Custom catalysts: Key enablers to sustainable solutions for the petrochemical industry

Radhika Rao
Evonik Catalysts

Given the almost universal presence of petrochemicals as building blocks for goods of our everyday life, it is no surprise that there has been significant growth globally in their industrial production. However, opposition arises from the fact that petrochemicals are derived from petroleum, via refining. But where there is opposition, there is opportunity – particularly in the realm of sustainability. Research shows that cleaner and sustainable production can contribute to the economic growth of companies and provide competitive advantages.

Catalysts as key enablers

Petrochemical companies are typically interested in improving their existing process or developing a new process to produce the target molecule in a more efficient or sustainable manner, using circular raw materials.

In these cases, the development of new catalysts is vital as catalysts are the key to making processes more efficient and a necessity in facilitating an entirely new process. As the enablers of said processes, catalysts are the main factor in the realm of sustainability and the key driver for improving the carbon footprint for the petrochemical industry.

Custom catalysts development models

For many petrochemical applications, catalysts are developed specifically for a process with the objectives of performance, process efficiency, or carbon footprint improvements – known as custom or tailored catalysts. Often the application process owner seeks the support of a catalyst manufacturer for development and/or manufacturing. In such custom catalyst projects, four cooperation models are common, and supported by existing players to a varying extent.

❶ Joint Development

When a new catalyst is designed alongside a new process, a joint development model can be used. This venture allows for experienced catalyst manufacturers to help develop and define processes for their customers – ones that are resource efficient, whilst producing a catalyst that offers distinguished performance.

An example to illustrate such a catalyst and process development collaboration is the joint development from Vinnolit and Evonik, to produce polyvinyl chloride (PVC) more economically and sustainably. PVC is produced using the vinyl chloride monomer (VCM), the synthesis of which can create toxic chlorinated byproducts; in 300 kta of VCM production, this could be a figure of 860 tons. However, Evonik's fixed-bed catalysts tailored to the selective hydrogenation of acetylene in VCM recycle streams help avoid these undesired byproducts, also lowering costs of separation and disposal of byproducts. Further development of the catalysts also offers increased levels of activity at a low palladium content along with excellent robustness in the process.

❷ Custom Design

Where the process is already fixed, a catalyst can be tailored to it. Solutions can range from a drop-in catalyst replacement for an existing system to fine-tuning catalyst properties to achieve higher process efficiency, conversion and selectivity, lower attrition and downtime, easier downstream processing, or even new product properties.
An example of this model is Technip's Hummingbird ® technology, transferred to the commercial scale with the help of a custom designed catalyst from Evonik. Herein, ethanol is converted to ethylene with high activity and selectivity by operating at a lower process temperature, as compared to the state-of-the-art technologies. The process also offers feedstock flexibility and ease of separation. The advantages of this technology were strongly facilitated by the custom designed catalyst.

❸ Custom Manufacturing

If the process has already been developed and a catalyst recipe exists at a lab scale, there are opportunities for modifying said recipe, and scaling it up to specifically improve the process, catalyst, and performance. This custom manufacturing model can result in reduced byproducts and emissions, as well as offer raw material savings.

An instance of such a custom catalyst project – and a clear example of how the carbon footprint of petrochemical and refinery processes can be improved – is the Evonik cooperation with Gasolfin; the sole owner of a fully patented process to convert low value (bio)naphtha and pyrolysis oils to high value (bio)propylene up to 45 wt% in refineries and petrochemical plants. Its process requires much less energy and operational costs than state-of-the-art propane

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dehydrogenation processes, while halving CO_2 emissions. The catalyst formulation and recipe invented and patented by Gasolfin was modified and scaled up by Evonik to allow for smooth commercial production. With the enhancements of catalyst properties and scale of manufacturing, the process at Gasolfin received an additional boost in terms of process efficiency with regards to energy usage and product yield.

❹ Toll Manufacturing

To support manufacturing of established catalysts at a competitive cost position while providing additional capacity and flexibility – including the avoidance of capital expenditure spending – toll processing is another mode of collaboration, where the customer has a catalyst that is already produced at commercial scale along with its specifications. Herein the reliable production network and capacity of catalyst manufacturers can be leveraged. As an established player in larger scope toll manufacturing of catalysts, Evonik works with about 50% of leading global chemical and other catalyst manufacturers in toll manufacturing relationships.

The models shown above are four examples of how custom catalyst development can be handled. However, in reality the process can be complex and the lines between them may blur. This is where companies that are both catalyst and process engineering experts, like Evonik, can provide a full technical solution package and cater to specific requirements.

Regardless of the route chosen, there is an opportunity for sustainability to be enabled with the support of such a partner. Alongside increased productivity and better quality of the end product, optimized tailored catalysts also lead to minimizing energy consumption and reducing waste generation, which are significant sustainability outcomes. More specifically, modifications can result in better tolerance of raw material impurities, important for biogenic and circular sources. It can also result in a longer lifetime for the catalyst, and lower capital expenditure – both of which have positive financial implications for the client long-term.

Summary

Regardless of the oft-negative public spotlight the industry receives, petrochemicals remain a necessity in today's world. However, consumers, organisations and even government entities are placing increasing focus and mounting pressure on the sustainability credentials of the companies they interact and work with. It has never been more important to prioritise more sustainable processes, and the right tailored catalyst provides the opportunity to improve processes and deliver benefits in the realm of sustainability, whilst positively impacting operational efficiency and price competitiveness.

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