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SANDEN scroll expander experimental results

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Tests and their analysis: Camila Dávila

Report: Camila Dávila
Review: Vincent Lemort

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1 Introduction

This project is done in collaboration with ORCAN energy (German company), SANDEN (Japanese company) and ULiège (University of Liège, Belgium). The global objective is, with a small and compact Rankine box, to recover a maximum of waste heat from the coolant circuit of a truck engine and convert it into mechanical energy to increase the engine BTE.

At the University of Liège facilities, the scroll expander provided by SANDEN has been tested. This expander is the key component of the Rankine box, and its characterization is crucial to evaluate the potential of the proposal.

2 Description of the test facility

2.1 General architecture of the test bench

The test bench is composed of an evaporator, the scroll expander, a condenser, a liquid receiver, a sub cooler and a pump. The heat source of the evaporator is an electric oil boiler where the oil temperature is adjustable. The cold source of the condenser is tap water where the water flow rate is adjustable.

The working fluid is HFC – 245fa. Temperature, pressure, and refrigerant flow measurements are taken. The evolution of each test is constantly monitored. A scheme of the test bench is shown in Figure 1. Pictures of the experimental facilities are shown in Figure 2.

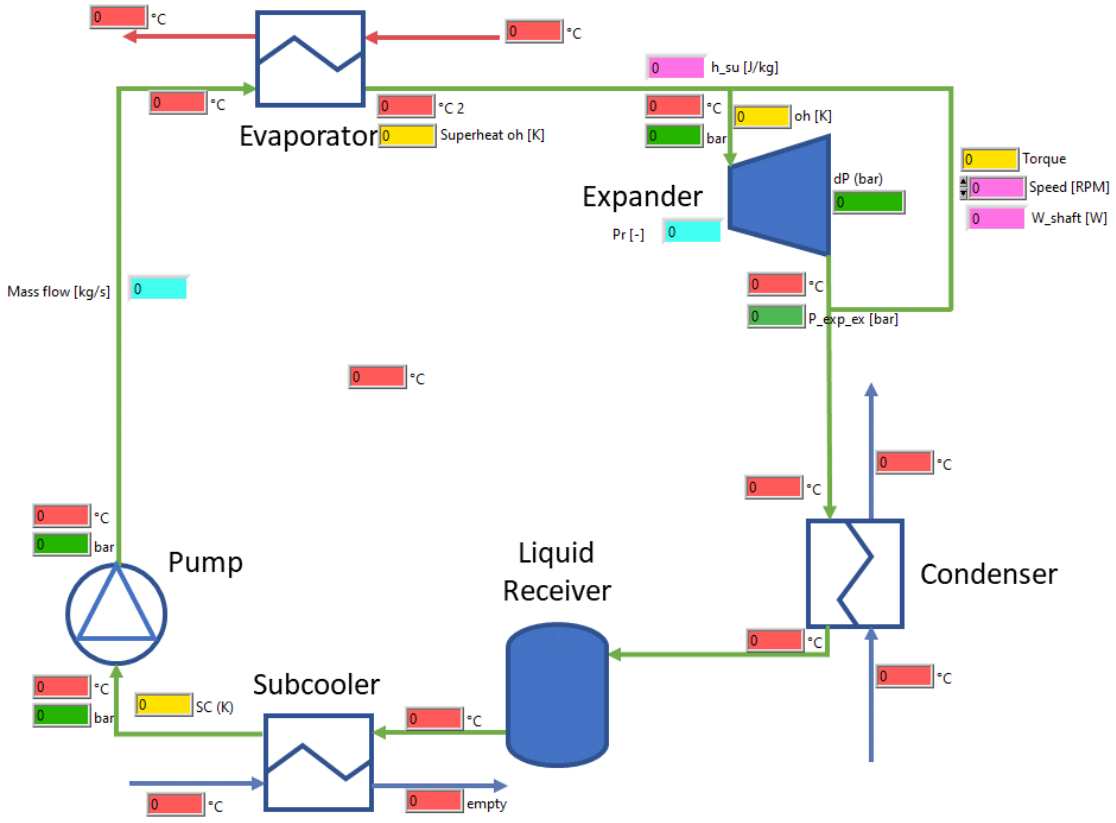

Figure 1. SANDEN scroll expander test bench scheme

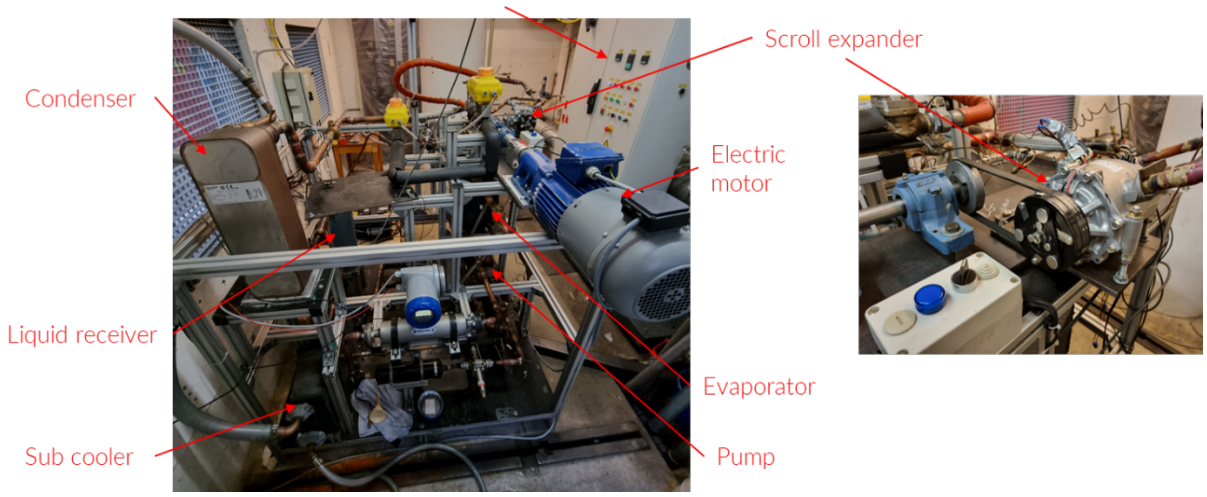

Figure 2. Experimental facilities photos

2.2 Instrumentation

Table 1 shows the list of sensors used on the experimental facilities, their type, range, and accuracy. The shaft power output is calculated based on the torque measured on the shaft and the rotational speed, also measured.

Table 1. Experimental facilities list of sensors

Sensor	Type	Range	Quantity	Accuracy
Pressure transmitter	Absolute	0 - 25 [bar]	2	± 0.2 %
	Absolute	0 - 10 [bar]	1	± 0.2 %
	Differential	0 - 25 [bar]	1	1.0 % <
Flowmeter	Mass flowmeter	400 - 2500 [kg/m^3]	1	± 0.15%
Thermocouples	J	-250 – 350 [°C]	15	± 0.3 K
Torque transducer	-	0 – 20 [Nm]	1	0.1 %
Tachymeter	Digital	10 – 20000 [RPM]	1	-

2.3 Test bench control and test matrix

The oil boiler temperature control is based on a PID; due to it, the temperature evolution of the oil affects in the same oscillating way every measurement in the test bench (temperatures, pressures, torque, speed and refrigerant flow), as shown in Figure 3 for the temperature evolution and Figure 4 (left) for the torque behavior for the same period of time. Thus, the achievable test pressure ratio in the expander is limited by the safety working pressures at the inlet and outlet of the pump, that are affected by the oscillations associated to the PID oil boiler controller.

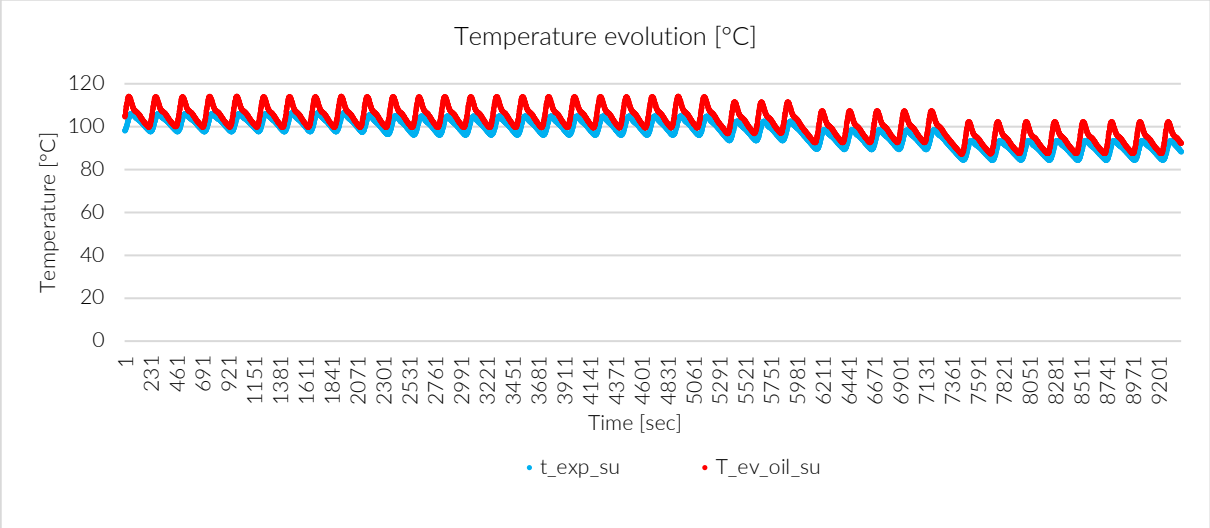

Figure 3. Temperature evolution over test time of the oil supply temperature to the evaporator and the refrigerant supply temperature to the expander

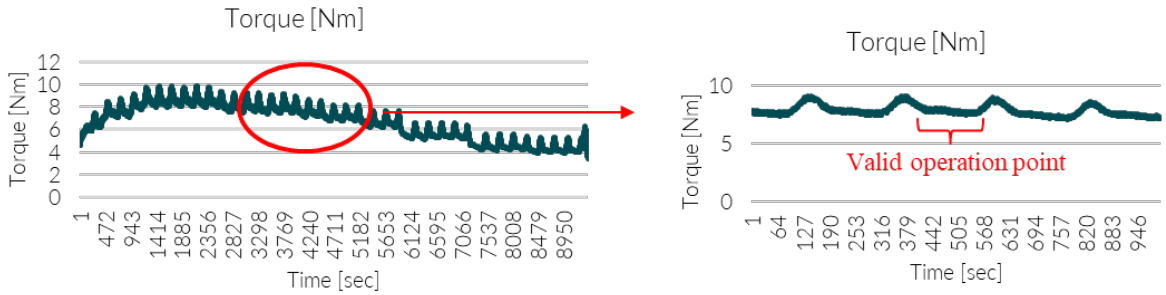

Figure 4. Torque evolution for the same time sample as Figure 3 (left); torque zoom for a smaller time sample (right)

For the experimental matrix and the test results, a valid operation point is considered as the valleys between peaks as shown in Figure 4 (right). Every measurement is averaged over these periods of time for further calculations.

