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VENTURI CAVITATION EROSION TESTS AT 80°F AND 160°F ON 1018 CARBON STEEL

M.E. 600

by

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Introduction:

The aim of the experiments which I've done on the venturi type damage tester is to study the effect of cavitation on a given material under certain conditions of flow velocity and temperature.

This report presents the results obtained for CS 1018 specimens under the following conditions:

a) a flow velocity of 36.3 m/sec and temp. 80° F

b) a flow velocity of 49 m/sec and temp 160°F

Brief Description of System:

The venturi type damage tester system consists of a high pressure tank and a low pressure one enclosed in a main loop with a pump between them on one side and the venturi ~~table~~ tube on the other side. Connected to the low pressure tank is a surge tank for applying whatever initial pressure we like on the system. The water used in the system should be deaerated to exclude the effect of air bubbles. A deaerator tank is used for that purpose.

About two thirds of this tank is filled with water and the other one third is evacuated by an ejector at the top of the tank. Water from the high pressure tank is sprayed in vacuum region and the deaerated water is pumped to the low pressure tank.

The idea of this system is that water at high pressure and given temp is throttled in the venturi tube to a lower pressure such that this pressure along a certain portion of the tube is below saturation pressure which is determined by temperature of water. Cavitation is then prevailing in that zone.

Observations:

(a) It was observed that level of water in deaerator plays an important role in determining the air content of water after deaeration. The level of water should be adjusted in such a way to give enough time for the water sprayed from top to feel the vacuum condition. So it is advisable to fill the tank with water to no more than 2/3 of its volume and not as pointed out in previous reports, which was about 4/5, although in the first procedure more time is needed to reach the required pressure. Also the deaeration process should run for approximately one hour to make sure that all the water in the main loop has undergone deaeration.

(b) When finishing from the deaeration process care should be given to the sequence of closing the valves between the deaerator tank and the high and low pressure tanks of the main loop. Those connecting the deaerator tank to the high pressure one are closed first; then those to low pressure tank; simultaneously the small pump is shut. If the small pump is shut before the valves are closed, we have backward flow of water from main loop to deaerator tank since the pressure in the first is usually higher.

Also, after isolating the deaerator tank from main loop at end of the deaeration process, it was observed that the water in the deaerator began to go up and down sometimes in a crazy manner that leads to shaking of the tank. I cannot give a definite physical explanation to that aspect but all that I can say is that these fluctuations in level of water are minimized if the valves to the low pressure tank are closed simultaneously with the shutting of small pump and they would be severe if there is an elapse of time between the two steps. This is perhaps because of the expansion pressure waves reflected back into the deaerator. This water disturbance is stopped immediately if the vent valve is opened. Furthermore, I don't think that this aspect is due to possible boiling of water due to vacuum conditions; because you can feel that what is taking place inside tank is not a boiling process but what you might have if you shake a big vessel full of water.

(c) When depressurizing the system the valve exposing the top of surge tank to atmospheric pressure should be partially opened and not fully because in the first case it was observed that air leakage is low; and also that gives time to any air bubbles that might still exist in the system to be compressed out under the existing pressure gradient.

Also, it is advisable to leave the system slightly pressurized 5-7 psig before inserting the samples to have air leakage at its minimum.

(d) The surge tank pressure and the speed of the pump should be adjusted in such a way to produce a cavitation zone extending between the throat and just before the specimen; this is to assure that the collapsing of bubbles took place on surface of the samples. At the same time we must make sure that we are running at the required velocity of water.

For example, it was found that for a flow velocity of 36.3 m/sec and a surge tank pressure bet 55-60 psig, we were able to produce the desired cavitation zone.

(e) When running at low temps the cooling water should be turned on at the beginning of the experiment; otherwise we'll not be able to maintain the required system temp if the capacity of the cooling water is limited.

(f) When filling the deaerator tank from city water; be sure that the vent valve is opened otherwise we'll have a pressurized flow and if the flow rate of water is high the pressure might reach an undesirable value.

(g) Sometimes when starting the system after inserting the samples, the noise in the pipe sounds unfamiliar and we have a lot of vibration and resonance conditions might be reached. This is due to the fact that there is not enough water in the main loop; and water from deaerator should be pumped to the loop. Also, that might have happened when starting the system; so the pump should be run at low speed until there is enough water in the loop again.

