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Use Case

Debutanizer Column (Distillation Column) monitoring

Debutanizer Column (Distillation Column) monitoring– Extension Module

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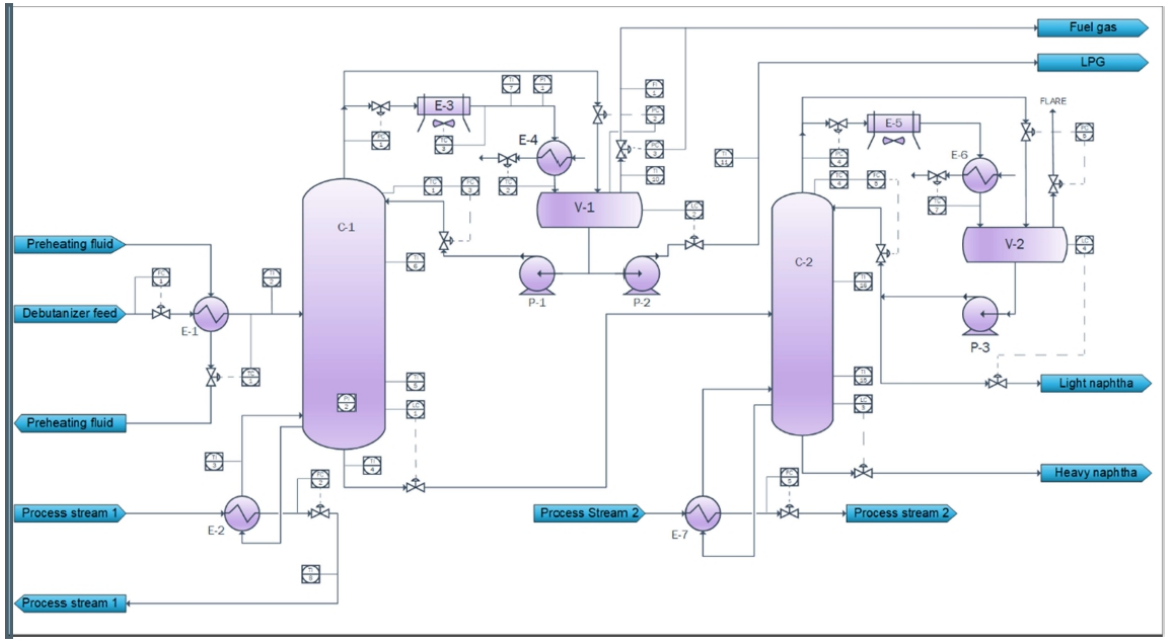
Challenges

- Gas Chromatograph is used to continuously monitor the C4 content in the bottoms.
- Higher content of C4-frac in bottoms can lead to a lower quality of LPG product.
- Gas chromatograph is often off due to maintenance, due to which the challenges in monitoring the product quality arises.

Objectives

- Maximizing the LPG content in the top product
- Continuous monitoring of C4 fraction in the bottom products
- Predictive model for estimating the Butane fraction in the bottoms, for better performance



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Advanced Statistics:

- Calculate and monitor the average, standard deviation of C4-fraction on hourly basis

Correlation Matrix:

- Flow Controller(FC2) and Level Controller(LC1) seems to be highly correlated

PCA analysis:

- FC3 & TC3 seems to be the important parameters for process variability analysis & C4 Total fraction in the bottoms

Heat Map/Covariance:

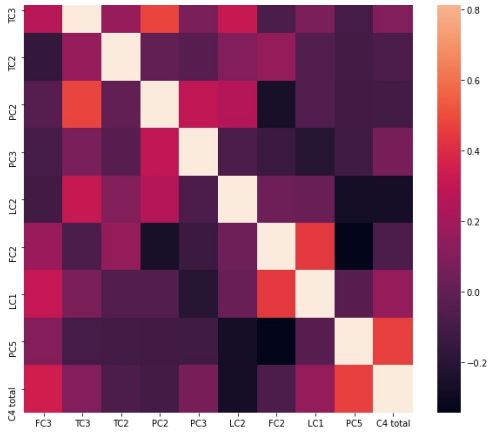
- Interaction between the process parameters

Average C4 total Hourly

Hourly	
2018-12-31 23:00:00	17.25
2018-12-31 23:02:00	2.68
2018-12-31 23:04:00	14.07
2018-12-31 23:06:00	14.14
2018-12-31 23:08:00	14.60
...	...
2019-01-01 02:22:00	0.97
2019-01-01 02:24:00	2.84
2019-01-01 02:26:00	3.05
2019-01-01 02:28:00	5.49
2019-01-01 02:30:00	4.35

