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APPENDIX - A: PERFORMANCE OF THERMO-COMPRESSORS

Motive pressure (barg)	Motive steam temp. (deg.C)	Discharge pressure (bara)	Suction pressure (bara)	Suction temp. (deg.C)	Compression ratio	Suction to motive ratio	Area ratio	Entrainment ratio	Motive flow (kg/hr)	Suction flow (kg/hr)	Discharge flow rate (kg/hr)
10	350	2.0	1.0	215	2.00	0.09	10	0.70	560	440	1000
10	350	3.0	1.0	215	3.00	0.09	5	0.22	802	198	1000
10	350	3.0	2.0	215	1.50	0.18	10	1.50	379	621	1000
10	350	4.0	2.0	215	2.00	0.18	5	0.70	567	433	1000
20	380	2.0	1.0	265	2.00	0.05	25	1.00	466	534	1000
20	380	3.0	1.0	265	3.00	0.05	10	0.30	744	256	1000
20	380	3.0	2.0	265	1.50	0.10	25	2.20	289	711	1000
20	380	4.0	2.0	265	2.00	0.10	10	0.70	561	439	1000
20	380	5.0	2.0	265	2.50	0.10	5	0.22	803	197	1000
20	380	6.0	2.0	265	3.00	0.10	5	0.23	796	204	1000
20	380	2.0	1.0	265	2.00	0.03	50	1.30	397	603	1000
30	410	3.0	1.0	285	3.00	0.03	25	0.50	631	369	1000
30	410	4.0	1.0	285	4.00	0.03	15	0.25	774	226	1000
30	410	4.0	1.0	285	5.00	0.03	10	0.10	895	105	1000
30	410	5.0	1.0	285	5.00	0.03	10	0.08	914	86	1000
30	410	3.0	2.0	285	1.50	0.06	50	3.00	226	774	1000
30	410	4.0	2.0	285	2.00	0.06	25	1.30	403	597	1000
30	410	5.0	2.0	285	2.50	0.06	15	0.80	523	477	1000
30	410	6.0	2.0	285	3.00	0.06	10	0.35	715	285	1000
30	410	4.0	3.0	285	1.33	0.10	50	5.00	152	848	1000

Motive pressure (barg)	Motive steam temp. (deg.C)	Discharge pressure (bara)	Suction pressure (bara)	Suction temp. (deg.C)	Compression ratio	Suction to motive ratio	Area ratio	Entrainment ratio	Motive flow (kg/hr)	Suction flow (kg/hr)	Discharge flow rate (kg/hr)
30	410	5.0	3.0	285	1.67	0.10	25	2.20	289	711	1000
30	410	6.0	3.0	285	2.00	0.10	10	0.70	561	439	1000
30	410	5.0	4.0	285	1.25	0.13	50	6.00	132	868	1000
30	410	6.0	4.0	285	1.50	0.13	25	3.00	233	767	1000
30	410	6.0	5.0	285	1.20	0.16	100	2.20	294	706	1000
40	440	2.0	1.0	291	2.00	0.02	50	1.00	456	544	1000
40	440	3.0	1.0	291	3.00	0.02	25	0.40	677	323	1000
40	440	4.0	1.0	291	4.00	0.02	25	0.30	736	264	1000
40	440	5.0	1.0	291	5.00	0.02	15	0.15	848	152	1000
40	440	6.0	1.0	291	6.00	0.02	10	0.07	923	77	1000
40	440	3.0	2.0	291	1.50	0.05	50	4.00	177	823	1000
40	440	4.0	2.0	291	2.00	0.05	25	1.00	462	538	1000
40	440	5.0	2.0	291	2.50	0.05	15	0.70	551	449	1000
40	440	6.0	2.0	291	3.00	0.05	10	0.40	682	318	1000
40	440	4.0	3.0	291	1.33	0.07	50	3.50	200	800	1000
40	440	5.0	3.0	291	1.67	0.07	25	1.50	369	631	1000
40	440	6.0	3.0	291	2.00	0.07	15	0.80	523	477	1000
40	440	5.0	4.0	291	1.25	0.10	50	5.00	151	849	1000
40	440	6.0	4.0	291	1.50	0.10	25	2.20	288	712	1000
40	440	6.0	5.0	291	1.20	0.12	50	6.00	130	870	1000
50	450	2.0	1.0	307	2.00	0.02	50	1.00	454	546	1000

Motive pressure (barg)	Motive steam temp. (deg.C)	Discharge pressure (bara)	Suction pressure (bara)	Suction temp. (deg.C)	Compression ratio	Suction to motive ratio	Area ratio	Entrainment ratio	Motive flow (kg/hr)	Suction flow (kg/hr)	Discharge flow rate (kg/hr)
50	450	3.0	1.0	307	3.00	0.02	25	0.50	625	375	1000
50	450	4.0	1.0	307	4.00	0.02	25	0.40	675	325	1000
50	450	5.0	1.0	307	5.00	0.02	15	0.35	704	296	1000
50	450	6.0	1.0	307	6.00	0.02	10	0.07	922	78	1000
50	450	3.0	2.0	307	1.50	0.04	50	2.00	299	701	1000
50	450	4.0	2.0	307	2.00	0.04	25	1.00	461	539	1000
50	450	5.0	2.0	307	2.50	0.04	25	0.70	550	450	1000
50	450	6.0	2.0	307	3.00	0.04	15	0.40	681	319	1000
50	450	4.0	3.0	307	1.33	0.06	50	3.00	225	775	1000
50	450	5.0	3.0	307	1.67	0.06	25	1.50	367	633	1000
50	450	6.0	3.0	307	2.00	0.06	25	1.40	383	617	1000
50	450	5.0	4.0	307	1.25	0.08	50	4.00	181	819	1000
50	450	6.0	4.0	307	1.50	0.08	25	1.50	371	629	1000
50	450	6.0	5.0	307	1.20	0.10	50	6.00	129	871	1000

APPENDIX - B: PERFORMANCE OF STEAM TURBINES COMBINED WITH THERMO-COMPRESSORS

Turbine inlet pressure (barg)	Process steam pressure (bara)	Turbine outlet pressure (bara)	Compression ratio	Suction to motive ratio	Area ratio	Entrainment ratio	Total team flow rate (kg/hr)	Motive flow of thermo-compressor (kg/hr)	Steam flow through the turbine (kg/hr)	Entropy of steam at turbine inlet (kJ/kg)	Enthalpy of outlet steam (kJ/kg)	Power generated from the turbine (kW)
10	1.0	1.0	1.0	0.09	0.0	0.00	1000	0	1000	7.256	2637	64.9
10	2.0	1.0	2.0	0.09	10.0	0.70	1000	560	440	7.256	2637	28.5
10	2.0	2.0	1.0	0.18	0.0	0.00	1000	0	1000	7.256	2759	49.6
10	3.0	1.0	3.0	0.09	5.0	0.22	1000	802	198	7.256	2637	12.8
10	3.0	2.0	1.5	0.18	10.0	1.50	1000	379	621	7.256	2759	30.8
10	3.0	3.0	1.0	0.27	0.0	0.00	1000	0	1000	7.256	2839	39.6
10	4.0	2.0	2.0	0.18	5.0	0.70	1000	567	433	7.256	2759	21.5
10	4.0	4.0	1.0	0.36	0.0	0.00	1000	0	1000	7.256	2901	31.9
20	1.0	1.0	1.0	0.05	0.0	0.00	1000	0	1000	7.038	2555	80.9
20	2.0	1.0	2.0	0.05	25.0	1.00	1000	466	534	7.038	2555	43.2
20	2.0	2.0	1.0	0.10	0.0	0.00	1000	0	1000	7.038	2671	66.4
20	3.0	1.0	3.0	0.05	10.0	0.30	1000	744	256	7.038	2555	20.7
20	3.0	2.0	1.5	0.10	25.0	2.20	1000	289	711	7.038	2671	47.2
20	3.0	3.0	1.0	0.14	0.0	0.00	1000	0	1000	7.038	2744	57.3
20	4.0	2.0	2.0	0.10	10.0	0.70	1000	561	439	7.038	2671	29.1
20	4.0	4.0	1.0	0.19	0.0	0.00	1000	0	1000	7.038	2799	50.4

