Use Case

Compressor Performance Monitoring & Efficiency Prediction

(using Physics based Models)

Compressor performance monitoring & Efficiency Prediction using Physics based Models

Pilot Guided Analytics

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Problem Objective

- To analyze & Monitor the trends of measured signals
  - Condition Monitoring in near-real time
- To predict the Efficiency, Head and Power of the Compressor
- Performance Curve analysis for validation of the model

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Collected Data

- Compressor Manufacturing Data (Performance Maps)
  - Suction and discharge Pressure
  - Suction and discharge Temperature
  - Suction and discharge Flow Rate
- Historic and Live Compressor Data
  - 4 months worth data
- Sample frequency- 1 hour

Time	Suction			Discharge		Gas MW	Speed	Inlet steam			Exhaust steam	
	Press	Temp	Flow	Press	Temp			Press	Temp	Flow	Press	Temp
	bara	C	t/d	barg	C		rpm	barg	C	kg/h	barg	C
01-05-20 00:00:00	184.1763611	41.02483368	1786.817871	200.7230682	50.86456299	3.106985569	10939.93359	43.44106293	344.4839783	23.30888557	4.004976749	161.3882751
01-05-20 01:00:00	184.1342468	41.06996918	1775.080322	200.6859436	51.01315689	3.093738556	10938.98633	43.28238297	344.4839783	23.30601311	4.020554543	161.6551971
01-05-20 02:00:00	184.1660156	41.25017548	1788.919434	200.6357269	51.10482407	3.083550215	10937.6875	43.78447723	344.2866211	23.18753815	4.025369644	160.8624725
01-05-20 03:00:00	184.0799103	41.29583359	1798.895874	200.5262299	51.10482407	3.095892429	10941.89551	43.35646057	344.0655518	23.41646576	4.016423225	161.2881775
01-05-20 04:00:00	184.233963	40.84972	1793.39856	200.6821747	50.76903534	3.097402096	10941.49805	43.31080246	344.4839783	23.40904808	4.023211956	161.7704163
01-05-20 05:00:00	184.1652985	39.18424988	1784.101318	200.5756836	49.09011078	3.056933403	10930.90918	44.02579117	344.4839783	22.98506737	4.010633945	160.7330475
01-05-20 06:00:00	184.0116119	39.87890244	1786.031006	200.5763397	49.75878525	3.107517481	10970.30859	43.24895859	344.4997559	23.39672279	4.002766609	161.7469177
01-05-20 07:00:00	184.0717468	41.24313354	1781.463989	200.6524048	51.10482407	3.113248348	10945.72852	43.53514099	344.4839783	23.27212334	4.018791199	161.0949554
01-05-20 08:00:00	184.0775604	41.92720795	1786.932129	200.7063446	51.85744476	3.109447002	10943.50781	43.24277496	344.4839783	23.41936493	4.011700153	161.5111084
01-05-20 09:00:00	184.155426	41.78944397	1783.152222	200.7326813	51.69823456	3.092677832	10933.65039	43.62132263	344.2866211	23.25661087	4.021304131	160.7077789
01-05-20 10:00:00	184.0974121	42.19130707	1775.550659	200.7368927	52.20191193	3.085113525	10924.56543	43.81132126	344.0497742	23.12077713	4.011844635	160.6773376
01-05-20 11:00:00	184.0850372	42.28646469	1778.597412	200.7732697	52.2771759	3.078355551	10941.83594	43.19317245	343.8208313	23.47943687	4.018475533	161.4257202
01-05-20 12:00:00	184.0554352	42.16332626	1775.866333	200.8227692	52.20480728	3.114395857	10944.55957	43.40764618	344.0497742	23.33466911	4.005450249	160.7830811
01-05-20 13:00:00	183.8661804	42.76148605	1775.838501	200.5749207	52.8647995	3.125636578	10931.33203	43.68711472	344.0497742	23.32213593	4.021449089	160.4767761
01-05-20 14:00:00	184.0708466	42.86792374	1768.439087	200.8459473	52.95164108	3.078885794	10931.20801	44.03565979	344.2708435	23.12755394	4.018712044	160.4392548
01-05-20 15:00:00	184.0236816	42.90969849	1774.580078	200.8625031	52.95743179	3.047352314	10941.93555	43.62895584	344.0576782	23.36078644	4.0073452	160.5989532
01-05-20 16:00:00	184.1719818	42.33516693	1769.109985	200.9896393	52.36401749	3.078888178	10932.70801	43.57553482	343.8129272	23.37037659	4.02289629	160.3438416
01-05-20 17:00:00	183.9823151	41.83950424	1770.497437	200.7794952	51.93849564	3.09994626	10947.78809	43.46580124	344.0497742	23.41637039	4.005450249	161.0270386
01-05-20 18:00:00	184.1758423	41.53789902	1775.579834	200.9417419	51.52455521	3.09994626	10935.75098	43.21685791	343.8129272	23.46843719	4.013449669	160.843338
01-05-20 19:00:00	184.1508331	42.0490036	1774.635498	200.9368134	52.19322968	3.105985165	10949.85645	43.31211853	343.8129272	23.44098282	4.007950306	160.8426819
01-05-20 20:00:00	184.2319489	41.7734642	1771.380615	201.0662689	51.78507614	3.105863333	10944.77148	43.94789505	344.0497742	23.24364281	4.005213737	160.3659668
01-05-20 21:00:00	184.2309418	41.75399399	1776.185425	201.0103149	51.78507614	3.105828524	10945.6709	43.76395035	344.0497742	23.31272888	4.010160446	160.7631836
01-05-20 22:00:00	184.3801727	41.41026306	1773.904175	201.2193451	51.43771362	3.097032547	10953.25293	43.90829086	344.2866211	23.29892921	4.002766609	160.6630707
01-05-20 23:00:00	184.2296753	41.46975708	1771.693481	201.0576324	51.52455521	3.110551834	10940.125	43.35041046	343.8208313	23.39683151	4.009634018	160.6452789
02-05-20 00:00:00	184.3381348	41.31969452	1776.400146	201.0949554	51.43304443	3.116996765	10933.93457	43.67395401	343.5761108	23.364048	4.023448467	160.1975098
02-05-20 01:00:00	184.0727539	41.54570007	1769.555908	200.8531036	51.52455521	3.109837055	10931.82617	43.34738159	343.3326721	23.42022705	4.016120434	160.1800537