The objective to reach is a shaft power production from the expander of 2.5 kW, along with describing the operating conditions to achieve this. According to the project documentation, the reference inlet temperature of the refrigerant to the expander is 102°C; also, the maximum rotational speed to which the expander can work is 6000 RPM.

Then, the test matrix is focused on the power production target; since the measured power depends on the rotational speed, several operational conditions between 2000 RPM and 5500 RPM are tested. A wide range of pressure ratios is sought for each rotational speed, limited by the conditions previously exposed (PID temperature effect, safety limits of the pump). For the refrigerant inlet temperature to the expander, a range between 86°C and 109°C is tested. The experimental campaign leads to the test conditions shown in Table 2.

Table 2. Resulting test conditions for the Scroll Expander

Expander rotational speed [RPM]	Pressure ratio range [-]
2000	2.5 - 4.2
2500	2.4 – 4.2
3000	2.4 – 4.1
3500	2.5 – 5.2
4000	2.4 – 5.3
5000	2.4 – 4.0
5500	2.4 – 4.2

The test procedure is an iterative process that consists firstly in heating up the refrigerant loop to increase the inlet temperature and pressure to the expander; during this time, the expander is not engaged and the bypass is open.

Once an overheating of minimum 20K is reached, the electric motor is set to a speed of 2000 RPM, then the bypass is closed and the expander engaged. This minimum overheating is necessary to avoid liquid refrigerant entering to the expander, since once the expander is engaged, the overheating decreases rapidly. During operation, an minimum overheating of 10K is sought.

Once the test bench is steady, the different test conditions are reached by iteration of :

- The refrigerant inlet temperature: by changing the oil temperature setpoint; affects the refrigerant inlet pressure to the expander.
- The refrigerant flow: by regulation of the pump; affects the refrigerant inlet pressure to the expander.
- The cooling in the condenser: by regulation of the cold side of the condenser (cold water flow regulation); affects the temperature and pressure at the outlet of the expander; affects the temperature and pressure at the inlet of the pump.
- The electric motor breaking: by regulation of the electric motor rotational speed; affects the torque and thus, the expander speed and power shaft produced.

3 Performance indicators

To characterize the scroll expander, the following performance indicators are computed:

- Isentropic efficiency

$$\varepsilon_s = \frac{\dot{W}_{sh,meas}}{\dot{W}_s} = \frac{\dot{W}_{sh,meas}}{\dot{M}_{meas} * w_s} = \frac{\dot{W}_{sh,meas}}{\dot{M}_{meas} * (h_{su} - h_{ex,s})}$$

- Shaft power output

$$\dot{W}_{sh,meas} = \frac{Torque * \pi * RPM}{30} \; [W]$$

- Volumetric efficiency

$$\varepsilon_v = \varphi_{meas} = \frac{\dot{V}_{meas}}{\dot{V}_{th}} = \frac{\dot{M}_{measured} * v_{su,exp}}{(\frac{N}{60}) * V_{s,exp}} \quad \frac{\left[\frac{kg}{s}\right]\left[\frac{m^3}{kg}\right]}{\left[\frac{1}{s}\right][m^3]}$$

- Brake thermal efficiency

$$BTE = \frac{\dot{W}_{sh,meas}}{\dot{M}_{meas} * (h_{ex,ev} - h_{su,ev})}$$

Other indicators included in the results are:

- Net enthalpy flow rate

$$\dot{H} = \dot{M}_{meas} * (h_{su} - h_{ex}) \; [W]$$

- Heat loss

$$\dot{Q}_{loss} = \dot{H} - \dot{W}_{sh,meas} \; [W]$$

Some of the scroll expander specifications are shown in Table 3.

Table 3. SANDEN scroll expander technical specifications

Working fluid	HFC – 245fa
Size	ø 170 mm x L 230 mm
Weight	Approx. 5.5 kg
Maximum speed	6000 rpm
Inlet volume ($V_{s,exp}$)	71.2 cc
Outlet volume	121 cc
Volume ratio	1.7
Average Is. efficiency	70%

4 Results and conclusions

The information related to this part of the study is shared on the project SharePoint, under the "*ULG_Shared – Sanden Scroll expander test*" folder. The information is also available in the Annex section.

The objectives for the ORCAN Rankine box are the following:

- Electric net output power at the reference conditions: 2.5 kW. Net power calculated from the gross power output.
- Reference heat input: 146 kW thermal
- Reference temperature of the heat source: 102°C

Therefore, these conditions are also the boundary conditions for the tested scroll expander, where the focus of the tests is on the electric power output from the expander. Indeed, the expander test campaign aims at achieving the 2.5 kW target.

The results related to the shaft power produced for several pressure ratios and rotational speeds are shown in Figure 5. One of the conclusions of the tests is that the best results for target electrical power output (≥2.5 kW) are achieved at 3500-4000 RPM, for pressure ratios above 4.4.

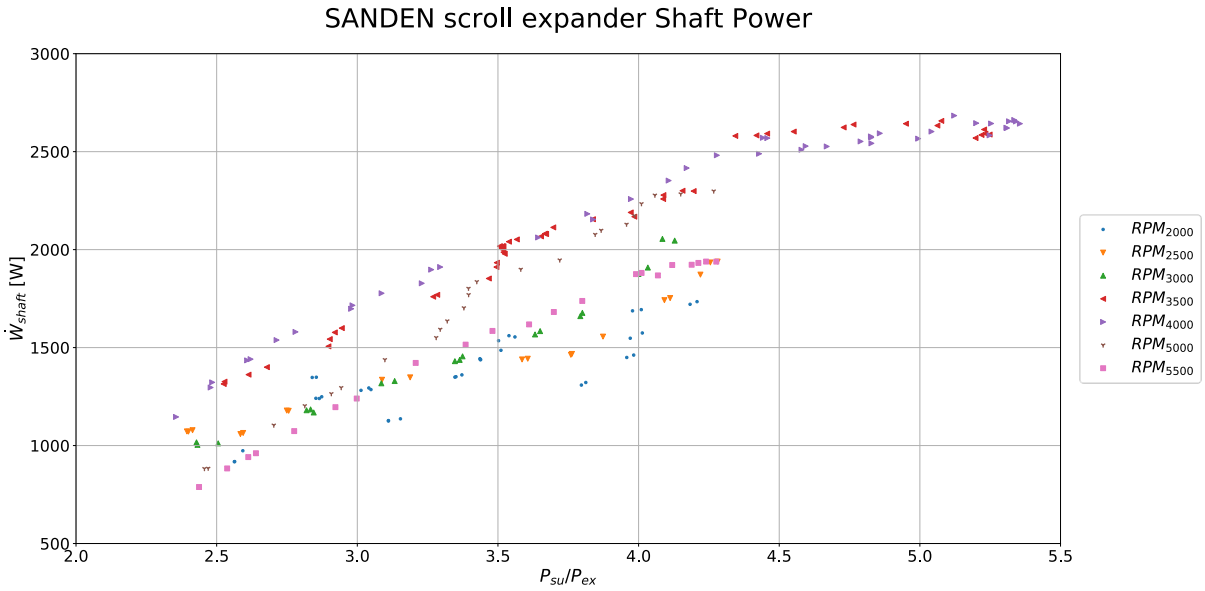

Figure 5. Evolution of the SANDEN scroll expander shaft power with the pressure ratio for several rotational speeds

Also, there is a potential of getting higher electrical power output at higher pressure ratios, conditions that are not reachable due to the previously exposed test bench limitations. As previously mentioned, the experimental results are computed during the steady state valleys of each test. However, a closer look to the results during peaks shows potential higher results for the shaft power output.

Table 4 shows the shaft power output results during tests on steady state, highlighting the maximum value reached experimentally (2683 W). The limitations of the test bench do not allow to achieve higher pressure ratios due to the oscillation caused by the PID control of the boiler. It was observed, however, that during those peaks (not considered as steady states) a higher electrical output was achieved as shown in Figure 6. Thus, there's potential of higher electrical power output at higher pressure ratios.

Also, a possible cause of the power drop for speeds above 4000 rpm is the increase of the oil circulation ratio at higher speed; remove some oil could potentially improve the response of the expander at higher speeds, and thus, increase the power electrical output. Thus, there's potential of higher electrical power output at higher speeds.

Table 4. Best shaft power output results on steady state conditions

RPM	Pressure ratio	W_shaft [W]	Eff_s	Eff_v
4000	4.44	2570	0.56	0.72
4000	4.46	2569	0.57	0.71
3500	5.20	2569	0.55	0.75
3500	5.22	2585	0.56	0.75
3500	5.25	2587	0.55	0.75
3500	5.23	2591	0.55	0.75
3500	5.23	2612	0.55	0.75
3500	5.08	2657	0.55	**0.76**
3500	5.06	2633	0.55	0.75
3500	4.95	2642	0.55	**0.76**
3500	4.76	2638	0.56	0.75
3500	4.73	2623	0.57	0.75
3500	4.55	2602	0.57	**0.76**
3500	4.46	2592	0.58	0.75
3500	4.42	2582	0.58	0.75
3500	4.34	2580	**0.59**	0.75
4000	5.25	2583	0.53	0.72
4000	5.31	2620	0.52	0.72

RPM	Pressure ratio	W_shaft [W]	Eff_s	Eff_v
4000	5.31	2621	0.53	0.72
4000	**5.36**	2642	0.53	0.72
4000	5.34	2653	0.52	0.72
4000	5.32	2655	0.53	0.72
4000	5.34	2661	0.53	0.72
4000	5.25	2643	0.53	0.71
4000	5.20	2645	0.53	0.72
4000	5.12	**2683**	0.53	0.72
4000	4.99	2566	0.54	0.72
4000	5.04	2602	0.54	0.71
4000	4.86	2593	0.54	0.72
4000	4.83	2577	0.54	0.72
4000	4.83	2572	0.54	0.72
4000	4.83	2542	0.54	0.72
4000	4.79	2552	0.54	0.72
4000	4.67	2526	0.55	0.72
4000	4.59	2528	0.55	0.72
4000	4.58	2509	0.55	0.72

