Finding ways to turn down the gas

Prototype study sets framework for reduced plant CO2 emissions

One of the biggest challenges facing the chemicals industry is reducing CO2 emissions from manufacturing operations through energy efficiency and carbon abatement measures. A study carried out in the Netherlands has helped to establish the real potential for improvement and a methodology that can be applied at other Shell chemicals sites.

The Moerdijk plant in the Netherlands has been used to develop a framework for a range of realistic and measurable energy efficiency and carbon abatement measures to reduce emissions.

The Shell Group is striving to achieve 1st quartile energy efficiency/CO2 performance for the majority of its assets. A detailed prototype study conducted at Moerdijk in the Netherlands has helped to highlight methods, technologies and routes for how its chemicals plants can get there.

The study set out to establish exactly what the potential was for improving energy efficiency and reducing CO2 at a typical chemicals site. It looked at different types of improvement projects, ranging from simple incremental steps achieved by running and maintaining plants more effectively and applying the "best available technologies", through to game-changing opportunities for managing utilities, using alternative feedstocks and adopting emerging carbon abatement technologies.

MEASURABLE POTENTIAL

"To take a more strategic, integrated approach to improved CO2 management we need to know what the real measurable potential is to save energy or reduce emissions from our operations, and to better understand the cost/benefit of implementing different kinds of measures," says Stephen Kinder, Shell Chemicals CO2 Strategy Manager.

"Under the current cost of CO2 economics it's important to be able to focus on the 'quick wins' now, while preparing and planning for step-change tactics that will require significant investment in technology and/or infrastructure over the medium and long term."

He says the output of the Moerdijk study will provide a methodology framework for similar studies at other Shell chemicals

sites, depending on current performance, scope for improvement and investment required.

"Each chemicals site is different but they all involve complex, energy intensive operations. Improving efficiency is not a new activity because energy is always a large cost element in chemicals manufacturing, but having a framework of options, technologies and implementation plans will enable us to execute the most effective measures globally."

Significant progress has already been made at many Shell sites, with an overall increase in energy efficiency of around 9% since 2001. Operational improvement projects at Moerdijk have helped to achieve 1st quartile ranking in terms of cracker energy efficiency, which made identifying opportunities for further improvements a challenge for the study team.

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> **Joop van der Steen, Energy Management specialist, Shell Global Solutions.**

NO EASY OPTIONS

"We knew there would be no easy options because if they existed they would already have been taken," says Joop van der Steen, an Energy Management specialist from Shell Global Solutions, who led the study. "But identifying these opportunities at Moerdijk provides a lot of scope for other sites that may be starting from a lower base."

The challenge was to bring together operations, engineering and technical teams from the site and come up with realistic and achievable opportunities to take the next steps in improving both energy and CO_2 performance.

"Current industry benchmarking offers a good comparison of performance against other industry players using proven methods but doesn't give you the full picture of what is technically possible," says van der Steen.

"We set out to examine all the options and their likely impact, which includes methods or technologies that are not yet widely employed."

One of the first objectives was to assess the progress of work already done and to better understand the drivers of current performance. "We had to establish a base level from which we could determine the impact of future regulation on the site's performance, both in terms of energy and emissions, and to assess the likely impact of improvement plans," says van der Steen.

"Data from previous studies, once validated, gave us a good starting point and helped to confirm the measures that had already been employed and which were working."

The team went on to focus on two main areas: further operational improvements that could be employed in the short term by making better use of energy and heat on the site; and longer term strategic options for the supply of utilities, use of alternative feedstocks and fuels, and adoption of carbon capture technologies

"Although there has already been significant progress at Moerdijk in terms of energy efficiency, it is a constantly moving target. We are continually challenged to keep making incremental improvements in order to just maintain 1st Quartile status," says Melissa Rodriguez, a CO_2/Energy Technologist from the site who participated in the study.

"As part of the study we looked at the way plants are configured, opportunities for upgrading equipment or process technologies, and overall ways to optimise the use of energy and heat across all the units. We also had to be sure that any gains in efficiency would actually deliver lower CO_2 emissions rather than just higher plant throughput."

Moerdijk's ethylene cracker, which is a large contributor to the site's CO_2 emissions, came under particular scrutiny. "Even the validity of the cracking process was challenged by the study team, but the results of this exercise and analysis of other external studies confirmed that steam cracking still offers the most viable method of ethylene production at the site," says van der Steen.

Areas for improvement were identified, however, including reducing waste heat from flue gases, lowering furnace temperatures and ensuring that maintenance regimes are designed to keep the plant running at optimal levels. Other opportunities involve extending the cracker's ability to more use of lighter feedstock such as liquefied petroleum gas.

The CO_2 prototype study at Moerdijk looked at every aspect of the site's operations that impact energy use and emissions.

BIG WINS

Of more strategic significance, however, were the 'big wins' the study highlighted for the longer term. These focused on methods used to supply utilities and generate energy, and carbon abatement techniques – all of which require substantial investment and infrastructure but have the potential to make a step change improvement in performance.

Ideas explored included making more use of efficient cogeneration plants, using alternative fuels for both power generation and furnaces, exporting waste energy and the application of carbon capture and storage technologies.

While some of Moerdijk's heat and power already comes from a cogeneration unit, the full cost/benefit of cogeneration can only be realised on a large scale, where the significant investment required can be shared with other users," says van der Steen.

The configuration and performance of Moerdijk's ethylene cracker, a large contributor to CO_2 emissions due to the high operating temperatures involved, came under close scrutiny as part of the study.

Technology for carbon capture and storage (CCS) is still in its infancy but results of the study suggest it could also have a major role at chemical sites such as Moerdijk, if cost effective methods for extracting pure CO_2 from emissions streams can be achieved.

The Shell Group has identified CCS as a key element of its greenhouse gas strategy and as the economics of carbon abatement change, investment in the infrastructure and technology for these longer term options could accelerate.

"Although there is still uncertainty over the future direction of legislation and global agreements on CO_2, the cost of emissions is likely to continue rising," says Kinder. "We need to understand and be prepared to develop these options for low carbon operations as they become technically and economically viable."

The framework that emerged from the Moerdijk study has led to development of similar studies and improvement plans at other chemical sites around the world. "The prototype study has been key to generating the data and methodologies that enables us to start making smart choices over routes to improved energy efficiency and CO_2 reduction," he says.

"Having this framework will help to ensure that as we implement our carbon and energy master plans we allocate capital in areas where it will have the biggest impact on the Shell Group's overall energy and emissions performance."

For more information on Shell's response to climate change please visit: **shell.com/climate**

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> **Melissa Rodriguez, CO_2/Energy Technologist at Moerdijk.**