- Results obtained for specimen #9 at $V = 49\ m/sec$ & $T = 160°F$

Time Int. (hrs)	Cum. Time (hrs.)	wt. loss mg	Cum. wt. loss mg.	MDPR $\frac{mils}{hr}$
0	0	0	0	
2 3/4	2 3/4	0.83	0.83	47.8×10^{-3}
1 1/2	4 1/4	0.32	1.15	42.8×10^{-3}
2	6 1/4	0.71	1.86	47.14×10^{-3}
2	8 1/4	0.89	2.75	52.8×10^{-3}
1 1/2	9 3/4	0.61	3.36	54.58×10^{-3}
2	11 3/4	0.69	4.05	54.59×10^{-3}
2	13 3/4	0.48	4.53	52.18×10^{-3}

- Results obtained for specimen # 10 at $V = 49\ m/sec$ & $T = 16$

Time Int. (hrs.)	Cum. Time (hrs.)	wt. Loss mg	Cum. wt Loss mg	MDPR $\frac{mils}{hr}$
0	0	0	0	
2 3/4	2 3/4	0.58	0.58	33.4×10^{-3}
1 1/2	4 1/4	0.5	1.08	40.25×10^{-3}
2	6 1/4	0.52	1.6	40.55×10^{-3}
2	8 1/4	1.97	3.57	68.54×10^{-3}
1 1/2	9 3/4	0.15	3.72	60.43×10^{-3}
2	11 3/4	0.34	4.06	54.73×10^{-3}
2	13 3/4	0.96	5.02	57.83×10^{-3}

- Results obtained for specimen # 11 at V = 36.3 m/sec & T = 80°F

Time Int. hrs.	Cum. Time hrs	Wt. Loss mg	Cum. wt. Loss mg	MDPR mils/hr
0	0	0	0	
1½	1½	0.45	0.45	47.52×10^{-3}
2¼	3¾	0.55	1.0	42.24×10^{-3}
2½	6¼	0.65	1.65	41.81×10^{-3}
3	9¼	0.6	2.25	38.52×10^{-3}
4	13¼	1.1	3.35	40×10^{-3}
3½	16¾	0.8	4.15	39.24×10^{-3}
2	18¾	0.35	4.5	38×10^{-3}
3½	22¼	0.85	5.35	38×10^{-3}
3½	25¾	1.2	6.55	40.29×10^{-3}