Turbine inlet pressure (barg)	Process steam pressure (bara)	Turbine outlet pressure (bara)	Compression ratio	Suction to motive ratio	Area ratio	Entrainment ratio	Total team flow rate (kg/hr)	Motive flow of thermo-compressor (kg/hr)	Steam flow through the turbine (kg/hr)	Entropy of steam at turbine inlet (kJ/kg)	Enthalpy of outlet steam (kJ/kg)	Power generated from the turbine (kW)
30	2.0	1.0	2.0	0.03	50.0	1.30	1000	397	603	6.940	2519	55.3
30	2.0	2.0	1.0	0.06	0.0	0.00	1000	0	1000	6.940	2633	77.5
30	3.0	1.0	3.0	0.03	25.0	0.50	1000	631	369	6.940	2519	33.9
30	3.0	2.0	1.5	0.06	50.0	3.00	1000	226	774	6.940	2633	60.0
30	3.0	3.0	1.0	0.10	0.0	0.00	1000	0	1000	6.940	2338	114.4
30	4.0	1.0	4.0	0.03	15.0	0.25	1000	774	226	6.940	2519	20.8
30	4.0	2.0	2.0	0.06	25.0	1.30	1000	403	597	6.940	2633	46.3
30	4.0	3.0	1.3	0.10	50.0	5.00	1000	152	848	6.940	2338	58.3
30	4.0	4.0	1.0	0.13	0.0	0.00	1000	0	1000	6.940	2757	62.0
30	5.0	1.0	5.0	0.03	10.0	0.08	1000	914	86	6.940	2519	7.9
30	5.0	2.0	2.5	0.06	15.0	0.80	1000	523	477	6.940	2633	37.0
30	5.0	3.0	1.7	0.10	25.0	2.20	1000	289	711	6.940	2338	48.8
30	5.0	4.0	1.3	0.13	50.0	6.00	1000	132	868	6.940	2757	53.8
30	5.0	5.0	1.0	0.16	0.0	0.00	1000	0	1000	6.940	2800	56.6
30	6.0	2.0	3.0	0.06	10.0	0.35	1000	715	285	6.940	2633	22.1
30	6.0	3.0	2.0	0.10	10.0	0.70	1000	561	439	6.940	2338	30.0
30	6.0	4.0	1.5	0.13	25.0	3.00	1000	233	767	6.940	2757	47.6
30	6.0	5.0	1.2	0.16	100.0	2.20	1000	294	706	6.940	2800	49.0
30	6.0	6.0	1.0	0.19	0.0	0.00	1000	0	1000	6.940	2837	52.0

Turbine inlet pressure (barg)	Process steam pressure (bara)	Turbine outlet pressure (bara)	Compression ratio	Suction to motive ratio	Area ratio	Entrainment ratio	Total team flow rate (kg/hr)	Motive flow of thermo-compressor (kg/hr)	Steam flow through the turbine (kg/hr)	Entropy of steam at turbine inlet (kJ/kg)	Enthalpy of outlet steam (kJ/kg)	Power generated from the turbine (kW)
40	2.0	1.0	2.0	0.02	50.0	1.00	1000	456	544	6.893	2501	54.8
40	2.0	2.0	1.0	0.05	0.0	0.00	1000	0	1000	6.893	2614	86.6
40	3.0	1.0	3.0	0.02	25.0	0.40	1000	677	323	6.893	2501	32.6
40	3.0	2.0	1.5	0.05	50.0	4.00	1000	177	823	6.893	2614	71.3
40	3.0	3.0	1.0	0.07	0.0	0.00	1000	0	1000	6.893	2685	77.8
40	4.0	1.0	4.0	0.02	25.0	0.30	1000	736	264	6.893	2501	26.6
40	4.0	2.0	2.0	0.05	25.0	1.00	1000	462	538	6.893	2614	46.6
40	4.0	3.0	1.3	0.07	50.0	3.50	1000	200	800	6.893	2685	62.2
40	4.0	4.0	1.0	0.10	0.0	0.00	1000	0	1000	6.893	2737	71.3
40	5.0	1.0	5.0	0.02	15.0	0.15	1000	848	152	6.893	2501	15.3
40	5.0	2.0	2.5	0.05	15.0	0.70	1000	551	449	6.893	2614	38.9
40	5.0	3.0	1.7	0.07	25.0	1.50	1000	369	631	6.893	2685	49.1
40	5.0	4.0	1.3	0.10	50.0	5.00	1000	151	849	6.893	2737	60.5
40	5.0	5.0	1.0	0.12	0.0	0.00	1000	0	1000	6.893	2779	66.0
40	6.0	1.0	6.0	0.02	10.0	0.07	1000	923	77	6.893	2501	7.8
40	6.0	2.0	3.0	0.05	10.0	0.40	1000	682	318	6.893	2614	27.5
40	6.0	3.0	2.0	0.07	15.0	0.80	1000	523	477	6.893	2685	37.1
40	6.0	4.0	1.5	0.10	25.0	2.20	1000	288	712	6.893	2737	50.7
40	6.0	5.0	1.2	0.12	50.0	6.00	1000	130	870	6.893	2779	57.4
40	6.0	6.0	1.0	0.15	0.0	0.00	1000	0	1000	6.893	2816	61.4

