Price Benchmarking Index

**Relationship among Feedstock and Energy Prices: Multi Variate Linear Regression Analysis**

Based on insights from major manufacturers globally, the Energy and Feedstock price movement significantly contributes to determining the price of Acrylic Acid. However, the factors impacting the price of Acrylic Acid will vary in different geographies primarily because of feedstock production routes and energy mix.

**Multivariate Linear Regression Analysis**

* ChemAnalyst used the Multivariate Linear regression, a technique that estimates a single regression model with more than one outcome variable.
* A multivariate linear regression analysis was performed to understand the combined impact of Crude Oil and Propylene Polymer Grade price fluctuation on the price trend of Ester Acrylic Acid.

**Correlation**

* ChemAnalyst used the Correlation to derive the correlation coefficient between Crude Oil, Propylene Polymer Grade, Ester Acrylic Acid and Glacial Acrylic Acid while considering the price forecast.
* The correlation coefficient is a statistical measure of the strength of a linear relationship between two variables ranging from -1 to 1.
* A correlation of -1.0 indicates a perfect negative correlation, and a correlation of 1.0 indicates a perfect positive correlation.
* The coefficients have been observed leaning towards positive 1, realising a positive correlation.

To develop the Acrylic Acid Price Benchmark and Index, ChemAnlayst considered Crude Oil Price (FOB) India Basket, and Propylene Polymer Grade Contracted Price (Ex-Hazira) from the ChemAnalyst database.

**Steps Involved**

**Feedstock and Energy Prices:**Propylene, Crude Oil, Ester Acrylic Acid and Glacial Acrylic Acid have been forecasted Multi Variate Linear Regression Analysis.

**Step 1:**Crude oil Prices over the last 10 years, starting from April 2012 have been considered for the regression analysis.

**Step 2:**Linear regression analysis between the Crude oil prices with Propylene price was performed to understand the correlation (Multiple R), R-squared factor of the regression analysis.

**Step 3:** The procedure in step 2 was repeated, this time between Propylene Price and Ester Acrylic Acid.

**Step 4:** A multivariate regression analysis was performed to understand the combined impact of Crude Oil and Propylene Polymer Grade price fluctuation on the price trend of Ester Acrylic Acid.

**Step 5:** The procedure in Steps 2, 3 and 4 was repeated with Crude Oil and Polymer Grade Propylene Prices (feedstock prices).

**Step 6:** Another multivariate analysis was performed to determine the combined impact of Energy and feedstock prices.

**Step 7:** The correlation factors from the above analysis were evaluated to find the strongest correlation among them.

**Step 8:** The regression coefficients of each of the input variables of the analysis with the strongest correlation were chosen along with the intercept to predict the future points along the best fit line.

*Note: In this method, ChemAnalyst has assumed the Crude Oil and Propylene Polymer Grade to be independent variables as the corelation factor for these prices. The double impact of Crude Oil as a feedstock source and as an energy source has been neglected deliberately as its impact on feedstock prices is already reflected in the price trend of Propylene and Ester Grade Acrylic Acid.*

Price Forecast.

ChemAnalyst adopted two approaches to do the price forecast.

* **Approach 1**: Linear Regression Analysis Based on Historical Data of GAA and AA
* **Approach 2**: Primary Research— Surveys conducted at different levels among the participants of acrylic acid supply chain.

**Approach 1**: Linear Regression Analysis Based on Historical Data of GAA and AA

The forecasting exercise is based on the historical price movement. The forecasted value is conditioned below.

* The crude oil prices will remain within average limits during the next ten years.
* No technological innovations of substantial magnitude will take place which may lead to sea-change in technologies / processes used today.
* Change in the Historical Exchange Rate will follow the same trend.
* Absence of any abnormal situation

Put Name of Two Sheets showing output- PropyleneP\_Crude\_oil\_Regression, EAA\_Del\_Price\_PropyleneP\_Regres, GAA\_Del\_Price\_PropyleneP\_Regres

**Approach 2**: Primary Research— Surveys conducted at different levels among the participants of acrylic acid supply chain.

Key Findings include:

* **It was understood that various factors are in play such as** Exchange rate, Conversion rate, Demand / availability scenario, Feedstock price changes, Geo-political scenario, Global economy, etc, Inflation, Taxation.
* Presently, crude oil price fluctuations are showing considerable volatility due to several socio-political factors worldwide. Various influencing factors for price movement include raw-materials / feedstock prices and demand – supply balances in the region which built the relationship of product to substitute products having comparable properties and common end-uses as well as their prices.
* Feedstock prices directly affect the price of product. Increased feedstock prices, if passed on to end-users, increase the inflation and if not, they squeeze the margins of producers leading to making the industry unattractive for further investments. This leads to supply crunch and shortage of product in the market. The shortage leads to further increase in prices of product.

Respondent shared their forecasted estimates as given below:

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