ETHYLENE GLYCOL US

ICIS Weekly Margin – Ethylene Glycol (EG) US Methodology

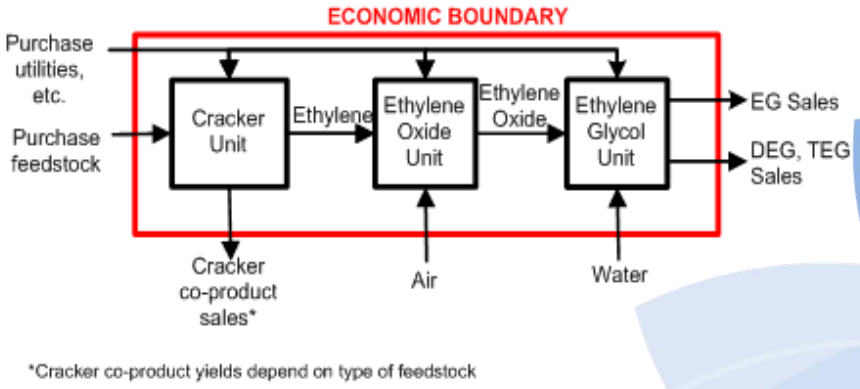
This document is intended to provide methodology support for customers receiving the ICIS Weekly Margin – EG US report. Please note that the margin measured is that for (mono) EG, with the higher molecular weight glycols considered as co-products.

THE BUSINESS MODEL

The simplified diagram below shows the main method of making (mono) EG from ethane (derived from natural gas reserves) or from light naphtha (derived from crude oil).

The ethane or naphtha is fed into a cracker unit where ethylene and other co-products are made. The co-products and amounts of each depend on the type of feedstock used. The ethylene from the cracker unit is separated from the co-products and processed with oxygen to make ethylene oxide which is then hydrolysed to produce EG and higher molecular weight glycols including diethylene glycol (DEG) and triethylene glycol (TEG). The cracker 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 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 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.
- Yield model data for the oxygen requirement and cost of oxygen calculations, including allowance for a monthly fixed fee to a third party onsite industrial gases supplier, have been provided by industrial gas consultants, Esprit Associates (www.espritassociates.com).
- Plant manufacturing and feedstock yield model data for the cracker unit have been provided by Linde Engineering division, a part 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 contract (domestic) EG industrial grade (EGI) margin (ethane feed) is calculated in the US. The figures refer to averages for contract sales values for 2010; the calculation for EG fibre grade (EGF) export contract values is similar, as is that for the EG margins (light naphtha feed). Figures indicated in red are those found in the tables of the margin report; others relate to underlying assumptions of the model.

EG margin calculation - averaged for 2010

Integrated margin	**cts/lb EG**	
EGI contract price	47.14	
Logistics costs/netbacks	(6.87)	
Net selling price		40.27
Purchase feedstock (ethane)[1]	(16.69)	
Oxygen	(1.19)	
Co-product sales/lb of EG produced[2,3]	7.86	
Variable cost of EO/EG unit[4]	(3.23)	
		(13.25)
Integrated margin		*27.02*

Standalone margin	**cts/lb EG**	
EGI contract price	47.14	
Logistics costs/netbacks	(6.87)	
Net selling price		40.27
Ethylene price	(45.90)	

Freight/terminalling saving for not exporting	4.43		
Net ethylene price paid	(41.47)		
Net ethylene price /lb EG produced[3] ie purchase feedstock (ethylene)		(26.75)	
Purchase oxygen/lb of EG produced		(1.19)	
Co-product value of DEG/TEG/lb of EG produced		5.75	
Variable cost of EO/EG unit[4]		(3.23)	
			(25.42)
Standalone margin			*14.85*

[1]The model assumes 1.266 lb of ethane are required to produce 1 lb of ethylene and 0.645 lb of oxygen are required to produce 1 lb of EG. The average ethane price (excluding freight costs) for 2010 was 59.98 cents/US gal (20.18 cents/lb).

