4 October 2022

Variable Margin Methodology: ABS North America

Independent Commodity Intelligence Services

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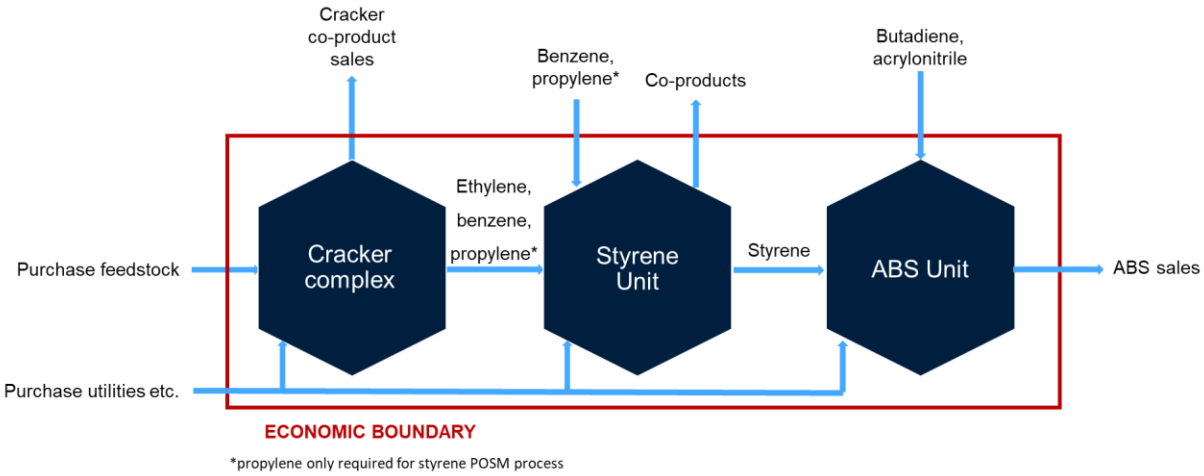
THE BUSINESS MODEL

Acrylonitrile Butadiene Styrene (ABS) is produced by the copolymerisation of styrene, acrylonitrile and butadiene.

The diagram below shows the fully integrated ABS copolymerisation process. Naphtha and steam are fed into a cracker unit, where ethylene and co-products (such as propylene, butadiene and benzene) are made. Ethylene is further processed (catalytic alkylation) with benzene (both from the cracker and bought from the market) to make ethylbenzene. Styrene is produced from this using either the dehydrogenation or POSM process (producing toluene and propylene oxide as respectively as co-products). The styrene produced is then fed to the ABS unit with acrylonitrile and butadiene, which are copolymerised to produce ABS.



THE MARGIN CALCULATION

- The margin measure provides an assessment of the ex-works cash margin obtained for the product over raw material costs, credit for selling co-products, and key variable manufacturing costs, including power and steam, catalysts and chemicals. This measure can also be termed as a variable margin, contribution or benefit.

- This margin measure provides simple signals on the direction of business margins as dictated by the environment, thus informing market positioning by sellers, buyers and traders.

- ICIS does not model beyond raw material costs, credit for selling co-products and key variable manufacturing costs. Further analysis would cease to be generic to the industry and would be highly specific to individual business operations, their site structure, location, ownership and financial structures. Such detail would not fairly reflect or be applicable in a wider industry context. It may also be more subjective, open to fair challenges and not feasible to reference in commercial discussions.

- ICIS models plant operations for a series of ‘representative’ plants around the world. These representative plants have no flexibility with respect to feedstock or process configuration and ICIS assumes the plants to be purchasing inputs and selling outputs at constant prices.

- As the process model is generic and not based on any individual operation, the contribution measure is indicative. Instead of absolute value terms, it is most valuable as an index and in step-change terms.

- ICIS plant manufacturing and feedstock yield assumptions incorporate data from Intratec (www.intratec.us), an independent provider of chemical production cost reports.

