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APPENDIX

APPENDIX A

CALIBRATION OF ORIFICE METER

The purpose of the calibration is to determine the coefficient of discharge of the orifice meter used in the experiment.

The pressure taps of the designed orifice meter is tapped radially (see Fig. A-1). The center of the inlet pressure tap is 1D, where D is the pipe diameter, preceding the inlet face of the orifice plate. The center of the outlet (downstream) pressure tap is 0.5D from the inlet face of the orifice plate. The dimensions of the orifice meter is as follows:

Pipe diameter, D = 47.25 mm

Diameter of orifice, d = 25.40 mm

Orifice plate thickness = 3.175 mm

The red oil with specific gravity 0.83 (at temperature of 27° C) is used in the manometer to measure the pressure drop across the orifice. Since the discharge side of the system of the Cyclone conveyor has a low air pressure the flow may be approximated as the incompressible flow. The flow rate of fluid through an orifice is calculated by a formula³,

$$Q = C \frac{\pi d^2 / 4}{\sqrt{1 - (d/D)^4}} \sqrt{2gh} \quad (A-1)$$

where
where

Q = volume flow rate, m³/s

C = coefficient of discharge

d = orifice diameter, m

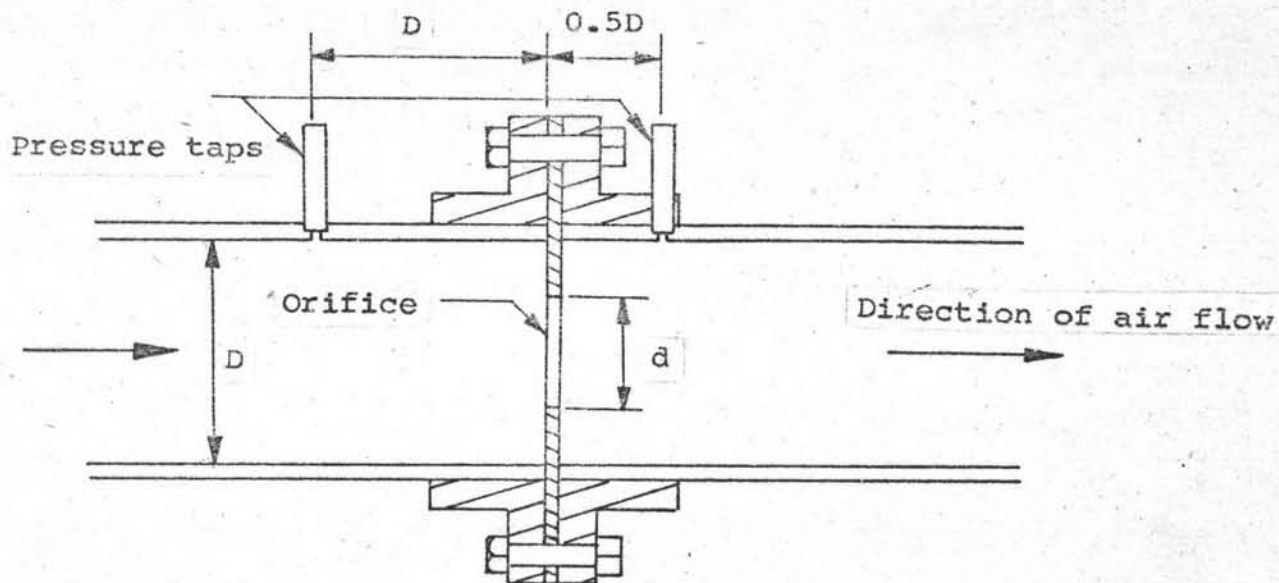


Fig. A-1 ORIFICE METER WITH RADIAL TAPS

D = pipe diameter, m

g = gravitational acceleration, 9.8 m/s^2

h = pressure drop across orifice, m of fluid.

Substitution the values from the data given above into Eq. (A-1), the flow rate of air at flowing condition (temperature of 27°C) is

$$\begin{aligned}
 Q &= C \frac{\sqrt{(25.4)^2 / 4 \times 10^6}}{\sqrt{1 - (25.4/47.25)^4}} \times \sqrt{2 \times 9.8 h_{\text{air}}} && \text{m}^3/\text{s} \\
 &= 2.3433 \times 10^{-3} C \sqrt{h_{\text{air}}} && \text{m}^3/\text{s} \\
 &= 2.2433 \times 10^{-3} \times 60 \times 10^3 \times C \sqrt{\frac{62.19}{0.07086} \frac{h_w}{100}} && \text{Lit/min} \\
 Q &= 416.5162 C \sqrt{h_w} && \text{Lit/min (A-2)}
 \end{aligned}$$

Where

h_w = pressure drop across the orifice,
cm of water.

In the calibration the Parkinson Crowan Measurement is used as the calibrator with the flow rate measured in cubic feet. The calibrator is connected to the downstream side of the orifice meter. A pressure regulator is used to control the flow rate of air. During calibration, record the values of pressure drop across the orifice, time, and volume, then calculate the flow rate, Q , using the test data. A coefficient of discharge can be determined by substituting a flow rate measured into Eq. (A-2). The test data are shown in Table A-1. The average value of the coefficient of discharge obtained from the Table A-1 is 0.5592. Substituting this average value into Eq.(A-2), will give

$$Q = 232.9158 \sqrt{h_w} \quad \text{Lit/min} \quad (\text{A-3})$$

The Eq. (A-3) is used to calculate the flow rate of air, at flowing conditions, in the experiment. It is assumed that the air temperature at flowing conditions is constant at 27 C throughout the experiment. The calibration curve for the orifice meter at flowing conditions is shown in Fig. 4-1.