Compressor Data in excel format

$$k = [1.46 - 0.16(\gamma - 0.55)](1 - 0.067\gamma - AT) \quad (3)$$

Where:

T = Temperature, K (°R)

γ = Gas relative density; ratio of gas molecular weight to air molecular weight

A = 0.000272 (0.000151)

The actual discharge temperature based on an isentropic path can be estimated by

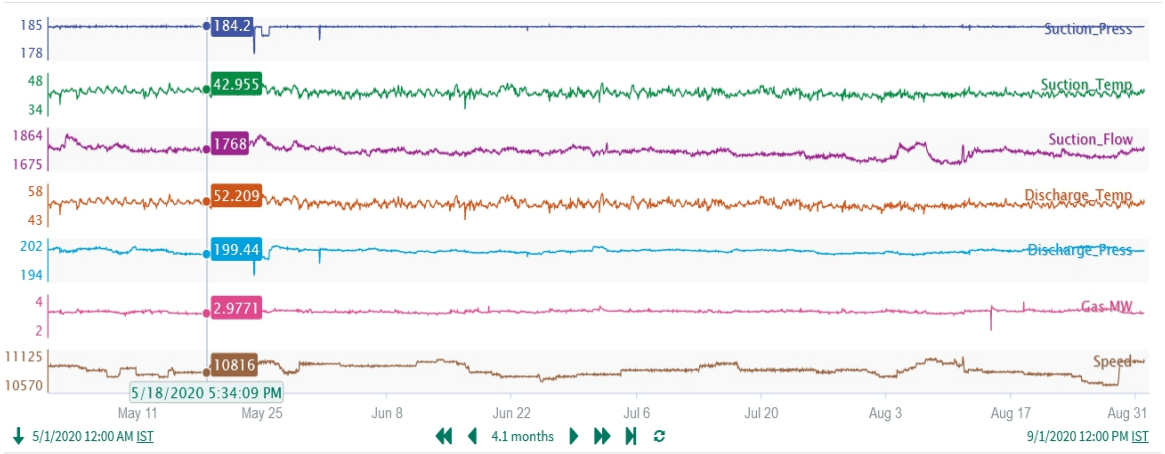
$$T_2 = T_1 \left[1 + \frac{\left(\frac{P_2}{P_1}\right)^{\left(\frac{k-1}{k}\right)} - 1}{\eta_{Isen}} \right] \quad (4)$$

