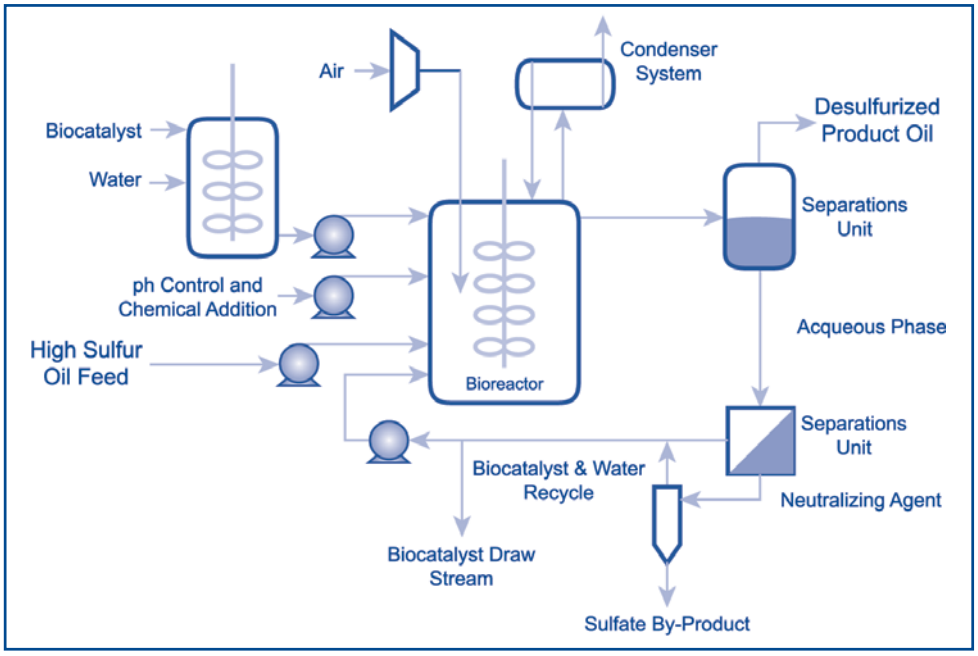
Industrial Technologies Program

Gasoline Biodesulfurization

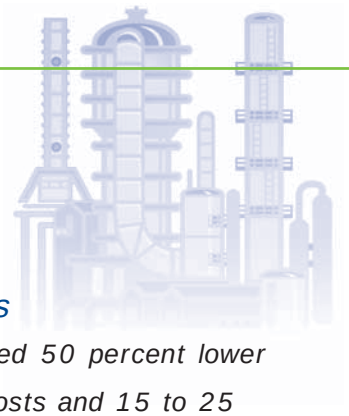
Biodesulfurization Will Yield Lower Sulfur Gasoline at Lower Production Costs

The biological removal of sulfur from gasoline, a process called biocatalytic desulfurization (BDS), may offer gasoline producers an innovative approach to both energy and cost savings over conventional technologies. Conventional hydrodesulfurization (HDS) is an expensive and energy-intensive process requiring high temperature and pressure. Expensive collateral processes are required to generate hydrogen and to convert the main process by-product, hydrogen sulfide, from a toxic, odorous gas into an acceptable product such as elemental sulfur. In addition, the HDS process saturates olefins in the gasoline, which deteriorates product quality by lowering octane rating.

BDS offers potential cost savings because the process operates at ambient temperature and pressure and produces a non-toxic by-product eliminating the need for collateral processing of hydrogen sulfide. In addition, the process offers the potential to produce a value-added end-product containing sulfur. Biocatalysis is highly selective with the ability to target individual or defined groups of sulfur-containing species, thereby minimizing side reactions. Consequently, BDS retains the quality and value of the gasoline produced.



Preliminary bench-scale process design to test gasoline biodesulfurization.



Benefits

- *Anticipated 50 percent lower capital costs and 15 to 25 percent lower operating costs than HDS*
- *BDS does not degrade octane in gasoline*
- *BDS does not require high temperature or pressure*
- *Improved environmental performance at projected lower cost*

Applications

Biodesulfurization may be applied to FCC gasoline to reduce the sulfur content in pool gasoline to less than 200 parts per million (ppm). BDS is especially well suited to refineries that process high-sulfur crudes but lack residue upgrading capabilities.

Project Description

Goal: Develop a biocatalyst and define a process schematic to reduce the sulfur content of FCC gasoline to 100 ppm.

Biodesulfurization Biocatalyst Development

Researchers identified several bacterial strains capable of utilizing thiophenes (T) and benzothiophenes (BT) as the sole sulfur source. The genes responsible for the sulfur biotransformation from the most promising strains were isolated, cloned, and evaluated for effectiveness in T and BT conversion. Attempts to overexpress the genes in gasoline-tolerant bacterial strains were successful in a few cases, but the recombinant bacterial strains demonstrated little to no sulfur biotransformation activity against gasoline in bench-scale tests.

Nearly 70 bacterial strains were screened for gasoline resistance and the best of these were grown in continuous culture in the presence of gasoline. One bacterial strain (PpG1) outperformed the rest and was chosen as the best candidate for further development as the gasoline biodesulfurization host.

Gasoline Biodesulfurization Process Design and Performance Model Development

The results of the PpG1 continuous culture experiment established the conditions for growth of a gasoline-tolerant bacteria and were used as the basis of the preliminary gasoline biodesulfurization process design. Using the preliminary process design and an assumed biocatalyst conversion rate, researchers constructed a performance model based on a 20,000 barrels-per-stream-day unit that would reduce gasoline sulfur content from 350 ppm to 35 ppm.

Results

- Developed and evaluated multiple biocatalyst systems for the biodesulfurization of gasoline.
- Constructed mutant library of a gene with increased activity against C3- and C4-thiophenes and benzothiophenes. Analysis methods were developed and a preliminary analysis of the library performed.
- Developed preliminary gasoline desulfurization process design and model based on assumptions made from experimental results.

Project Partners

Enchira Biotechnology Corporation
The Woodlands, TX

Coordinating Research Council
Alpharetta, GA

Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

A Strong Energy Portfolio for a Strong America

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