NANYANG TECHNOLOGICAL UNIVERSITY

School of Mechanical and Aerospace Engineering

E3.6
TRANSIENT HEAT CONDUCTION

Thermal & Fluid Lab
N3-B2C-06

Name of Student: CHIA CHIN ANN CALEB **Lab**

Group: ME37

School of Mechanical & Aerospace Engineering, NTU

Matric No: U2121391K **Date:** 30/03/2023

Name of Supervisor: Prof Tuan Tran

Grade: _____

NOTE: This title page should be attached to your log sheets before submission.

6 RESULTS

Sample Calculations

Pump At High Speed

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Pump At High Speed

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7 DISCUSSIONS

1) T_1, T_2, and T_3 versus Time at different pump rates

For the graph of T_1 against Time, the temperatures are relatively constant for both low-speed and high-speed pump rates. This is because the temperatures were maintained by the water bath which was kept constant for both experiment set-ups.

For the graph of T_2 against Time, both the low-speed and high-speed pump rates' temperatures increased at a decreasing rate as time passed. However, the temperature for the low-speed pump had an overall higher value as compared to the temperature of the high-speed pump. This is due to the thermal layer boundary being smaller for the low-speed pump rate than for the high-speed pump rate. As such, the heat convected is faster for the low-speed pump.

As for the graph of T_3 against Time, both produced a graph that increased at a decreasing rate but its initial rate of increase was rather high. This is because the pump rate causes the flow rate of the water to be higher, resulting in a faster rate of heat transfer by convection.

2) The non-dimensional temperature difference, θ versus Time at different pump rates

The non-dimensional temperature difference decreased at a faster rate as time passed for the high-speed pump rate when compared to the low-speed pump rate. This indicates that the rate of heat transfer is higher for the high-speed pump rate than for the low-speed pump rate. This can be caused by the water flowing faster in the cylinder, resulting in a higher rate of heat transfer by convention.

3) The effect of pump rates on the heat convection coefficient (h)

The heat convection coefficient is relatively higher for the high-speed pump rate than the low-speed pump rate, with the exception when time is at 38 seconds. This can be attributed to a higher rate of heat transfer by convection as the flow rate of water in the cylinder is higher.

4) The heat convective coefficient (h) versus Time

The heat convective coefficient for the high-Speed pump rate decreased at an increasing rate as time passed. On the other hand, the heat convective coefficient increased initially and peaked when time is about 38 seconds before decreasing as time passed.

In theory, the heat convective coefficient should be constant since the pump rate – which affects the flow rate – is kept constant throughout the experiment. This occurrence could be due to the fluctuations in voltage and current being supplied to the pump.

EXPERIMENTAL DATA

Pump Speed – High

Pump Speed High				Stainless Steel radius = 10 mm			
Time (s)	T1	T2	T3	theta	Fo	1/Bi	h
0	81.05	40.77	23.42				
2	80.96	78.18	24.39	0.983	**0.09**		
4	80.88	79.55	30.62	0.875	**0.18**		
6	80.85	79.75	39.69	0.717	**0.27**		
8	80.88	79.75	48.02	0.572	**0.36**		
10	80.89	79.86	54.95	0.451	**0.45**		
12	80.87	79.92	60.54	0.354	**0.54**	0.48	3395.83
14	80.87	80.00	64.87	0.279	**0.63**		
16	80.87	80.10	68.22	0.220	**0.72**		
18	80.88	80.15	70.80	0.175	**0.81**		
20	80.89	80.23	72.84	0.140	**0.9**		
22	80.88	80.25	74.50	0.111	**0.99**		
24	80.87	80.28	75.82	0.088	**1.08**	0.49	3326.53
26	80.88	80.32	76.80	0.071	**1.17**		
28	80.88	80.35	77.59	0.057	**1.26**		
30	80.88	80.37	78.20	0.047	**1.35**		
32	80.88	80.38	78.67	0.038	**1.44**		
34	80.88	80.40	79.03	0.032	**1.53**		
36	80.88	80.40	79.32	0.027	**1.62**	0.57	2859.65
38	80.87	80.41	79.54	0.023	**1.71**		
40	80.87	80.42	79.72	0.020	**1.8**		
42	80.87	80.43	79.87	0.017	**1.89**		
44	80.86	80.42	79.97	0.015	**1.98**		
46	80.86	80.41	80.05	0.014	**2.07**		
48	80.85	80.42	80.11	0.013	**2.16**		
50	80.84	80.41	80.16	0.012	**2.25**	0.72	2263.9
52	80.85	80.42	80.21	0.011	**2.34**		
54	80.84	80.42	80.24	0.010	**2.43**		
56	80.84	80.41	80.26	0.010	**2.52**		
58	80.84	80.40	80.27	0.010	**2.61**		
60	80.84	80.41	80.28	0.010	**2.7**		
62	80.84	80.41	80.30	0.009	**2.79**		
64	80.84	80.41	80.30	0.009	**2.88**	0.88	1852.3
66	80.84	80.41	80.30	0.009	**2.97**		
68	80.84	80.40	80.29	0.010	**3.06**		
70	80.85	80.40	80.29	0.010	**3.15**		
72	80.85	80.41	80.29	0.010	**3.24**		
74	80.87	80.44	80.30	0.010	**3.33**		
76	80.91	80.47	80.31	0.010	**3.42**		
78	80.93	80.49	80.32	0.0106	**3.51**	1.18	1381.4
80	80.95	80.50	80.31	0.011	**3.6**		