If the presence of the water vapor is neglected at both the initial and final conditions the flow rate of air, Q_o , at the standard condition ($T_o = 20\text{C}$, $P_o = 101.33 \text{ kN/m}^2$, or 760 mmHg, relative humidity 36%, air density 1.2kg/m^3 , adopted by the ASME) can be computed from Eq.(A-4)¹

$$Q_o = \frac{P}{P_o} \cdot \frac{T_o}{T} \cdot Q \quad (\text{A-4})$$

Where Q_o = volume flow rate at standard condition

TABLE A-1 CALIBRATION OF ORIFICE

Test No.	Orifice pressure drop (cm w)	Volume		Time (sec)	Flow rate Q (lit/min)	Coefficient of discharge C
		ft ³	lit			
1	0.84	8	226.56	62.0	219.25	0.5743
2	1.69	10	283.20	56.0	303.43	0.5604
3	2.11	10	283.20	50.1	339.16	0.5606
4	3.37	14	396.48	55.9	425.56	0.5566
5	4.22	14	396.48	51.1	465.53	0.5441

Average value of C = 0.5592

T_o = temperature at standard condition

P_o = pressure at standard condition

Q = Volume flow rate at flowing condition

T = temperature at flowing condition

P = pressure at flowing condition.

APPENDIX B

SAMPLE OF CALCULATIONS

Given data; For Cyclone no.3

Regulated pressure of the

Compressed air supplied = 68.93 kN/m²

h_1	=	0.97	cm of water
h_2	=	2.95	cm of water
Δh_1	=	0.53	cm of water (gauge)
Δh_2	=	1.58	cm of water (gauge)
d_s	=	11.43	mm
T	=	27 C	
T_o	=	20 C	
P_o	=	760	mm Hg

1) Flow rate of compressed air supplied, Q_1

At flowing condition, from Eq.(A-3)

$$\begin{aligned}
 Q_1 &= 232.9158\sqrt{\Delta h_1} && \text{Lit/min} \\
 &= 232.9158\sqrt{0.97} && \text{"} \\
 &= 229.40 && \text{"}
 \end{aligned}$$

At standard condition, from Eq.(A-4)

$$\begin{aligned}
 Q_o &= \frac{(760 + \frac{h_1 \times 10}{13.6})}{760} \times \frac{273+20}{273+27} \times Q_1 && \text{Lit/min} \\
 &= \frac{(760 + \frac{0.53 \times 10}{13.6})}{760} \times \frac{293}{300} \times 229.40 && \text{"} \\
 &= 224.16 && \text{"}
 \end{aligned}$$

2) Total flow rate of air when the suction pipe is open, Q_2

At flowing condition, from Eq.(A-3)

$$\begin{aligned} Q_2 &= 232.9158 \sqrt{\Delta h_2} && \text{Lit/min} \\ &= 232.9158 \sqrt{2.95} && " \\ &= 400.05 && " \end{aligned}$$

At standard condition, from Eq.(A-4)

$$\begin{aligned} Q_1 &= \frac{(760 \frac{h_2 \times 10}{13.7})}{760} \times \frac{273+20}{273+27} \times Q_2 && \text{Lit/min} \\ &= \frac{(760 \frac{1.58 \times 10}{13.6})}{760} \times \frac{293}{300} \times 400.05 && " \\ &= 391.31 && " \end{aligned}$$

3) Flow rate of air entering the suction pipe, Q_3

$$Q_3 = Q_2 - Q_1$$

At standard condition,

$$\begin{aligned} Q_3 &= 391.31 - 224.16 && \text{Lit/min} \\ &= 167.15 && " \end{aligned}$$

4) Velocity of air in the suction pipe, V_s

$$\frac{\pi}{4} d_s^2 = \frac{\pi}{4} \left(\frac{11.43}{1000} \right)^2 = 102.6083 \times 10^{-6} \quad \text{m}^2$$

$$V_s = \frac{Q_3}{\frac{\pi}{4} d_s^2} = \frac{Q_3 (\text{Lit/min})}{10^3 \times 60 \times 102.6083 \times 10^{-6}} \quad \text{m/s}$$

$$= 0.1624 Q_3 (\text{Lit/min}) \quad "$$

$$= 0.1624 \times 167.15 \quad "$$

$$= 27.15 \quad "$$

APPENDIX C

TABLE OF DATA AND RESULTS

TABLE C-1 DIMENSIONS OF CYCLONES

Cyclone - No.	H (cm)	D ₁ (cm)	D ₂ (cm)	(degree)
1	7.5	7.5	7.50	0
2	7.5	7.5	8.80	5
3	7.5	7.5	10.20	10
4	7.5	7.5	11.50	15
5	7.5	7.5	13.00	20
6	15.0	7.5	7.50	0
7	15.0	7.5	10.12	5
8	15.0	7.5	12.80	10
9	15.0	7.5	15.54	15
10	15.0	7.5	18.42	20
11	30.0	7.5	7.50	0
12	30.0	7.5	12.75	5
13	30.0	7.5	18.10	10
14	30.0	7.5	23.60	15
15	30.0	7.5	29.30	20
16	45.0	7.5	7.50	0
17	45.0	7.5	15.40	5
18	45.0	7.5	23.40	10
19	45.0	7.5	31.60	15
20	45.0	7.5	40.10	20

TABLE C-2 DATA AND RESULTS OF CYCLONE NO. 1

Pressure of compressed air supplied	Vacuum produced, B (mm Hg)								Δh_1 cmW	Δh_2 cmW	h_1 cmWG	h_2 cmWG	Q_1 Lit/min	Q_2 Lit/min	Q_3 Lit/min	V_s m/s	
	0	0.1H	0.2H	0.3H	0.4H	Ave.											
kN/m^2	0	0.1H	0.2H	0.3H	0.4H	Ave.											
34.46	5	6.12	6.12	6.12	6.12	6.12	6.12	0.57	1.56	0.32	0.84	171.80	284.36	112.56	18.27		
68.93	10	11.32	11.16	11.16	11.16	11.16	11.00	1.05	2.89	0.62	1.69	233.25	387.36	154.11	25.03		
103.39	15	16.74	16.74	16.74	16.74	16.74	16.74	1.90	4.34	1.26	2.32	313.95	474.98	161.03	26.15		
137.86	20	23.25	23.25	23.10	23.10	23.10	23.10	2.53	5.84	1.48	3.27	362.36	550.53	188.17	30.56		
172.32	25	29.61	29.61	29.30	29.30	29.30	29.30	2.95	7.53	1.69	4.11	391.36	626.73	235.37	38.22		
206.78	30	34.88	34.88	34.88	34.72	34.72	34.41	4.32	9.28	2.53	5.16	473.98	696.46	222.48	36.13		
241.25	35	40.92	40.92	40.77	40.77	40.77	40.46	5.63	11.17	3.48	6.32	541.59	764.95	223.36	36.27		
275.71	40	47.28	40.28	46.50	46.50	46.50	46.35	6.85	13.32	4.11	7.48	597.76	836.26	238.50	38.78		

