

Research topics

Hydrogen Integration in Oil Refining

Dr Nan Zhang

Abstract

This project provides a methodology for analysing the use of hydrogen resources in a refinery. The analysis gives insights into process design and operations planning, and suggests a new way of thinking about refinery design and operation.

Project description

There is a worldwide trend towards using crude oils that contain more long-chain hydrocarbons ("heavy ends") and organic sulphur. To obtain the best value from these heavy crudes, refiners must be able to convert heavy-end compounds to lighter fractions that can be blended with gasoline or diesel oil. Sulphur must also be removed, and legislation is placing increasingly tight limits on the sulphur content of fuels. Both sulphur removal and cracking can be carried out by hydroprocessing operations. The performance of these processes can be substantially improved by better understanding of the chemistry of these operations and the integration of hydrogen in the refinery. At the same time, regulations on gasoline composition are constraining reformer operation and removing some of the sources of hydrogen traditionally available to refineries. Different methods of providing refinery hydrogen include recovery from fuel gas and tail gas, dehydrogenation processes, heavy-end gasification, steam reforming and outside purchase. Systematic methods for identifying hydrogen needs and available production are needed in order to optimise site performance and maintain the flexibility to run different crude oils while ensuring maximum equipment utilisation.

A methodology for the assessment of hydrogen resources has been developed. The results can be presented in a simple, graphical manner, which gives the engineer insights into process design, sensitivity analysis and operations planning. Targets can be set for hydrogen recovery and hydrogen plant production. Targets also give insights into the effective use of hydrogen purification units.

Methods have been developed for the design of hydrogen distribution networks and to consider means by which refinery throughput and profitability can be increased through manipulation of the hydrogen distribution system. The design methods have been automated and take account of distribution costs associated with pipework and compressors. Basic changes to the refinery processes being served by the hydrogen system can also be exploited systematically to improve the overall refinery profitability. The hydrogen management method has now been applied in a number of industrial case studies.