- Results obtained for specimen # 12 at $V = 36.3$ m/sec & $T = 80°F$

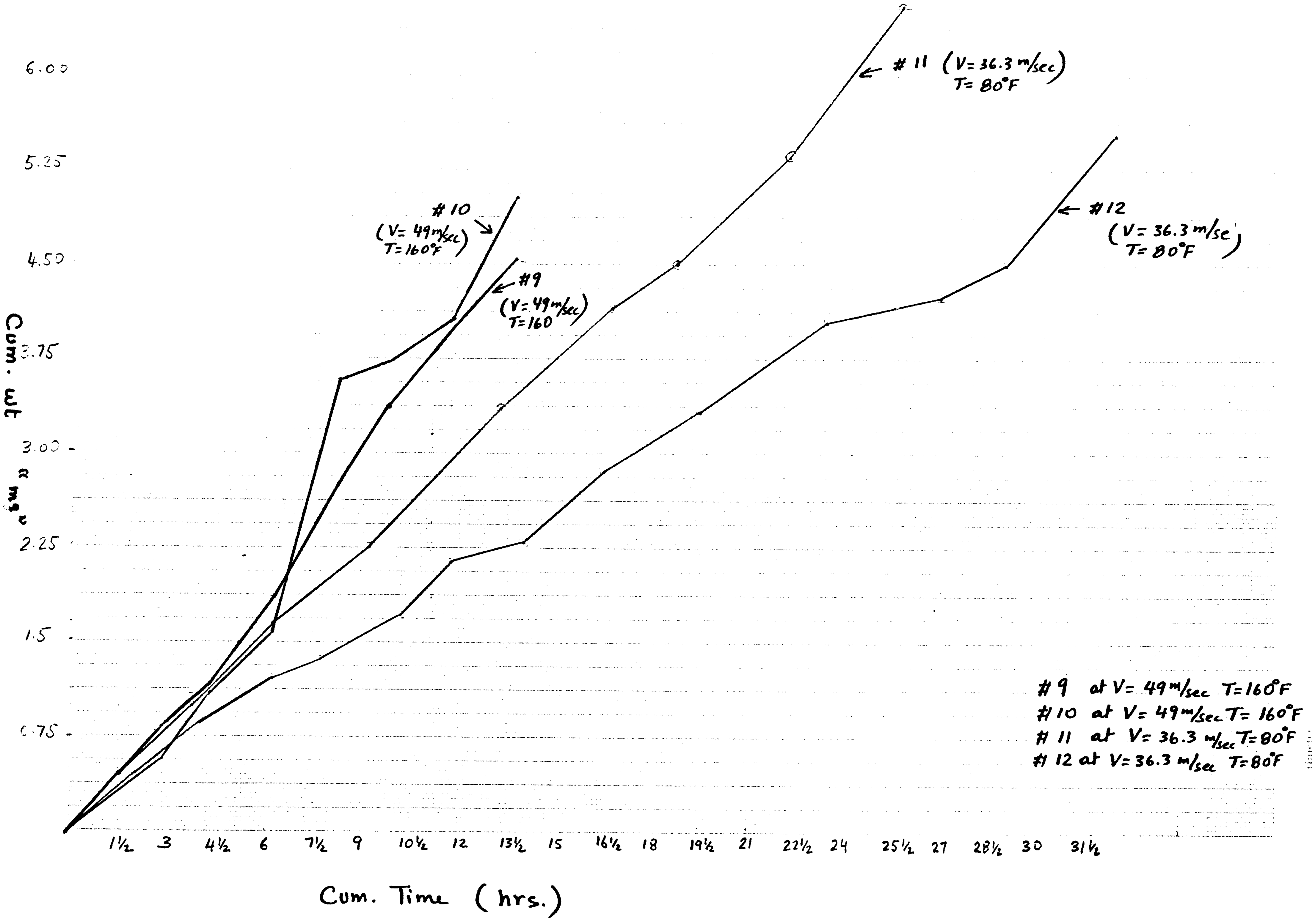
Time Int	Cum. Time hrs.	wt. Loss mg	Cum. wt Loss "mg"	MDPR mils/hr
0	0	0	0	
2	2	0.45	0.45	35.64×10^{-3}
2	4	0.41	0.86	34.0×10^{-3}
2 1/4	6 1/4	0.35	1.21	30.66×10^{-3}
1 1/2	7 3/4	0.15	1.36	27.8×10^{-3}
2 1/2	10 1/4	0.35	1.71	26.42×10^{-3}
1 1/2	11 3/4	0.42	2.13	28.71×10^{-3}
2 1/4	14	0.15	2.28	25.8×10^{-3}
2 1/2	16 1/2	0.6	2.88	27.65×10^{-3}
3	19 1/2	0.45	3.33	27.05×10^{-3}
4	23 1/2	0.7	4.03	27.16×10^{-3}
3 1/2	27	0.2	4.23	24.8×10^{-3}
2	29	0.25	4.48	24.5×10^{-3}
3 1/2	32 1/2	1.05	5.53	26.95×10^{-3}