Turbine inlet pressure (barg)	Process steam pressure (bara)	Turbine outlet pressure (bara)	Compression ratio	Suction to motive ratio	Area ratio	Entrainment ratio	Total team flow rate (kg/hr)	Motive flow of thermo-compressor (kg/hr)	Steam flow through the turbine (kg/hr)	Entropy of steam at turbine inlet (kJ/kg)	Enthalpy of outlet steam (kJ/kg)	Power generated from the turbine (kW)
50	2.0	1.0	2.0	0.02	50.0	1.00	1000	454	546	6.810	2470	57.7
50	2.0	2.0	1.0	0.04	0.0	0.00	1000	0	1000	6.810	2582	91.8
50	3.0	1.0	3.0	0.02	25.0	0.50	1000	625	375	6.810	2470	39.7
50	3.0	2.0	1.5	0.04	50.0	2.00	1000	299	701	6.810	2582	64.3
50	3.0	3.0	1.0	0.06	0.0	0.00	1000	0	1000	6.810	2651	83.1
50	4.0	1.0	4.0	0.02	25.0	0.40	1000	675	325	6.810	2470	34.3
50	4.0	2.0	2.0	0.04	25.0	1.00	1000	461	539	6.810	2582	49.5
50	4.0	3.0	1.3	0.06	50.0	3.00	1000	225	775	6.810	2651	64.4
50	4.0	4.0	1.0	0.08	0.0	0.00	1000	0	1000	6.810	2702	76.8
50	5.0	1.0	5.0	0.02	15.0	0.35	1000	704	296	6.810	2470	31.3
50	5.0	2.0	2.5	0.04	25.0	0.70	1000	550	450	6.810	2582	41.3
50	5.0	3.0	1.7	0.06	25.0	1.50	1000	367	633	6.810	2651	52.6
50	5.0	4.0	1.3	0.08	50.0	4.00	1000	181	819	6.810	2702	62.8
50	5.0	5.0	1.0	0.10	0.0	0.00	1000	0	1000	6.810	2744	71.5
50	6.0	1.0	6.0	0.02	10.0	0.07	1000	922	78	6.810	2470	8.2
50	6.0	2.0	3.0	0.04	15.0	0.40	1000	681	319	6.810	2582	29.3
50	6.0	3.0	2.0	0.06	25.0	1.40	1000	383	617	6.810	2651	51.3
50	6.0	4.0	1.5	0.08	25.0	1.50	1000	371	629	6.810	2702	48.3
50	6.0	5.0	1.2	0.10	50.0	6.00	1000	129	871	6.810	2744	62.3
50	6.0	6.0	1.0	0.12	0.0	0.00	1000	0	1000	6.810	2778	67.3

APPENDIX - C: DETAILS OF RETROFITTING STEAM PRV WITH A BACK PRESSURE TURBINE

Inlet Steam Enthalpy (kJ /kg)	Steam Flow Rate (kg/hr)	Fuel cost for steam generation for turbine (USD/hr)	1 bara exhaust pressure					
			Power Output /(kW)	Revenue from power generation (USD/hr)	Fuel cost for steam generation for process heat requirement (USD/hr)	Additional cost of fuel for power generation (USD/hr)	Installed cost of a steam turbine system (USD)	Simple payback period (years)
3156 (10 barg @ 350 deg.C)	1000	66.8	64.8	13.8	56.2	10.6	110,850	4.43
	2000	133.6	129.6	27.5	112.4	21.2	221,700	4.43
	3000	200.4	194.4	41.3	168.5	31.8	332,550	4.43
	4000	267.1	259.2	55.0	224.7	42.4	443,400	4.43
3202(20 barg @ 380 deg. C)	1000	67.8	80.8	17.2	56.2	11.6	147,800	3.37
	2000	135.6	161.6	34.3	112.4	23.2	295,600	3.37
	3000	203.4	242.4	51.5	168.5	34.8	443,400	3.37
	4000	271.2	323.2	68.6	224.7	46.5	591,200	3.37
3253 (30 barg @ 410 deg.C)	1000	68.9	91.8	19.5	56.2	12.7	147,800	2.76
	2000	137.8	183.6	39.0	112.4	25.5	295,600	2.76
	3000	206.8	275.4	58.5	168.5	38.2	443,400	2.76
	4000	275.7	367.2	78.0	224.7	51.0	591,200	2.76
3307 (40 barg @ 440 deg. C)	1000	70.1	100.8	21.4	56.2	13.9	147,800	2.50
	2000	140.2	201.6	42.8	112.4	27.9	295,600	2.50
	3000	210.3	302.4	64.2	168.5	41.8	443,400	2.50
	4000	280.4	403.2	85.6	224.7	55.7	591,200	2.50
3316 (50 barg @ 450 deg. C)	1000	70.3	105.8	22.5	56.2	14.1	184,750	2.80
	2000	140.6	211.6	44.9	112.4	28.3	369,500	2.80
	3000	210.9	317.4	67.4	168.5	42.4	554,250	2.80
	4000	281.2	423.2	89.8	224.7	56.5	739,000	2.80

Inlet Steam Enthalpy (kJ /kg)	Steam Flow Rate (kg/hr)	Fuel cost for steam generation for turbine (USD/hr)	2 bara exhaust pressure					
			Power Output (kW)	Revenue from power generation (USD/hr)	Fuel cost for steam generation for process heat requirement (USD/hr)	Additional cost of fuel for power generation / (USD/hr)	Installed cost of a steam turbine system (USD)	Simple payback period (years)
3156 (10 barg @ 350 deg.C)	1000	66.8	49.6	10.5	56.9	9.9	73,900	15.24
	2000	133.6	99.2	21.1	113.7	19.8	147,800	15.24
	3000	200.4	148.8	31.6	170.6	29.8	221,700	15.24
	4000	267.1	198.4	42.1	227.5	39.7	295,600	15.24
3202(20 barg @ 380 deg. C)	1000	67.8	66.4	14.1	56.9	10.9	110,850	4.42
	2000	135.6	132.8	28.2	113.7	21.9	221,700	4.42
	3000	203.4	199.2	42.3	170.6	32.8	332,550	4.42
	4000	271.2	265.6	56.4	227.5	43.7	443,400	4.42
3253 (30 barg @ 410 deg.C)	1000	68.9	77.4	16.4	56.9	12.1	110,850	3.20
	2000	137.8	154.8	32.9	113.7	24.1	221,700	3.20
	3000	206.8	232.2	49.3	170.6	36.2	332,550	3.20
	4000	275.7	309.6	65.7	227.5	48.2	443,400	3.20
3307 (40 barg @ 440 deg. C)	1000	70.1	87.6	18.6	56.9	13.2	147,800	3.49
	2000	140.2	175.2	37.2	113.7	26.5	295,600	3.49
	3000	210.3	262.8	55.8	170.6	39.7	443,400	3.49
	4000	280.4	350.4	74.4	227.5	53.0	591,200	3.49
3316 (50 barg @ 450 deg. C)	1000	70.3	91.8	19.5	56.9	13.4	147,800	3.09
	2000	140.6	183.6	39.0	113.7	26.9	295,600	3.09
	3000	210.9	275.4	58.5	170.6	40.3	443,400	3.09
	4000	281.2	367.2	78.0	227.5	53.8	591,200	3.09