TABLE C-3 DATA AND RESULTS OF CYCLONE NO.2

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
KN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWg	Lit/min	Lit/min	Lit/min	m/s
34.46	5	6.51	6.51	6.51	6.36	6.36	6.45	0.57	1.56	0.32	0.84	171.80	284.36	112.56	18.27
68.93	10	13.18	13.02	12.71	12.71	12.56	12.84	1.22	2.87	0.74	1.58	251.45	385.99	134.54	21.85
103.39	15	19.38	19.38	19.38	19.38	19.38	19.38	2.28	4.24	1.48	2.32	343.99	469.48	125.49	20.38
137.86	20	23.25	23.25	23.25	22.79	22.48	23.01	2.07	5.65	1.26	3.16	327.70	542.39	214.69	34.86
172.32	25	28.37	28.37	27.44	26.51	25.35	27.41	2.74	7.25	1.90	4.01	377.25	614.91	237.66	38.60
206.78	30	34.57	34.57	33.79	33.17	32.55	33.73	3.29	8.85	2.74	5.06	413.72	680.07	266.35	43.26
241.25	35	40.30	40.30	38.75	38.75	38.29	39.38	4.01	10.69	3.58	6.11	457.12	748.18	291.06	47.27
275.71	40	49.60	49.60	48.05	47.74	47.74	48.55	4.76	12.69	4.64	7.17	498.55	816.00	317.45	51.55

TABLE C-4 DATA AND RESULTS OF CYCLONE NO.3

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	11.00	11.00	10.58	10.58	10.58	10.91	0.57	1.58	0.36	0.84	171.81	286.18	114.37	18.57
68.93	10	19.38	19.38	19.22	19.07	19.07	19.22	0.97	2.95	0.53	1.58	224.16	391.32	167.16	27.15
103.39	15	28.68	28.68	28.21	27.90	27.90	28.28	1.52	4.38	0.84	2.42	280.69	477.21	196.52	31.91
137.86	20	38.13	38.13	37.36	37.31	37.20	37.64	2.11	6.05	1.16	3.37	330.82	561.37	230.55	37.44
172.32	25	47.43	47.43	46.81	46.50	46.35	46.91	2.74	7.50	1.58	4.22	377.14	625.55	248.41	40.34
206.78	30	56.42	56.42	55.80	55.49	55.03	55.84	3.48	9.19	2.00	5.16	425.20	693.08	267.88	43.50
241.25	35	-	-	-	-	-	-	4.32	11.00	2.53	6.11	473.98	758.96	284.98	46.28
275.71	40	-	-	-	-	-	-	5.16	12.90	3.06	7.17	518.28	822.73	304.45	49.44

TABLE C-5 DATA AND RESULTS OF CYCLONE NO.4

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	9.14	9.14	9.14	9.14	8.99	9.12	0.61	1.54	0.32	0.84	177.73	282.54	104.81	17.02
68.93	10	16.43	16.35	16.35	16.12	15.97	16.25	1.03	2.85	0.53	1.58	230.99	384.63	153.64	24.95
103.39	15	22.79	22.79	22.63	22.63	22.48	22.66	1.62	4.22	0.84	2.32	289.78	468.37	178.59	29.00
137.86	20	30.23	30.23	30.23	30.07	30.07	30.17	2.32	5.63	1.26	3.06	346.92	541.37	194.45	31.58
172.32	25	38.91	38.91	38.60	38.60	38.29	38.66	3.16	7.17	1.69	3.90	405.05	611.44	206.39	33.52
206.78	30	46.81	46.66	46.66	46.50	46.35	46.60	4.07	8.75	2.11	4.74	459.88	676.01	216.13	35.10
241.25	35	56.11	56.11	55.96	55.34	55.34	55.78	4.85	10.56	2.64	5.90	502.27	743.47	241.20	39.17
275.71	40	-	-	-	-	-	-	5.37	12.48	2.95	6.85	528.67	808.98	280.31	45.52

TABLE C-6 DATA AND RESULTS OF CYCLONE NO.5

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m^2	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	8.06	8.06	8.06	8.06	8.06	8.06	0.57	1.60	0.42	0.84	171.82	287.99	116.17	18.87
68.93	10	14.75	14.73	14.73	14.73	14.73	14.73	1.05	2.95	0.63	1.69	233.25	391.36	158.11	25.68
103.39	15	21.70	21.70	21.70	21.70	21.70	21.70	1.54	4.49	0.84	2.53	282.54	483.22	200.68	32.59
137.86	20	26.20	26.20	26.20	26.20	26.20	26.20	2.95	6.03	1.58	3.37	391.32	560.44	169.22	27.48
172.32	25	31.47	31.31	30.85	30.85	30.69	31.04	4.74	7.76	2.32	4.22	496.39	636.30	139.91	22.72
206.78	30	36.58	36.27	36.12	35.96	35.81	36.15	6.01	9.49	3.06	5.06	559.35	704.23	144.88	23.53
241.25	35	43.25	42.78	42.32	42.32	42.01	42.54	7.06	11.43	3.79	6.22	606.67	773.73	167.06	27.13
275.71	40	50.53	50.38	50.07	50.07	49.91	50.20	7.84	13.32	4.22	7.27	639.57	836.10	196.53	31.92