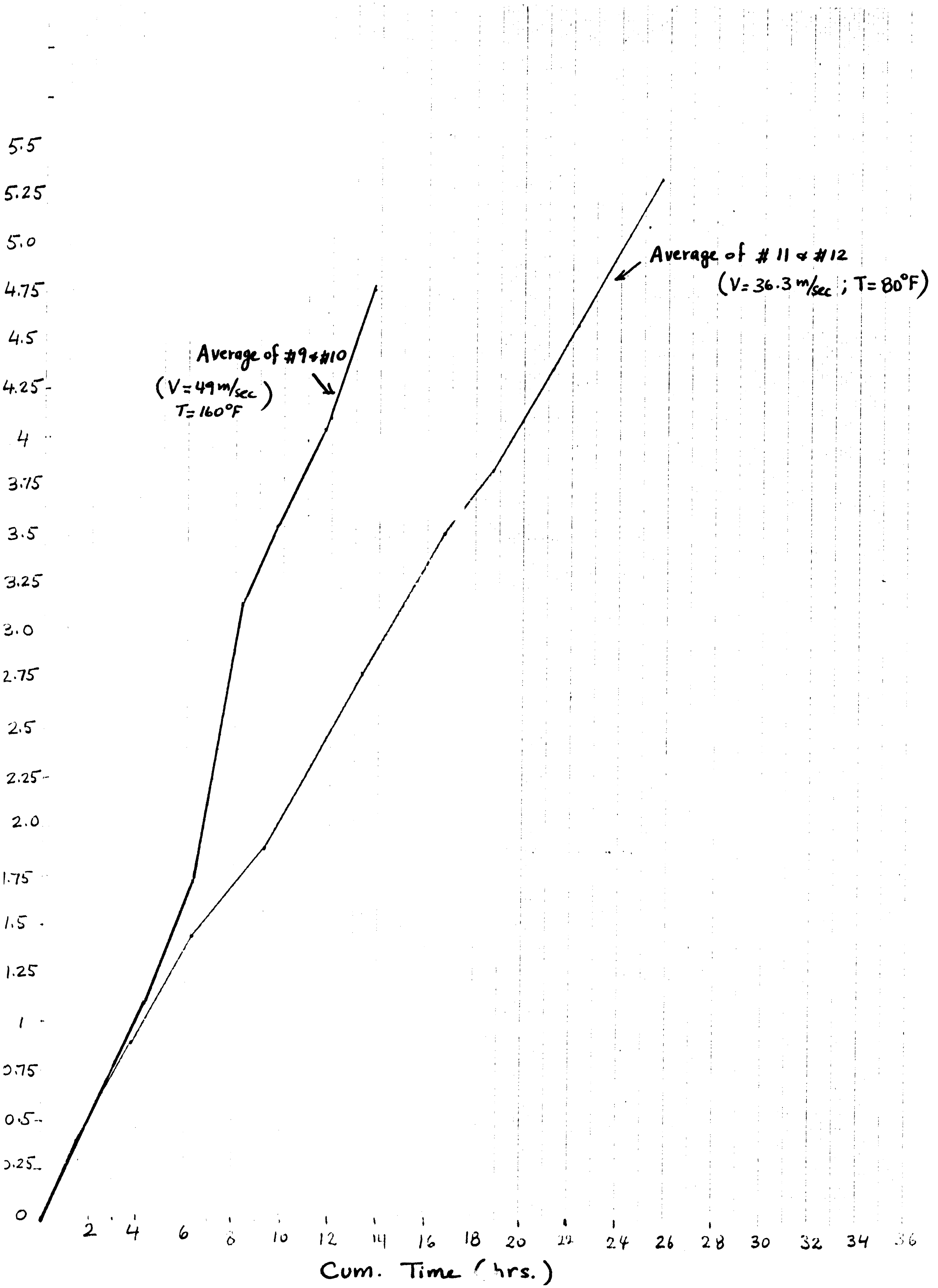
A - Average Values for specimens # 9

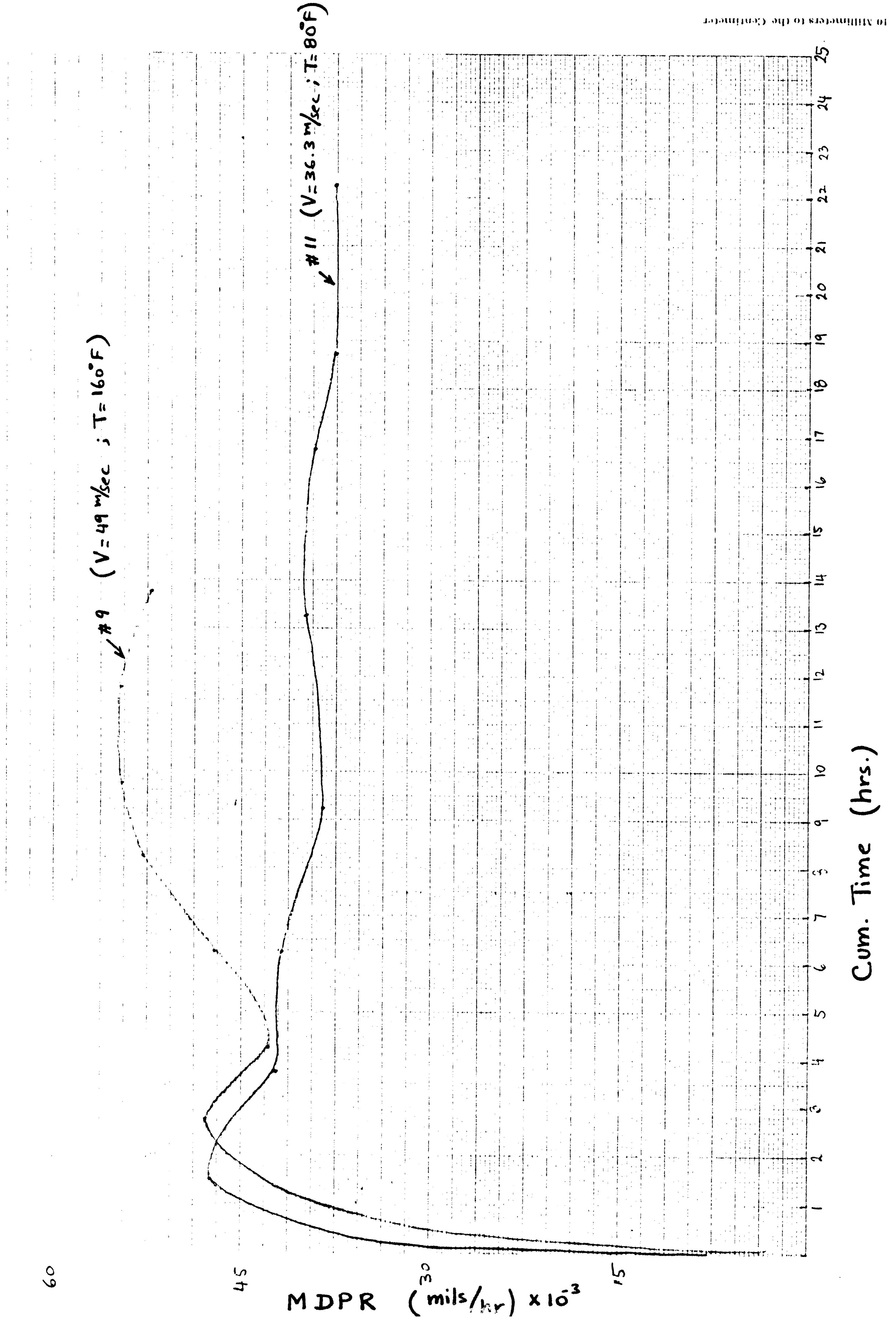
Cum. Time hrs.	Cum. wt. loss mg	MDPR mils/hr
2 3/4	0.7	40.32×10^{-3}
4 1/4	1.11	41.37×10^{-3}
6 1/4	1.73	43.84×10^{-3}
8 1/4	3.16	60.67×10^{-3}
9 3/4	3.54	57.5×10^{-3}
11 3/4	4.05	54.6×10^{-3}
13 3/4	4.77	54.95×10^{-3}