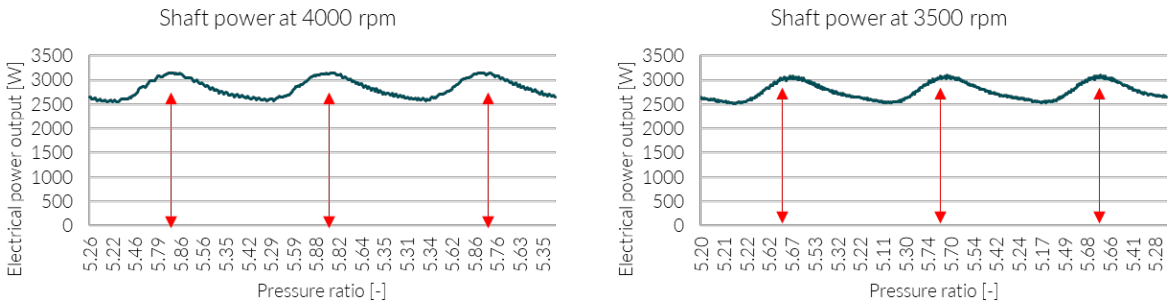

Figure 6. Best shaft power during peaks

Figure 7 and Figure 8 shows the isentropic and volumetric efficiency of the expander, respectively; Figure 9 shows the expander brake thermal efficiency. It can be seen that the best results for isentropic and volumetric efficiency are achieved at lower speeds (2000 RPM), and that the brake thermal efficiency is higher for lower speeds.

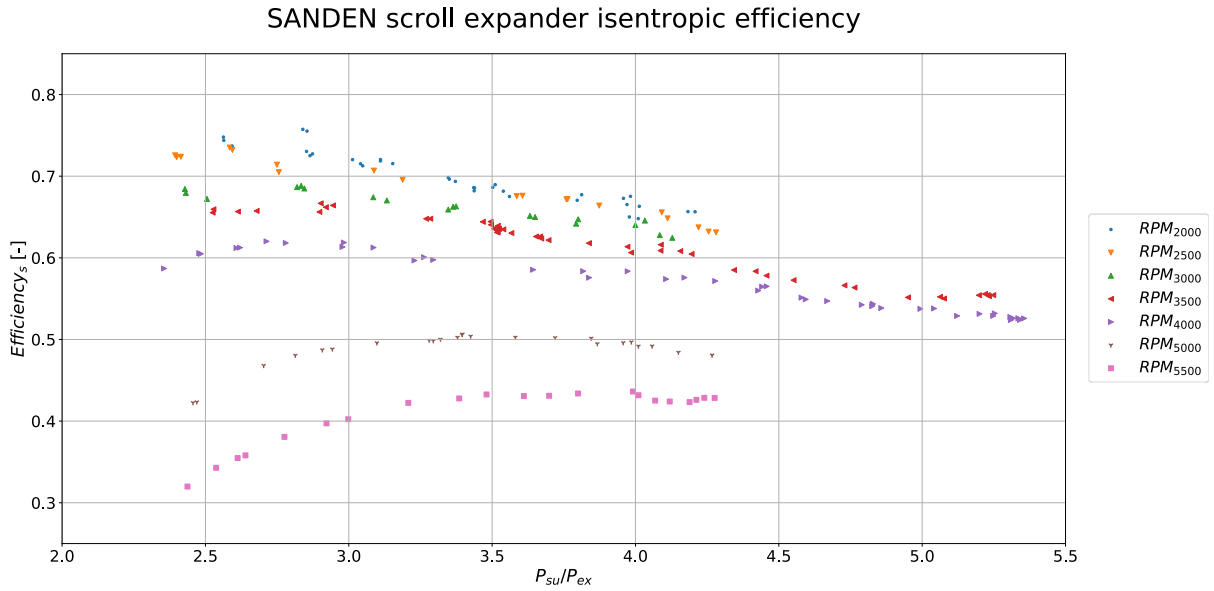

Figure 7. Evolution of the SANDEN scroll expander isentropic efficiency with the pressure ratio for several rotational speeds

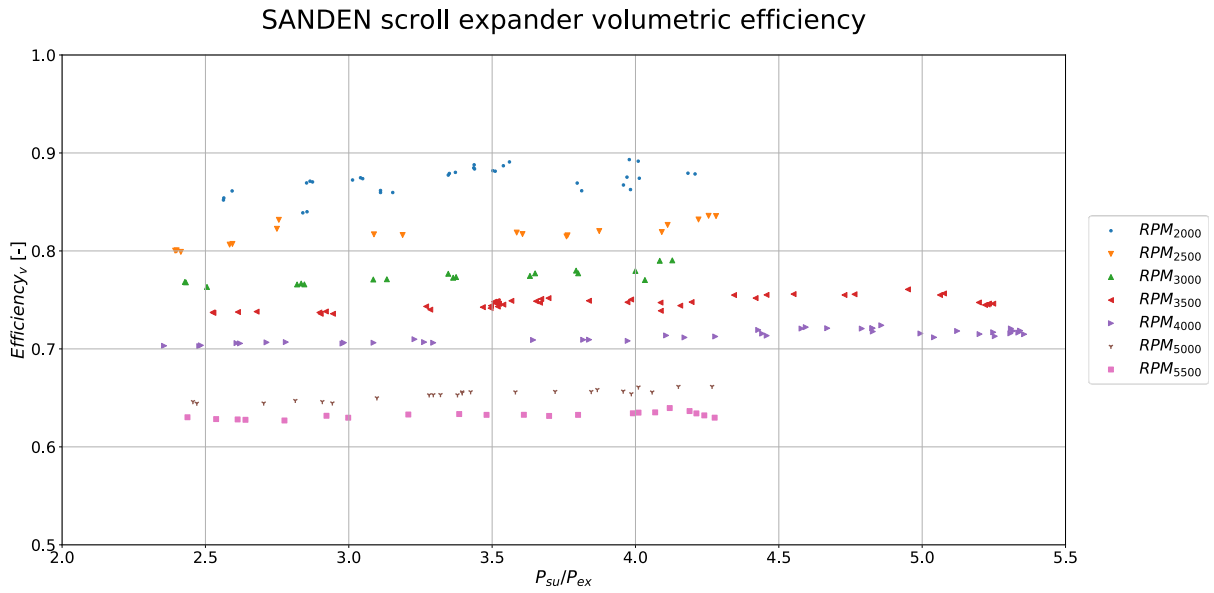

Figure 8. Evolution of the SANDEN scroll expander volumetric efficiency with the pressure ratio for several rotational speeds

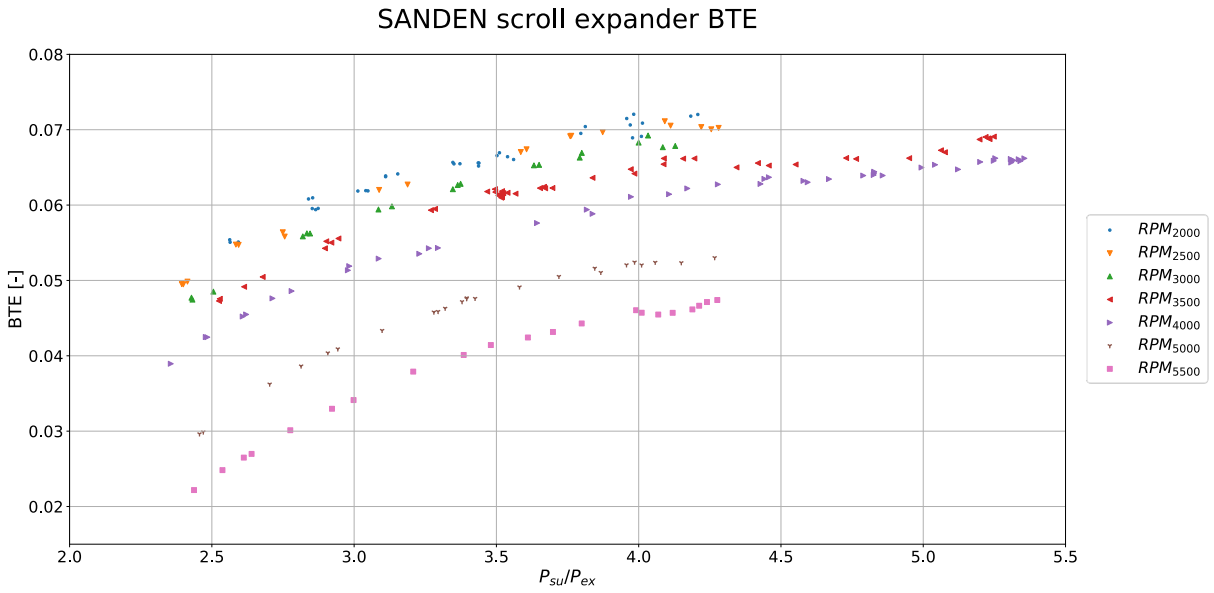

Figure 9. Evolution of the SANDEN scroll expander BTE with the pressure ratio for several rotational speeds