- Ex-works product price assessments link to ICIS pricing quotations for large-volume commodity products, with netbacks assessed using the ICIS petrochemicals logistics model. To estimate representative transport costs, the ICIS logistics model considers a network with nodes at individual production sites connected by streets and ports linking each continent. The logistics model incorporates shipping data from Xeneta (www.xeneta.com), and duties data from SimplyDuty (www.simplyduty.com).

The calculation below shows how ICIS derives the ABS integrated margin (feedstock ethane, dehydrogenation route for styrene) and standalone margin for North America. The example is based on contract sales prices, is denominated in US dollars per tonne, and uses pricing from the year 2017.

Ethane-based margin ($/tonne)

ABS contract price	1,626
Co-product sales	51
Total income	**1,677**
Purchase feedstock (ethane) and utilities	1,284
Variable costs	**1,284**
ABS margin	**1,677 – 1,284 = 393**

Standalone margin ($/tonne)

ABS contract price	1,626
Total income	**1,626**
Purchase feedstock and utilities	1,624
Variable costs	**1,624**
ABS margin	**1,626 – 1,624 = 2**

INTEGRATED AND STANDALONE

- Non-integrated or standalone market participants produce ABS only. Our margin model assumes plants that are co-located and that styrene, as well as the butadiene and acrylonitrile, is sourced from the open market.

- Integrated market participants produce styrene and ABS (as well as ethylene for a fully integrated supply chain). In a fully integrated supply chain, the business model is to buy naphtha, process it into ethylene, benzene and cracker co-products. The balance of benzene is procured from the market. Ethylene and benzene are converted into styrene, then used to synthesize ABS, which is sold alongside cracker co-products.

- ICIS has also modelled plants that produce styrene but are not cracker integrated, i.e. ethylene and benzene are both purchased on the open market.

- Integrated production units may be co-located and/or connected by pipeline and with common equity ownership across both assets in the supply chain. Therefore, the economic boundary for the majority of industry producers is more extensive than a standalone polymer unit.

MODEL YIELD PATTERN AND CALCULATION

Plant manufacturing data relates to the variable cost components of chemical unit operations. Yield pattern data relates to the overall material balance of the cracker unit. For example, for one tonne of styrene produced, 0.8 - 0.9 tonnes of naphtha feedstock are required, which will additionally produce co-products (including, but not limited to, propylene and butadiene) of 0.3 - 0.6 tonnes (depending on the process). Approximately 0.6 tonnes of styrene are required to produce a single tonne of ABS.

- As the dominant cracker feedstock in North America for ethylene, ICIS has selected ethane as a representative feedstock for cracker-integrated production and therefore best demonstrates the overall margin differences given by integration. Naphtha has also been modelled to allow comparison with other regions. Ethylene feedstocks like LPG are also used here, but the effect these different feedstocks have on ABS margins is minimal. ICIS has also modelled standalone production, where ethylene is purchased on the open market.
- ICIS calculates ABS margins for the following production processes in North America:
    - Ethane cracker-integrated
    - Naphtha cracker-integrated
    - Styrene unit-integrated:
        - Styrene ex-POSM
        - Styrene ex-dehydrogenation
    - Standalone production

This analysis demonstrates business volatility and the influence of price floors (as an uneconomic margin generally forces supply reductions).

ASSESSMENT INPUTS

ICIS uses the following pricing inputs to generate the full content of the ICIS ABS North America margins:

