OUT OF UNCERTAINTY COMES OPPORTUNITY: THRIVING IN THE NEW REALITY WITH AN ETHYLENE OXIDE REVAMP

■ Reduce energy and production costs ■ Change the product mix ■ Increase work rate

The refining landscape has shifted in unprecedented ways in recent years. The global pandemic brought a reset in energy demand, utilisation challenges and pressure on margins, and although the sector has somewhat rebounded, it seems certain that conditions will remain highly challenging.

For most refiners, therefore, taking steps to improve their performance in the short term could be business critical. Failing to invest carries the risk of competitive vulnerability, though capital discipline is key. So, in this set of articles, we reveal a wide range of low-capital revamp opportunities that will help refiners to unlock high returns quickly.

These are unprecedented times for the global petrochemical industry, and some products and value chains, including EO, are suffering from exceptionally challenging market conditions and low operating rates.

This environment forces EO producers to re-examine their operating and investment plans. When margins were good the whole focus was on maximising production and minimising downtime, but now it is important to realise that there are other ways to improve profitability.

Some of the options to consider are:

- **Debottlenecking** to run harder and reduce unit production costs;
- **Adding or increasing high-purity EO (HPEO) capacity** to improve margins and diversify the product portfolio;
- **Lowering the carbon dioxide level** to allow catalyst to run longer and at higher selectivity;
- **Operating at lower rates** to maximise selectivity and lifetime from the catalyst; and
- **Increasing energy efficiency.**

The right choice depends on the local market environment and the drivers of each producer and each site. The position in terms of ethylene availability and the depth of the local market for HPEO can have a major influence on the choice of strategy.

WHAT DO WE OFFER?

Our tailored revamps are carefully designed to help you meet your objectives and may involve:

- Studies to evaluate the optimum response for your specific situation;
- Our latest-generation catalysts, such as the high-performance catalyst family that has a high initial selectivity, offers slow performance decline, can operate at high work rates and is tolerant of high carbon dioxide concentrations; and
- Our world-leading process technologies, which are the most widely used in the industry.

HOW DO WE IMPLEMENT?

Devising your optimum solution often begins with understanding your particular situation. Do you have any particular operational constraints? What are your strategic objectives? What impact do the local markets and economics have? Are there any other parts of your business that might be impacted?

Consequently, we often work closely with customers to shape the solution, investigating options and evaluating the optimal response for their specific circumstances.

Working together, we would identify and evaluate ways to help you meet your objectives. These may involve, for example, running your asset differently, or making some hardware changes.

NEXT

DEVISING CUSTOMER-SPECIFIC RESPONSE OPTIONS

"For some, the optimum solution will involve adding or increasing HPEO, increasing work rate and changing to a latest-generation catalyst. But for others, we might target bringing down operating costs by running at lower rates or by looking for opportunities to improve efficiency.

"There's no silver bullet because every operator's circumstances are unique, but whether it involves making hardware changes, adding latest-generation catalysts or adjusting the mode of operation, we can usually find multiple ways to unlock value from their asset so that they are able to compete better in the new reality."

Peter Stewart, Ethylene Oxide Global Business Manager, Shell Catalysts & Technologies

CUSTOMER CASE STUDIES

Click on the links to find out how:

Liaoning Oxiranchem, Inc. cost-effectively unlocked a 50% capacity increase →

a **European EO producer** determined how to unlock an 85% HPEO capacity increase →

Shell Geismar increased catalyst selectivity with a CO_2 revamp →

TAKE THE NEXT STEP

Schedule a revamps consultation

WATCH THE ON-DEMAND WEBINAR HERE

SHELL CATALYSTS & TECHNOLOGIES
TRANSFORMING ENERGY TOGETHER

BACK

HOW LIAONING OXIRANCHEM, INC. COST-EFFECTIVELY UNLOCKED A 50% CAPACITY INCREASE

DRIVERS

Liaoning Oxiranchem, Inc. (Oxiran) is one of China's largest producers of high-margin, high-purity ethylene oxide (HPEO) and the country's biggest ethylene oxide (EO) derivatives player.

To maintain its competitive position, it targeted increasing the capacity of its plant in Yangzhou, Jiangsu Province from 200 to 300 kta. Achieving such an increase would make it the largest HPEO plant in China.

