



ESDU-SPB-M11-1

Apr.09: Interactions and rheological properties of asphaltenes investigated using AFM



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Sub-project B

Interactions and Rheological Properties of Asphaltenes Investigated using AFM

Department of Chemical Engineering
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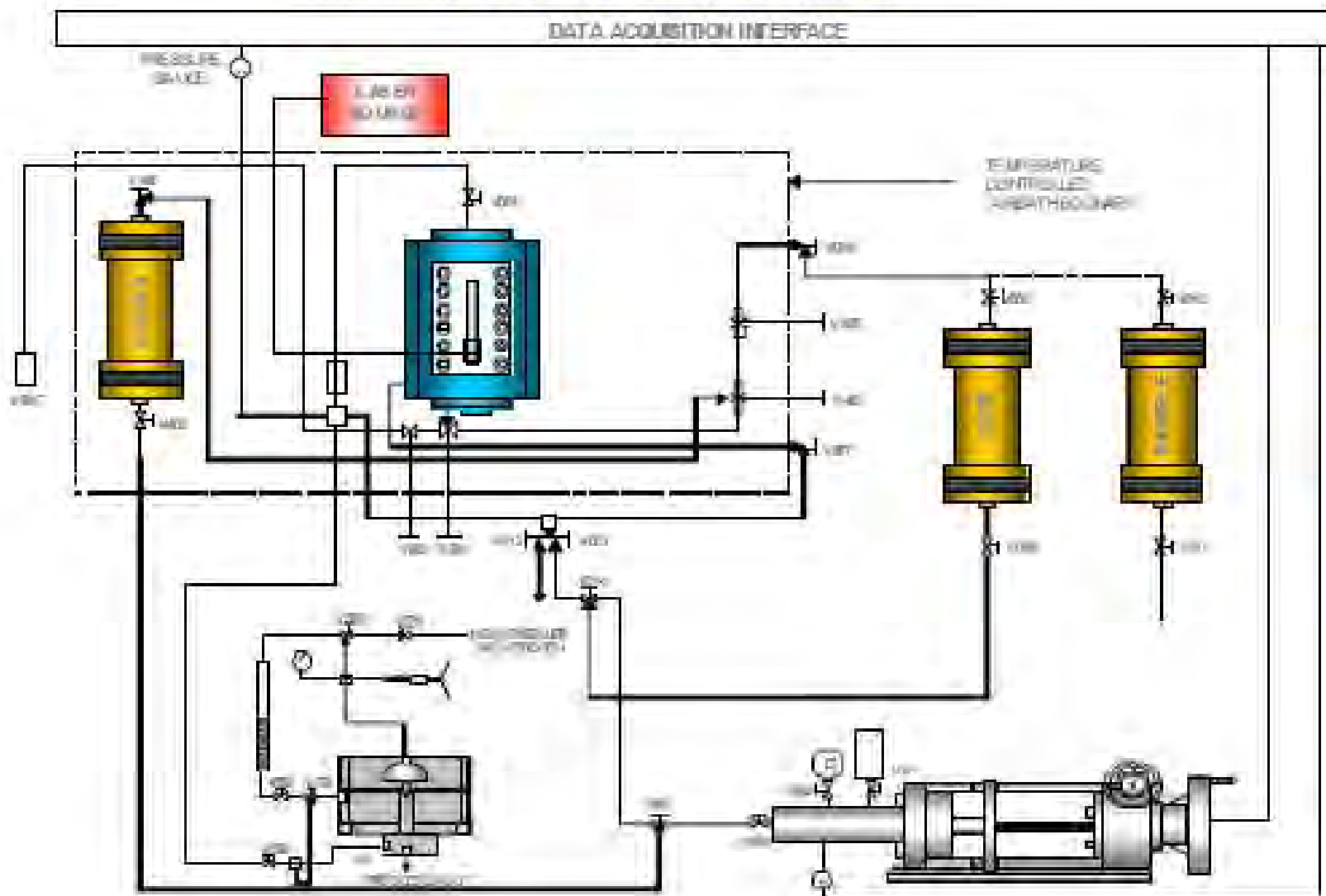
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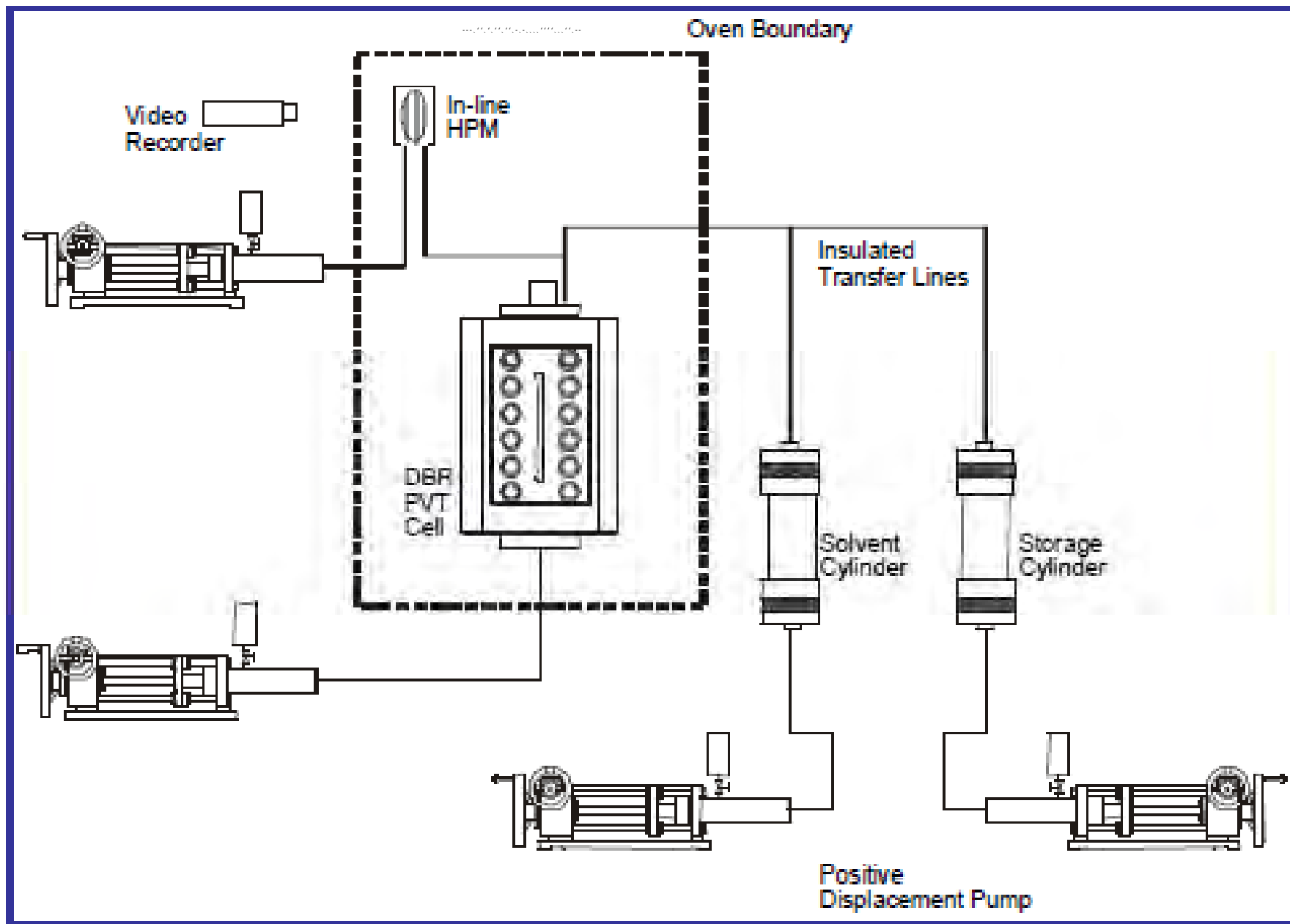
April 2009