- ABS Inj Medium, Package in US Gulf Domestic FD (cts/lb to $/tonne)
- Styrene in US Gulf Contract FOB (cts/lb converted to $/tonne)
- Ethane Mt Belvieu FOB USG Spot (weekly average) (cts/US gal converted to $/tonne)
- Naphtha in US Gulf Spot Del USG Paraffinic (weekly average) ($/tonne)
- Ethylene – Net US Gulf Contract Delivered (cts/lb converted to $/tonne)
- Propylene in US Gulf Contract P Grade (cts/lb converted to $/tonne)
- Butadiene in US Gulf Contract FOB USG (cts/lb converted to $/tonne)
- Crude C4s in US Gulf Spot CIF (weekly average) ($/tonne)
- Benzene in US Gulf Contract FOB ($/US gal converted to $/tonne)
- Gasoline Premium Unleaded (Pipeline) in US Gulf Spot US Gulf (weekly average) (cts/US gal converted to $/tonne)
- Residual Fuel Oil: FOB US Gulf (barges) Spot No 6 1.0% (weekly average) (cts/bbl converted to $/tonne)
- NYMEX Henry Hub Natural Gas forward month (ICIS energy, weekly average) ($/MMBtu converted to $/tonne)
- Propylene oxide in US Gulf Contract FOB (cts/lb converted to $/tonne)
- Toluene N Grade in US Gulf Spot FOB (weekly assessment) ($/US gal to $/tonne)
- Mineral Oil, Group I SN150 in US Gulf FOB Spot (weekly average) ($/US gal converted to $/tonne)
- Acrylonitrile in US Gulf Contract DEL (cts/lb converted to $/tonne)

CONVERSIONS

The following conversion factors are used:

- Ethane: 742.2 US gal per tonne
- Benzene: 299 US gal per tonne
- Gasoline: 358.8 US gal per tonne
- Residual Fuel Oil: 264 US gal per tonne (42 US gal/bbl)
- Natural Gas: 0.0173 tonnes of fuel oil equivalents per MMBtu
- Mineral Oil: 302.3 US gal per tonne

The methodology associated with each ICIS pricing individual pricing quotation referenced above is available on the ICIS Compliance and Methodology website.

In addition to the listed ICIS pricing inputs, the model also takes into account logistics costs (calculated through the ICIS logistics model), and utility costs.

A key objective of the calculation procedure is to provide a weekly summary that strongly aligns to the reported market price positions on the date of publication.

Where inputs are unavailable for individual weeks, e.g. due to public holidays, prior-week data is carried forward to the current week. This is for the specific purpose of populating the model and preventing model inconsistency. This form of data interpolation infers some limited data points that may not be market derived, and customers should be aware of this assumption.

ABS NORTH AMERICA WEBPAGE

Filter data on the website using the following criteria.

- **Process**: Select level of integration (from a naphtha-integrated cracker, styrene unit or standalone ABS unit) and styrene production route (dehydrogenation or POSM).
- **Price terms**: ICIS generates ABS variable margins only for contract price terms.

Variable margins data are available online from January 2014 onwards. Six months trailing data shows as default.

The website deploys the following data, all per tonne of ABS.

- **Main product value, ex-works**: the estimated ABS netback value for the producer, taking into account the ICIS assessed price, shipping costs, handling costs and applicable duties.
- **Co-product credits**: the revenues from the other products generated in a process, also ex-works. This data is also available broken down into co-product types.
- **Feedstock and utility costs**: or total variable input costs for a process. This data is also available broken down into the component feedstock costs and utility costs.

Calculated outputs are:

- **Variable cost** = [Feedstock and utility costs] – [Co-product credits]
- **Variable margin** = [Main product value] + [Co-product credits] – [Feedstock and utility costs]

A selected variable margin (i.e. a margin for a specific location, process and price term) is comparable with margins of different process technologies in the same region, and with margins using the same technology in different regions. Subscribers can review margin performance by week, month, quarterly and per annum. Subscribers can view the flows of

different products, in terms of their volume and value, into and out of the representative production unit used to calculate the ABS variable margin.

PUBLISHING FREQUENCY

The ICIS Weekly Margin – ABS North America model is based on the latest data at the close of business in Europe on Friday and released to customers on the following Monday subject to schedule planning. When the Monday is a public holiday in the UK, margins will be made available the following day. Margins are not published on some public holidays. Holiday dates and days of publication may be subject to revision.