TABLE C-7 DATA AND RESULTS OF CYCLONE NO.6

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
$\sqrt{\text{kN/m}^2}$	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	4.88	4.88	4.88	4.88	4.88	4.88	0.53	1.33	0.32	0.74	165.67	262.54	96.87	15.73
68.93	10	9.15	9.15	9.15	9.15	9.15	9.15	0.95	2.42	0.53	1.10	221.84	354.27	132.43	21.51
103.39	15	13.95	13.80	13.80	13.64	13.64	13.77	1.48	3.71	0.84	2.11	276.98	439.08	162.09	26.32
137.86	20	18.76	18.60	18.45	18.45	18.29	18.51	2.00	5.16	1.05	2.85	322.04	518.18	196.14	31.85
172.32	25	23.41	23.25	23.10	23.10	23.10	23.19	2.66	6.62	1.48	3.65	371.55	587.38	215.83	35.05
206.78	30	27.44	27.44	27.44	27.44	27.44	27.44	3.35	8.22	1.83	4.53	417.11	655.08	237.93	38.65
241.25	35	32.55	32.55	32.40	32.40	32.40	32.46	4.17	9.82	2.42	5.38	465.63	716.59	250.96	40.76
275.71	40	37.36	37.36	37.36	37.20	37.20	37.30	5.04	11.64	2.85	6.43	512.12	780.96	268.84	43.66
344.64	50	48.21	48.21	47.90	47.74	47.59	47.93	7.04	15.77	4.07	8.64	605.97	910.89	304.92	49.52



TABLE C-8 DATA AND RESULTS OF CYCLONE NO.7

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	7.60	7.60	7.60	7.60	7.60	7.60	0.53	1.48	0.32	0.74	165.66	276.95	111.29	18.07
68.93	10	14.42	14.26	14.26	14.26	14.10	14.26	0.97	2.87	0.57	1.58	224.17	385.98	161.81	26.28
103.39	15	21.70	21.39	21.24	21.24	21.16	21.35	1.48	4.28	0.84	2.32	276.98	471.69	194.71	31.62
137.86	20	28.99	28.83	28.68	28.52	28.52	28.71	2.03	5.90	1.10	3.29	324.47	554.33	229.86	37.33
172.32	25	36.58	36.58	36.27	36.12	36.04	36.32	2.78	7.63	1.52	4.11	379.86	630.88	251.02	40.76
206.78	30	44.02	43.87	43.56	43.56	43.40	43.68	3.46	9.28	1.90	4.95	424.54	696.32	271.78	44.14
241.25	35	51.77	51.62	51.00	51.00	50.69	51.22	4.30	11.24	2.32	6.07	472.79	767.16	294.37	47.80

TABLE C-9 DATA AND RESULTS OF CYCLONE NO.8

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
		0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	6.59	6.59	6.59	6.51	6.51	6.56	0.63	1.48	0.42	0.78	180.64	276.96	96.32	15.64
68.93	10	12.56	12.56	12.56	12.56	12.56	12.56	1.05	2.74	0.63	1.48	233.25	377.10	143.85	23.36
103.39	15	19.07	19.07	19.07	18.91	18.91	19.01	1.62	4.13	0.84	2.32	289.78	463.35	173.57	28.19
137.86	20	26.20	26.20	26.20	26.04	26.04	16.14	2.21	5.69	1.16	3.06	338.57	544.25	205.68	33.40
172.32	25	34.88	34.88	34.57	34.57	34.57	34.69	2.87	7.38	1.58	4.01	385.98	620.40	234.42	38.07
206.78	30	42.78	42.78	42.63	42.63	42.63	42.69	3.58	9.19	2.00	4.95	431.26	692.94	261.68	42.50
241.25	35	51.15	51.15	51.15	51.15	51.15	51.15	4.43	11.20	2.42	6.01	479.93	765.75	285.82	46.42

TABLE C-10 DATA AND RESULTS OF CYCLONE NO.9

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	5.42	5.42	5.42	5.42	5.42	5.42	0.63	1.48	0.32	0.78	180.62	276.96	96.34	15.64
68.93	10	10.23	10.23	9.92	10.23	10.08	10.14	1.05	2.72	0.57	1.48	233.24	375.72	142.48	23.14
103.39	15	15.34	15.19	15.19	15.19	15.19	15.22	1.62	4.01	0.84	2.21	289.78	456.52	166.74	27.08
137.86	20	20.62	20.31	20.31	20.31	20.31	20.37	2.19	5.48	1.26	3.16	337.06	534.16	197.10	32.01
172.32	25	26.04	25.89	25.73	25.73	25.73	25.83	2.89	7.11	1.69	3.90	387.36	608.88	221.52	35.97
206.78	30	31.16	30.85	30.69	30.85	30.85	30.88	3.61	8.73	2.00	4.74	433.06	675.23	424.17	39.33
241.25	35	36.74	36.12	35.96	36.12	36.12	36.21	4.49	10.54	2.42	5.80	483.17	742.70	259.53	42.15
275.71	40	41.54	41.08	40.92	41.08	41.08	41.14	5.42	12.44	2.95	6.75	531.12	807.60	276.48	44.90
344.64	50	50.69	50.07	49.76	49.76	49.76	50.01	7.59	16.66	4.11	8.92	629.22	936.55	307.33	49.91