5 Annex. Experimental results

T_su	P_su	h_su	s_su	T_ex	P_ex	h_ex_s	RPM	m_dot_wf	Torque	Press.Ratio	W_shaft	deltaH	Spec.Vol.Suc.	h_evap_in	Eff_s	BTE	Eff_v	h_ex	H_dot	Q_dot_loss
[K]	[Pa]	[J/kg]	[J/kgK]	[K]	[Pa]	[J/kg]		[kg/s]	[Nm]	[Pa]	[W]	[J/kg]	[m3/kg]	[J/kg]				[J/kg]	[W]	[W]
374.1	955214.9	483869.5	1831.4	350.9	293940.1	460670.9	1500	0.0860	8.399	3.25	1319	23198.57	0.0202	225571.4	0.66	0.059	0.98	471235.5	1086	-233
373.6	951140.4	483397.6	1830.4	350.7	292463.9	460217.6	1500	0.0859	8.362	3.25	1313	23179.98	0.0203	225569.3	0.66	0.059	0.98	471068.9	1059	-254
372.5	951220.4	482171.4	1827.1	348.7	293548.5	459173.8	1500	0.0858	8.340	3.24	1309	22997.65	0.0202	225567.7	0.66	0.059	0.97	469073.0	1124	-186
372.7	925035.7	482918.0	1830.5	348.7	293629.5	460348.4	1600	0.0854	7.865	3.15	1317	22569.64	0.0209	225503.5	0.68	0.060	0.94	469089.5	1181	-136
372.0	923276.4	482141.6	1828.6	348.3	291627.7	459539.6	1600	0.0857	7.897	3.17	1322	22602.03	0.0209	225457.4	0.68	0.060	0.94	468698.7	1152	-170
371.8	915672.1	482071.6	1828.8	348.3	292633.4	459688.7	1720	0.0856	7.744	3.13	1394	22382.93	0.0211	225417.3	0.73	0.063	0.88	468670.5	1148	-247
372.2	917661.1	482455.7	1829.7	348.4	292822.4	460013.6	1720	0.0858	7.785	3.13	1402	22442.13	0.0210	225404.4	0.73	0.064	0.88	468823.5	1170	-232
372.3	899773.5	482963.5	1832.1	348.8	295942.0	461034.3	1800	0.0859	7.419	3.04	1398	21929.12	0.0216	225374.7	0.74	0.063	0.87	469070.3	1194	-204
372.2	901733.4	482782.1	1831.5	348.7	296219.3	460848.3	1800	0.0862	7.440	3.04	1402	21933.83	0.0215	225352.9	0.74	0.063	0.87	468970.1	1191	-211
372.6	881591.4	483616.1	1834.9	349.2	298213.5	462147.5	1900	0.0865	7.041	2.96	1400	21468.59	0.0222	225333.8	0.75	0.063	0.85	469522.5	1219	-181
372.1	880235.6	483070.7	1833.5	349.0	296833.1	461583.1	1900	0.0864	7.027	2.97	1398	21487.67	0.0221	225336.2	0.75	0.063	0.85	469304.8	1189	-209
372.1	886206.6	482924.9	1832.8	348.7	296393.4	461299.5	1900	0.0863	7.131	2.99	1418	21625.45	0.0220	225306.3	0.76	0.064	0.84	469009.3	1201	-217
369.9	845454.5	481243.6	1830.7	347.7	297812.3	460690.6	2000	0.0866	6.438	2.84	1348	20553.09	0.0230	225253.8	0.76	0.061	0.84	467949.2	1151	-197
369.6	843231.6	480929.6	1830.0	347.3	295470.6	460293.4	2000	0.0865	6.443	2.85	1349	20636.22	0.0230	225271.5	0.76	0.061	0.84	467669.3	1148	-201
365.8	786500.6	477835.5	1825.3	345.2	298942.8	458913.6	2200	0.0878	5.400	2.63	1243	18921.87	0.0246	225279.4	0.75	0.056	0.83	465513.7	1082	-162
365.6	779486.3	477677.9	1825.3	345.1	297407.6	458827.6	2200	0.0866	5.317	2.62	1224	18850.30	0.0248	225284.2	0.75	0.056	0.82	465436.9	1060	-165
360.9	718383.1	473742.6	1818.8	342.2	294090.3	456418.4	2365	0.0864	4.317	2.44	1069	17324.20	0.0268	225180.5	0.71	0.050	0.82	462599.5	963	-106
360.8	719202.6	473636.9	1818.5	342.0	291840.0	456150.9	2400	0.0862	4.360	2.46	1095	17486.05	0.0267	225220.0	0.73	0.051	0.81	462436.5	966	-130
360.8	718375.7	473642.2	1818.5	342.0	291172.5	456132.0	2400	0.0863	4.359	2.47	1095	17510.19	0.0268	225202.0	0.72	0.051	0.81	462427.6	968	-127
361.0	707071.8	474056.7	1820.5	342.6	294680.6	457034.8	2500	0.0870	4.094	2.40	1071	17021.86	0.0273	225206.1	0.72	0.049	0.80	463013.8	961	-111
360.9	707475.6	474009.3	1820.4	342.6	295483.7	457033.2	2500	0.0870	4.097	2.39	1072	16976.09	0.0273	225203.7	0.73	0.050	0.80	462997.9	959	-114
360.9	707803.6	473985.8	1820.3	342.5	293216.7	456853.4	2500	0.0870	4.121	2.41	1078	17132.36	0.0273	225209.3	0.72	0.050	0.80	462933.2	961	-117
382.2	892763.1	494245.9	1862.4	358.2	200998.3	463635.9	4000	0.1487	6.140	4.44	2571	30609.95	0.0228	221951.6	0.56	0.063	0.72	480014.4	2117	-454
381.9	891848.4	493903.8	1861.6	357.9	200083.0	463256.6	4000	0.1483	6.137	4.46	2569	30647.19	0.0228	221970.5	0.57	0.064	0.71	479761.9	2098	-471
382.5	877736.5	494858.0	1864.9	358.7	205172.5	464911.3	4000	0.1450	5.927	4.28	2481	29946.75	0.0233	222055.7	0.57	0.063	0.71	480513.5	2079	-402
382.7	865482.9	495245.2	1866.7	359.2	207520.7	465749.2	4000	0.1423	5.771	4.17	2416	29496.01	0.0237	222243.4	0.58	0.062	0.71	480966.5	2032	-385
381.2	851991.8	493768.0	1863.7	358.1	207468.7	464706.1	4000	0.1410	5.619	4.11	2352	29061.90	0.0240	222272.7	0.57	0.061	0.71	479863.2	1961	-392
380.9	831212.5	493780.3	1865.0	358.0	209240.6	465345.9	4000	0.1361	5.394	3.97	2258	28434.49	0.0247	222183.8	0.58	0.061	0.71	479776.3	1906	-352
379.0	825118.5	491794.2	1860.2	356.9	216141.5	464347.7	4000	0.1362	5.213	3.82	2183	27446.51	0.0247	222084.0	0.58	0.059	0.71	478571.8	1802	-381
378.5	822270.5	491331.9	1859.2	356.5	214251.5	463815.9	4000	0.1360	5.145	3.84	2154	27515.97	0.0248	222135.4	0.58	0.059	0.71	478123.7	1796	-358
378.6	806255.9	491683.1	1861.2	357.1	221339.2	465156.3	4000	0.1328	4.925	3.64	2062	26526.84	0.0253	222157.4	0.59	0.058	0.71	478612.8	1736	-326
378.9	796949.9	492194.7	1863.1	358.3	241908.3	467646.7	4000	0.1303	4.565	3.29	1911	24548.02	0.0257	222120.9	0.60	0.054	0.71	479489.3	1655	-256

T_su	P_su	h_su	s_su	T_ex	P_ex	h_ex_s	RPM	m_dot_wf	Torque	Press.Ratio	W_shaft	deltaH	Spec.Vol.Suc.	h_evap_in	Eff_s	BTE	Eff_v	h_ex	H_dot	Q_dot_loss
[K]	[Pa]	[J/kg]	[J/kgK]	[K]	[Pa]	[J/kg]		[kg/s]	[Nm]	[Pa]	[W]	[J/kg]	[m3/kg]	[J/kg]				[J/kg]	[W]	[W]
378.8	792836.5	492081.1	1863.1	358.3	243008.9	467732.5	4000	0.1297	4.533	3.26	1898	24348.63	0.0259	222514.5	0.60	0.054	0.71	479488.5	1633	-264
378.1	773316.1	491684.9	1863.4	358.1	239492.4	467540.7	4000	0.1269	4.366	3.23	1828	24144.23	0.0266	222576.9	0.60	0.054	0.71	479310.9	1570	-258
376.6	765264.7	490160.0	1859.9	356.8	247959.2	467046.8	4000	0.1255	4.245	3.09	1777	23113.20	0.0267	222492.2	0.61	0.053	0.71	477916.8	1537	-240
376.8	755409.8	490567.5	1861.7	357.4	253679.0	468130.1	4000	0.1234	4.056	2.98	1698	22437.45	0.0271	222548.9	0.61	0.051	0.71	478402.4	1501	-197
376.4	754380.1	490145.1	1860.7	357.0	252919.9	467705.7	4000	0.1236	4.098	2.98	1716	22439.37	0.0271	222598.2	0.62	0.052	0.71	478052.9	1494	-222
376.8	742870.4	490708.7	1863.0	358.3	267197.0	469638.3	4000	0.1213	3.774	2.78	1580	21070.38	0.0277	222619.3	0.62	0.049	0.71	479068.2	1412	-168
377.2	739063.4	491270.5	1864.8	359.0	272420.6	470653.6	4000	0.1203	3.674	2.71	1538	20616.86	0.0279	222751.3	0.62	0.048	0.71	479699.3	1392	-146
375.3	727815.1	489393.2	1860.6	358.0	279053.4	469695.1	4000	0.1190	3.427	2.61	1435	19698.08	0.0282	222740.9	0.61	0.045	0.71	478604.7	1284	-151
375.1	727049.4	489158.7	1860.1	357.7	277447.2	469379.3	4000	0.1189	3.442	2.62	1441	19779.44	0.0282	222808.1	0.61	0.045	0.71	478314.3	1290	-151
375.5	717770.7	489754.5	1862.4	358.8	288946.9	471010.2	4000	0.1167	3.159	2.48	1323	18744.26	0.0286	222791.5	0.60	0.042	0.70	479238.8	1227	-96
375.7	705535.3	490162.7	1864.4	359.0	284653.2	471414.9	4000	0.1141	3.096	2.48	1296	18747.86	0.0292	222859.1	0.61	0.042	0.70	479554.9	1211	-85
374.9	682135.8	489731.1	1865.1	359.2	289577.3	472014.7	4000	0.1102	2.738	2.36	1146	17716.36	0.0303	222727.5	0.59	0.039	0.70	479630.1	1113	-33
377.2	834620.5	489616.1	1853.8	356.5	195610.4	460169.4	5000	0.1624	4.393	4.27	2299	29446.77	0.0242	222538.9	0.48	0.053	0.66	478500.7	1805	-494
377.2	839083.8	489585.8	1853.5	356.8	202210.5	460710.4	5000	0.1634	4.364	4.15	2284	28875.41	0.0240	222470.3	0.48	0.052	0.66	478653.9	1786	-498
376.9	843460.3	489085.6	1851.9	356.5	207849.8	460718.1	5000	0.1632	4.352	4.06	2278	28367.50	0.0238	222749.5	0.49	0.052	0.66	478235.5	1771	-507
377.4	829432.2	489923.7	1855.0	357.2	206835.6	461677.7	5000	0.1609	4.269	4.01	2234	28245.98	0.0244	223026.9	0.49	0.052	0.66	478979.9	1760	-474
377.2	811302.1	489982.8	1856.3	357.0	203563.8	461813.3	5000	0.1552	4.152	3.99	2173	28169.46	0.0250	222972.7	0.50	0.052	0.65	478824.9	1732	-441
377.6	798409.5	490704.8	1859.1	357.6	201767.3	462578.8	5000	0.1527	4.069	3.96	2129	28126.02	0.0255	222763.9	0.50	0.052	0.66	479416.7	1723	-406
376.6	799485.2	489537.2	1855.9	356.9	206755.4	461992.8	5000	0.1540	4.010	3.87	2099	27544.37	0.0254	222597.1	0.49	0.051	0.66	478646.4	1677	-421
376.2	787002.4	489303.2	1856.2	356.3	204649.6	461864.0	5000	0.1510	3.970	3.85	2077	27439.23	0.0258	222721.5	0.50	0.052	0.66	478155.9	1683	-394
374.8	756137.5	488309.3	1855.7	355.5	203281.0	461565.1	5000	0.1450	3.720	3.72	1947	26744.19	0.0269	222475.0	0.50	0.051	0.66	477372.7	1585	-362
374.2	758843.5	487651.0	1853.7	355.3	211906.6	461737.3	5000	0.1458	3.630	3.58	1900	25913.72	0.0267	222468.7	0.50	0.049	0.66	477016.8	1551	-349
374.6	757987.7	488100.8	1855.0	356.1	221322.1	463041.3	5000	0.1454	3.509	3.42	1836	25059.49	0.0268	222804.9	0.50	0.048	0.66	477657.8	1519	-318
374.7	747072.2	488385.2	1856.5	356.4	220045.0	463452.5	5000	0.1429	3.444	3.40	1802	24932.70	0.0272	223229.8	0.51	0.048	0.66	477938.0	1493	-310
374.9	734715.6	488832.0	1858.6	356.5	216370.3	463829.9	5000	0.1398	3.383	3.40	1770	25002.03	0.0278	223244.2	0.51	0.048	0.66	478122.5	1497	-273
373.8	717650.8	487882.3	1857.4	355.7	212386.0	463026.0	5000	0.1363	3.254	3.38	1703	24856.36	0.0284	223053.4	0.50	0.047	0.65	477365.5	1433	-269
373.5	703170.4	487765.1	1858.2	355.5	211815.5	463244.7	5000	0.1334	3.126	3.32	1636	24520.38	0.0291	222839.2	0.50	0.046	0.65	477216.6	1407	-229
372.6	692233.8	487017.4	1857.0	354.9	210103.7	462690.2	5000	0.1314	3.045	3.29	1593	24327.15	0.0295	222742.3	0.50	0.046	0.65	476643.6	1364	-230
373.5	676568.8	488198.4	1861.4	355.6	206251.0	463825.6	5000	0.1275	2.964	3.28	1551	24372.85	0.0304	222623.2	0.50	0.046	0.65	477418.8	1375	-176
372.6	666341.5	487438.1	1860.2	355.6	215071.8	464263.2	5000	0.1252	2.749	3.10	1438	23174.87	0.0308	222445.7	0.50	0.043	0.65	477223.2	1279	-159
371.7	635975.9	487000.0	1861.6	355.4	218746.8	465086.3	5000	0.1185	2.417	2.91	1265	21913.67	0.0324	222545.6	0.49	0.040	0.65	477021.4	1182	-83
370.5	643836.9	485515.8	1857.0	354.2	218788.0	463487.8	5000	0.1205	2.476	2.94	1296	22028.03	0.0318	222624.6	0.49	0.041	0.64	475818.6	1168	-127