Correlation Matrix-KPI identification

	FC1	TC1	PC1	FC3	TC3	TC2	PC2	PC3	LC2	FC2	LC1	PC5	C4 total
FC1	1.000000	0.081611	0.266328	0.163452	-0.070812	0.010379	-0.142341	-0.244943	0.047023	0.546848	0.934437	-0.067446	0.133766
TC1	0.081611	1.000000	0.313162	0.058536	-0.290785	-0.250796	-0.212635	0.080888	-0.149378	-0.168603	0.061637	0.337213	0.241723
PC1	0.266328	0.313162	1.000000	-0.208753	-0.242458	-0.174972	0.055175	0.008902	0.003655	0.116241	0.199102	-0.082490	-0.199053
FC3	0.163452	0.058536	-0.208753	1.000000	0.263452	-0.163155	-0.043626	-0.099410	-0.107617	0.174349	0.306520	0.104099	0.344505
TC3	-0.070812	-0.290785	-0.242458	0.263452	1.000000	0.165339	0.480546	0.075440	0.313235	-0.079835	0.081733	-0.100310	0.098162
TC2	0.010379	-0.250796	-0.174972	-0.163155	0.165339	1.000000	-0.003156	-0.030440	0.099978	0.156145	-0.058304	-0.105313	-0.071630
PC2	-0.142341	-0.212635	0.055175	-0.043626	0.480546	-0.003156	1.000000	0.294596	0.254857	-0.255265	-0.057803	-0.111589	-0.101796
PC3	-0.244943	0.080888	0.008902	-0.099410	0.075440	-0.030440	0.294596	1.000000	-0.073676	-0.138041	-0.201789	-0.116218	0.071070
LC2	0.047023	-0.149378	0.003655	-0.107617	0.313235	0.099978	0.254857	-0.073676	1.000000	0.038378	0.021649	-0.270944	-0.267284
FC2	0.546848	-0.168603	0.116241	0.174349	-0.079835	0.156145	-0.255265	-0.138041	0.038378	1.000000	0.444436	-0.342598	-0.072212
LC1	0.934437	0.061637	0.199102	0.306520	0.081733	-0.058304	-0.057803	-0.201789	0.021649	0.444436	1.000000	-0.037209	0.159118
PC5	-0.067446	0.337213	-0.082490	0.104099	-0.100310	-0.105313	-0.111589	-0.116218	-0.270944	-0.342598	-0.037209	1.000000	0.469903
C4 total	0.133766	0.241723	-0.199053	0.344505	0.098162	-0.071630	-0.101796	0.071070	-0.267284	-0.072212	0.159118	0.469903	1.000000



	Dim 1	Dim 2
FC1	0.408820	-0.140828
TC1	-0.134697	-0.418433
TI2	-0.202727	-0.470834
PC1	-0.293919	-0.009425
FC3	0.675520	-0.062553
TC3	0.356588	0.629799

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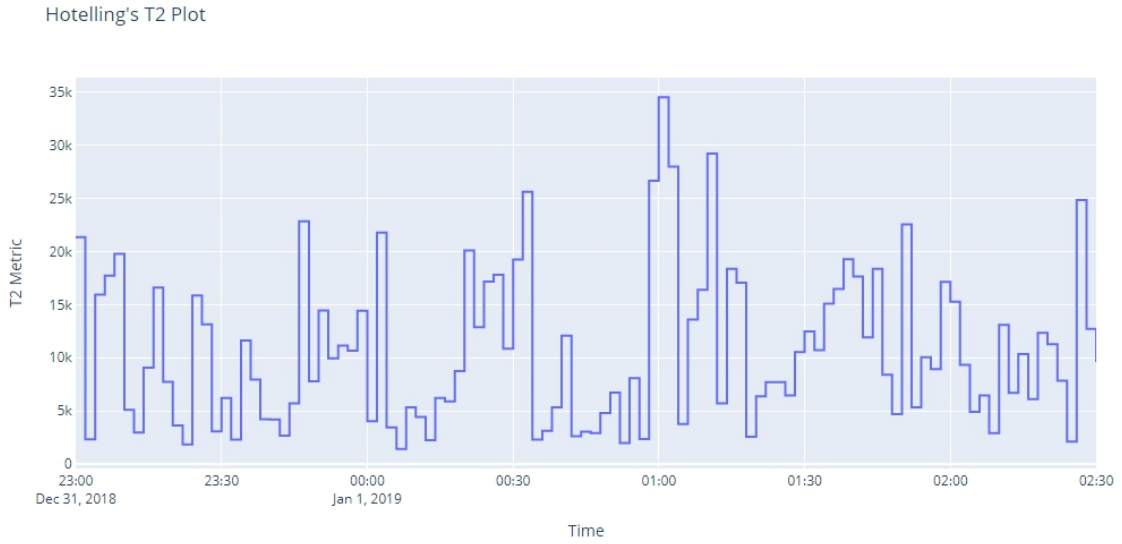
Root cause analysis using PCA

