ETHYLENE ASIA

THE BUSINESS MODEL

The simplified diagram below shows the main method of making ethylene from naphtha, a product mainly derived from crude oil. Ethylene is also made from other feedstocks including liquefied petroleum gas (LPG) which can be derived from gas separation processes and as a byproduct of refinery processes. Naphtha with steam is fed into the cracker unit where ethylene and other co-products (such as propylene, butadiene and benzene) are made. The ethylene from the cracker unit is separated from other co-products and then typically piped to other chemical plants where it is further processed into derivative products such as polyethylene. The other co-products are also separated and sold for use in other chemical plants or used for fuel.

A simplified illustration of material flows is as follows:

THE MARGIN CALCULATION

- Margin measure provides 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 such as power and steam. This measure can also be termed as a variable margin, contribution or benefit.

- It represents a cash margin measure available for supporting the direct and allocated fixed manufacturing costs, working capital, taxes, royalties, corporate costs, debt service costs, capital costs and owner’s returns from the business.
This margin measure provides simple signals on the direction of business margins, as dictated by the environment alone, thus informing market positioning by sellers, buyers and traders.

ICIS chooses not to model beyond raw material costs, credit for selling co-products and key variable manufacturing costs as this ceases to be generic to the industry and 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.

Plant manufacturing and feedstock yield model data has been provided by Linde Engineering, a division of Linde AG. Linde Engineering (www.linde-engineering.com) is a leading international chemical plant designer, process engineering, procurement and construction contractor. It has extensive experience in ethylene plant design.

The process model is generic and not referenced to any individual operation, so that the contribution measure is only indicative. It can be most valuably referenced in index and step-change terms as opposed to absolute value terms.

Ex-works product price assessments are linked to ICIS pricing quotations for large-volume commodity products with netbacks assessed using typical logistic cost assessments.

Below is a detailed calculation of how the ethylene margin (naphtha feed) is calculated for northeast Asia. The figures refer to averages for 2011; the calculation for southeast Asia is similar, as is that for the ethylene margin (LPG feed). Figures indicated in red are those found in the tables of the margin report; others relate to underlying assumptions of the model.

**Ethylene margin (naphtha feed) calculation ($/tonne) – averaged for 2011**

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<table>
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<tbody>
<tr>
<td>Ethylene price</td>
<td>1,198</td>
</tr>
<tr>
<td>Logistics costs</td>
<td>(105)</td>
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<tr>
<td>Net ethylene selling price</td>
<td>1,093</td>
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</tbody>
</table>
Purchase feedstock (naphtha) $3,108
Co-product sales $2,222

Ethylene margin (naphtha feed) $207

1 The model assumes 3.278 tonnes of naphtha are required to produce 1 tonne of ethylene. The average net naphtha price (including freight costs) for 2011 was $948/tonne.
2 Co-product sales include credits for propylene, butadiene, raffinate-1, benzene, pygas and a fuel export balance.

Note: “Ethylene cost naphtha feed” is the difference between the purchase feedstock costs ($3,108/tonne ethylene) and the co-product credits ($2,222/tonne ethylene), ie $886/tonne ethylene.

MODEL YIELD PATTERN AND CALCULATION

Plant manufacturing data relates to the variable cost components of the cracker operations. Yield pattern data relates to the overall material balance of the cracker unit, for example, for 1 tonne of ethylene produced, a cracker requires 3.2 tonnes naphtha feedstock, and will produce co-products (such as but not limited to propylene, butadiene and benzene) of 2.2 tonnes in addition to the 1 tonne of ethylene. This plant manufacturing and feedstock yield model data has been provided by Linde Engineering, a division of Linde AG.

- Naphtha is the dominant cracker feedstock in both northeast and southeast Asia. The report also models LPG feedstocks (propane and butane) as some cracker units have a degree of flexibility to increase LPG usage when better economics are available for its use.

- Due to the different cracker yield patterns for using naphtha or LPG feedstocks, this comparative analysis is not a simple case of comparing feedstock price differences; it takes into account the different co-product credits.
This analysis demonstrates the volatility of the business and the influence of price floors since an uneconomic margin generally forces supply reductions.

The exact yield patterns of the cracker used cannot be published in an unrestricted document such as this methodology statement. However, for ICIS Weekly Margin – Ethylene Asia report subscribers with a specific requirement to see this data, it can be shared on a case-by-case basis.

Please contact the Global ICIS Customer Support Centre if this data is required.

ASSESSMENT INPUTS

The following pricing inputs are used to generate the full content of the ICIS Weekly Margin – Ethylene Asia report.