Objectives

- Investigation of the deposition of asphaltenes onto the surfaces of reservoirs and heat exchangers through monitoring
 1. Adsorption and adhesion of asphaltenic materials
 2. Rheological properties of asphaltenes, such as shear stress, and viscosity of deposited materials at the interface
- Exploitation of an Atomic Force Microscopy (AFM)
 1. Measuring the interaction forces between asphaltenic particles
 2. Stress-Relaxation of asphaltenic surfaces

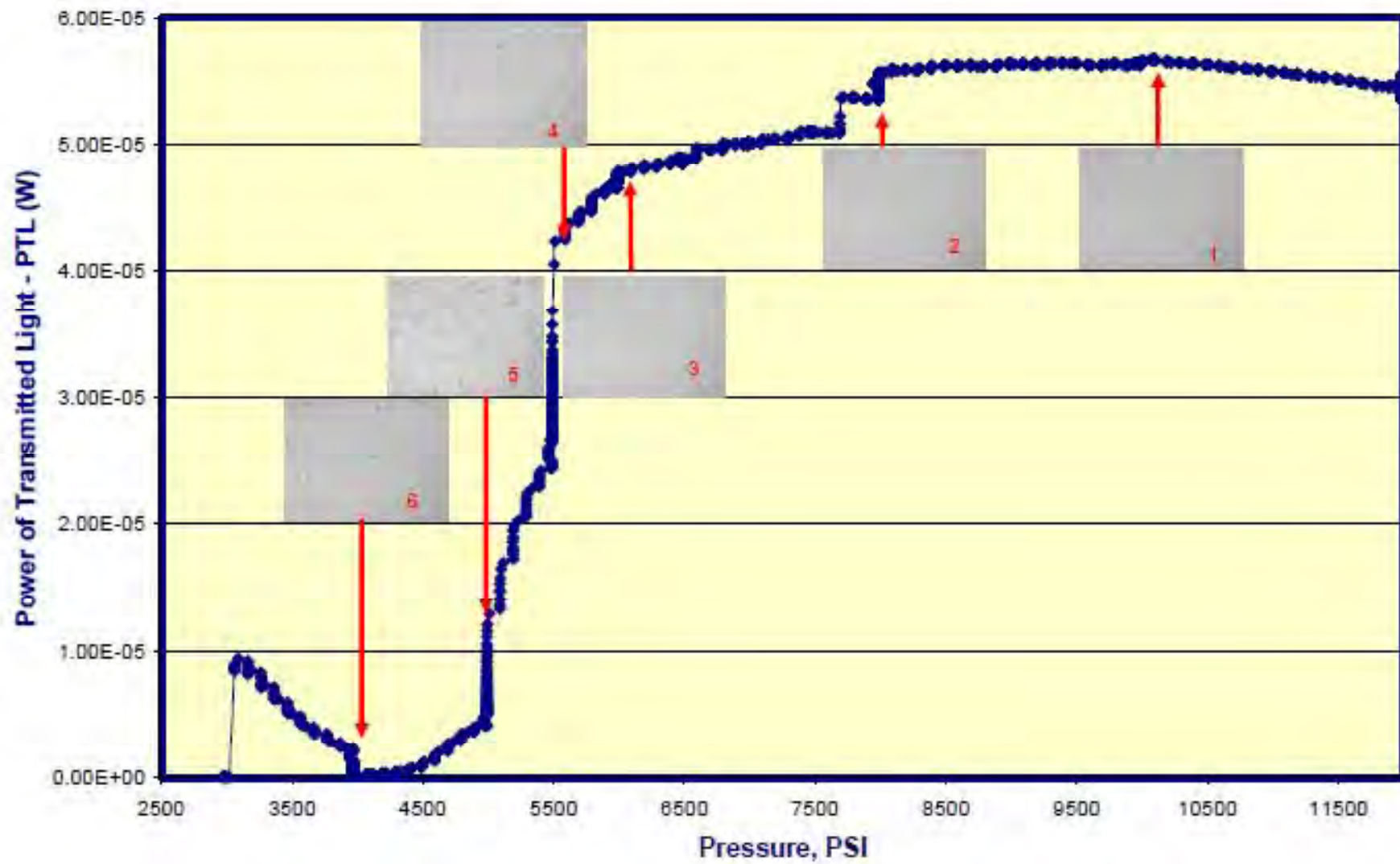