[2]Co-product sales include credits for propylene, C4s and pygas, but allow for a fuel import balance from the cracker, and credits for DEG and TEG from the EG unit.

[3]The model assumes 0.645 lb of ethylene and 0.67 lb of oxygen are required to produce 1 lb of EG.

[4]Includes power for the EO and hydrolysis to EG.

DIFFERENCE BETWEEN INTEGRATED AND NON-INTEGRATED ANALYSIS

- Non-integrated or standalone: Market participant involved with EG production only. The business model is to buy ethylene, convert it into EG and sell the EG, DEG and TEG. This business model is only applicable to a minority of manufacturing facilities in the US.

- Integrated: Market participant involved with both ethylene and EG production. The business model is to buy ethane or light naphtha feedstock, process it to ethylene and cracker co-products, convert the ethylene into EG, and sell both the EG, DEG and TEG and the cracker co-products. This business model is applicable to the majority of manufacturing facilities in the US.

WHY INTEGRATED ANALYSIS

- Integrated analysis provides the key reason for being (or 'raison d'être') in the commodity EG business.
- Most US EG plants are integrated back to cracker sources of ethylene. This may be co-located and/or connected by pipe and with common equity ownership across both assets in the supply chain, i.e. the economic boundaries for the majority of the industry producers are bigger than a standalone unit.
- The margin is therefore measured across the supply chain from cracker feedstock (ethane or naphtha) through to EG, DEG, TEG and cracker co-products.
- This analysis demonstrates the volatility of the business and the influence of price floors that can lead to an uneconomic integrated margin, and generally forcing a reduction in supply.

WHY NON-INTEGRATED ANALYSIS

- A non-integrated or standalone analysis that considers the EG unit in isolation may be useful for understanding marginal opportunities where optimisation processes could result in ethylene being preferentially used for other ethylene derivative products. However, analysis of non-integrated historical data does show inadequate margins to justify fresh business investment to meet growing market demands.

MODEL YIELD PATTERN AND CALCULATION

- Plant manufacturing data relates to the variable cost components of the chemical unit operations. Yield pattern data relates to the overall material balance of the cracker unit, for example, for 1 lb of ethylene produced, a cracker requires 1.266 lb of ethane feedstock, and will produce 0.02 lb of co-product propylene in addition to the 1 lb of ethylene. This plant manufacturing and feedstock yield model data for both the ethane and naphtha cracker models have been provided by Linde Engineering, a division of Linde AG. Yield model data for the oxygen requirement has been provided by industrial gas consultants, Esprit Associates.

  The exact yield pattern used cannot be published in an unrestricted document such as this methodology statement. However, for ICIS Weekly Margin – EG

US 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 – EG US report.

- Ethylene Glycol in US Gulf Contract FOB (EGI) (cts/lb)
- Ethylene Glycol in US Gulf Contract FOB (EGF) Export (cts/lb)
- Diethylene Glycol in US Gulf Contract FOB (cts/lb)
- Triethylene Glycol in US Gulf Contract FOB (cts/lb)
- Ethane Mt Belvieu FOB USG Spot (weekly average) [from 1 August 2011, previously Ethane Mt Belvieu FOB USG Pipeline Spot (Reuters, weekly average)] (cts/US gal)
- Naphtha in US Gulf Spot Del USG Paraffinic (weekly average) ($/tonne)
- Ethylene – Net US Gulf Contract Delivered (cts/lb)
- Ethylene in US Gulf Spot Del (Pipeline) (weekly average) (cts/lb)
- Propylene in US Gulf Contract P Grade (cts/lb)
- Propylene (P Grade) in US Gulf Spot Pipeline (weekly average) (cts/lb)
- Butadiene in US Gulf Contract FOB USG (cts/lb)
- Butadiene in US Gulf Spot CIF (weekly average) (cts/lb)
- Crude C4s in US Gulf Spot CIF (weekly average) ($/tonne)
- Benzene in US Gulf Contract FOB ($/US gal)
- Benzene in US Gulf Spot FOB Barges (Friday assessment) ($/US gal)
- Gasoline Premium Unleaded (Pipeline) in US Gulf Spot US Gulf (weekly average) (cts/US gal)