ABOUT THE PROJECT

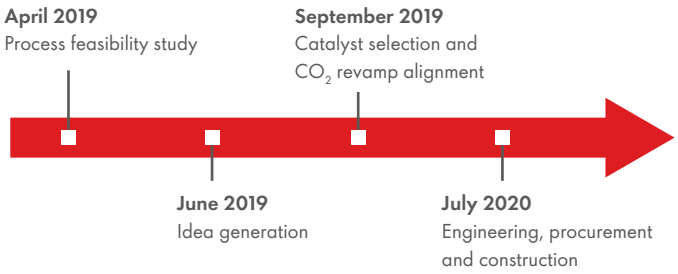
To explore how it could unlock such a capacity increase cost effectively, Oxiran commissioned Shell Catalysts & Technologies to perform a feasibility study. Working closely with technologists from the site, and after conducting a reactor integration check and oxygen mixer safety check, the organisation's catalyst and process experts identified a number of modifications that could help the site to achieve the desired capacity increase. These included:

- upgrading the catalyst from Shell's high selectivity catalyst to its high performance catalyst;
- modifying the reactor coolant system to enhance the mechanical integration and reliability of the system; and
- resizing the knockout drums to enable more gas to be treated.

Another important modification was to revamp the carbon dioxide (CO_2) removal system. The unit had high levels of CO_2 in the recycle gas, which was constraining the performance of its catalyst and limiting its cycle length.

To resolve this, the team worked closely with Shell Catalysts & Technologies' alliance partner, Eickmeyer & Associates, and installed its Catacarb process. This technology, which is designed to maintain the CO_2 concentration level while the CO_2 production increases by 50%, helps to bring the CO_2 content down to ultra-low levels and has an extensive track record for removing CO_2 from EO recycle gas.

This CO_2 revamp was key to maintaining the catalyst's three-year cycle.



CUSTOMER QUOTE

"It was essential that the project be delivered quickly because we wanted to take the opportunity to implement it during our next shutdown. So we were delighted when Shell Catalysts & Technologies conducted the revamp study in just five weeks. They helped us to move the project along at a rapid pace – it only took eight months from signing the agreement to the beginning of implementation."

Dong Zhenpeng, President, Liaoning Oxiranchem, Inc.

VALUE DELIVERED

The project is expected to increase the customer's bottom line by around $21 million.

Crucially, it required an investment of only $5 million, far lower than the capital cost of building a new grass-roots unit.

TAKE THE NEXT STEP

Schedule a revamps consultation

SHELL CATALYSTS & TECHNOLOGIES
TRANSFORMING ENERGY TOGETHER

HOW A EUROPEAN EO PRODUCER DETERMINED HOW TO UNLOCK AN 85% HPEO CAPACITY INCREASE

DRIVERS

To benefit from the strong ethylene oxide (EO) derivatives market, a European EO producer wanted to increase the capacity of its 140-kta single-train unit and targeted an ambitious 18-month project execution timeline.

ABOUT THE PROJECT

Working closely with the customer, Shell Catalysts & Technologies identified and evaluated a series of options. These included:

- conducting typical debottlenecking measures, such as adding a new compressor, changing the oxygen mixing nozzle and studying the modifications required in the EO reactor thermosyphon system. However, the customer had been implementing incremental debottlenecking measures since it started up and only limited further improvements could be achieved.
- switching to a new, latest-generation catalyst. Although this was a relatively low-cost option that could be implemented quickly, a thermal stability study demonstrated that the capacity increase would be limited to 15 kta. In addition, the relatively high water levels in the recycle gas feed to the EO reactor would make this unsuitable.
- adding a new EO train. This would have a longer lead time than the other options, but Shell Catalysts & Technologies was able to mitigate this by duplicating the design, equipment datasheets and heat and material balances from a previous unit.

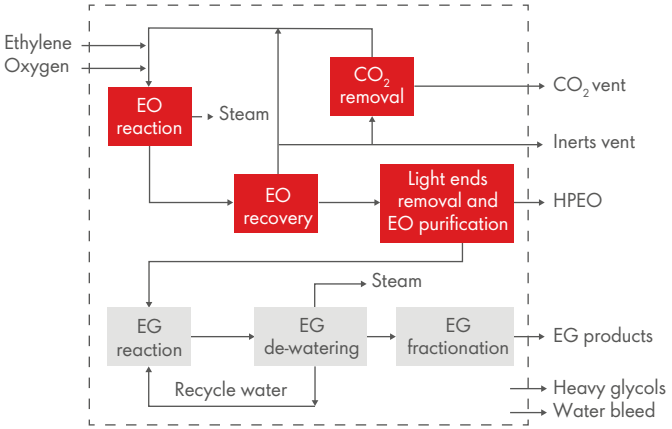


Figure 1: The existing train.