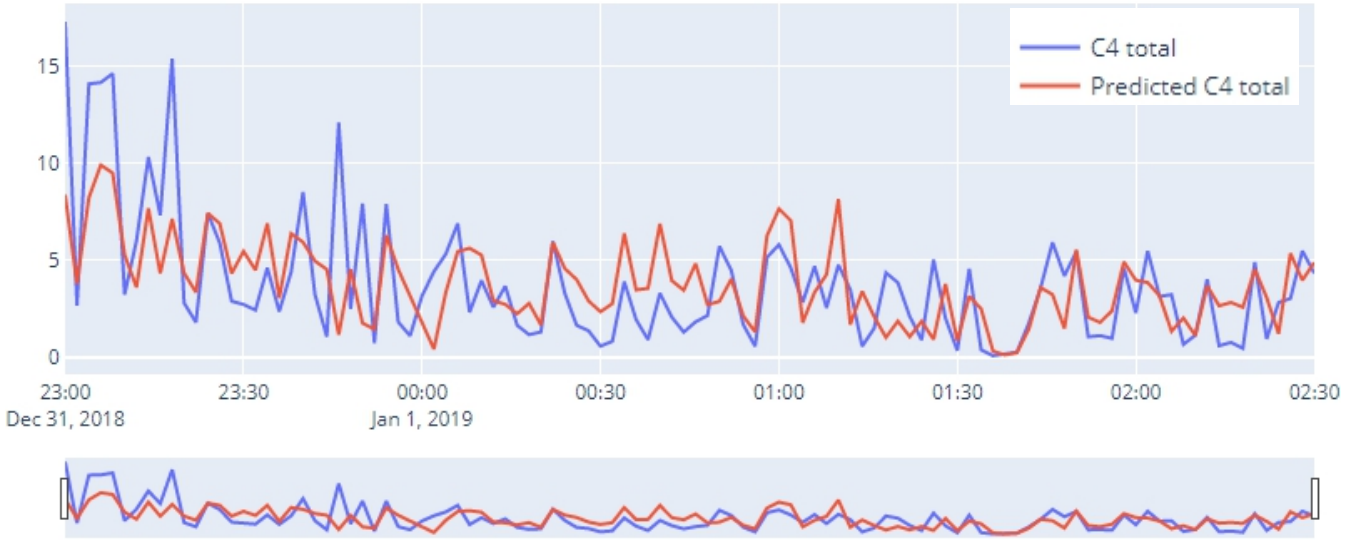
- Descriptive dashboard providing you a solutions with advance filtering of your critical KPIs and enabling the gateway of SPC for you, just on a single click.
  - T2 Plot
    - Larger peaks are indicative of large deviation in the process, that can be due to high concentration of C_4 fraction.
    - Time points at which peaks were observed should be considered for diagnosing the distillation column.



Predictive Modeling

- Interactive visualization
- Predicting the C4 fraction, with descriptive model metrics

Dep. Variable:	y	**R-squared (uncentered):**	0.175
Model:	OLS	**Adj. R-squared (uncentered):**	0.143
Method:	Least Squares	**F-statistic:**	5.423
Date:	Thu, 22 Oct 2020	**Prob (F-statistic):**	0.000533
Time:	18:36:33	**Log-Likelihood:**	-312.55
No. Observations:	106	**AIC:**	633.1
Df Residuals:	102	**BIC:**	643.7



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ROI:

- Enabled continuous monitoring of the C4-fraction, which enables the operator/engineer to closely observe the process irrespective of the gas chromatography's downtime

- Monetary and manual efforts for performing the lab analysis to estimate the quality of C_4-fractions was reduced significantly

- Significant time was saved by enabling the Advanced visualization for the tags/signals

- Troubleshooting/diagnosing the debutanizer process due to low quality product was a major challenge, where performing RCA using PCA extension metrics, such as t-score/Hotelling's T2 significantly reduced the time and manual efforts for abnormality identification and variability estimation