FCC additive cuts delta coke

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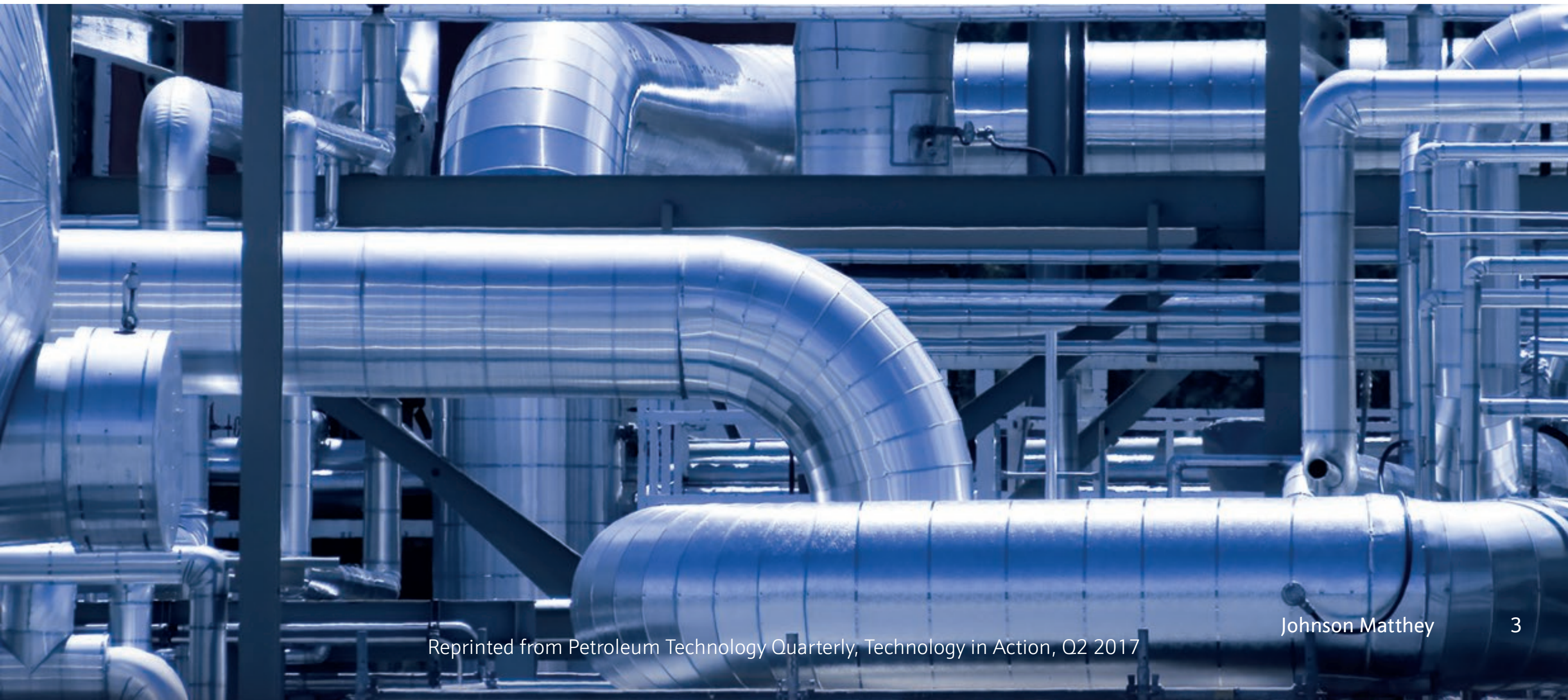
Tom Ventham, Johnson Matthey Process Technologies

In the majority of cases, the most profitable fluid catalytic cracking (FCC) units are the ones that are operated consistently against one or more operational process limits. Hitting more than one limit suggests the FCC operator is exploring the full envelope of this flexible unit to squeeze every last benefit from the process. In Johnson Matthey's experience the larger FCC units in the world are operating in this capacity, making it a highly competitive marketplace and providing true incentive to push the FCC operation to become ever more profitable.

The common limitations in FCC are maximum regenerator temperature, wet gas compressor volumetric throughput and air blower capacity. These limits are, to different extents, affected by delta coke. Since the first commercialisation of zeolite based FCC catalysts, suppliers have focused a significant part of their R&D work in the last decades on producing lower and lower delta coke catalysts. As a result, improvements in delta coke through recent successive generations of FCC catalyst technology are incremental and can be within the error band of an operating FCC unit (delta coke being a calculated value relying on the accuracy and reliability of several measurement devices including the flue gas analyser).



Johnson Matthey has produced a novel additive, **LO-COKER**™, which when added to a wide range of commercial FCC units consistently reduces delta coke in the order of 10%. This is a significant shift in delta coke when a catalyst system has already been optimised. FCC operators who are limited by constraints now have the room to push the operation of the unit further for increased profitability.

A delta coke reduction of 10% is consistently observed regardless of the FCC unit type, catalyst platform or supplier, type of feed processed, or operating mode targeted. Any refiner limited by maximum regenerator temperature or the ability to make significant changes to the unit operation now has the opportunity to take advantage of the benefits of delta coke reduction through the use of a delta coke reducing additive.