TABLE C-11 DATA AND RESULTS OF CYCLONE NO.10

Pressure of compressed air supplied		Vacuum produced, B (cm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m^2	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	2.17	2.17	2.17	2.17	2.17	2.17	0.57	0.84	0.32	0.42	171.80	208.58	36.78	5.97
68.93	10	5.74	5.58	5.58	5.42	5.42	5.55	1.05	1.64	0.63	0.84	233.25	291.59	58.31	9.47
103.39	15	9.14	8.84	8.68	8.68	8.60	8.79	1.58	2.53	0.84	1.26	286.18	362.28	76.10	12.36
137.86	20	12.71	12.24	12.24	12.24	12.09	12.31	2.15	3.54	1.20	1.90	333.95	428.80	94.85	15.40
172.32	25	17.05	16.59	16.59	16.59	16.43	16.65	2.83	4.70	1.58	2.53	383.28	494.39	111.11	18.04
206.78	30	21.24	20.93	20.62	20.62	20.62	20.80	3.52	5.84	1.90	3.06	427.59	551.38	123.79	20.10
241.25	35	25.58	25.11	25.11	24.96	24.80	25.11	4.36	7.17	2.32	3.90	476.08	611.44	135.36	21.98
275.71	40	29.14	28.83	28.68	28.68	28.68	28.80	5.29	8.58	2.87	4.64	524.68	669.34	144.66	23.49
344.64	50	34.26	34.26	34.10	34.10	34.10	34.17	7.38	11.53	4.01	6.22	620.40	777.11	156.71	25.45

TABLE C-12 DATA AND RESULTS OF CYCLONE NO.11

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	2.71	2.71	2.67	2.71	2.71	2.71	0.57	1.05	0.32	0.53	171.80	233.23	61.43	9.98
68.93	10	5.19	5.19	5.19	5.12	5.17	5.19	1.01	2.11	0.53	1.26	228.74	330.85	102.11	16.58
103.39	15	7.90	7.90	7.90	7.83	7.83	7.88	1.48	3.16	0.74	1.69	276.95	405.05	128.10	20.80
137.86	20	10.85	10.85	10.77	10.54	10.77	10.76	2.00	4.32	1.16	2.32	322.08	473.89	151.81	24.65
172.32	25	13.80	13.80	13.56	13.18	13.41	13.55	2.64	5.63	1.48	3.06	370.15	541.37	171.22	27.81
206.78	30	16.28	16.28	16.12	15.66	15.66	16.00	3.27	6.96	1.79	3.73	412.08	602.32	190.24	30.89
241.25	35	18.91	18.91	18.60	17.98	18.29	18.54	4.11	8.43	2.28	4.53	462.21	663.41	201.20	32.67
275.71	40	21.70	21.70	21.55	21.24	21.24	21.49	4.95	10.01	2.70	5.38	507.45	723.49	216.04	35.08
344.64	50	29.14	28.21	28.21	27.13	27.28	28.00	6.96	13.70	3.79	7.34	602.36	848.00	245.64	39.89

TABLE C-13 DATA AND RESULTS OF CYCLONE NO. 12

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	4.96	4.96	4.80	4.80	4.80	4.87	0.57	1.31	0.32	0.74	171.80	260.56	88.76	14.41
68.93	10	9.46	9.38	9.30	9.30	9.30	9.35	1.01	2.64	0.53	1.37	228.74	370.12	141.38	22.96
103.39	15	14.26	14.26	13.95	13.95	13.95	14.08	1.52	3.84	0.84	2.00	280.70	446.65	165.95	26.95
137.86	20	19.07	19.07	18.99	18.91	18.91	18.99	2.04	5.31	1.16	2.85	325.28	525.66	200.38	32.54
172.32	25	24.34	24.34	24.18	24.03	23.87	24.15	2.78	6.92	1.48	3.69	379.84	600.57	220.73	35.85
206.78	30	29.14	29.14	28.99	28.68	28.52	28.90	3.48	8.43	1.90	4.64	425.16	663.47	238.31	38.70
241.25	35	34.57	34.26	34.10	33.64	33.48	34.01	4.36	10.29	2.32	5.48	476.08	733.61	257.53	41.82
275.71	40	39.22	39.06	38.75	38.44	38.13	38.72	5.21	12.27	2.85	6.54	520.68	801.90	281.22	45.67
344.64	50	49.14	48.52	48.21	48.05	48.05	48.40	7.23	16.44	3.96	8.85	614.03	930.28	316.25	51.36

TABLE C-14 DATA AND RESULTS OF CYCLONE NO.13

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	4.03	4.03	4.03	4.03	4.03	4.03	0.53	1.16	0.32	0.63	165.66	245.16	79.50	12.91
68.93	10	8.06	7.90	7.75	7.75	7.75	7.84	0.99	2.28	0.53	1.26	226.46	343.92	117.46	19.08
103.39	15	12.24	12.09	11.94	11.94	11.62	11.97	1.48	3.48	0.74	1.90	276.95	425.16	148.21	24.07
137.86	20	16.82	16.43	16.28	15.97	15.97	16.29	2.04	4.81	1.16	2.64	325.28	500.20	174.92	28.41
172.32	25	21.31	21.08	20.62	20.46	20.46	20.79	2.70	6.26	1.48	3.37	374.34	571.03	196.69	31.94
206.78	30	25.89	25.27	24.96	24.49	24.49	25.02	3.37	7.76	1.83	4.11	418.35	636.23	217.88	35.38
241.25	35	30.54	29.76	29.45	28.99	28.99	29.55	4.15	9.94	2.32	5.16	464.74	704.30	239.56	38.90
275.71	40	35.19	34.26	33.79	33.33	33.84	34.01	5.06	11.17	2.74	6.07	513.08	764.77	251.69	40.87
344.64	50	44.33	43.09	42.47	41.85	41.85	42.72	7.06	15.12	3.79	8.22	606.67	891.61	284.94	46.27