T_su	P_su	h_su	s_su	T_ex	P_ex	h_ex_s	RPM	m_dot_wf	Torque	Press.Ratio	W_shaft	deltaH	Spec.Vol.Suc.	h_evap_in	Eff_s	BTE	Eff_v	h_ex	H_dot	Q_dot_loss
[K]	[Pa]	[J/kg]	[J/kgK]	[K]	[Pa]	[J/kg]		[kg/s]	[Nm]	[Pa]	[W]	[J/kg]	[m3/kg]	[J/kg]				[J/kg]	[W]	[W]
371.1	631749.3	486379.1	1860.3	355.4	224559.9	465171.2	5000	0.1181	2.299	2.81	1203	21207.91	0.0325	222638.8	0.48	0.039	0.65	476903.9	1119	-84
371.4	621637.1	486936.0	1862.7	356.2	229976.5	466479.8	5000	0.1153	2.110	2.70	1104	20456.14	0.0332	222681.3	0.47	0.036	0.64	477634.8	1072	-32
371.5	605378.9	487274.5	1865.1	357.8	245116.5	468606.8	5000	0.1118	1.689	2.47	884	18667.66	0.0342	222727.4	0.42	0.030	0.64	479006.5	925	41
372.8	607775.2	488646.9	1868.6	359.1	247428.7	470006.4	5000	0.1120	1.686	2.46	882	18640.50	0.0342	222840.0	0.42	0.030	0.65	480196.8	947	64
373.0	756611.6	486324.2	1850.3	354.0	176953.4	456994.7	5500	0.1543	3.368	4.28	1939	29329.44	0.0266	221267.3	0.43	0.047	0.63	476332.6	1542	-397
373.0	757951.6	486333.6	1850.3	354.0	178770.3	457174.1	5500	0.1552	3.368	4.24	1939	29159.48	0.0266	221227.7	0.43	0.047	0.63	476257.4	1564	-375
373.3	760552.9	486563.2	1850.7	354.3	180554.7	457515.4	5500	0.1561	3.356	4.21	1932	29047.75	0.0265	221228.8	0.43	0.047	0.63	476549.1	1563	-369
373.1	761767.4	486335.3	1850.0	354.3	181875.8	457427.1	5500	0.1571	3.340	4.19	1923	28908.17	0.0264	221237.5	0.42	0.046	0.64	476520.5	1542	-380
373.4	764942.0	486628.9	1850.6	354.7	185699.8	458029.3	5500	0.1584	3.338	4.12	1921	28599.65	0.0263	221291.3	0.42	0.046	0.64	476813.2	1555	-366
373.6	754243.2	487062.2	1852.5	354.9	185386.9	458640.6	5500	0.1546	3.246	4.07	1868	28421.56	0.0268	221354.9	0.43	0.045	0.64	477079.4	1544	-325
373.5	755575.9	486907.7	1852.0	354.9	188401.7	458791.3	5500	0.1550	3.268	4.01	1881	28116.40	0.0267	221375.0	0.43	0.046	0.63	477028.3	1531	-350
374.1	749393.7	487634.1	1854.4	355.4	187783.2	459529.5	5500	0.1529	3.257	3.99	1875	28104.58	0.0271	221405.4	0.44	0.046	0.63	477461.9	1556	-319
372.9	726471.4	486731.5	1853.6	355.0	191194.4	459643.7	5500	0.1479	3.019	3.80	1738	27087.82	0.0279	221395.8	0.43	0.044	0.63	477050.3	1432	-306
372.2	723052.1	486088.1	1852.2	354.6	195491.6	459592.2	5500	0.1472	2.921	3.70	1682	26495.88	0.0280	221483.4	0.43	0.043	0.63	476558.4	1403	-278
371.0	708362.9	485021.1	1850.4	354.0	196189.6	459072.3	5500	0.1448	2.811	3.61	1618	25948.81	0.0285	221609.6	0.43	0.042	0.63	475959.1	1312	-306
370.7	710531.2	484576.4	1849.0	353.7	204150.9	459405.3	5500	0.1455	2.753	3.48	1585	25171.09	0.0284	221697.0	0.43	0.041	0.63	475536.2	1316	-269
371.3	702138.0	485391.3	1851.9	354.6	207432.4	460684.7	5500	0.1434	2.632	3.39	1515	24706.58	0.0288	221910.6	0.43	0.040	0.63	476363.5	1294	-221
371.5	698594.8	485652.9	1852.9	355.4	217797.9	461994.9	5500	0.1423	2.470	3.21	1422	23657.96	0.0290	222040.8	0.42	0.038	0.63	476974.7	1235	-187
370.4	682547.1	484766.3	1851.7	355.5	227700.8	462506.3	5500	0.1385	2.154	3.00	1240	22260.01	0.0297	222316.2	0.40	0.034	0.63	476913.1	1087	-153
370.5	680441.1	484887.6	1852.2	355.8	232857.4	463125.7	5500	0.1383	2.078	2.92	1196	21761.97	0.0298	222682.8	0.40	0.033	0.63	477185.2	1066	-130
370.5	674807.1	485006.3	1853.0	356.6	243131.4	464260.2	5500	0.1360	1.865	2.78	1074	20746.10	0.0301	222845.1	0.38	0.030	0.63	477804.6	979	-95
370.6	674206.1	485142.7	1853.4	357.5	255422.5	465398.3	5500	0.1359	1.669	2.64	961	19744.40	0.0301	223118.9	0.36	0.027	0.63	478530.1	899	-62
370.4	673271.5	484904.6	1852.9	357.6	257738.1	465385.4	5500	0.1359	1.635	2.61	941	19519.22	0.0302	223489.7	0.35	0.026	0.63	478525.3	867	-74
370.8	673813.9	485371.0	1854.1	358.3	265570.7	466409.2	5500	0.1359	1.534	2.54	883	18961.80	0.0302	223556.6	0.34	0.025	0.63	479116.7	850	-33
370.6	671679.1	485161.1	1853.7	359.0	275583.4	467022.5	5500	0.1359	1.370	2.44	788	18138.63	0.0303	223665.9	0.32	0.022	0.63	479640.5	750	-38
369.5	815914.4	481372.8	1833.0	343.9	203307.8	453947.6	2000	0.0866	7.522	4.01	1575	27425.13	0.0240	224766.5	0.66	0.071	0.87	465926.8	1337	-237
368.3	804823.8	480219.4	1830.6	343.3	202718.9	453095.8	2000	0.0858	7.394	3.97	1548	27123.59	0.0242	224757.6	0.67	0.071	0.88	465352.2	1275	-272
378.6	874755.2	490534.2	1853.8	351.9	207899.2	461364.9	2000	0.0906	8.286	4.21	1734	29169.36	0.0230	224687.3	0.66	0.072	0.88	473719.3	1523	-211
377.4	870174.6	489230.2	1850.6	351.3	208036.1	460304.1	2000	0.0906	8.221	4.18	1721	28926.14	0.0230	224722.2	0.66	0.072	0.88	473069.8	1464	-257
370.3	761885.0	483269.2	1841.7	344.9	191305.3	455670.8	2000	0.0784	6.983	3.98	1462	27598.41	0.0261	224586.0	0.68	0.072	0.86	467098.1	1268	-194
369.9	757681.7	482910.4	1841.1	344.7	191436.3	455460.5	2000	0.0785	6.925	3.96	1450	27449.95	0.0262	224532.2	0.67	0.071	0.87	466892.1	1257	-192
361.4	709742.7	474426.8	1821.4	337.1	186163.7	448435.1	2000	0.0751	6.315	3.81	1322	25991.74	0.0272	224425.4	0.68	0.070	0.86	459671.8	1108	-214