Schematic of a PVT Analysis System

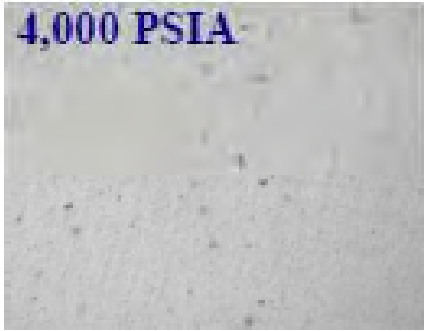
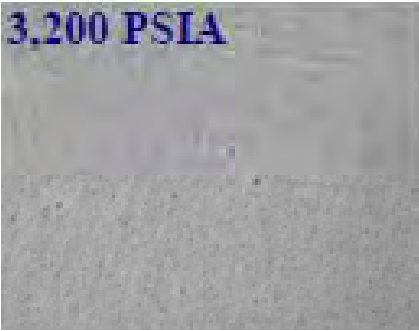
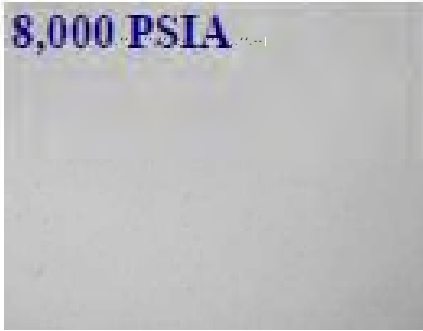
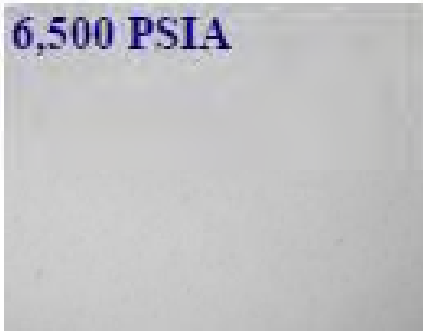
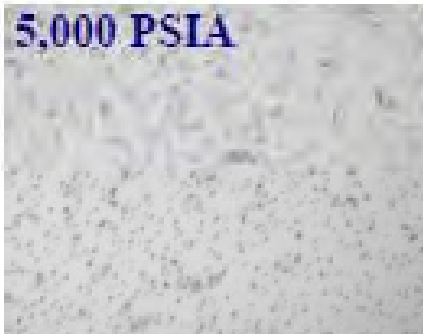
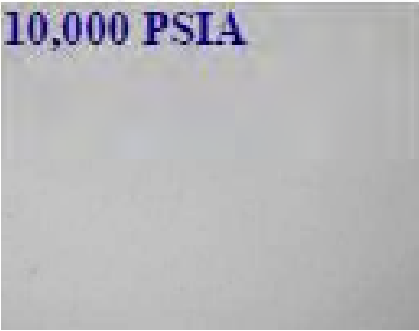
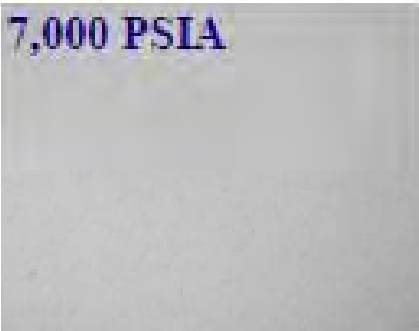
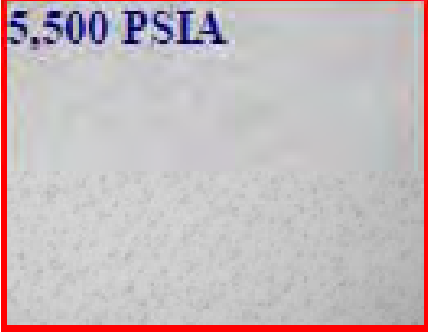
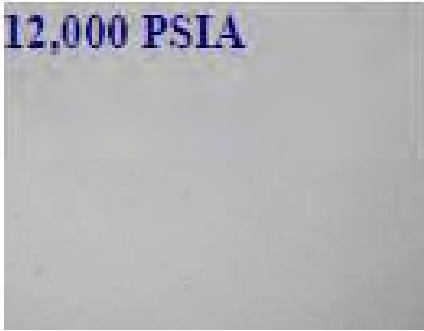
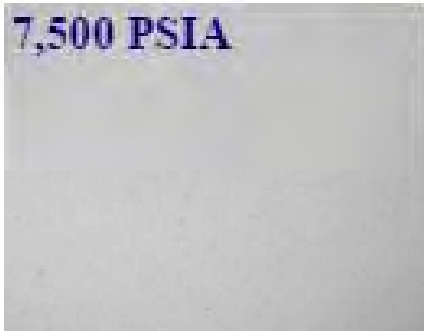
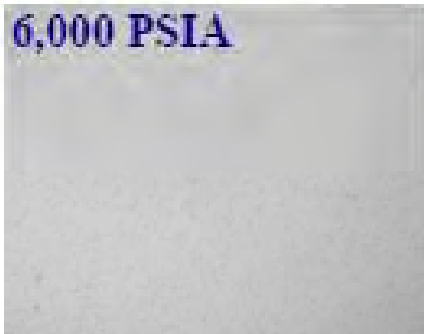