B - Average values for specimens # 11 and # 12

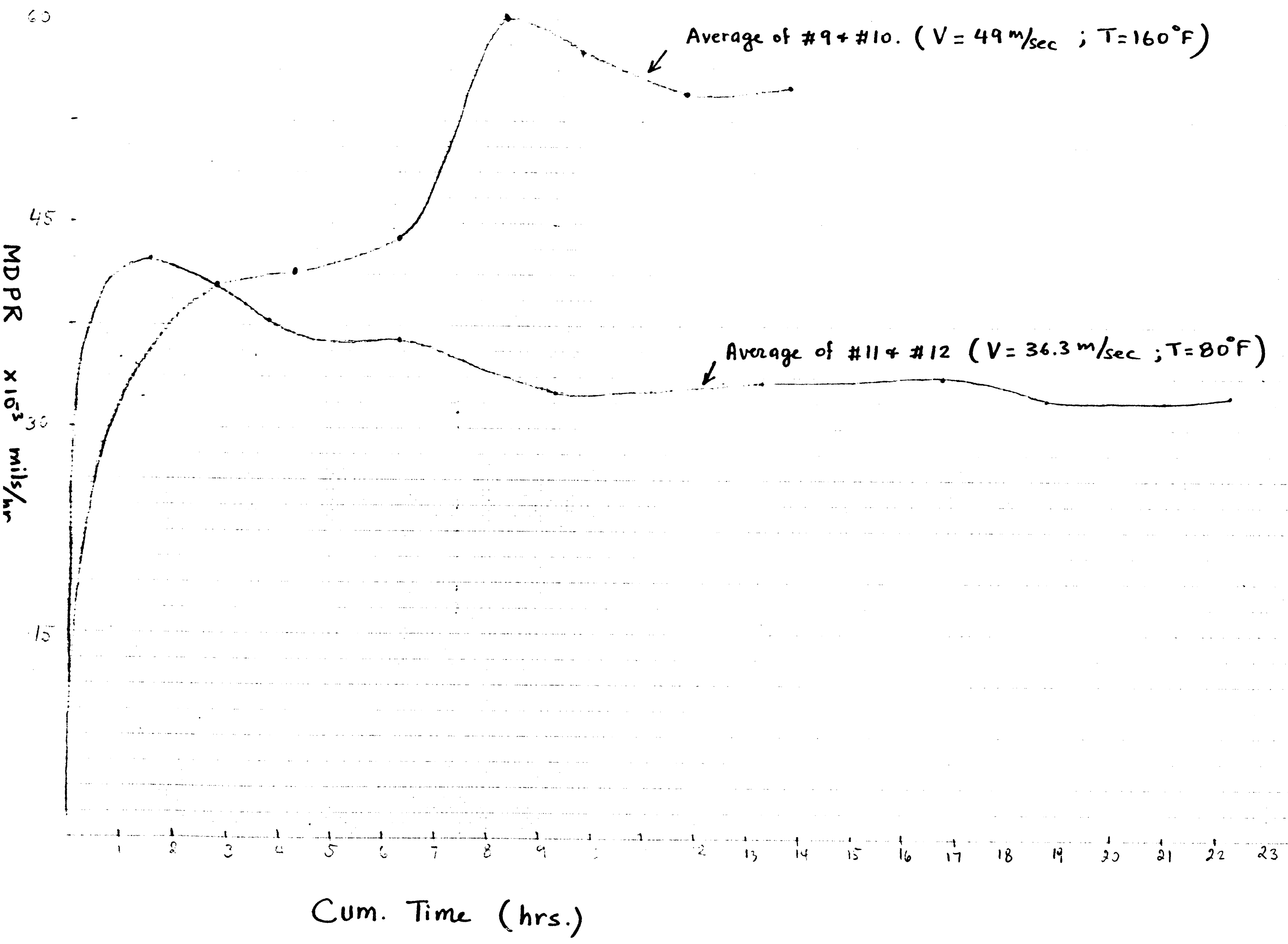
Cum. Time hrs	Cum wt. loss mg	MDPR mils /hr
1 1/2	0.4	42.24×10^{-3}
3 3/4	0.9	38×10^{-3}
6 1/4	1.43	36.24×10^{-3}
9 1/4	1.91	32.7×10^{-3}
13 1/4	2.79	33.35×10^{-3}
16 3/4	3.53	33.38×10^{-3}
18 3/4	3.85	32.52×10^{-3}
22 1/4	4.58	32.6×10^{-3}
25 3/4	5.35	32.91×10^{-3}

#10 (V= 49m/sec T=160°F)
#9 (V= 49m/sec T=160)
#11 (V=36.3 m/sec T= 80°F)
#12 (V= 36.3 m/se T= 80°F)
#9 at V= 49m/sec T=160°F
#10 at V= 49m/sec T= 160°F
#11 at V= 36.3 m/sec T=80°F
#12 at V=36.3 m/sec T=80°F
Cum. wt "mg"
6.00
5.25
4.50
3.75
3.00
2.25
1.5
0.75
1½
3
4½
6
7½
9
10½
12
13½
15
16½
18
19½
21
22½
24
25½
27
28½
30
31½
Cum. Time (hrs.)


5.5
5.25
5.0
4.75
4.5
4.25
4
3.75
3.5
3.25
3.0
2.75
2.5
2.25
2.0
1.75
1.5
1.25
1
0.75
0.5
0.25
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
Cum. Time (hrs.)
Average of #9 & #10
(V = 49 m/sec
T = 160°F)
Average of #11 & #12
(V = 36.3 m/sec ; T = 80°F)



MDPR (mils/hr) x 10⁻³
60
45
30
15
Cum. Time (hrs.)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
#9 (V = 49 m/sec ; T = 160°F)
#11 (V = 36.3 m/sec ; T = 80°F)


Average of #9 + #10. (V = 49 m/sec ; T = 160°F)
Average of #11 + #12 (V = 36.3 m/sec ; T = 80°F)
60
45
30
15
MDPR x10⁻³ mils/hr
1
2
3
4
5
6
7
8
9
12
13
14
15
16
17
18
19
20
21
22
23
24
Cum. Time (hrs.)