Flow-Assurance Test Loop For Wax Deposition Control in Crude-Oil Transfer Lines

TEAM M100

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Introduction

- Wax deposition in crude-oil pipelines occurs when temperature drops below WAT, causing buildup that increases pressure drop and reduces flow. Current testing methods are limited or costly. This project develops a lab-scale flow loop to simulate conditions and measure wax behavior in a controlled, repeatable way.

Objectives

- Develop a lab-scale flow loop that simulates pipeline conditions, generates controlled wax deposition, and measures pressure drop and wax thickness.
- Provide a repeatable and reliable testing platform to evaluate wax mitigation methods for research and industry applications.

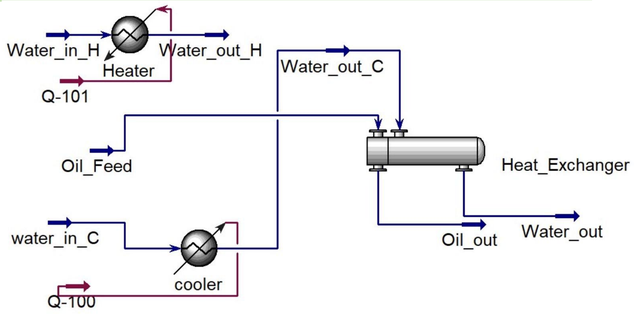
Constraints

- Must comply with OSHA lab safety standards.
- Use corrosion-resistant materials.
- Must allow complete wax removal.
- Materials must be hydrocarbon compatible.
- Results must be presented in tabulated form.
- Bulk temperature must cross WAT during testing.
- Use only waxy crude or validated model oil.

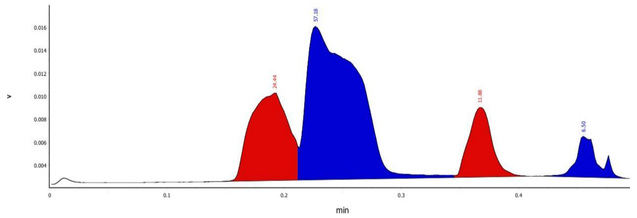
Specifications

- Flow velocity: 0.1 – 7 m/s
- Pressure: 1 – 20 bar
- Represent crude behavior in C20–C44 range
- Footprint: ≤ 4 m^2
- Temperature control: 20–80°C (±0.5°C)
- Cleaning/reset time: ≤ 60 min
- Include over-pressure & over-temperature interlocks

Design Verification



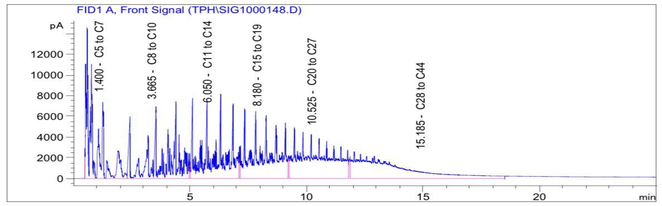
Aspen-hysys Heat Exchanger Simulation



Channel 1

Peak	Fill	Peak Name	t_R	t_S	t_E	H (V)	H_{Norm}	A (V.s)	A_{Norm}	$W_{0.1}$	Asym	Effic	Res	T...	Amount
1			0.19	0.13	0.21	0.01	24.90	0.02	24.44					BD	
2			0.23	0.21	0.34	0.01	43.64	0.04	57.18					DD	
3			0.37	0.34	0.41	0.01	19.80	0.01	11.88	0.04	1.24	1659		DB	
4			0.46	0.42	0.49	0.00	11.65	0.00	6.50	0.04	1.84	2270	2.38	BB	
						0.03	100.00	0.07	100.00						0.000

Crude-Oil SARA Analysis



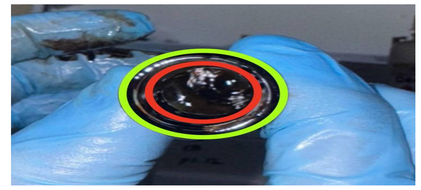
This is a result compounds table. Use the footer button in the table format dialog box to define the summations in the last table line.

#	Exp.RT	Meas.RT	Compound Name	Main Peak Area %
1	1.423	1.400	C5 to C7	14.138
2	3.670	3.665	C8 to C10	13.625
3	6.050	6.050	C11 to C14	15.093
4	8.180	8.180	C15 to C19	16.830
5	10.550	10.525	C20 to C27	20.079
6	15.185	15.185	C28 to C44	20.236

Crude-Oil GC Test

Test Validation

Time .min	Temperature .C	Flow L .min	Flow .m3 .s	draulic Effective Diameter	m/elocity .m	s/Pressure Drop .ps	Pressure Drop .bal	pstream Pressure .psi	pstream Pressure .bala	Thickness .m
49	26.1	4.09	0.000068	10.000	0.868	1.644	0.113	19.644	1.354	0.000
50	26.1	4.09	0.000068	10.000	0.868	1.644	0.113	19.644	1.354	0.000
51	26.0	4.09	0.000068	10.000	0.868	1.644	0.113	19.644	1.354	0.000
52	26.0	4.09	0.000068	10.000	0.868	1.644	0.113	19.644	1.354	0.000
53	25.9	4.11	0.000069	9.894	0.882	1.726	0.119	19.726	1.360	0.151
54	25.9	4.14	0.000069	9.793	0.915	1.808	0.125	19.808	1.366	0.295
55	25.8	4.16	0.000069	9.697	0.938	1.890	0.130	19.890	1.371	0.432
56	25.7	4.18	0.000070	9.606	0.961	1.973	0.136	19.973	1.377	0.563
57	25.7	4.20	0.000070	9.519	0.983	2.055	0.142	20.055	1.383	0.687
58	25.6	4.22	0.000070	9.437	1.005	2.137	0.147	20.137	1.388	0.804
59	25.6	4.23	0.000071	9.358	1.026	2.220	0.153	20.220	1.394	0.917



Physical Prototype

Conclusion

- The system demonstrated stable and repeatable operation.
- Clear pressure-drop increases were observed during wax deposition.
- The flow loop effectively replicates real pipeline conditions.
- The system provides consistent data for analyzing wax deposition behavior.