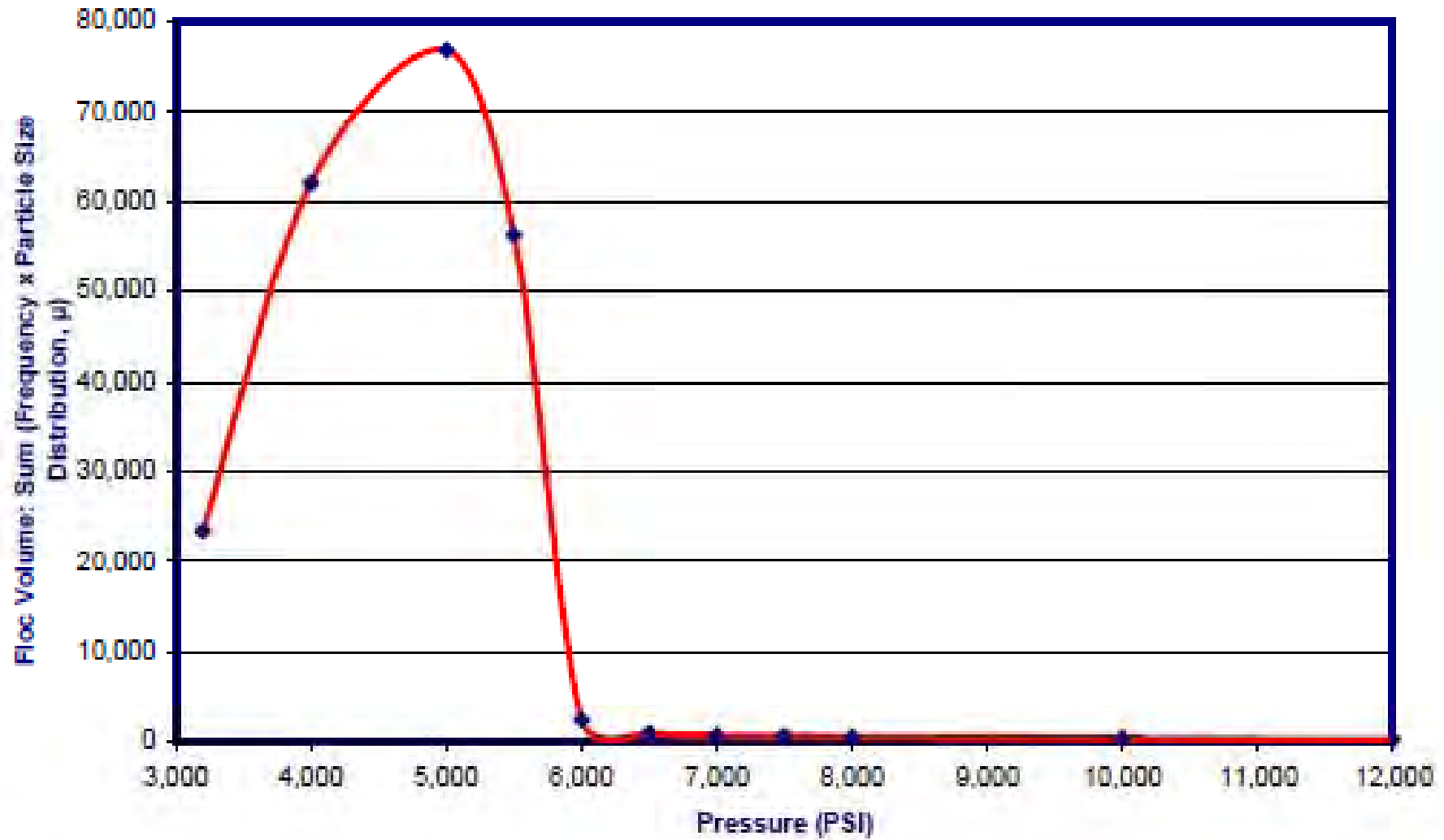
Sample SB-12410 - Compositions							
Component	MW (g/mol)	Flashed Gas		Flashed Oil		Monophasic	
		wt %	mole %	wt %	mole %	wt %	mole %
C02	44.01	2.31	1.44	0.00	0.00	0.52	0.97
H2S	34.08	0.06	0.05	0.00	0.00	0.01	0.03
N2	28.01	0.29	0.28	0.00	0.00	0.07	0.19
C1	16.04	35.59	61.09	0.00	0.00	8.08	40.89
C2	30.07	16.94	15.52	0.00	0.00	3.84	10.39
C3	44.10	16.29	10.17	0.18	0.79	3.84	7.07
i-C4	58.12	2.78	1.32	0.08	0.27	0.69	0.97
n-C4	58.12	9.54	4.52	0.49	1.61	2.55	3.56
i-C5	72.15	3.30	1.26	0.47	1.25	1.11	1.25
n-C5	72.15	5.08	1.94	1.03	2.70	1.95	2.19
C6	84.00	4.42	1.45	2.79	6.30	3.16	3.05
Mycyclo-C5	84.16	0.25	0.08	0.23	0.52	0.24	0.23
Benzene	78.11	0.10	0.03	0.09	0.22	0.09	0.10
Cyclo-C6	84.16	0.16	0.05	0.22	0.50	0.21	0.20
C7	96.00	1.61	0.46	3.43	6.78	3.02	2.55
Mycyclo-C6	98.19	0.17	0.05	0.44	0.86	0.38	0.32
Toluene	92.14	0.25	0.07	0.58	1.21	0.51	0.45
C8	107.00	0.44	0.11	3.95	7.01	3.15	2.39
C2-Benzene	106.17	0.01	0.00	0.21	0.38	0.17	0.13
m&p-Xylene	106.17	0.03	0.01	0.51	0.91	0.40	0.31