NORTHEAST ASIA

- Naphtha in Asia Pacific Spot CFR Japan (ICIS pricing, Friday assessment) ($/tonne)
- Propane CFR China (refrigerated cargo) C1 Energy (weekly average) [from 1 November 2010, previously Propane C+F Tokyo Term Spot (Reuters, weekly average)] ($/tonne)
- Butane CFR China (refrigerated cargo) C1 Energy (weekly average) [from 1 November 2010; previously Butane Tokyo C+F Tokyo Term Spot (Reuters, weekly average)] ($/tonne)
- Ethylene in Asia Pacific Spot CFR NE Asia (ICIS pricing, weekly average) ($/tonne)
- Propylene in Asia Pacific Spot CFR NE Asia (ICIS pricing, weekly average) ($/tonne)
- Propylene in Asia Pacific Spot CFR China Main Port (ICIS pricing, weekly average) ($/tonne)
- Butadiene in Asia Pacific Spot CFR NE Asia (ICIS pricing, weekly average) ($/tonne)
- Benzene in Asia Pacific Spot CFR NE Asia (ICIS pricing, Friday assessment) ($/tonne)
- Benzene in Asia Pacific Spot FOB Korea (ICIS pricing, Friday assessment) ($/tonne)
- Toluene in Asia Pacific Spot CFR NE Asia (ICIS pricing, Friday assessment) ($/tonne)
- Xylene (Solvent Grade) in Asia Pacific Spot FOB Korea (ICIS pricing, Friday assessment) ($/tonne)
- High Sulphur Fuel Oil mixed/cracked 180 cst FOB Singapore Spot (C1 Energy, weekly average) [from 1 September 2011; previously Fuel Oil 180 cst FOB Singapore Spot (Reuters, weekly average)] ($/tonne)

SOUTHEAST ASIA
- Naphtha in Asia Pacific Spot FOB Singapore (ICIS pricing, Friday assessment) ($/bbl)
- Naphtha in Asia Pacific Spot FOB Singapore (ICIS pricing, weekly average) ($/bbl)
- Propane CFR China (refrigerated cargo) C1 Energy (weekly average) [from 1 November 2010; previously Propane C+F Tokyo Term Spot (Reuters, weekly average)] ($/tonne)
- Butane CFR China (refrigerated cargo) C1 Energy (weekly average) [from 1 November 2010; previously Butane Tokyo C+F Tokyo Term Spot (Reuters, weekly average)] ($/tonne)
- Ethylene in Asia Pacific Spot CFR SE Asia (ICIS pricing, weekly average) ($/tonne)
- Propylene in Asia Pacific Spot CFR SE Asia (ICIS pricing, weekly average) ($/tonne)
- Butadiene in Asia Pacific Spot CFR SE Asia (ICIS pricing, weekly average) ($/tonne)
- Benzene in Asia Pacific Spot FOB SE Asia (ICIS pricing, Friday assessment) ($/tonne)
- Toluene in Asia Pacific Spot CFR SE Asia (ICIS pricing, Friday assessment) ($/tonne)
Gasoline 95 Unleaded FOB Singapore Spot (C1 Energy (weekly average) [from 1 September 2011; previously Gasoline 95 Unleaded FOB Singapore Cargo Spot (Reuters, weekly average)] ($/bbl)

High Sulphur Fuel Oil mixed/cracked 180 cst FOB Singapore Spot (C1 Energy, weekly average) [from 1 September 2011; previously Fuel Oil 180 cst FOB Singapore Spot (Reuters, weekly average)] ($/tonne)

The methodology associated with each ICIS pricing individual pricing quotation referenced above can be found in the free access methodology area of www.icispricing.com.

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

Where price quotations are not available for individual days or weeks due to public holidays, then prior day or week data is carried forward for the specific purpose of populating the model and preventing model inconsistency. This form of data interpolation is inferring some limited data points that may not be market derived, and customers should be aware of this assumption.

All data in the ICIS Weekly Margin – Ethylene Asia report is denominated in US dollars.

LONGER RANGE VIEWS:
SOUTHEAST ASIAN MARGINS VERSUS NORTHEAST ASIAN MARGINS

This provides a weekly comparison of the calculated spot naphtha-feed ethylene margin for southeast Asian operators minus the calculated spot naphtha-feed ethylene margin for northeast Asian operators. When this differential provides a positive numerical output, this implies that naphtha-feed ethylene margins are higher for southeast Asian operators than for northeast Asian operators. Similarly, when this differential provides a negative numerical output, this implies that naphtha-feed ethylene margins are higher for northeast Asian operators than for southeast Asian operators.
LPG VERSUS NAPHTHA FEED

This provides a weekly comparison of the calculated spot LPG-feed ethylene margin minus the calculated spot naphtha-feed ethylene margin. When this differential provides a positive numerical output, this implies that LPG feedstocks derive a higher margin for a cracker operator compared with naphtha feedstock. Similarly, when this differential provides a negative numerical output, this implies that LPG feedstocks derive a lower margin for a cracker operator compared with naphtha feedstock.

PUBLICATION FREQUENCY

The ICIS Weekly Margin – Ethylene Asia report is produced on a Friday at the close of business in Asia and distributed to customers on the following Monday, subject to schedule planning. When the Monday is a public holiday in the UK, the report is distributed on the Tuesday. The report is not published on some public holidays. Holiday dates and days of publication may be subject to revision.

For information on ICIS' full portfolio of margin reports, visit http://www.icis.com/chemicals/channel-info-about/margin-reports/

To understand the margin and cost curve analysis behind the Asian ethylene market and the methodology of our data collection, click on the link to view and listen to the archived version of the presentation.