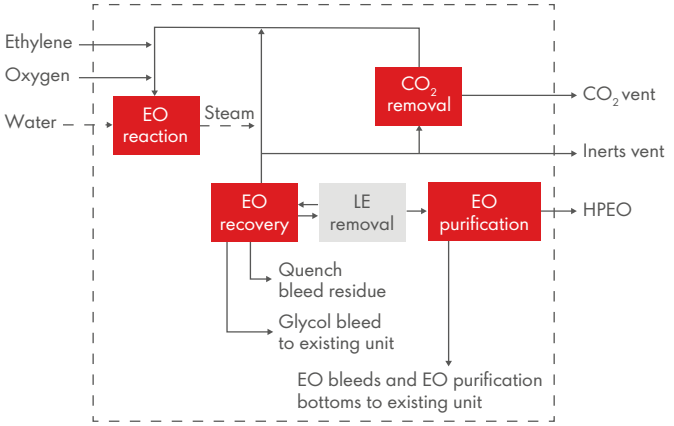


Figure 2: The new train to be added.

The producer chose the third option, adding a new train, which leveraged an existing Shell Catalysts & Technologies 120 EOE kta train design that would provide the customer with an 85% capacity increase.

As shown in Figures 1 and 2, the new train will be similar to the existing one but produce only high-purity EO (no EO products). The bleeds from the new high recovery EO purification column are processed into the existing glycol section, in addition to the glycol bleed from the EO stripper, to reduce capex and take advantage of the lower loading in the glycol section of existing unit. The new train feeds into the unit's existing downstream section.

Although the new train was based on an existing design, Shell Catalysts & Technologies made a number of project-specific modifications. For example, it was closely integrated with the existing plant to enable it to process EO bleeds, and the new EO reactor design was modified so that latest generation catalysts could be loaded.

In addition, the team developed a new design for the EO purification column that would enable better heat integration with the existing plant. This helped to lower the overall steam consumption by some 30%.

To overcome the plot space challenge of adding a new train in an existing unit, the team worked closely with the engineering, procurement and construction contractor to define a plot plan to fit it into the existing area while meeting all technology and safety requirements.

CO-CREATING THE SOLUTION

"Key to the success of this project was our ability to work with the customer in a highly collaborative way. This is how we identified a solution that delivers on the three main objectives: We found ways to compress the timeline and to minimise the cost while nearly doubling the unit's capacity."

Luis Castro, Technical Service Engineer, Shell Catalysts & Technologies

VALUE DELIVERED

Duplicating an EO train design, intelligently integrating it into the existing unit, deploying latest-generation catalysts and applying sophisticated heat integration techniques helped to provide:

- **Fast implementation:** Shell Catalysts & Technologies delivered the basic engineering package in just 20 weeks; this would typically require at least 28 weeks for a completely new, tailor-made design.
- **Reduced capital expenditure:** Close integration with the existing plant helped to minimise the capital cost.
- **Low energy costs:** The energy-efficient design helped to cut the EO purification column's energy consumption by 30%.

For the customer, this project provided an extremely compelling investment. Adding 120 kta of EO capacity could be worth almost $20 million a year[1]. Implementation of the project has been delayed by the economic environment.

[1]Assumes ethylene cost of $950/ton and EO price of $1300/ton

TAKE THE NEXT STEP

Schedule a revamps consultation

SHELL CATALYSTS & TECHNOLOGIES
TRANSFORMING ENERGY TOGETHER

BACK

HOW SHELL'S GEISMAR EO UNIT #2 UNLOCKED A HIGHLY VALUABLE INCREASE IN CATALYST SELECTIVITY WITH A CO_2 REVAMP

DRIVERS

Shell Chemicals' plant at Geismar, Louisiana, was keen to modernise its ethylene oxide (EO) unit #2 to maintain its competitiveness. As a relatively old unit, it had high levels of carbon dioxide (CO_2) in the recycle gas, which were constraining the performance of its catalyst and limiting its cycle length.

ABOUT THE PROJECT

Technologists from the site joined forces with Shell Catalysts & Technologies for a CO_2 revamp project. Working together, the team implemented a series of changes over several cycles. As shown in Figure 1, these included installing equipment, such as:

- new CO_2 absorber packing [1];
- a recycle loop-gas pre-heater [2]; and
- a flash tank with a steam jet on the CO_2 stripper [3].

In addition, the team worked closely with Shell Catalysts & Technologies' alliance partner, Eickmeyer & Associates, and installed its Catacarb process. This technology, which is designed to bring the CO_2 content down to low levels, has an extensive track record for removing CO_2 from EO recycle gas.