TABLE C-15 DATA AND RESULTS OF CYCLONE NO.14

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m^2	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	3.26	3.26	3.26	3.26	3.1	3.22	0.53	1.05	0.32	0.57	165.67	233.24	67.57	10.97
68.93	10	6.04	6.04	6.04	6.04	5.81	6.00	0.95	2.11	0.53	1.16	221.84	330.82	108.98	17.70
103.39	15	9.14	9.14	8.99	8.99	8.68	8.99	1.48	3.16	0.84	1.79	276.98	405.09	128.11	20.80
137.86	20	12.40	12.24	12.24	12.09	11.78	12.15	2.11	4.43	1.16	2.42	330.82	479.93	149.11	24.22
172.32	25	15.97	15.73	15.81	15.34	15.04	15.58	2.85	5.73	1.52	3.16	384.61	546.21	161.16	26.24
206.78	30	19.38	18.91	18.91	18.45	17.83	18.70	3.50	7.06	1.96	3.90	426.40	606.73	180.33	29.28
241.25	35	22.79	22.17	22.17	21.70	21.08	21.98	4.32	8.64	2.42	4.64	473.93	671.68	197.75	32.11
275.71	40	26.04	25.19	25.19	24.49	24.03	24.99	5.27	10.12	2.80	5.54	523.65	727.56	203.91	33.11
344.64	50	31.78	30.54	30.61	30.23	28.99	30.43	7.34	13.60	4.00	7.38	618.71	844.93	226.22	36.74

TABLE C-16 DATA AND RESULTS OF CYCLONE NO.15

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	2.32	2.32	2.25	2.25	2.17	2.26	0.53	0.95	0.32	0.53	165.67	221.84	56.17	9.12
68.93	10	4.57	4.57	4.50	4.34	4.18	4.43	0.97	1.83	0.48	0.95	224.15	308.02	83.87	13.62
103.39	15	6.98	6.82	6.82	6.74	6.51	6.77	1.48	2.85	0.78	1.54	276.96	384.62	107.66	17.48
137.86	20	9.53	9.30	9.30	9.07	8.84	9.21	2.04	3.94	1.16	2.11	325.28	452.47	127.19	20.66
172.32	25	11.94	11.62	11.62	11.39	11.16	11.55	2.74	5.16	1.48	2.85	377.10	518.18	141.08	22.91
206.78	30	14.03	13.64	13.64	13.33	13.02	13.53	3.37	6.39	1.90	3.48	418.38	576.99	158.61	25.76
241.25	35	16.12	15.65	15.65	15.34	14.88	15.50	4.24	7.70	2.32	4.22	469.48	633.83	164.35	26.69
275.71	40	18.14	17.52	17.52	17.21	16.59	17.39	5.10	9.15	2.74	4.95	515.10	691.43	176.33	28.64
344.64	50	21.86	21.24	21.24	20.85	20.15	21.07	7.17	12.27	3.90	6.68	611.44	802.01	190.57	30.95

TABLE C-17 DATA AND RESULTS OF CYCLONE NO.16

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	1.24	1.24	1.24	1.24	1.24	1.24	0.59	1.01	0.32	0.53	174.79	228.74	53.25	8.76
68.93	10	2.56	2.56	2.56	2.56	2.56	2.56	1.05	1.90	0.57	0.99	233.24	313.87	80.63	13.09
103.39	15	3.95	3.95	3.88	3.88	3.88	3.91	1.64	2.74	0.84	1.48	291.56	377.10	85.58	13.89
137.86	20	5.58	5.58	5.27	5.42	5.42	5.46	2.21	3.80	1.16	2.11	338.57	444.36	105.79	17.18
172.32	25	7.13	7.13	6.98	7.13	7.13	7.10	2.91	4.93	1.52	2.74	388.64	506.45	117.81	19.13
206.78	30	8.68	8.68	8.52	8.68	8.68	8.65	3.58	6.11	1.94	3.37	431.24	564.15	132.91	21.58
241.25	35	10.54	10.38	10.23	10.38	10.38	10.39	4.43	7.42	2.36	4.00	479.90	622.07	142.17	23.09
275.71	40	12.24	12.24	11.94	12.09	12.09	12.12	5.31	9.06	2.82	4.85	525.64	687.95	162.31	26.36
344.46	50	15.50	15.50	15.19	15.34	15.34	15.38	7.48	12.23	4.00	6.62	624.58	800.66	176.08	28.60



TABLE C-18 DATA AND RESULTS OF CYCLONE NO.17

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	2.32	2.32	2.32	2.32	2.32	2.32	0.59	1.16	0.32	0.63	174.79	245.16	70.37	11.43
68.93	10	4.65	4.65	4.65	4.65	4.65	4.65	1.05	2.11	0.59	1.16	233.24	330.82	97.58	15.85
103.39	15	7.13	7.13	6.98	7.13	7.13	7.10	1.58	3.27	0.84	1.79	286.18	412.08	125.90	20.45
137.86	20	10.23	10.23	10.23	10.23	10.08	10.20	2.21	4.53	1.16	2.42	338.57	485.32	146.75	23.83
172.32	25	13.80	13.48	13.80	13.80	13.80	13.74	2.85	5.80	1.56	3.16	384.62	549.54	164.92	26.78
206.78	30	17.21	17.05	17.05	17.21	17.21	17.14	3.58	7.27	1.94	3.90	431.24	615.69	184.45	29.95
241.25	35	20.93	20.62	20.62	20.77	20.77	20.74	4.43	8.96	2.42	4.85	479.93	684.14	204.21	33.16
275.71	40	24.34	24.03	23.87	24.18	24.18	24.12	5.33	10.65	2.85	5.80	526.65	746.56	219.91	35.71
344.64	50	31.31	30.69	30.54	30.85	30.85	30.85	7.48	14.34	4.00	7.80	624.58	867.96	243.38	39.52

TABLE C-19 DATA AND RESULTS OF CYCLONE NO.18

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	v_s
KN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	1.94	1.94	1.94	1.94	1.94	1.94	0.63	1.05	0.36	0.63	180.63	233.25	52.62	8.54
68.93	10	3.80	3.72	3.72	3.80	3.80	3.77	1.12	2.04	0.63	1.10	240.90	325.26	84.36	13.70
103.39	15	5.81	5.74	5.66	5.74	5.74	5.74	1.69	3.06	0.84	1.64	295.98	398.57	102.59	16.66
137.86	20	8.06	7.98	7.83	7.90	7.98	7.95	2.26	4.22	1.26	2.32	342.41	468.37	125.96	20.46
172.32	25	10.70	10.54	10.23	10.31	10.46	10.45	2.95	5.38	1.58	2.95	391.32	529.16	137.84	22.38
206.78	30	13.18	10.02	12.71	12.86	12.86	12.93	3.69	6.75	1.90	3.69	437.80	593.14	155.34	25.23
241.25	35	15.97	15.81	15.34	15.50	15.66	15.66	4.49	8.22	2.42	4.53	483.17	655.08	171.91	27.92
275.71	40	18.60	18.60	18.06	18.06	18.21	18.31	5.38	9.91	2.95	5.38	529.16	719.86	190.70	30.97
344.64	50	23.87	23.41	22.79	22.79	22.94	23.16	7.53	13.43	4.11	7.17	626.73	839.46	212.73	34.55