o-Xylene	106.17	0.02	0.00	0.29	0.52	0.23	0.17
C9	121.00	0.20	0.05	4.22	6.63	3.31	2.22
C10	134.00	0.10	0.02	5.46	7.74	4.24	2.57
C11	147.00	0.02	0.00	5.04	6.51	3.90	2.16
C12	161.00	0.00	0.00	4.57	5.39	3.54	1.78
C13	175.00	0.00	0.00	4.33	4.70	3.35	1.66
C14	190.00	0.00	0.00	3.78	3.78	2.62	1.25
C15	206.00	0.00	0.00	3.98	3.67	3.08	1.21
C16	222.00	0.02	0.00	3.52	3.01	2.72	1.00
C17	237.00	0.00	0.00	3.29	2.64	2.54	0.87
C18	251.00	0.00	0.00	3.04	2.30	2.35	0.76
C19	263.00	0.00	0.00	3.06	2.21	2.37	0.73
C20	275.00	0.00	0.00	2.94	2.03	2.27	0.67
C21	291.00	0.00	0.00	2.68	1.75	2.07	0.58
C22	300.00	0.00	0.00	2.54	1.61	1.96	0.53
C23	312.00	0.00	0.00	2.24	1.36	1.73	0.45
C24	324.00	0.00	0.00	2.17	1.27	1.68	0.42
C25	337.00	0.00	0.00	1.96	1.10	1.51	0.36
C26	349.00	0.00	0.00	1.91	1.04	1.47	0.34
C27	360.00	0.00	0.00	1.79	0.95	1.39	0.31
C28	372.00	0.00	0.00	1.84	0.94	1.43	0.31
C29	382.00	0.00	0.00	1.66	0.83	1.29	0.27
C30+	537.08	0.00	0.00	18.97	6.71	14.66	2.22
MW		27.54		189.96		81.24	
Mole %		66.94		33.06			

