

PERP Program

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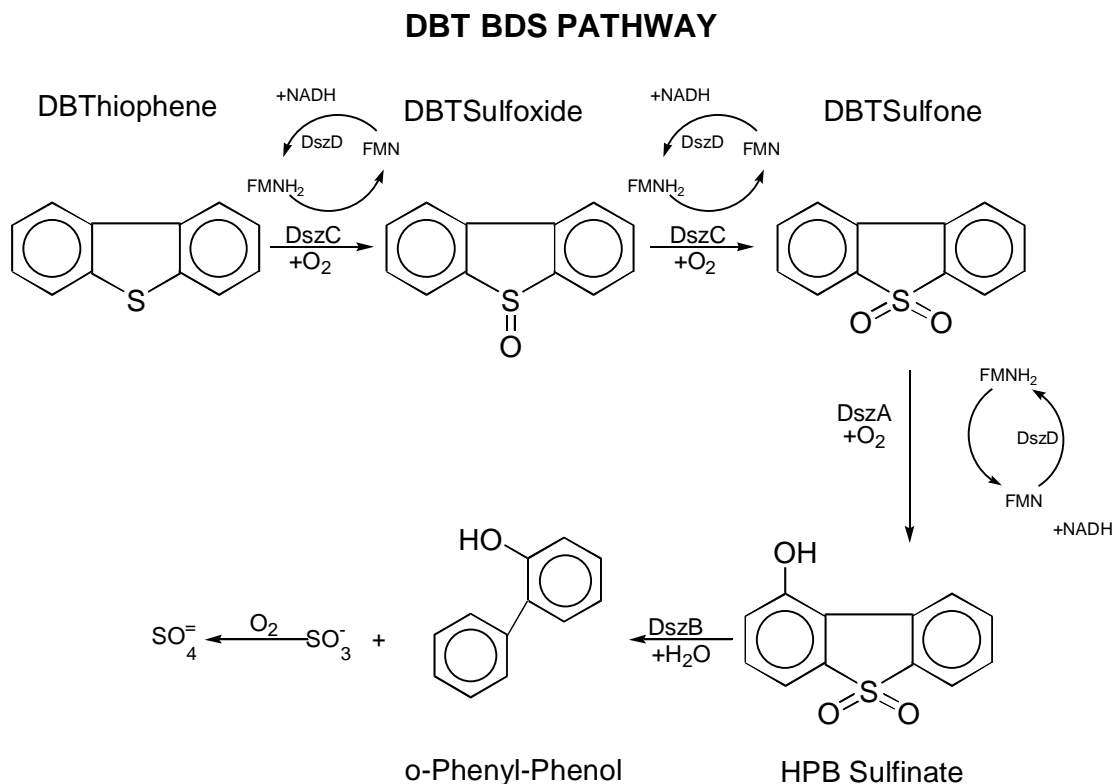
Chem Systems' Process Evaluation/Research Planning program has published a new report, ***Biodesulfurization of Petroleum Fractions (98/99S7)***.

Biocatalytic desulfurization (BDS) of petroleum distillate (particularly, road diesel fuel) is one of a number of possible modes of applying biologically-based processing to the needs of the petroleum industry. The technology considered in this report, that being developed for commercialization by Energy Biosystems Corporation (EBC) of Woodlands, TX, is based on a genetically-modified bacterial strain, as is typical of industrial biocatalytic processes being developed today. EBC and others are also working on developing biocatalytic processes for otherwise upgrading distillates and other petroleum fractions in refineries, for upgrading crude petroleum upstream, and for dealing with environmental problems of the industry. These developments are part of a wider trend to use bioprocessing to make products and do many of the tasks that are accomplished currently by conventional chemical processing. If commercialized for refineries, however, biologically-based approaches will be at scales and with economic impacts beyond anything previously seen in industry.

Refiners are being critically challenged today to upgrade their capacity for making diesel fuel, while the sulfur specifications for diesel are becoming more severe throughout the world. At the same time, they face dwindling supplies of light, low sulfur crude oil that favor distillate production. Average sulfur levels in petroleum crudes continue to rise, which also tend over time to be heavier, yielding more residuals and requiring more severe processing to make gasoline and other light fuels. Refiners that have configured their facilities for gasoline production must increasingly process its highly aromatic distillate byproducts, such as light cycle oil, for the additional feedstock to produce more distillate.

The BDS process being developed by EBC is based on naturally occurring aerobic bacteria that can remove organically bound sulfur in heterocycles of petroleum without degrading the fuel value of the hydrocarbon matrix. The process operates at ambient temperature and pressure and uses air to promote the consumption of sulfur. The biocatalyst has been genetically engineered to have a high level of enzymatic activity for the selective oxidation of sulfur in diesel fuel and to produce a water-soluble organic sulfonate product if desired. The sulfonate can be oxidized and reacted to produce a water-soluble sulfate salt, leaving the heterocyclic compound in the organic phase, thus minimizing the loss of diesel fuel. The process is still in a developmental phase and has recently been improved to maximize the rate of sulfur removal and extend biocatalyst life, thereby substantially reducing capital and operating costs. The biodesulfurization pathway, using dibenzothiophene (DBT) as a model substrate is shown on the next page.

An economic case was modeled that illustrates the comparison of the two routes for achieving advanced low-sulfur diesel specifications, starting with current levels of HDS sulfur reduction. Chem Systems examined the costs of a BDS route compared to a stand-alone HDS technology as a revamp to an existing, less severe HDS. In each case, the feed material was, in effect, today's standard U.S. diesel fuel, a hydrotreated (500 ppm sulfur) mixture of straight run gas oil and light cycle oil.



In Chem Systems' view, HDS performs well in removing about 80-90 percent of the sulfur-bearing species in distillates, and increasingly poor on removing the rest, while BDS performs best on this residual. That is, the substituted polyaromatic sulfur-bearing species that are characterized as the typical marker, dibenzothiophene (DBT), are the hardest to convert by HDS, but are most susceptible to the BDS enzymatic route. Clearly, this reality calls for the hybrid application of these two technologies. This study discusses several potential hybrid configurations, and several refinery scenarios that may embody them.