TABLE C-20 DATA AND RESULTS OF CYCLONE NO.19

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m ²	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	1.40	1.24	1.24	1.24	1.24	1.27	0.59	0.84	0.32	0.53	174.79	208.60	33.81	5.49
68.93	10	2.79	2.64	2.64	2.64	2.48	2.64	1.10	1.62	0.57	0.95	238.72	289.81	51.09	8.30
103.39	15	4.26	4.18	4.03	4.03	3.88	4.08	1.62	2.59	0.95	1.37	289.81	366.59	76.78	12.47
137.86	20	5.89	5.74	5.58	5.58	5.42	5.64	2.28	3.54	1.16	1.90	343.89	428.80	84.91	13.79
172.32	25	7.60	7.44	7.44	7.28	7.13	7.38	2.89	4.58	1.58	2.42	387.32	487.99	100.67	16.35
206.78	30	9.30	9.14	9.14	8.99	8.84	9.08	3.60	5.69	2.00	3.10	432.46	544.27	111.81	18.16
241.25	35	11.16	11.16	11.00	11.00	10.85	11.04	4.43	6.92	2.36	3.79	479.90	600.62	120.72	19.60
275.71	40	12.86	12.71	12.71	12.56	12.56	12.68	5.36	8.26	2.95	4.43	528.18	656.61	128.43	20.86
344.64	50	15.19	15.04	15.04	14.88	14.88	15.01	7.53	11.11	4.00	6.03	626.67	762.68	136.01	22.09

TABLE C-21 DATA AND RESULTS OF CYCLONE NO.20

Pressure of compressed air supplied		Vacuum produced, B (mm Hg)						Δh_1	Δh_2	h_1	h_2	Q_1	Q_2	Q_3	V_s
kN/m^2	Psig	0	0.1H	0.2H	0.3H	0.4H	Ave.	cmW	cmW	cmWG	cmWG	Lit/min	Lit/min	Lit/min	m/s
34.46	5	0.85	0.85	0.85	0.85	0.93	0.87	0.63	0.78	0.32	0.48	180.56	201.01	20.45	3.32
68.93	10	1.94	1.94	1.94	1.94	2.02	1.95	1.12	1.52	0.57	0.91	240.88	280.71	39.83	6.47
103.39	15	3.02	3.02	3.02	3.02	3.10	3.04	1.73	2.32	0.95	1.31	299.49	346.94	47.45	7.70
137.86	20	4.34	4.34	4.34	4.34	4.50	4.37	2.24	3.16	1.16	1.79	340.86	405.09	64.23	10.43
172.32	25	5.74	5.74	5.74	5.74	5.89	5.77	2.95	4.01	1.58	2.34	391.32	456.58	65.26	10.60
206.78	30	7.28	7.28	7.28	7.28	7.44	7.32	3.63	5.02	2.00	3.06	434.26	511.20	76.94	12.50
241.25	35	8.84	8.76	8.84	8.84	8.99	8.85	4.47	6.11	2.42	3.63	482.09	564.29	82.20	13.35
275.71	40	9.92	9.76	9.76	9.76	9.92	9.83	5.38	7.23	2.85	4.26	529.11	614.21	85.10	13.82
344.64	50	11.78	11.62	11.62	11.62	11.94	11.72	7.48	9.70	4.00	5.90	624.85	712.55	87.97	14.29

TABLE C-22 TEST RESULTS OF CONVEYING OF SAND

Cyclone No.	Pressure of compressed air supplied		Quantity		Conveying Rate (kg/hr)
	kN/m ²	Psig	Weight	Time	
			(kg)	(min)	
3	103.39	15	0.5	2.87	10.60
	137.86	20	0.5	2.08	14.48
	172.32	25	1.0	3.22	18.63
	206.78	30	1.0	2.88	20.83
	241.25	35	1.0	2.55	23.53
	275.71	40	1.0	2.38	25.21
7	103.39	15	0.5	3.78	7.94
	137.86	20	0.5	2.63	11.41
	172.32	25	1.0	3.90	15.38
	206.78	30	1.0	3.40	17.65
	241.25	35	1.0	2.98	20.13
	275.71	40	1.0	2.55	23.53
12	172.32	25	0.5	3.83	7.83
	206.78	30	0.5	3.08	9.74
	241.25	35	0.5	2.58	11.63
	275.71	40	0.5	2.52	11.90
	344.64	50	0.5	2.02	14.85
17	172.32	25	0.25	5.70	2.63
	206.78	30	0.25	4.02	3.73
	241.25	35	0.25	2.87	5.23
	275.71	40	0.25	2.53	5.93
	344.64	50	0.25	2.05	7.32