T_su	P_su	h_su	s_su	T_ex	P_ex	h_ex_s	RPM	m_dot_wf	Torque	Press.Ratio	W_shaft	deltaH	Spec.Vol.Suc.	h_evap_in	Eff_s	BTE	Eff_v	h_ex	H_dot	Q_dot_loss
[K]	[Pa]	[J/kg]	[J/kgK]	[K]	[Pa]	[J/kg]		[kg/s]	[Nm]	[Pa]	[W]	[J/kg]	[m3/kg]	[J/kg]				[J/kg]	[W]	[W]
361.1	705727.1	474213.4	1821.1	336.9	185881.3	448312.5	2000	0.0754	6.252	3.80	1309	25900.91	0.0274	224384.6	0.67	0.070	0.87	459508.2	1108	-201
361.5	675514.0	475247.9	1826.3	338.8	214216.6	452759.4	2000	0.0706	5.429	3.15	1136	22488.49	0.0289	224395.9	0.72	0.064	0.86	460784.1	1022	-115
361.2	673469.2	474982.7	1825.7	338.8	216501.4	452776.8	2000	0.0705	5.386	3.11	1127	22205.94	0.0289	224527.7	0.72	0.064	0.86	460729.0	1005	-123
360.9	672250.8	474698.1	1825.0	338.7	216113.0	452513.8	2000	0.0706	5.377	3.11	1126	22184.30	0.0290	224642.0	0.72	0.064	0.86	460657.2	991	-134
359.4	644419.0	473615.4	1824.3	339.7	251323.8	455205.3	2000	0.0670	4.387	2.56	918	18410.05	0.0302	224920.4	0.74	0.055	0.85	460955.3	849	-69
359.4	642512.9	473615.2	1824.5	339.6	250706.3	455210.9	2000	0.0667	4.384	2.56	918	18404.28	0.0303	225145.7	0.75	0.055	0.85	460831.3	852	-65
359.5	674367.3	473159.2	1820.6	339.6	260059.4	454626.9	2000	0.0713	4.651	2.59	974	18532.34	0.0287	225238.0	0.74	0.055	0.86	460682.9	889	-84
367.6	780241.2	479986.2	1831.6	345.7	271524.3	459155.1	2000	0.0824	5.966	2.87	1249	20831.07	0.0251	225595.5	0.73	0.060	0.87	466467.5	1114	-135
367.6	778529.1	479951.1	1831.6	345.8	272895.4	459261.4	2000	0.0821	5.929	2.85	1241	20689.65	0.0251	226152.9	0.73	0.060	0.87	466580.1	1098	-143
367.7	778819.8	480018.4	1831.7	345.9	271858.5	459241.8	2000	0.0823	5.925	2.86	1240	20776.62	0.0251	226370.2	0.73	0.059	0.87	466640.5	1101	-139
366.7	773474.7	479052.8	1829.5	344.6	253718.4	457123.3	2000	0.0823	6.142	3.05	1286	21929.57	0.0252	226498.7	0.71	0.062	0.87	465707.2	1098	-188
367.7	776783.2	480117.5	1832.2	345.2	255430.6	458154.1	2000	0.0824	6.181	3.04	1294	21963.39	0.0252	226420.9	0.72	0.062	0.87	466305.6	1138	-156
367.6	772635.7	480103.7	1832.4	345.3	256415.5	458313.2	2000	0.0817	6.123	3.01	1282	21790.49	0.0254	226398.9	0.72	0.062	0.87	466350.1	1123	-159
367.7	762625.9	480398.2	1833.9	344.1	227857.5	456495.8	2000	0.0808	6.446	3.35	1349	23902.32	0.0258	226202.7	0.70	0.066	0.88	465739.9	1185	-164
367.6	763687.8	480232.3	1833.4	344.0	227921.4	456325.6	2000	0.0812	6.455	3.35	1351	23906.75	0.0257	225933.5	0.70	0.065	0.88	465623.7	1186	-166
367.7	766956.6	480277.3	1833.3	344.1	227460.0	456250.5	2000	0.0817	6.500	3.37	1361	24026.82	0.0256	225779.3	0.69	0.065	0.88	465668.1	1193	-168
367.8	802244.7	479698.0	1829.3	344.0	233394.3	455430.0	2000	0.0869	6.871	3.44	1438	24268.00	0.0243	225753.8	0.68	0.065	0.89	465472.1	1236	-202
367.2	801678.2	479122.0	1827.8	343.6	233141.0	454898.7	2000	0.0866	6.872	3.44	1439	24223.25	0.0242	225887.2	0.69	0.066	0.88	465158.0	1210	-229
367.7	803369.3	479580.3	1828.9	344.0	233818.7	455333.9	2000	0.0868	6.895	3.44	1443	24246.32	0.0242	225985.8	0.69	0.066	0.88	465489.5	1223	-221
372.7	813763.9	484931.7	1842.7	348.3	231795.4	459788.8	2000	0.0857	7.100	3.51	1486	25142.91	0.0244	225906.1	0.69	0.067	0.88	469781.0	1299	-188
372.2	847994.6	483830.7	1837.5	348.0	238175.9	458590.9	2000	0.0912	7.425	3.56	1554	25239.85	0.0232	225802.1	0.68	0.066	0.89	469348.6	1321	-233
371.4	840613.0	483000.0	1835.8	347.5	239075.0	458068.2	2000	0.0897	7.333	3.50	1535	24931.73	0.0233	225962.2	0.69	0.067	0.88	468854.7	1269	-266
372.5	851030.1	484022.1	1837.9	348.3	240475.2	458890.4	2000	0.0911	7.456	3.54	1561	25131.72	0.0231	226084.1	0.68	0.066	0.89	469631.3	1311	-250
372.5	878099.2	483530.4	1834.9	347.1	219018.0	456053.1	2000	0.0951	8.091	4.01	1694	27477.34	0.0222	225920.7	0.65	0.069	0.89	468840.9	1397	-296
372.7	875720.6	483861.8	1835.9	347.4	220125.8	456497.1	2000	0.0949	8.062	3.98	1688	27364.76	0.0223	225760.8	0.65	0.069	0.89	469091.5	1401	-286
372.7	844293.1	484416.7	1839.3	347.4	197239.6	455477.6	2500	0.1061	7.409	4.28	1939	28939.09	0.0234	224370.4	0.63	0.070	0.84	469464.8	1587	-352
373.0	844518.2	484721.2	1840.1	347.7	198494.3	455869.8	2500	0.1061	7.393	4.26	1935	28851.37	0.0234	224370.5	0.63	0.070	0.84	469737.7	1589	-345
372.7	820812.3	484853.7	1842.0	347.6	194540.9	456095.6	2500	0.1022	7.156	4.22	1873	28758.04	0.0242	224344.4	0.64	0.070	0.83	469716.8	1547	-326
372.8	773164.3	485859.2	1847.9	347.9	188956.2	457490.3	2500	0.0937	6.657	4.09	1742	28368.85	0.0260	224320.6	0.66	0.071	0.82	470107.5	1475	-267
373.2	777035.3	486225.0	1848.6	348.2	188962.8	457729.5	2500	0.0949	6.698	4.11	1753	28495.49	0.0258	224320.1	0.65	0.071	0.83	470424.2	1499	-254
369.2	710540.4	482956.1	1844.7	345.0	183432.8	455814.0	2500	0.0863	5.947	3.87	1556	27142.12	0.0282	224256.5	0.66	0.070	0.82	467376.4	1345	-211
367.7	681374.2	481882.7	1844.0	344.1	181068.9	455346.9	2500	0.0823	5.609	3.76	1468	26535.88	0.0294	224237.1	0.67	0.069	0.82	466565.3	1261	-207