Isothermal Depressurisation @ 111.5 °C

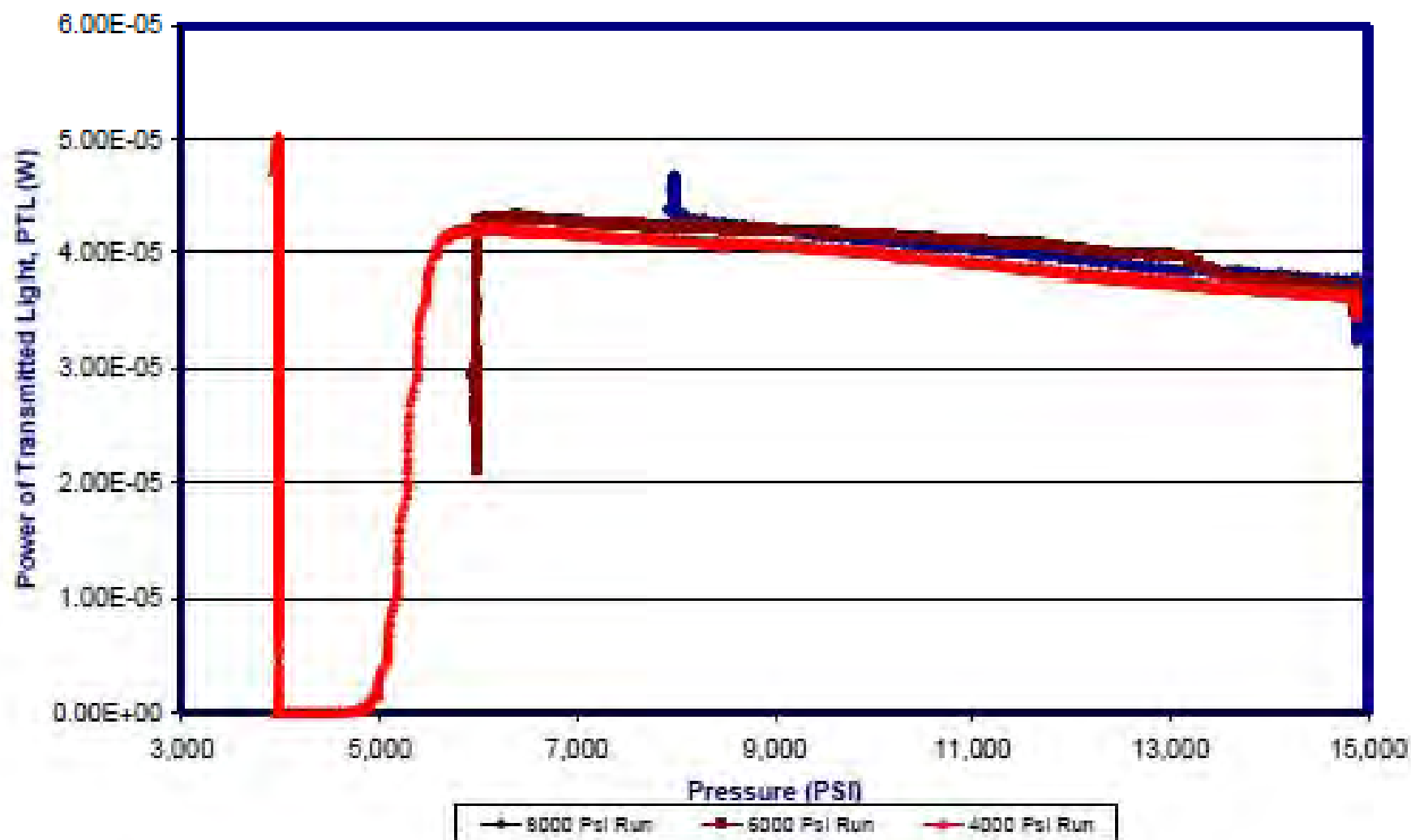




Asphaltene Floc Volume Vs. Pressure Isothermal Depressurisation @ 111.5 °C



Zero Mixing, Depressurisation Rate = 50 Psi / Min



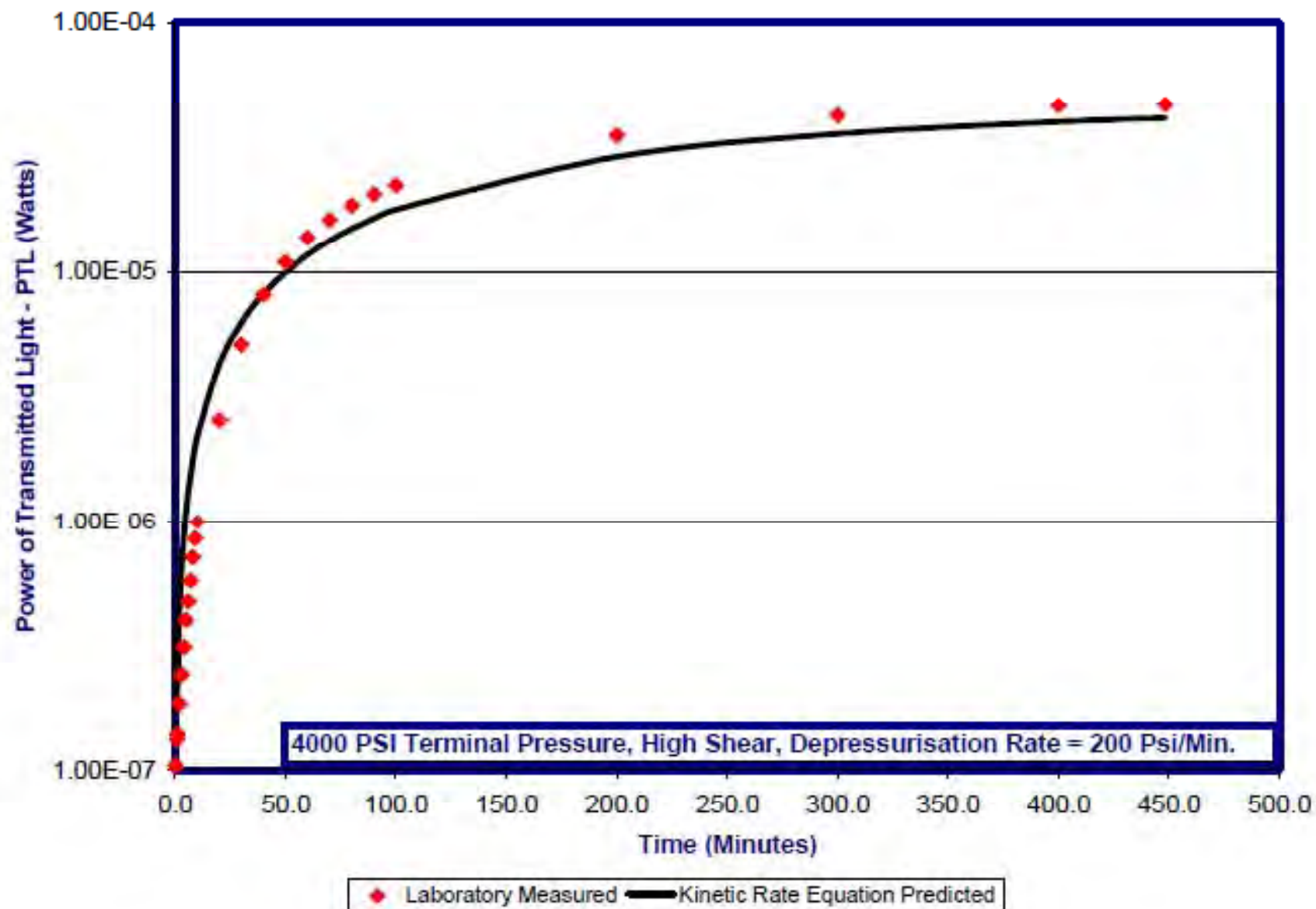


Figure 4-31: First-Order Kinetic Rate Equation Fit [$k = 0.0048 \text{ minute}^{-1}$] For 200 Psi/Minute Depressurisation and High Mixing Kinetic Run.

AFM Measurements

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