TABLE C-23 TEST RESULTS OF CONVEYING OF CANE-SUGAR

Cyclone No.	Pressure of compressed air supplied		Quantity		Conveying Rate (kg/hr)
	kN/m ²	Psig	Weight	Time	
			(kg)	(min)	
3	103.39	15	0.50	2.32	12.93
	137.86	20	0.50	1.73	17.34
	172.32	25	0.75	2.16	20.83
	206.78	30	1.00	2.40	25.00
	241.25	35	1.00	2.11	28.44
	275.71	40	1.00	1.92	31.25
7	103.39	15	0.50	2.58	11.63
	137.86	20	0.50	1.88	15.96
	172.32	25	0.75	2.22	20.27
	206.78	30	1.00	2.47	24.29
	241.25	35	1.00	2.18	27.52
12	172.32	25	0.50	2.75	10.91
	206.78	30	0.50	2.28	13.16
	241.25	35	0.50	1.92	15.62
	275.71	40	0.75	2.50	18.00
	344.64	50	0.75	2.12	21.23
17	172.32	25	0.25	3.77	3.98
	206.78	30	0.25	2.58	5.81
	241.25	35	0.25	2.07	7.25
	275.71	40	0.50	3.53	8.50
	344.64	50	0.50	2.85	10.53

TABLE C-24 TEST RESULTS OF CONVEYING OF TAPIOCA

Cyclone No.	Pressure of compressed air applied		Quantity		Conveying Rate (kg/hr)
	kN/m ²	Psig	Weight	Time	
			(kg)	(min)	
3	103.39	15	0.50	2.10	14.29
	137.86	20	0.50	1.55	19.35
	172.32	25	0.75	1.92	23.44
	206.78	30	1.00	2.05	29.26
	241.25	35	1.00	1.87	32.09
	275.71	40	1.00	1.72	34.88
7	103.39	15	0.50	2.87	10.45
	137.86	20	0.50	1.91	15.71
	172.32	25	0.75	2.28	19.74
	206.78	30	1.00	2.52	23.81
	241.25	35	1.00	2.23	26.91
12	172.32	25	0.50	3.43	8.75
	206.78	30	0.50	2.71	11.07
	241.25	35	0.50	2.23	13.45
	275.71	40	0.75	2.93	15.36
	344.64	50	0.75	2.32	19.40
17	172.32	25	0.25	5.97	2.51
	206.78	30	0.25	3.95	3.79
	241.25	35	0.25	2.98	5.03
	275.71	40	0.50	4.98	6.02
	344.64	50	0.50	3.73	8.04

APPENDIX D

POWER CONSUMPTION

For the most efficient Cyclone, Cyclone no. 3, the results of conveying tapioca are the following :

compressed air supplied, Q_1	= 400	Lit/min	
conveying rate	= 26.4	kg/hr	(From Fig.4-22)
suction air, Q_3	= 257	Lit/min	(From Fig.4-16)
vacuum, B	= 51	mm Hg	(From Fig.4-5)
pressure of compressed air, P	= 188	kN/m ²	(From Fig.4-4)
atmospheric pressure, P_o	= 101.33	kN/m ²	
density of air(at 20°C),	= 1.18	kg/m ³	
discharge pressure, Δh_2	= 4.65	cm WG	(From Table C-4)
pipe diameter at discharge pressure tap	= 28.88	mm	

(i) The power required for an adiabatic compression is⁵

$$\begin{aligned}
 \text{kW} &= \frac{k}{k-1} P_1 Q_1 \left[\left(\frac{P}{P_o} \right)^{\frac{k-1}{k}} - 1 \right] && \text{(D-1)} \\
 &= \frac{1.4}{0.4} \times 101.33 \times \frac{400}{1000 \times 60} \left[\left(\frac{188 + 101.33}{101.33} \right)^{\frac{0.4}{1.4}} - 1 \right] \\
 &= 0.8264
 \end{aligned}$$

Assuming that compressor efficiency is 55 % ,
 thus the actual power required is

$$\begin{aligned} \text{kW(actual)} &= \frac{0.8264}{0.55} \\ &= 1.5025 \end{aligned}$$

(ii) If the vacuum was produced by the other mechanical means such as a blower, the power required would be⁷:

$$\text{hp} = \text{rpm} \times \text{displacement}(\text{cf/r}) \times \frac{\text{vacuum}}{2} \times 0.005 \quad (\text{D-2})$$

The above formula can be approximated as

$$\text{hp(approx.)} = \text{acfm} \times 1.2 \times \frac{\text{vacuum}}{2} \times 0.005 \quad (\text{D-3})$$

$$\text{where acfm} = \frac{\text{scfm} \times 30}{30 - \text{operating vacuum (in Hg)}} \quad (\text{D-4})$$

Putting Eq.(D-4) into Eq.(D-3), where scfm = Q_3 and vacuum = B, gives

$$\text{hp(approx.)} = \frac{Q_3 \times 30}{30 - B} \times 1.2 \times \frac{B}{2} \times 0.005 \quad (\text{D-5})$$

In the Cyclone system, assuming that the power equivalent to 51 mm Hg can be calculated by the equation (D-5), therefore the power for this vacuum is

$$\text{hp(approx.)} = \frac{257 \times 30}{28.3199(30 - \frac{51}{25.4})} \times 1.2 \times \frac{51}{25.4 \times 2} \times 0.005$$

$$= 0.0586$$

$$\text{kW(approx.)} = \frac{0.0586}{1.341}$$

$$= 0.0437$$

(iii) The remaining power for the pressure system can be calculated by the following formula⁴:

$$\text{kW} = Q_2 \left(h_2 + \frac{v^2}{2g} \right) \quad (\text{D-6})$$

where v = velocity of air at discharge pressure tap

$$\begin{aligned}
 V &= \frac{400 + 257}{\frac{\pi}{4} \left(\frac{28.88}{1000} \right)^2} \times \frac{1}{1000 \times 60} && \text{m/s} \\
 &= 16.72 && \text{m/s}
 \end{aligned}$$

From Eq.(D-6),

$$\begin{aligned}
 \text{kW} &= 1.18 \times \frac{400 + 257}{1000 \times 60} \left(\frac{4.65}{100} \times \frac{62.3}{0.07346} + \frac{(16.72)^2}{2 \times 9.8} \right) \\
 &= 0.6938
 \end{aligned}$$

(iv) The power lost in the Cyclone will be,

$$\begin{aligned}
 \text{kW} &= 1.5025 - (0.0437 + 0.6938) \\
 &= 0.7650
 \end{aligned}$$

VITA

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