Inlet Steam Enthalpy (kJ /kg)	Steam Flow Rate (kg/hr)	Fuel cost for steam generation for turbine (USD/hr)	3 bara exhaust pressure					
			Power Output (kW)	Revenue from power generation (USD/hr)	Fuel cost for steam generation for process heat requirement (USD/hr)	Additional cost of fuel for power generation / (USD/hr)	Installed cost of a steam turbine system (USD)	Simple payback period (years)
3156 (10 barg @ 350 deg.C)	1000	66.8	39.6	8.4	57.3	9.5	73,900	(8.54)
	2000	133.6	79.2	16.8	114.6	19.0	147,800	(8.54)
	3000	200.4	118.8	25.2	171.9	28.5	221,700	(8.54)
	4000	267.1	158.4	33.6	229.1	38.0	295,600	(8.54)
3202(20 barg @ 380 deg. C)	1000	67.8	57.2	12.1	57.3	10.5	110,850	8.58
	2000	135.6	114.4	24.3	114.6	21.0	221,700	8.58
	3000	203.4	171.6	36.4	171.9	31.5	332,550	8.58
	4000	271.2	228.8	48.6	229.1	42.1	443,400	8.58
3253 (30 barg @ 410 deg.C)	1000	68.9	68.6	14.6	57.3	11.6	110,850	4.78
	2000	137.8	137.2	29.1	114.6	23.3	221,700	4.78
	3000	206.8	205.8	43.7	171.9	34.9	332,550	4.78
	4000	275.7	274.4	58.3	229.1	46.6	443,400	4.78
3307 (40 barg @ 440 deg. C)	1000	70.1	77.8	16.5	57.3	12.8	110,850	3.79
	2000	140.2	155.6	33.0	114.6	25.7	221,700	3.79
	3000	210.3	233.4	49.6	171.9	38.5	332,550	3.79
	4000	280.4	311.2	66.1	229.1	51.3	443,400	3.79
3316 (50 barg @ 450 deg. C)	1000	70.3	83.2	17.7	57.3	13.0	147,800	4.02
	2000	140.6	166.4	35.3	114.6	26.1	295,600	4.02
	3000	210.9	249.6	53.0	171.9	39.1	443,400	4.02
	4000	281.2	332.8	70.7	229.1	52.1	591,200	4.02

Inlet Steam Enthalpy (kJ /kg)	Steam Flow Rate (kg/hr)	Fuel cost for steam generation for turbine (USD/hr)	4 bara exhaust pressure					
			Power Output (kW)	Revenue from power generation (USD/hr)	Fuel cost for steam generation for process heat requirement (USD/hr)	Additional cost of fuel for power generation / (USD/hr)	Installed cost of a steam turbine system (USD)	Simple payback period /(years)
3156 (10 barg @ 350 deg.C)	1000	66.8	31.8	6.8	57.6	9.2	73,900	(3.8)
	2000	133.6	63.6	13.5	115.1	18.4	147,800	(3.8)
	3000	200.4	95.4	20.3	172.7	27.6	221,700	(3.8)
	4000	267.1	127.2	27.0	230.3	36.9	295,600	(3.8)
3202(20 barg @ 380 deg. C)	1000	67.8	50.4	10.7	57.6	10.2	73,900	19.7
	2000	135.6	100.8	21.4	115.1	20.5	147,800	19.7
	3000	203.4	151.2	32.1	172.7	30.7	221,700	19.7
	4000	271.2	201.6	42.8	230.3	40.9	295,600	19.7
3253 (30 barg @ 410 deg.C)	1000	68.9	62.0	13.2	57.6	11.4	110,850	7.7
	2000	137.8	124.0	26.3	115.1	22.7	221,700	7.7
	3000	206.8	186.0	39.5	172.7	34.1	332,550	7.7
	4000	275.7	248.0	52.7	230.3	45.4	443,400	7.7
3307 (40 barg @ 440 deg. C)	1000	70.1	71.2	15.1	57.6	12.5	147,800	7.2
	2000	140.2	142.4	30.2	115.1	25.1	295,600	7.2
	3000	210.3	213.6	45.3	172.7	37.6	443,400	7.2
	4000	280.4	284.8	60.5	230.3	50.2	591,200	7.2
3316 (50 barg @ 450 deg. C)	1000	70.3	76.8	16.3	57.6	12.7	110,850	3.9
	2000	140.6	153.6	32.6	115.1	25.5	221,700	3.9
	3000	210.9	230.4	48.9	172.7	38.2	332,550	3.9
	4000	281.2	307.2	65.2	230.3	51.0	443,400	3.9

Inlet Steam Enthalpy (kJ /kg)	Steam Flow Rate (kg/hr)	Fuel cost for steam generation for turbine (USD/hr)	5 bara exhaust pressure					
			Power Output (kW)	Revenue from power generation (USD/hr)	Fuel cost for steam generation for process heat requirement (USD/hr)	Additional cost of fuel for power generation /(USD/hr)	Installed cost of a steam turbine system /(USD)	Simple payback period (years)
3156 (10 barg @ 350 deg.C)	1000	66.8	25.6	5.4	57.8	9.0	36,950	(1.3)
	2000	133.6	51.2	10.9	115.6	18.0	73,900	(1.3)
	3000	200.4	76.8	16.3	173.4	27.0	110,850	(1.3)
	4000	267.1	102.4	21.7	231.2	36.0	147,800	(1.3)
3202(20 barg @ 380 deg. C)	1000	67.8	44.6	9.5	57.8	10.0	73,900	(17.4)
	2000	135.6	89.2	18.9	115.6	20.0	147,800	(17.4)
	3000	203.4	133.8	28.4	173.4	30.0	221,700	(17.4)
	4000	271.2	178.4	37.9	231.2	40.0	295,600	(17.4)
3253 (30 barg @ 410 deg.C)	1000	68.9	56.6	12.0	57.8	11.1	110,850	15.8
	2000	137.8	113.2	24.0	115.6	22.3	221,700	15.8
	3000	206.8	169.8	36.0	173.4	33.4	332,550	15.8
	4000	275.7	226.4	48.1	231.2	44.5	443,400	15.8
3307 (40 barg @ 440 deg. C)	1000	70.1	66.0	14.0	57.8	12.3	110,850	8.3
	2000	140.2	132.0	28.0	115.6	24.6	221,700	8.3
	3000	210.3	198.0	42.0	173.4	37.0	332,550	8.3
	4000	280.4	264.0	56.0	231.2	49.3	443,400	8.3
3316 (50 barg @ 450 deg. C)	1000	70.3	71.4	15.2	57.8	12.5	110,850	5.3
	2000	140.6	142.8	30.3	115.6	25.0	221,700	5.3
	3000	210.9	214.2	45.5	173.4	37.6	332,550	5.3
	4000	281.2	285.6	60.6	231.2	50.1	443,400	5.3