Solving for the isentropic efficiency,

$$\eta_{Isen} = \frac{T_1}{T_2 - T_1} \left[\left(\frac{P_2}{P_1}\right)^{\left(\frac{k-1}{k}\right)} - 1 \right] \quad (5)$$

Similarly, the actual discharge temperature based on a polytropic path can be estimated by

Physics based Modeling equations from literature



Visualization of all the mesured variables

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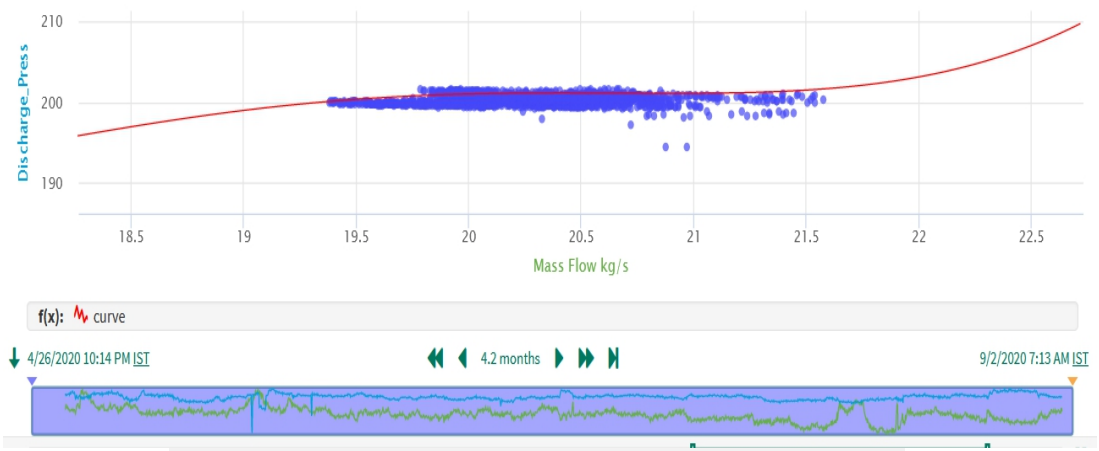
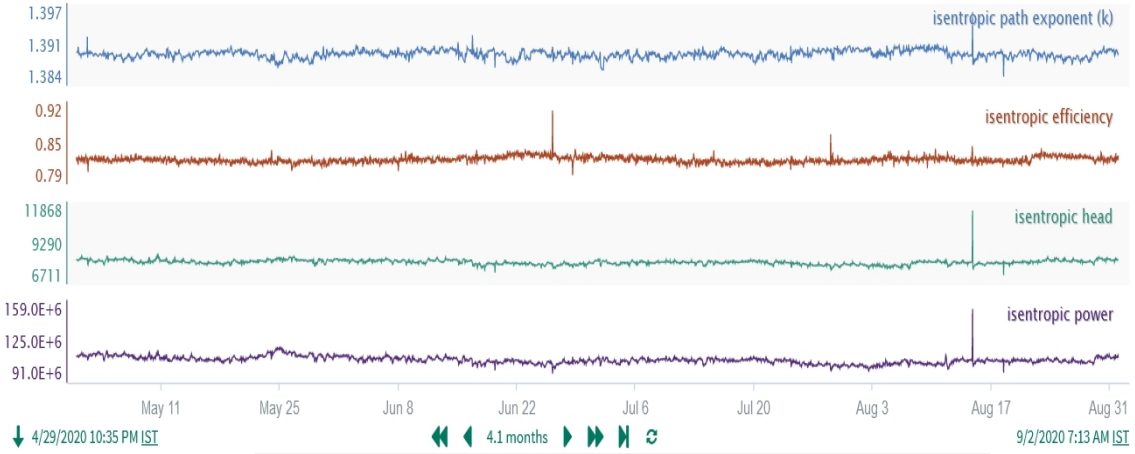
Prediction of Compressor Efficiency