- Residual Fuel Oil: FOB US Gulf (barges) Spot No 6 1.0% (weekly average) ($/bbl)
- NYMEX Henry Hub Natural Gas forward month (ICIS energy, weekly average) [from 25 March 2013, previously Henry Hub Natural Gas (Reuters, weekly average)] ($/MMBtu)

Conversions

The following conversions 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

Oxygen is valued in energy terms, with 1 lb of oxygen considered to be equivalent to 0.116 lb of fuel oil and 0.67 lb of oxygen required per pound of EG produced. The model assumes oxygen is supplied under long-term contract from an onsite industrial gases unit, owned and operated by a third party. A fixed monthly fee payable to the industrial gases supplier, to cover both the variable costs of operation of the industrial gases unit and its capital costs, is allowed for within the variable costs per pound of EG produced.

The ICIS pricing methodology associated with each individual pricing quotation referenced above can be found in the free access methodology area ofwww.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 ICIS price quotations are not available for individual weeks due to public holidays, then prior 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 – EG US report is denominated in US cents unless specifically indicated otherwise.

LONGER RANGE VIEWS

The ICIS Weekly – EG US report will provide longer range views for ethane feed and light naphtha feed.

SPOT VERSUS CONTRACT MARGIN (INTEGRATED)

This provides a weekly comparison of the calculated margin for the EGF export contract based sales minus EGI contract (domestic) based sales. The ICIS pricing reference is also changed for the cracker products, where a switch is made to spot pricing, so the analysis is deeper than a simple comparison of EGF export contract versus EGI contract (domestic) price netbacks. When this differential provides a positive numerical output, this implies that EGF export contract sales derive a higher margin for an integrated producer than EGI contract based sales. Similarly, when this differential provides a negative numerical output, this implies that EGF export contract sales derive a lower margin for an integrated producer than EGI contract based sales.

For the avoidance of any doubt, the basis in which ICIS pricing data is utilised for each of these respective models is summarised in the table below. For more detailed information about these quotations, please refer to the assessment Inputs section above.

ICIS price	Spot margin model	Contract margin model
EG	EGF export contract	EGI contract
DEG	Contract	Contract
TEG	Contract	Contract
Ethane	Spot	Spot
Light Naphtha	Spot	Spot
Gasoline	Spot	Spot
Residual Fuel Oil	Spot	Spot

Natural Gas	Spot	Spot
Ethylene	Spot	Contract
Propylene	Spot	Contract
Butadiene	Spot	Contract
Benzene	Spot	Contract
Crude C4	Spot	Spot

EGF EXPORT CONTRACT VERSUS EGI CONTRACT MARGIN (STANDALONE)

This provides a comparison of the calculated margin for EGF export sales minus EGI contract based sales measured across the EO/EG unit. When this differential provides a positive numerical output, this implies that EFG export based sales derive a higher margin than EGI contract based sales. Similarly, when this differential provides a negative numerical output, this implies that EGF export based sales derive a lower margin than EGI contract based sales.

READING THE CHARTS

In the short-term charts and longer range margin view, the integrated margin is derived by reading the top of the wedge, the sum of the ethylene margin per pound of EG (yellow) and the standalone EG margin (blue). Where the standalone margin is a loss (red), the integrated margin is read as the top of the yellow wedge.

PUBLISHING FREQUENCY

The ICIS Weekly Margin – EG US report is produced on a Monday using data from Friday close of business in the US and distributed to customers on the 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.

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