Inlet Steam Enthalpy (kJ /kg)	Steam Flow Rate (kg/hr)	Fuel cost for steam generation for turbine (USD/hr)	6 bara exhaust pressure					
			Power Output (kW)	Revenue from power generation (USD/hr)	Fuel cost for steam generation for process heat requirement (USD/hr)	Additional cost of fuel for power generation (USD/hr)	Installed cost of a steam turbine system /(USD)	Simple payback period (years)
3156 (10 barg @ 350 deg.C)	1000	66.8	20.0	4.2	58.0	8.8	36,950	(1.0)
	2000	133.6	40.0	8.5	115.9	17.6	73,900	(1.0)
	3000	200.4	60.0	12.7	173.9	26.4	110,850	(1.0)
	4000	267.1	80.0	17.0	231.9	35.3	147,800	(1.0)
3202(20 barg @ 380 deg. C)	1000	67.8	39.8	8.4	58.0	9.8	73,900	(6.8)
	2000	135.6	79.6	16.9	115.9	19.7	147,800	(6.8)
	3000	203.4	119.4	25.3	173.9	29.5	221,700	(6.8)
	4000	271.2	159.2	33.8	231.9	39.3	295,600	(6.8)
3253 (30 barg @ 410 deg.C)	1000	68.9	52.6	11.2	58.0	11.0	110,850	65.7
	2000	137.8	105.2	22.3	115.9	21.9	221,700	65.7
	3000	206.8	157.8	33.5	173.9	32.9	332,550	65.7
	4000	275.7	210.4	44.7	231.9	43.8	443,400	65.7
3307 (40 barg @ 440 deg. C)	1000	70.1	62.0	13.2	58.0	12.1	110,850	13.7
	2000	140.2	124.0	26.3	115.9	24.3	221,700	13.7
	3000	210.3	186.0	39.5	173.9	36.4	332,550	13.7
	4000	280.4	248.0	52.7	231.9	48.6	443,400	13.7
3316 (50 barg @ 450 deg. C)	1000	70.3	67.2	14.3	58.0	12.3	110,850	7.3
	2000	140.6	134.4	28.5	115.9	24.7	221,700	7.3
	3000	210.9	201.6	42.8	173.9	37.0	332,550	7.3
	4000	281.2	268.8	57.1	231.9	49.4	443,400	7.3

APPENDIX - D: PERFORMANCE DATA OF THERMO-COMPRESSORS AVAILABLE IN THE MARKET

Transvac Thermocompressor Data Sheet

v1.0

1	Client :	Haycarb PLC		Client Project Ref :			
2	Client's Ref :	40 Barg Motive		Plant Location :			
3	Transvac Ref :	Q19299R1		Equip. Item No. :			
4	Description :	Size 5 Steam Jet Thermocompressor		No. OFF :	1		
5	Unit Ref :	SJT125CM4F0		Operation :	Continuous		
6	Drawing No. :			Serial No. :			
7	Unit Body Size :	5					
8	**MOTIVE CONDITIONS**			**MATERIALS OF CONSTRUCTION**			
9	Pressure	(bar g)	40.00	Main Body	Chrome Molybdenum P11		
10	Temperature	(°C)	450.0	Nozzle	Chrome Molybdenum F11		
11	Flowrate	(kg/hr)	3439	Diffuser	Chrome Molybdenum F11		
12				Flanges	Chrome Molybdenum F11		
13	**SUCTION CONDITIONS**			Gaskets	Transvac to select		
14	Pressure	(bar g)	1.5	Bolts	Carbon Steel (if applicable)		
15	Temperature	(°C)	200	Nameplate	Stainless Steel		
16	Flowrate	(kg/hr)	1561				
17				**MECHANICAL DESIGN**	Motive Side	Suction / Discharge Side	
18	**DISCHARGE CONDITIONS**						
19	Pressure	(bar g)	5.00	Max.Design Pressure	42	7	(bar g)
20	Temperature	(°C)	359.3	Max. Design Temperature	465	465	(°C)
21	Flowrate	(kg/hr)	5000	Internal Corrosion Allowance	1.5	1.5	(mm)
22				Mechanical Design Code	ASME B31.3		
23				Welding Standard	ASME IX		
24	**DIFFUSER IS SONIC**			External Surface Finish	High Temp. Silicone Aluminium		
25				Weight	TBC (kg)		
26							
27	**DIMENSIONS**			CONNECTION DETAILS	Size	Rating	
28	A - 215 mm			Motive Steam (A)	2	600 LB	
29	B - 250 mm			Suction Steam (B)	6	300 LB	
30	C - 1040 mm			Discharge Steam (C)	5	300 LB	
31	D - 1290 mm			Flange Type	ASME B15.6 Weld Neck		
32	**DRAWING**						
33							
34							
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39							
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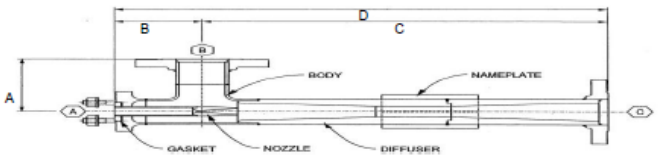
41							
42							
43	NOTE: Confirmed dimensions to be issued shortly after order placement						



Rev	Description	By	Date	Checked	Date
0	Issued for Quotation Purposes Only	RH	11/03/2013		

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Transvac Thermocompressor Data Sheet

v1.0

1	Client :	Haycarb PLC			Client Project Ref :		
2	Client's Ref :	10 Barg Motive			Plant Location :		
3	Transvac Ref :	Q19299R1			Equip. Item No. :		
4	Description :	Size 5 Steam Jet Thermocompressor			No. OFF :	1	
5	Unit Ref :	SJT125CS4F0			Operation :	Continuous	
6	Drawing No. :				Serial No. :		
7	Unit Body Size :	8					
8	**MOTIVE CONDITIONS**			**MATERIALS OF CONSTRUCTION**			
9	Pressure	(bar g)	10.00	Main Body	Carbon Steel		
10	Temperature	(°C)	350.0	Nozzle	Stainless Steel		
11	Flowrate	(kg/hr)	3648	Diffuser	Carbon Steel		
12				Flanges	Carbon Steel		
13	**SUCTION CONDITIONS**			Gaskets	Transvac to select		
14	Pressure	(bar g)	1	Bolts	Carbon Steel (if applicable)		
15	Temperature	(°C)	200	Nameplate	Stainless Steel		
16	Flowrate	(kg/hr)	1352				
17				**MECHANICAL DESIGN**	Motive Side	Suction / Discharge Side	
18	**DISCHARGE CONDITIONS**						
19	Pressure	(bar g)	3.00	Max.Design Pressure	20	7	(bar g)
20	Temperature	(°C)	305.8	Max. Design Temperature	365	365	(°C)
21	Flowrate	(kg/hr)	5000	Internal Corrosion Allowance	1.5	1.5	(mm)
22				Mechanical Design Code	ASME B31.3		
23				Welding Standard	ASME IX		
24	**DIFFUSER IS SONIC**			External Surface Finish	High Temp. Silicone Aluminium		
25				Weight	TBC (kg)		
26							
27	**DIMENSIONS**			**CONNECTION DETAILS**	Size	Rating	
28	A - 305 mm			Motive Steam (A)	4	300 LB	
29	B - 360 mm			Suction Steam (B)	5	150 LB	
30	C - 1230 mm			Discharge Steam (C)	5	150 LB	
31	D - 1590 mm			Flange Type	ASME B16.5 Slip On		
32	**DRAWING**						
33							
34							
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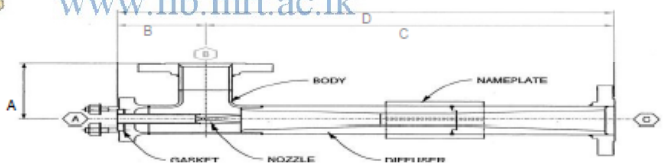
41							
42							
43	NOTE: Confirmed dimensions to be issued shortly after order placement						



Rev	Description	By	Date	Checked	Date
0	Issued for Quotation Purposes Only	RH	05/04/2013		