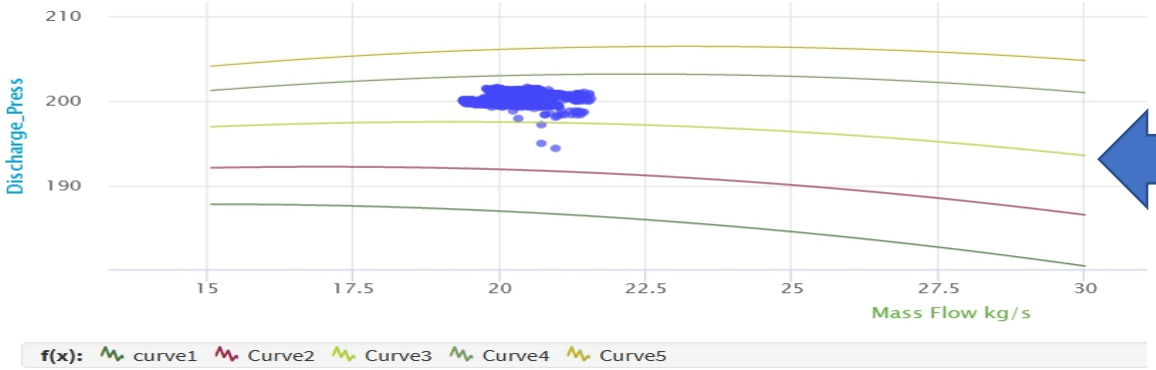
We predicted Compressor efficiency, head and Compressor power for isentropic and Polytropic conditions using the formulas that we got from literature



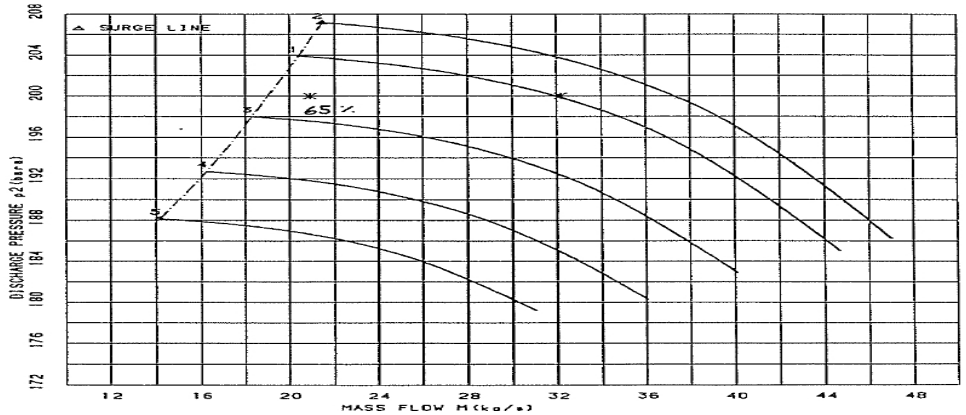
Curve fitting in data



Derived Signals



Performance Curve Analysis to validate Compressor efficiency



Theoretical Performance Curve