How can reductions of delta coke be valorised? That is the key question prospective users of **LO-COKER** must consider as reducing delta coke has no direct value in itself but the opportunities the reduction of delta coke provide is where great value is realised. Reduction in delta coke allows conversion to be increased, higher feed rates and processing of more refractory feeds. The reduction of feedstock value through increased residue processing provides a large economic benefit.

The negatives of processing poorer quality feeds may also be partially or fully offset with the use of **LO-COKER**. The first is the possible deterioration in yield selectivities when increasing feed metals, but with built-in metal trapping functionality this additive typically affords equal or improved conversion at higher metals levels. The second is the implication of increased SOx emissions when processing a greater proportion of sour residue components, or when the sulphur speciation of residue feeds tends to higher SOx even if total feed sulphur is maintained constant. Johnson Matthey's **LO-COKER** is based on a SOx-additive-like substrate, therefore SOx reduction is always observed when employing the additive, typically in the range of 40-60% in full burn operations.

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Allowing the processing of increased Concarbon feeds can give other opportunities when viewed from an alternative perspective. For example, other approaches of achieving a reduction in regenerator temperature include the installation of a catalyst cooler. Installation of such equipment, either in a new plant build or a retrofit project, is highly costly when compared to an additive solution such as **LO-COKER**, giving similar benefits at a fraction of the cost. To illustrate, Johnson Matthey was able to achieve 10% delta coke reduction in a 90 000 b/d residue FCC unit, which is the equivalent of installing a catalyst cooler with a duty of 27 MW.

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Alongside the 10% reduction in delta coke and 40-60% SOx reduction (in full burn), users of the additive also experience a reduction in dry gas. This change in dry gas is mainly a reduction in hydrogen make (see Figure 1). Due to the low molecular weight, when the volumetric throughput of the wet gas compressor is limiting for the operation, hydrogen can be the most challenging dry gas component. Alleviating the wet gas compressor constraint allows for feed rate increases, increased conversion, higher addition of ZSM-5 additives, and increased residue processing. Manipulating operating variables through the use of **LO-COKER** to push the FCC unit back against multiple constraints allows significant potential to improve refinery economics.

The methods by which **LO-COKER** achieves substantial reduction in delta coke and process benefits are numerous. A significant component of the reduction is the metals trapping ability on the separate particle, allowing the main FCC catalyst to work more efficiently. However, this is not the only mechanism as otherwise the additive would not give the consistent benefits observed in low metals operations. Other elements include a synergistic effect with the FCC catalyst matrix to improve pre-cracking of refractory molecules, enhanced porosity for improved stripping, and functionality for more efficient heat transfer through the FCC process.

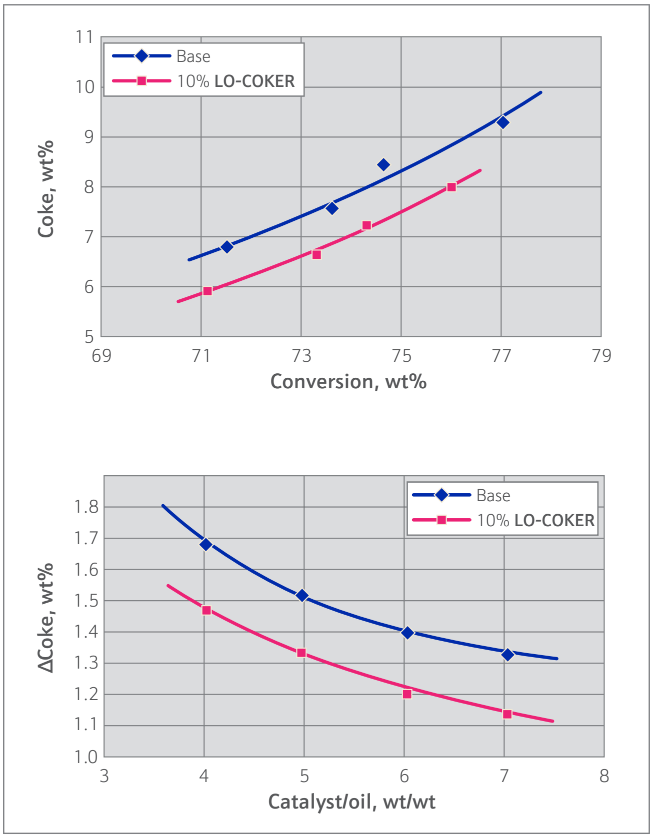

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Figure 1. A reduction in delta coke of 10% with **LO-COKER** enables higher conversion, higher feed rates and processing of more refractory feeds

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Note: The data shown here are a result of extensive laboratory work carried out by Johnson Matthey to optimise the formulation of this new FCC additive. ACE pilot plant studies use a fresh catalyst formulated for moderate residue operation as a base case. Both sets of fresh catalyst and the 90/10 blend of fresh catalyst and **LO-COKER** additive are deactivated following the standard deactivation procedure: metal deposition on 11 cracking/regeneration cycles targeting 2750 ppm of vanadium and 1650 ppm of nickel, and steam deactivated at 788°C for 10 hours with 70% steam.

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Billingham, UK
Tel: + 44 (0) 1642 553601
Tel: + 1-732-223-4644
www.matthey.com

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