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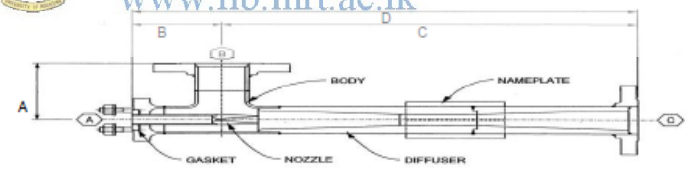
Transvac Thermocompressor Data Sheet

v1.0

1	Client :	Haycarb PLC		Client Project Ref :			
2	Client's Ref :			Plant Location :			
3	Transvac Ref :	Q19299R0		Equip. Item No. :			
4	Description :	Size 8 Steam Jet Thermocompressor		No. OFF :	1		
5	Unit Ref :	SJT200CS4F0		Operation :	Continuous		
6	Drawing No. :			Serial No. :			
7	Unit Body Size :	8					
8	**MOTIVE CONDITIONS**			**MATERIALS OF CONSTRUCTION**			
9	Pressure	(bar g)	10.00	Main Body	Carbon Steel		
10	Temperature	(°C)	280.0	Nozzle	Stainless Steel		
11	Flowrate	(kg/hr)	1880	Diffuser	Carbon Steel		
12				Flanges	Carbon Steel		
13	**SUCTION CONDITIONS**			Gaskets	Transvac to select		
14	Pressure	(bar g)	1	Bolts	Carbon Steel (if applicable)		
15	Temperature	(°C)	200	Nameplate	Stainless Steel		
16	Flowrate	(kg/hr)	3120				
17				**MECHANICAL DESIGN**	Motive	Suction / Discharge	
18	**DISCHARGE CONDITIONS**				Side	Side	
19	Pressure	(bar g)	1.50	Max.Design Pressure	12	5	(bar g)
20	Temperature	(°C)	226.3	Max. Design Temperature	300	300	(°C)
21	Flowrate	(kg/hr)	5000	Internal Corrosion Allowance	1.5	1.5	(mm)
22				Mechanical Design Code	ASME B31.3		
23				Welding Standard	ASME IX		
24	**DIFFUSER IS SUBSONIC**			External Surface Finish	High Temp. Silicone Aluminium		
25				Weight	TBC (kg)		
26							
27	**DIMENSIONS**			**CONNECTION DETAILS**	Size	Rating	
28	A - 305 mm			Motive Steam (A)	2 1/2	300 LB	
29	B - 360 mm			Suction Steam (B)	8	150 LB	
30	C - 1740 mm			Discharge Steam (C)	8	150 LB	
31	D - 2100 mm			Flange Type	ASME B16.5 Slip On		
32	**DRAWING**						



43 NOTE: Confirmed dimensions to be issued shortly after order placement

Rev	Description	By	Date	Checked	Date
0	Issued for Quotation Purposes Only	RH	02/04/2013		

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KADANT JOHNSON

Thermocompressor Sizing Calculations

Version 0.5.130

Customer: Haycarb

Location: India

Prepared by: RMW

Reference: E4712

Date:17/09/2013

INPUT DATA

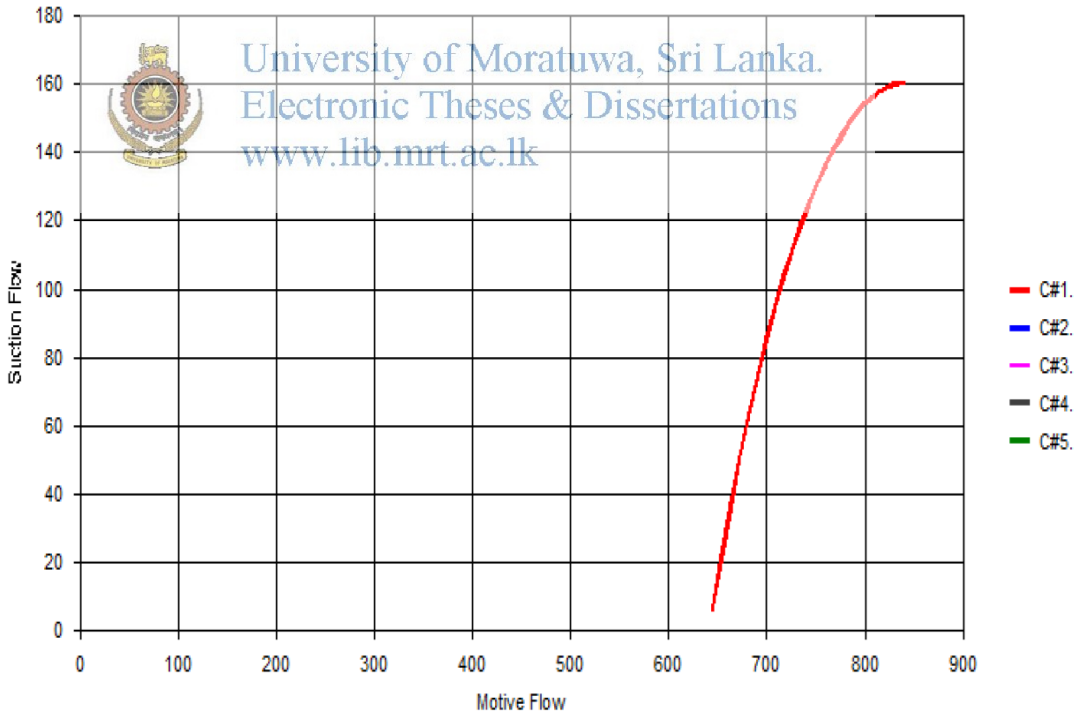
	Motive pressure bar(g)	Suction pressure bar(g)	Discharge pressure bar(g)	Motive temperature °C	Suction temperature °C	Suction flow kg/hr	Discharge flow kg/hr
Set #1	10	1	4	280	121	161	1000

OUTPUT DATA

	Motive flow kg/hr	Nozzle diameter mm	Throat diameter mm	Design percentage %	Choke percentage %	Discharge temperature °C	Estimated sound level dBA
Set #1	839.	NA	NA	100	100	248.2	92

