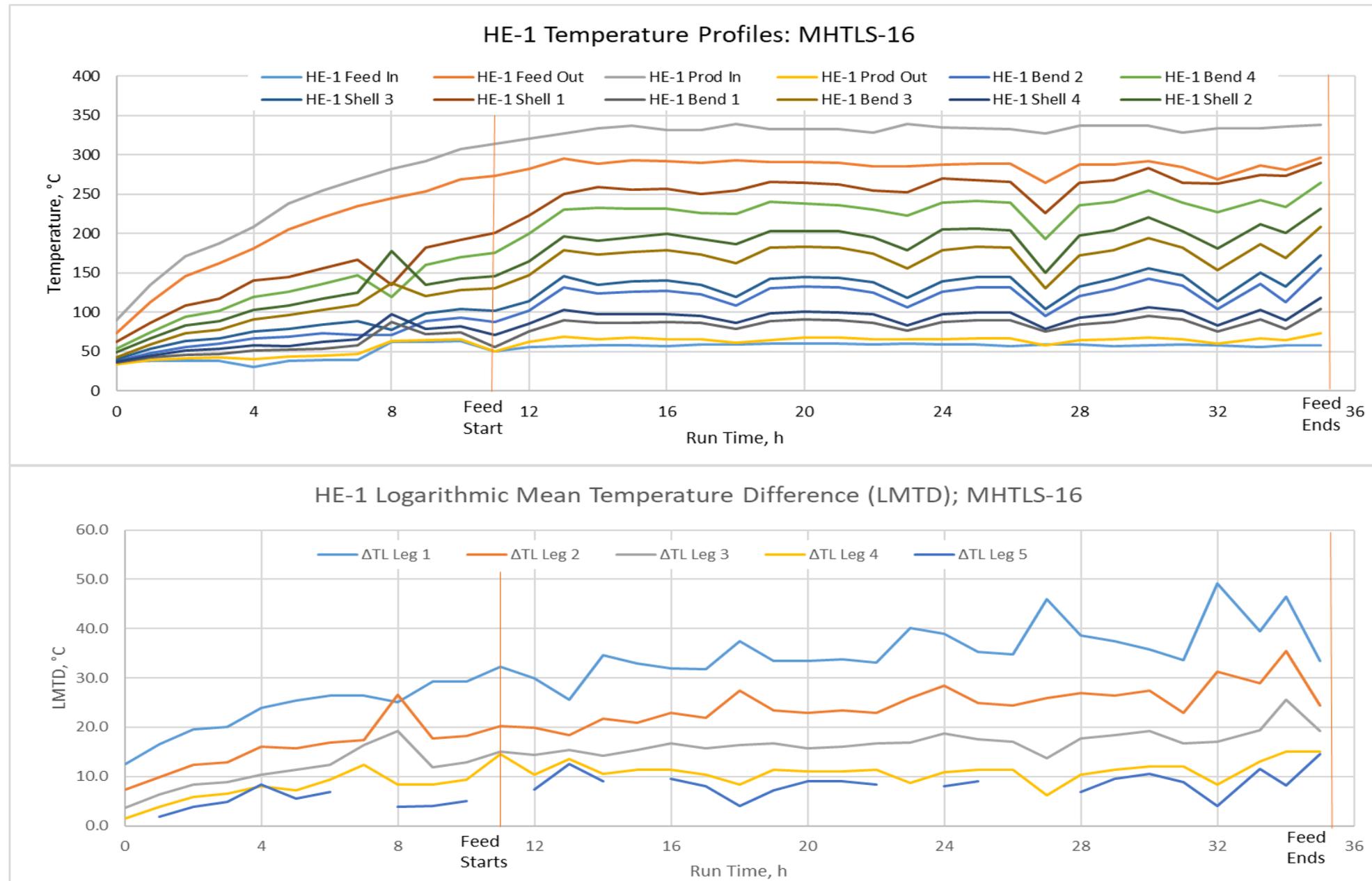
Temperature Profile and LMTD from MHTLS-15



MHTLS-16 HE-1 Data Collected by DAS



Temperature Profile and LMTD from MHTLS-16





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Thank you