T_su	P_su	h_su	s_su	T_ex	P_ex	h_ex_s	RPM	m_dot_wf	Torque	Press.Ratio	W_shaft	deltaH	Spec.Vol.Suc.	h_evap_in	Eff_s	BTE	Eff_v	h_ex	H_dot	Q_dot_loss
[K]	[Pa]	[J/kg]	[J/kgK]	[K]	[Pa]	[J/kg]		[kg/s]	[Nm]	[Pa]	[W]	[J/kg]	[m3/kg]	[J/kg]				[J/kg]	[W]	[W]
366.6	680698.1	480682.1	1840.8	342.9	181070.1	454279.5	2500	0.0825	5.592	3.76	1463	26402.61	0.0293	224198.9	0.67	0.069	0.81	465403.9	1261	-202
366.7	685960.6	480749.2	1840.6	343.4	190229.1	455171.4	2500	0.0835	5.516	3.61	1443	25577.80	0.0291	224163.4	0.68	0.067	0.82	465666.1	1259	-184
366.6	686429.8	480630.6	1840.2	343.3	191431.9	455175.5	2500	0.0837	5.502	3.59	1440	25455.09	0.0290	224114.1	0.68	0.067	0.82	465621.0	1257	-183
366.6	688771.5	480507.1	1839.7	344.5	216060.1	457386.5	2500	0.0838	5.152	3.19	1348	23120.69	0.0289	224108.5	0.70	0.063	0.82	466272.6	1193	-155
366.7	689886.3	480647.0	1840.0	344.9	223418.7	458146.7	2500	0.0840	5.105	3.09	1336	22500.24	0.0289	224151.7	0.71	0.062	0.82	466589.0	1181	-155
365.6	667282.3	479893.8	1839.7	345.3	242703.1	459702.9	2500	0.0817	4.505	2.75	1179	20190.95	0.0299	224193.1	0.71	0.056	0.82	466599.0	1087	-92
365.8	666327.7	480033.4	1840.2	345.4	241772.5	459782.2	2500	0.0825	4.500	2.76	1178	20251.18	0.0299	224291.8	0.70	0.056	0.83	466682.7	1101	-76
364.5	636229.7	479219.6	1840.5	345.1	245253.8	460166.3	2500	0.0763	4.068	2.59	1064	19053.37	0.0314	224307.1	0.73	0.055	0.81	466336.0	983	-81
363.8	633469.0	478488.8	1838.7	344.2	245106.6	459555.6	2500	0.0761	4.047	2.58	1059	18933.15	0.0314	224302.9	0.74	0.055	0.81	465462.8	991	-68
375.2	821872.7	487600.9	1849.3	350.9	201226.2	459205.3	3000	0.1152	6.543	4.08	2055	28395.60	0.0244	224180.7	0.63	0.068	0.79	472806.5	1705	-350
375.2	816632.0	487765.5	1850.1	350.9	197819.6	459127.9	3000	0.1144	6.516	4.13	2046	28637.55	0.0246	224147.1	0.62	0.068	0.79	472902.4	1700	-346
375.4	771346.2	488704.7	1855.6	350.8	191255.1	460332.8	3000	0.1042	6.078	4.03	1908	28371.84	0.0263	224120.5	0.65	0.069	0.77	472897.5	1647	-262
375.0	760537.9	488480.6	1855.8	351.0	190159.1	460273.9	3000	0.1039	5.974	4.00	1876	28206.70	0.0267	224061.4	0.64	0.068	0.78	473142.3	1593	-283
369.8	701601.4	483774.8	1847.6	346.4	184626.4	456911.0	3000	0.0965	5.342	3.80	1677	26863.81	0.0287	223970.5	0.65	0.067	0.78	468713.3	1453	-224
369.3	698972.5	483327.7	1846.6	346.2	184289.3	456539.0	3000	0.0966	5.288	3.79	1661	26788.76	0.0287	223984.9	0.64	0.066	0.78	468531.8	1429	-232
368.5	680853.0	482763.9	1846.5	345.9	186541.6	456747.0	3000	0.0937	5.045	3.65	1584	26016.87	0.0295	223966.6	0.65	0.065	0.78	468218.1	1363	-221
368.0	676911.3	482231.0	1845.3	345.2	186381.8	456352.7	3000	0.0930	4.991	3.63	1567	25878.30	0.0297	223983.9	0.65	0.065	0.77	467542.6	1365	-202
367.3	656255.3	481871.4	1846.0	345.4	194495.0	457435.7	3000	0.0898	4.634	3.37	1455	24435.66	0.0307	223990.4	0.66	0.063	0.77	467578.3	1284	-171
365.7	650310.5	480240.7	1842.1	344.2	194308.9	456096.0	3000	0.0899	4.556	3.35	1431	24144.64	0.0308	223982.6	0.66	0.062	0.78	466409.6	1243	-187
366.8	650889.8	481400.6	1845.2	344.8	193491.7	457054.4	3000	0.0891	4.577	3.36	1437	24346.18	0.0309	223964.2	0.66	0.063	0.77	466955.7	1287	-150
365.7	633436.5	480553.1	1844.4	344.7	202193.7	457650.1	3000	0.0866	4.233	3.13	1329	22903.01	0.0317	223963.7	0.67	0.060	0.77	466743.4	1196	-134
364.8	632663.9	479671.9	1842.0	343.9	205048.6	457141.6	3000	0.0867	4.196	3.09	1318	22530.27	0.0316	223995.4	0.67	0.059	0.77	465924.5	1193	-125
363.8	599817.2	479167.9	1843.6	344.1	210833.0	458212.4	3000	0.0814	3.722	2.85	1169	20955.51	0.0335	223922.5	0.68	0.056	0.77	466017.8	1071	-98
363.6	606188.6	478845.6	1842.1	343.8	213905.3	458005.5	3000	0.0826	3.772	2.83	1184	20840.12	0.0331	223890.0	0.69	0.056	0.77	465638.7	1091	-94
363.5	608884.2	478701.2	1841.5	343.7	215944.2	457977.7	3000	0.0829	3.759	2.82	1180	20723.47	0.0329	223903.3	0.69	0.056	0.77	465523.4	1093	-87
363.5	603203.1	478753.5	1842.1	345.5	240763.7	460358.0	3000	0.0818	3.221	2.51	1011	18395.52	0.0332	223889.7	0.67	0.049	0.76	466835.8	975	-37
363.7	608051.8	478898.5	1842.1	346.0	250052.1	461096.2	3000	0.0830	3.197	2.43	1004	17802.26	0.0329	223991.1	0.68	0.047	0.77	467203.6	970	-33
363.5	611915.3	478605.7	1840.9	345.9	251991.1	460857.8	3000	0.0837	3.237	2.43	1017	17747.89	0.0327	224068.1	0.68	0.048	0.77	467007.7	971	-46
376.6	852412.7	488624.4	1850.1	352.6	205103.7	459848.0	3500	0.1314	6.280	4.16	2301	28776.40	0.0235	224071.0	0.61	0.066	0.74	474488.5	1858	-443
376.8	847522.8	488985.6	1851.3	352.9	202007.7	459971.4	3500	0.1310	6.275	4.20	2299	29014.14	0.0237	223910.0	0.60	0.066	0.75	474790.7	1860	-439
377.2	843349.3	489449.1	1852.8	353.4	206343.8	460901.4	3500	0.1299	6.165	4.09	2259	28547.72	0.0239	223776.9	0.61	0.065	0.75	475193.0	1853	-406
376.5	849290.4	488554.0	1850.1	352.5	207749.8	460106.8	3500	0.1300	6.219	4.09	2278	28447.19	0.0236	223790.3	0.62	0.066	0.74	474278.5	1856	-422

T_su	P_su	h_su	s_su	T_ex	P_ex	h_ex_s	RPM	m_dot_wf	Torque	Press.Ratio	W_shaft	deltaH	Spec.Vol.Suc.	h_evap_in	Eff_s	BTE	Eff_v	h_ex	H_dot	Q_dot_loss
[K]	[Pa]	[J/kg]	[J/kgK]	[K]	[Pa]	[J/kg]		[kg/s]	[Nm]	[Pa]	[W]	[J/kg]	[m3/kg]	[J/kg]				[J/kg]	[W]	[W]
371.3	822520.0	483254.8	1837.6	348.3	206420.9	455792.8	3500	0.1302	5.918	3.98	2168	27462.02	0.0239	223761.5	0.61	0.064	0.75	470231.0	1696	-473
372.3	826255.1	484354.4	1840.3	349.0	208028.4	456853.1	3500	0.1298	5.978	3.97	2190	27501.27	0.0239	223773.6	0.61	0.065	0.75	470903.7	1745	-444
372.5	826307.0	484558.4	1840.9	349.5	215324.4	457716.4	3500	0.1299	5.883	3.84	2155	26841.97	0.0239	223816.8	0.62	0.064	0.75	471180.9	1738	-417
372.9	825583.1	485028.1	1842.2	350.2	223335.4	458879.2	3500	0.1300	5.769	3.70	2113	26148.97	0.0240	223948.5	0.62	0.062	0.75	471780.4	1722	-391
372.9	817832.5	485080.9	1842.8	350.2	223024.3	459068.5	3500	0.1278	5.682	3.67	2081	26012.47	0.0243	224152.0	0.63	0.062	0.75	471793.8	1698	-383
373.1	815875.1	485381.2	1843.8	350.5	222243.9	459313.5	3500	0.1280	5.678	3.67	2080	26067.69	0.0244	224141.5	0.62	0.062	0.75	472066.0	1704	-376
373.0	813497.8	485304.2	1843.7	350.4	222696.3	459336.8	3500	0.1272	5.644	3.65	2068	25967.45	0.0245	224127.6	0.63	0.062	0.75	471951.1	1698	-369
373.4	816445.9	485751.9	1844.7	351.0	228894.9	460222.8	3500	0.1275	5.602	3.57	2052	25529.01	0.0244	224140.4	0.63	0.062	0.75	472475.0	1693	-359
373.1	809738.7	485475.6	1844.4	350.9	230065.2	460222.9	3500	0.1264	5.504	3.52	2016	25252.79	0.0246	224248.5	0.63	0.061	0.75	472352.1	1658	-358
372.7	811212.5	484980.4	1843.0	350.6	230673.8	459793.2	3500	0.1269	5.509	3.52	2018	25187.18	0.0245	224288.9	0.63	0.061	0.75	472032.1	1644	-374
372.4	814817.4	484600.0	1841.7	350.1	230239.9	459331.0	3500	0.1272	5.570	3.54	2040	25268.99	0.0243	224307.4	0.63	0.062	0.75	471605.9	1653	-388
373.0	808327.5	485380.6	1844.2	350.9	230518.1	460207.2	3500	0.1261	5.508	3.51	2018	25173.33	0.0246	224313.5	0.64	0.061	0.75	472301.3	1650	-368
372.5	802235.8	484921.3	1843.4	350.3	228112.5	459718.5	3500	0.1252	5.461	3.52	2001	25202.81	0.0248	224290.8	0.63	0.061	0.75	471835.8	1638	-362
372.7	803931.7	485111.9	1843.8	350.6	228901.3	459921.9	3500	0.1252	5.482	3.51	2008	25189.96	0.0248	224271.1	0.64	0.061	0.75	472078.9	1632	-376
372.8	792690.3	485452.0	1845.5	350.7	224952.2	460139.1	3500	0.1230	5.401	3.52	1979	25312.88	0.0252	224215.1	0.64	0.062	0.75	472240.3	1625	-354
372.8	795104.0	485375.8	1845.1	350.5	225910.5	460099.5	3500	0.1230	5.424	3.52	1987	25276.29	0.0251	224148.2	0.64	0.062	0.74	471997.8	1645	-342
373.0	776548.5	485944.5	1847.9	350.9	222133.1	460708.8	3500	0.1196	5.277	3.50	1933	25235.66	0.0258	224107.4	0.64	0.062	0.74	472487.0	1610	-323
373.3	766409.5	486515.8	1850.1	351.1	219323.6	461213.7	3500	0.1172	5.217	3.49	1911	25302.14	0.0263	224029.4	0.64	0.062	0.74	472761.8	1612	-299
372.2	747522.3	485627.5	1849.1	350.3	215582.3	460518.8	3500	0.1146	5.057	3.47	1853	25108.74	0.0269	223898.3	0.64	0.062	0.74	472044.7	1556	-297
371.0	744126.1	484305.9	1845.8	349.6	226585.4	460390.9	3500	0.1142	4.830	3.28	1769	23914.93	0.0269	223843.5	0.65	0.059	0.74	471116.3	1506	-263
370.8	739714.4	484209.1	1845.9	349.6	226230.0	460380.0	3500	0.1140	4.803	3.27	1760	23829.03	0.0271	223989.1	0.65	0.059	0.74	471152.1	1488	-271
371.0	726880.7	484686.0	1848.1	351.0	246837.7	462881.5	3500	0.1104	4.366	2.94	1599	21804.44	0.0277	224038.5	0.66	0.056	0.74	472129.4	1387	-213
371.2	722935.2	484986.0	1849.2	351.3	247593.3	463320.1	3500	0.1100	4.306	2.92	1578	21665.93	0.0279	224281.7	0.66	0.055	0.74	472473.5	1376	-201
370.2	708915.3	484156.8	1848.0	350.7	244296.7	462650.7	3500	0.1076	4.213	2.90	1543	21506.12	0.0284	224339.5	0.67	0.055	0.74	471863.6	1323	-220
369.3	702806.3	483252.5	1846.0	349.7	242575.5	461836.1	3500	0.1072	4.112	2.90	1506	21416.44	0.0286	224269.7	0.66	0.054	0.74	470959.7	1318	-189
369.8	706039.4	483750.1	1847.1	351.9	279309.4	465036.0	3500	0.1075	3.620	2.53	1326	18714.15	0.0285	224258.4	0.66	0.048	0.74	472466.1	1213	-114
369.6	704542.9	483480.6	1846.5	351.9	279043.8	464805.6	3500	0.1074	3.588	2.52	1314	18675.00	0.0285	224591.3	0.66	0.047	0.74	472499.9	1179	-135
369.5	702395.6	483464.1	1846.7	351.4	268786.5	464096.1	3500	0.1071	3.718	2.61	1362	19367.98	0.0286	224754.2	0.66	0.049	0.74	472137.5	1213	-149
369.5	702908.1	483494.8	1846.7	351.0	262440.0	463632.0	3500	0.1072	3.822	2.68	1400	19862.72	0.0286	224700.9	0.66	0.050	0.74	471860.1	1247	-153
373.1	895285.2	483910.3	1834.9	347.7	172251.4	451358.5	3500	0.1424	7.014	5.20	2570	32551.88	0.0218	221366.5	0.55	0.069	0.75	470230.6	1949	-621
373.3	898880.5	484057.3	1835.1	347.9	172237.3	451417.3	3500	0.1425	7.057	5.22	2585	32639.96	0.0217	221292.4	0.56	0.069	0.74	470366.0	1951	-634
373.2	897332.9	483941.2	1834.9	347.8	170999.3	451204.4	3500	0.1426	7.063	5.25	2587	32736.75	0.0217	221249.4	0.55	0.069	0.75	470296.0	1945	-642