Thermocompressor Size: 3. Type: Standard

Comments: condition 1



KADANT JOHNSON

Thermocompressor Sizing Calculations

Version 0.5.130

Customer: Haycarb

Location: India

Prepared by: RMW

Reference: E4712

Date:17/09/2013

INPUT DATA

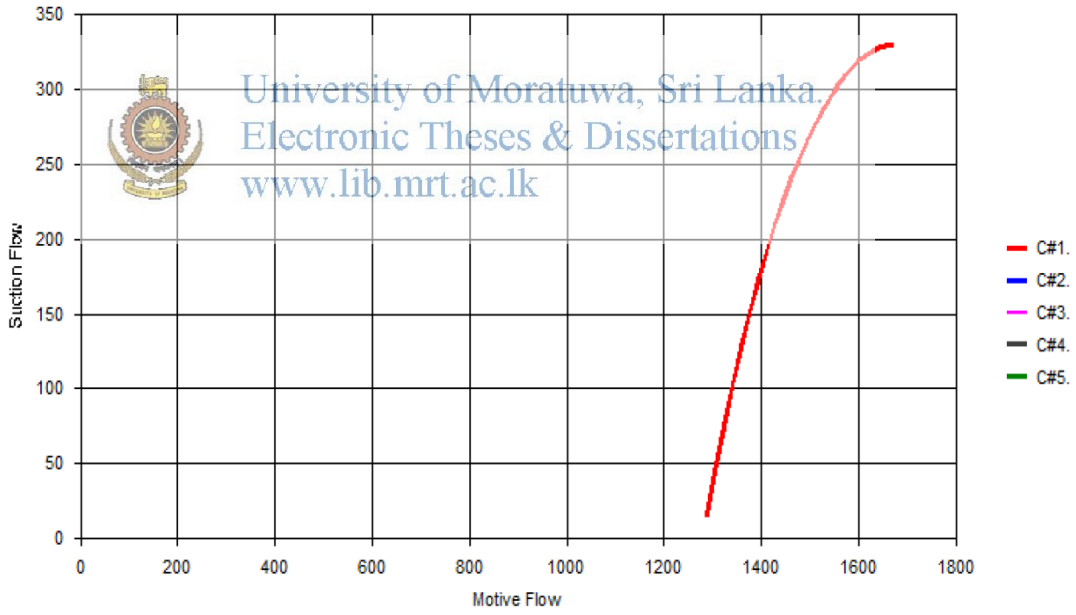
	Motive pressure bar(g)	Suction pressure bar(g)	Discharge pressure bar(g)	Motive temperature °C	Suction temperature °C	Suction flow kg/hr	Discharge flow kg/hr
Set #1	10	1	4	280	121	332	2000

OUTPUT DATA

	Motive flow kg/hr	Nozzle diameter mm	Throat diameter mm	Design percentage %	Choke percentage %	Discharge temperature °C	Estimated sound level dBA
Set #1	1668.	NA	NA	100	100	247.6	97

Thermocompressor Size: 4. Type: Standard

Comments: condition 2



KADANT JOHNSON

Thermocompressor Sizing Calculations

Version 0.5.130

Customer: Haycarb

Location: India

Prepared by: RMW

Reference: E4712

Date:17/09/2013

INPUT DATA

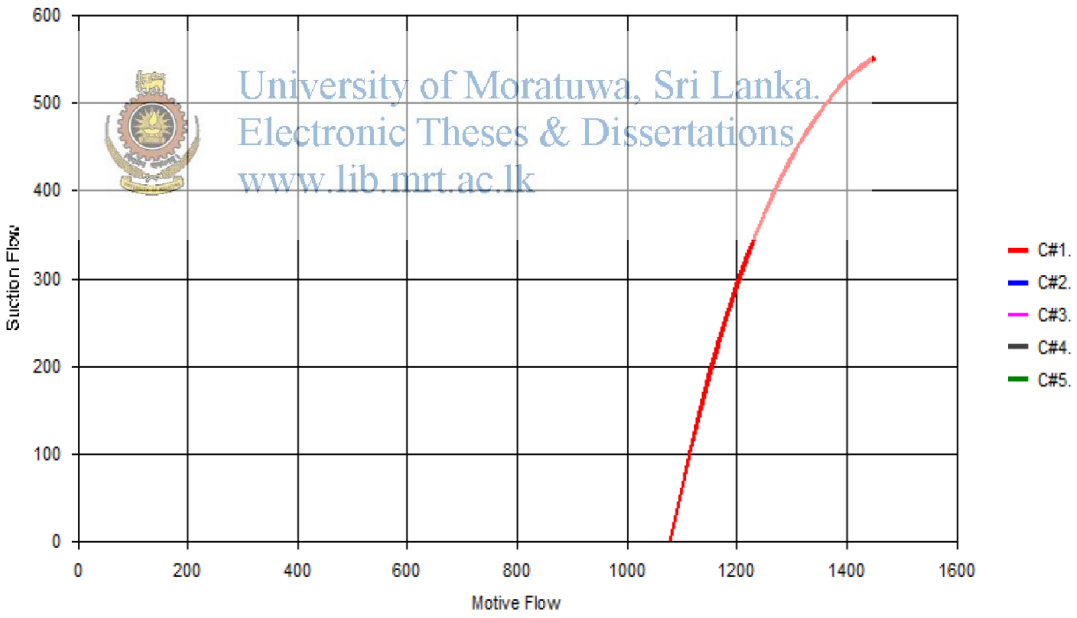
	Motive pressure bar(g)	Suction pressure bar(g)	Discharge pressure bar(g)	Motive temperature ° C	Suction temperature ° C	Suction flow kg/hr	Discharge flow kg/hr
Set #1	20	1	4	300	121	553	2000

OUTPUT DATA

	Motive flow kg/hr	Nozzle diameter mm	Throat diameter mm	Design percentage %	Choke percentage %	Discharge temperature ° C	Estimated sound level dBA
Set #1	1447.	NA	NA	100	100	237.5	96

Thermocompressor Size: 4. Type: Standard

Comments: condition 3



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INPUT DATA

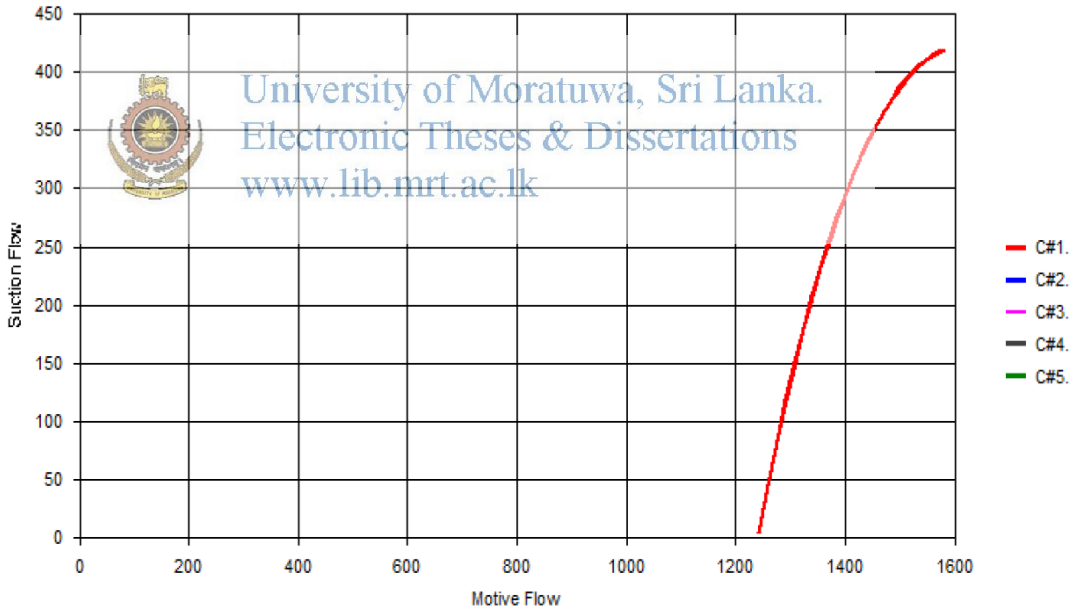
	Motive pressure bar(g)	Suction pressure bar(g)	Discharge pressure bar(g)	Motive temperature °C	Suction temperature °C	Suction flow kg/hr	Discharge flow kg/hr
Set #1	20	0	3	300	121	420	2000