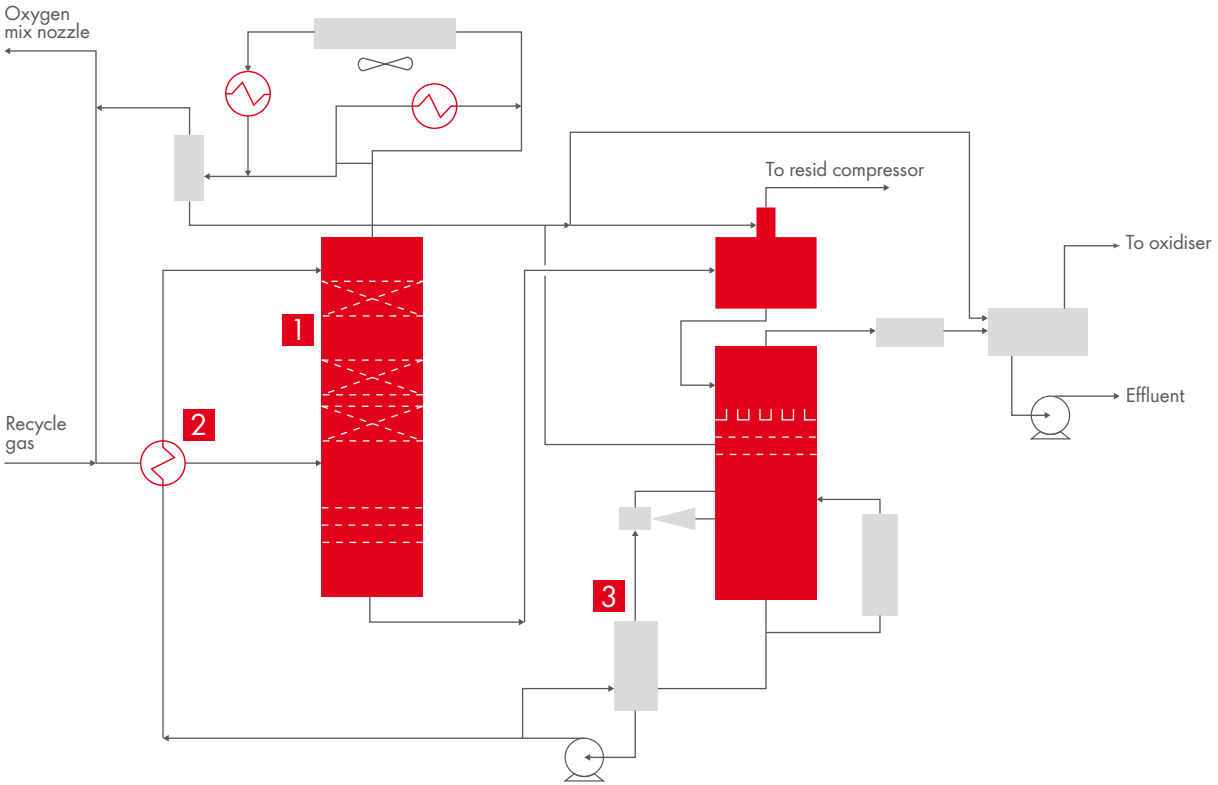


Figure 1: Geismar's EO process, with key revamp equipment additions shown in red.

CO_2 REVAMPS – THE BUSINESS OPPORTUNITY

"Because cash preservation has become a strategic imperative, we have seen a spike in interest in CO_2 revamps. They can provide major bottom-line value, principally for older plants. Modern unit designs tend to have lower CO_2 levels but there are many older designs out there that have high CO_2 levels, and a CO_2 revamp provides the opportunity to run a much better catalyst, or to run their existing catalyst for longer, which can be extremely valuable."

Don Scott, EO Catalyst Technical Consultant, Shell Catalysts & Technologies

FINDING THE SWEET SPOT

"A CO_2 revamp is a highly tailored programme that considers the customer's specific performance goals, the operational constraints of its asset and their available capital. Every EO plant is different and, typically, the older the plant, the more changes are required to reduce the CO_2 in the system. Typically, greater CO_2 reduction brings greater benefits, but requires more capital, so we usually work closely with the customer to find the sweet spot."

James Kau, Technical Manager, Shell Catalysts & Technologies

VALUE DELIVERED

This project, together with other simultaneous initiatives, helped the site to achieve:

- 50% lower start-of-cycle CO_2 concentration;
- 4% higher selectivity over the cycle; and
- 10% higher production rate.

Increasing a unit's catalyst selectivity can have a major impact on its economics. It means that smaller volumes of ethylene are needed to run the unit and less CO_2 waste is produced. For a world scale plant, ethylene savings for a 1% selectivity improvement could be above $4 million per year.

A similar project is being completed over several cycles for the site's second EO unit.

TAKE THE NEXT STEP

Schedule a revamps consultation

SHELL CATALYSTS & TECHNOLOGIES
TRANSFORMING ENERGY TOGETHER

BACK