Conversion Extraction Desulfurization Process

DE-FC26-01BC15281

Program

This project was selected in response to DOE's Ultra Clean Fuels solicitation DE-PS26-00NT50758.

Project Goal

The goal of this work is to demonstrate the feasibility of using the Conversion Extraction Desulfurization (CED) process to reduce sulfur in diesel fuels. This assessment will include both lab and bench-scale experimental work to test technical feasibility. An economic evaluation of the process also will be carried out to demonstrate financial viability.

Performer

Petro Star Inc.
Anchorage, AK

Degussa Corporation
Parsippany, NJ

Project Results

On September 20, 2001, DOE contracted Petro Star Inc. to develop its CED process to remove sulfur from diesel. Petro Star, a small Alaskan refiner, joined with Degussa Corporation to evaluate the technical and financial viability of the process. Degussa worked extensively on developing process engineering models of the CED process that were based on realistic feed compositions and thermodynamics.

The CED process development team demonstrated that CED technology is capable of reducing the sulfur content of light atmospheric gas oil from 5,000 ppm to less than 10 ppm at the laboratory scale. In continuous flow trials using rented equipment, the sulfur reaction capability of the process fell short of the 15 ppm goal by producing fuel with about 20 pm of sulfur. As a result, the technical development for the project was scaled back considerably, while a marketing study was completed.

Kline Company performed a marketing study to evaluate the possibility of licensing the CED technology. Kline found that, out of 143 refineries in the United States, 93 have crude oil capacity of less than 150,000 barrels per day and therefore qualify for various regulatory exceptions to the Environmental Protection Agency's (EPA) mid-2006 compliance on producing ultralow-sulfur diesel fuel. Kline interviewed top management in 43 of the 93 refineries. The conclusion from these interviews was that only 13 refineries harbored an opportunity for the CED process.

Petro Star's refinery at Valdez, AK. Photo courtesy of Petro Star.

Degussa personnel visited 4 of the 13 refineries in December 2002 over a four-day period. All four refineries were in the Petroleum Administration for Defense District (PADD) 3 (Gulf Coast States) and 4 (Mountain States) regions of the US. All of these refineries use moderate-pressure hydrodesulfurization to produce highway diesel fuel with sulfur content less than 500 ppm. The management of these refineries had an open mind toward alternate desulfurization technologies, especially if the technology could produce ultralow-sulfur fuel at a lower operating cost. Unfortunately, only one of the three refiners was interested in delaying compliance past mid-2006.

Based on the information in the Kline marketing study and on the four refinery visits, the research team decided that further investment in the technical development of the CED process is not warranted.

Benefits

Petro Star is developing the CED process to compete with standard hydrodesulfurization technologies. This will be of particular benefit to small and medium-sized refineries that do not have hydrotreating capability. The CED process does not require costly hydrogen processing, high temperatures, or high pressures. The process selectively oxidizes sulfur compounds and removes them at near-ambient conditions. It also removes nitrogen-containing compounds and aromatics that adversely affect diesel quality.

Background

EPA has ruled that diesel fuel must contain <15 ppm sulfur by 2006 (with some exceptions). In order to comply with these regulations, refiners will have to change the processes that they are now using. The primary method for removing sulfur from distillates is hydrotreating. Hydro- desulfurization (HDS) processes consume large amounts of hydrogen, require catalysts that are easily poisoned, and operate under severe temperature and pressure conditions. These conditions result in expensive capital and operating costs. There are also disposal problems associated with spent catalysts and the by-product formation of elemental sulfur. HDS cannot remove sulfur from the more complex thiophenic compounds without more severe operating conditions than are presently used in most hydrotreaters. These increased costs may force small and medium-sized refineries

out of the low-sulfur fuel market. Many of these refineries do not have hydrotreaters now and cannot justify their construction. Others cannot economically make the upgrades that will be needed. These refiners need a process that is not prohibitively expensive for them that will remove sulfur to the necessary levels.

Project Summary

The following steps were taken to evaluate the technical and economic viability of the CED process:

- Develop and optimize CED process.

  –Pilot-scale process validation tests. The pilot-scale testing was done by a contrac tor. Degussa and Petro Star personnel provided information on previous work, supervised tests, reviewed data, and incorporate the information into models.

  –Continued optimization tests. This entailed continuing laboratory testing to take advantage of pilot-scale work.

- Economic evaluation.

  –Pilot plant conceptual design. Degussa completed the conceptual engineering design and cost estimate for a 50 barrels per stream-day pilot plant.

  –Update market information. A third-party firm was contracted to conduct a market study. Petro Star and Degussa developed the specifications for this study, especially those aspects that involve the analysis of competing technologies.

Current Status (October 2005)

This project is complete. It had two major successes. Petro Star and Degussa were able to reduce the sulfur in diesel from 3,500 ppm to <20 ppm in a bench pilot plant without process optimization. Then they off-ramped the project, based on an economic evaluation of developing the process to where it could be used in a refinery. There was not enough potential for licensing to justify further development costs.

Publications
The final report has been published.

Project Start: September 20, 2001
Project End: December 30, 2004

Anticipated DOE Contribution: $1,296,060
Performer Contribution: $1,100,663 (46% of total)

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