T_su	P_su	h_su	s_su	T_ex	P_ex	h_ex_s	RPM	m_dot_wf	Torque	Press.Ratio	W_shaft	deltaH	Spec.Vol.Suc.	h_evap_in	Eff_s	BTE	Eff_v	h_ex	H_dot	Q_dot_loss
[K]	[Pa]	[J/kg]	[J/kgK]	[K]	[Pa]	[J/kg]		[kg/s]	[Nm]	[Pa]	[W]	[J/kg]	[m3/kg]	[J/kg]				[J/kg]	[W]	[W]
372.9	901875.0	483549.6	1833.6	347.5	172352.4	450927.1	3500	0.1437	7.075	5.23	2592	32622.44	0.0216	221204.9	0.55	0.069	0.75	470038.7	1941	-651
372.9	908175.1	483448.3	1832.9	347.5	173709.4	450871.6	3500	0.1447	7.133	5.23	2613	32576.71	0.0214	221184.9	0.55	0.069	0.75	469976.4	1950	-663
373.0	930905.1	483106.9	1830.7	347.7	183395.1	451203.8	3500	0.1514	7.253	5.08	2657	31903.16	0.0208	221192.1	0.55	0.067	0.76	469997.7	1985	-672
373.1	923407.1	483420.0	1832.0	348.0	182427.7	451514.3	3500	0.1495	7.188	5.06	2633	31905.71	0.0210	221523.6	0.55	0.067	0.76	470276.7	1964	-669
373.5	932966.5	483699.1	1832.2	348.5	188473.2	452218.5	3500	0.1522	7.214	4.95	2643	31480.60	0.0208	221509.8	0.55	0.066	0.76	470690.7	1980	-663
373.2	939066.1	483224.0	1830.6	348.4	197129.9	452561.7	3500	0.1527	7.202	4.76	2638	30662.28	0.0206	221905.2	0.56	0.066	0.76	470413.9	1956	-682
373.5	935276.6	483641.4	1831.9	348.7	197795.2	453065.5	3500	0.1515	7.162	4.73	2624	30575.85	0.0207	222264.3	0.57	0.066	0.76	470726.5	1957	-667
373.2	938671.4	483172.3	1830.5	348.6	206251.7	453403.9	3500	0.1527	7.104	4.55	2602	29768.47	0.0206	222482.5	0.57	0.065	0.76	470505.4	1934	-669
372.8	939440.7	482755.8	1829.3	348.4	210790.3	453444.1	3500	0.1529	7.076	4.46	2592	29311.71	0.0205	223003.4	0.58	0.065	0.76	470245.6	1913	-679
373.2	937318.5	483252.0	1830.8	348.8	212119.6	454046.3	3500	0.1515	7.051	4.42	2583	29205.74	0.0206	223334.5	0.58	0.066	0.75	470608.6	1916	-667
373.5	940866.2	483439.8	1831.1	349.1	216611.6	454557.4	3500	0.1527	7.044	4.34	2580	28882.35	0.0205	223467.2	0.59	0.065	0.75	470833.6	1925	-655
372.5	858113.5	483991.5	1837.3	348.2	163529.7	451148.1	4000	0.1487	6.170	5.25	2583	32843.40	0.0229	220326.3	0.53	0.066	0.72	470827.2	1958	-625
372.7	867491.5	484034.6	1836.9	348.3	163401.5	450983.2	4000	0.1514	6.259	5.31	2620	33051.41	0.0226	220311.3	0.52	0.066	0.72	470949.3	1981	-640
372.3	867735.1	483501.8	1835.4	347.8	163494.2	450521.3	4000	0.1507	6.263	5.31	2622	32980.49	0.0225	220335.8	0.53	0.066	0.72	470406.8	1973	-648
372.5	873593.5	483695.6	1835.6	348.0	163136.6	450533.4	4000	0.1516	6.312	5.36	2643	33162.26	0.0224	220296.7	0.53	0.066	0.71	470637.7	1979	-664
372.4	876951.4	483521.3	1834.9	348.0	164186.0	450439.1	4000	0.1531	6.339	5.34	2654	33082.20	0.0223	220307.0	0.52	0.066	0.72	470597.8	1979	-675
372.5	876693.8	483640.6	1835.3	348.0	164897.6	450632.9	4000	0.1529	6.342	5.32	2655	33007.67	0.0223	220304.5	0.53	0.066	0.72	470637.6	1989	-666
372.5	878654.2	483499.7	1834.8	347.9	164688.0	450446.2	4000	0.1531	6.357	5.34	2662	33053.52	0.0222	220330.3	0.53	0.066	0.72	470539.5	1984	-678
372.8	876072.0	483968.4	1836.2	348.4	166779.5	451153.9	4000	0.1514	6.314	5.25	2644	32814.50	0.0223	220334.5	0.53	0.066	0.71	470950.7	1971	-672
372.6	879885.5	483658.9	1835.1	348.3	169204.6	451088.0	4000	0.1529	6.319	5.20	2646	32570.91	0.0222	220325.4	0.53	0.066	0.72	470800.1	1966	-680
372.2	898997.6	482811.1	1831.7	347.8	175521.7	450686.2	4000	0.1580	6.411	5.12	2684	32124.89	0.0216	220366.9	0.53	0.065	0.72	470191.6	1994	-690
372.7	865232.8	483997.6	1836.9	348.7	173265.8	452138.3	4000	0.1499	6.130	4.99	2566	31859.35	0.0227	220450.8	0.54	0.065	0.72	471116.4	1930	-636
372.3	875358.6	483343.2	1834.6	347.9	173636.9	451401.9	4000	0.1515	6.216	5.04	2603	31941.37	0.0223	220418.6	0.54	0.065	0.71	470377.6	1964	-639
373.3	877062.0	484437.2	1837.4	349.4	180561.2	453097.1	4000	0.1537	6.195	4.86	2594	31340.06	0.0224	220441.7	0.54	0.064	0.72	471671.2	1962	-632
372.7	874857.4	483865.5	1836.0	348.9	181290.7	452713.9	4000	0.1530	6.157	4.83	2578	31151.63	0.0224	220611.6	0.54	0.064	0.72	471243.4	1931	-646
373.3	870674.9	484613.6	1838.3	349.5	180377.8	453360.2	4000	0.1517	6.144	4.83	2572	31253.34	0.0226	220668.4	0.54	0.064	0.72	471778.6	1947	-625
373.3	863441.2	484711.7	1839.0	349.4	178854.9	453426.3	4000	0.1495	6.073	4.83	2543	31285.46	0.0228	220655.2	0.54	0.064	0.72	471752.8	1937	-606
372.5	868626.3	483793.7	1836.2	348.8	181371.9	452782.9	4000	0.1517	6.096	4.79	2552	31010.77	0.0225	220611.5	0.54	0.064	0.72	471146.4	1919	-633
373.0	866534.7	484317.4	1837.7	349.4	185606.8	453740.4	4000	0.1510	6.035	4.67	2527	30577.00	0.0227	220675.8	0.55	0.063	0.72	471649.5	1913	-613
373.1	871224.6	484340.2	1837.5	349.6	189649.1	454088.7	4000	0.1522	6.039	4.59	2528	30251.49	0.0225	220757.3	0.55	0.063	0.72	471713.7	1922	-607
372.9	865442.4	484245.1	1837.6	349.5	189007.1	454053.9	4000	0.1508	5.995	4.58	2510	30191.22	0.0227	220956.2	0.55	0.063	0.72	471677.7	1895	-615
373.5	866043.2	484874.6	1839.2	350.2	195584.0	455273.3	4000	0.1502	5.946	4.43	2489	29601.35	0.0227	221013.1	0.56	0.063	0.72	472232.0	1899	-590