Pump Speed – Low

Pump Speed Low				Stainless Steel radius = 10 mm			
Time (s)	**T1**	**T2**	**T3**	**theta**	**Fo**	**1/Bi**	**h**
0	82.13	48.06	24.84	**No need to calculate at time=zero**			
2	82.11	79.94	26.14	0.954	**0.09**		
4	82.02	80.63	32.96	0.837	**0.18**		
6	81.88	80.70	41.70	0.687	**0.27**		
8	81.94	80.86	49.08	0.562	**0.36**		
10	81.93	80.70	55.20	0.457	**0.45**		
12	81.94	80.82	60.15	0.372	**0.54**	0.62	2629.03
14	81.92	80.92	64.01	0.306	**0.63**		
16	81.96	80.89	67.16	0.253	**0.72**		
18	81.96	81.01	69.76	0.208	**0.81**		
20	81.96	81.09	71.87	0.172	**0.9**		
22	81.94	81.13	73.60	0.143	**0.99**		
24	81.94	81.14	74.98	0.119	**1.08**	0.59	2762.71
26	81.94	81.21	76.07	0.100	**1.17**		
28	81.94	81.26	77.16	0.082	**1.26**		
30	81.94	81.29	77.91	0.069	**1.35**		
32	81.93	81.32	78.54	0.058	**1.44**		
34	81.93	81.31	79.06	0.049	**1.53**		
36	81.93	81.34	79.47	0.042	**1.62**	0.54	3018.52
38	81.93	81.37	79.79	0.037	**1.71**		
40	81.92	81.38	80.07	0.032	**1.8**		
42	81.92	81.37	80.30	0.028	**1.89**		
44	81.91	81.40	80.50	0.024	**1.98**		
46	81.92	81.42	80.67	0.021	**2.07**		
48	81.91	81.42	80.79	0.019	**2.16**		
50	81.91	81.42	80.90	0.017	**2.25**	0.78	2089.74
52	81.91	81.41	80.99	0.016	**2.34**		
54	81.90	81.42	81.05	0.015	**2.43**		
56	81.89	81.42	81.11	0.013	**2.52**		
58	81.89	81.41	81.15	0.013	**2.61**		
60	81.88	81.42	81.19	0.012	**2.7**		
62	81.88	81.41	81.22	0.011	**2.79**		
64	81.87	81.40	81.25	0.011	**2.88**	0.92	1771.74
66	81.87	81.41	81.26	0.010	**2.97**		
68	81.86	81.40	81.27	0.010	**3.06**		
70	81.85	81.39	81.29	0.010	**3.15**		
72	81.84	81.39	81.29	0.009	**3.24**		
74	81.84	81.40	81.30	0.009	**3.33**		
76	81.84	81.39	81.30	0.009	**3.42**		
78	81.82	81.38	81.29	0.009	**3.51**	1.18	1381.36
80	81.82	81.38	81.30	0.009	**3.6**		

Charts

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