OUTPUT DATA

	Motive flow kg/hr	Nozzle diameter mm	Throat diameter mm	Design percentage %	Choke percentage %	Discharge temperature °C	Estimated sound level dBA
Set #1	1580.	NA	NA	100	100	242.6	99

Thermocompressor Size: 4. Type: Standard

Comments: condition 4



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Location: India

Prepared by: RMW

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Date:17/09/2013

INPUT DATA

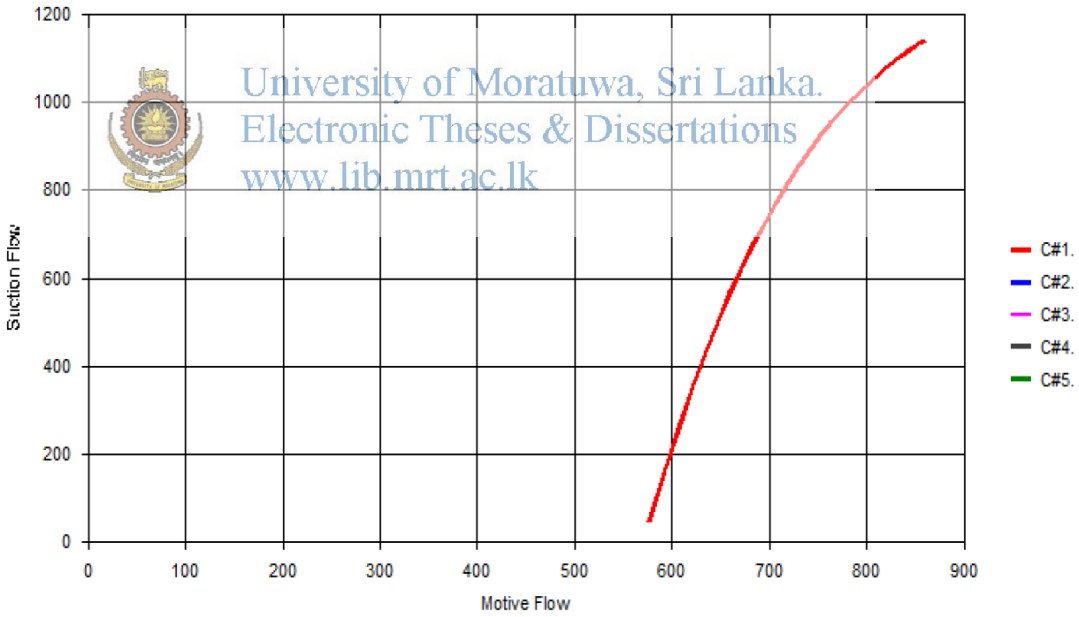
	Motive pressure bar(g)	Suction pressure bar(g)	Discharge pressure bar(g)	Motive temperature °C	Suction temperature °C	Suction flow kg/hr	Discharge flow kg/hr
Set #1	20	1	2	300	121	1142	2000

OUTPUT DATA

	Motive flow kg/hr	Nozzle diameter mm	Throat diameter mm	Design percentage %	Choke percentage %	Discharge temperature °C	Estimated sound level dBA
Set #1	858.	NA	NA	100	100	189.1	91

Thermocompressor Size: 4. Type: High Efficency

Comments: condition 5



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Customer: Haycarb

Location: India

Prepared by: RMW

Reference: E4712

Date:17/09/2013

INPUT DATA

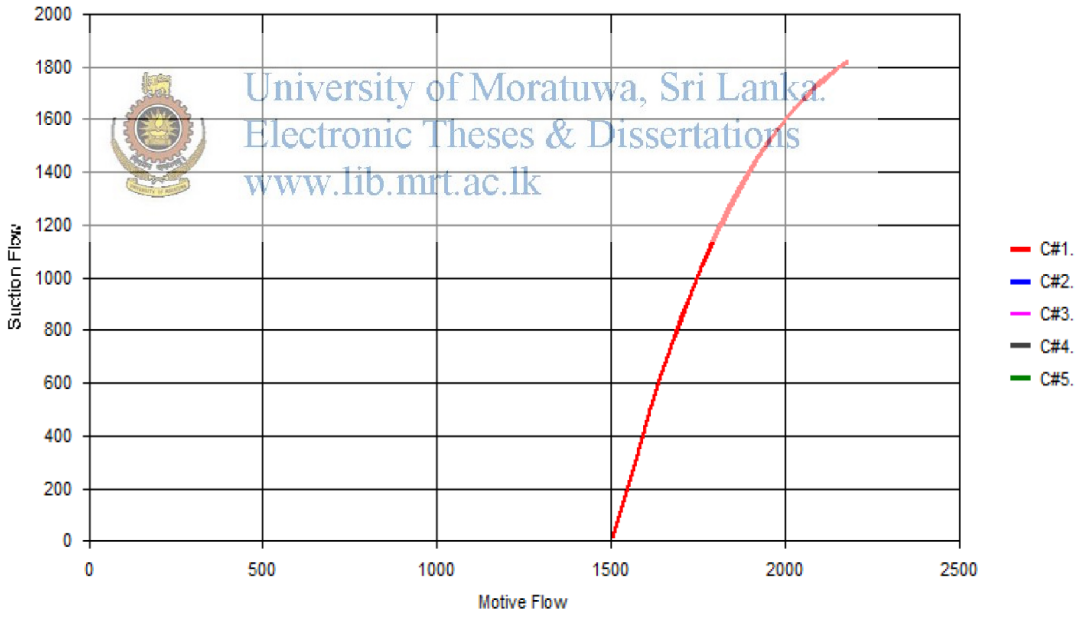
	Motive pressure bar(g)	Suction pressure bar(g)	Discharge pressure bar(g)	Motive temperature °C	Suction temperature °C	Suction flow kg/hr	Discharge flow kg/hr
Set #1	20	2	4	300	133.7	1822	4000

OUTPUT DATA

	Motive flow kg/hr	Nozzle diameter mm	Throat diameter mm	Design percentage %	Choke percentage %	Discharge temperature °C	Estimated sound level dBA
Set #1	2178.	NA	NA	100	100	214.7	97

Thermocompressor Size: 5. Type: High Efficency

Comments: condition 6



KADANT JOHNSON

Thermocompressor Sizing Calculations

Version 0.5.130

Customer: Haycarb

Location: India

Prepared by: RMW

Reference: E4712

Date:17/09/2013

INPUT DATA

	Motive pressure bar(g)	Suction pressure bar(g)	Discharge pressure bar(g)	Motive temperature °C	Suction temperature °C	Suction flow kg/hr	Discharge flow kg/hr
Set #1	30	1	4	400	150	1251	4000

OUTPUT DATA

	Motive flow kg/hr	Nozzle diameter mm	Throat diameter mm	Design percentage %	Choke percentage %	Discharge temperature °C	Estimated sound level dBA
Set #1	2749.	NA	NA	100	100	303.1	101

Thermocompressor Size: 5. Type: Standard

Comments: condition 7