

Desulfurization from Gas Oil: sulfur removal of gas oil to 10 ppm

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1. Introduction

The source of energy most used in the world is crude oil. Major portions of the crude oils are used as transportation fuels such as diesel, gasoline and jet fuel. However, the crude oil contains sulfur, typically in the form of organic sulfur compounds. The sulfur content and the API gravity are the properties that have more influence on the value of the crude oil. The sulfur content is expressed as a percentage of sulfur by weight and varies from less than 0.1% to greater than 5% depending on the type and source of crude oils¹.

The removal of organo-sulfur compounds (ORS) from diesel fuel is the key to reduce air pollution, reducing the emission of toxic gases (such as sulfur oxides) and other polluted materials. The adsorption desulfurization process is one of the easily and fast method to remove sulfur from diesel oils².

The adsorptive desulphurization of gasoline over nickel based adsorbent, provide high capacity and selectivity for the adsorptive desulfurization of gasoline. The adsorption involves C-S bond cleavage as evidenced, forming ethyl benzene from benzothiophene in the absence of hydrogen gas.

The hydrodesulfurized straight run gas oil having less than 50 ppm sulfur is treated with activated carbon fiber to attain the ultra-low sulfur gas oil having less than 10 ppm sulfur, for example.

The next paragraphs describe the desulphurization of gasoline with some of the used methods.

¹Desulfurization of Gasoline and Diesel Fuels, Using Non-Hydrogen Consuming Techniques, Abdullah Al-Malki, King Fahad University of Petroleum and Minerals, October 2004

²Adsorption Process of Sulfur Removal from Diesel Using Sorbent Materials, Isam A. H. Al Zubaidy, Fatma Bin Tarsh, Noora Naif Darwish, Balsam Sweidan Sana Abdul Majeed, Aysha Al Sharafi, and Lamis Abu Chacra, Journal of Clean Energy Technologies, Vol1, No. 1, January 2013

2. Current Desulfurization Technologies

Diesel fuel is a multi-purpose petroleum fuel used in all transportation machines. It is also one of the largest sources of air pollution, having serious health impacts. Besides soot or fine particles, diesel fueled engines also emit nitrogen oxides that can form ground level ozone.

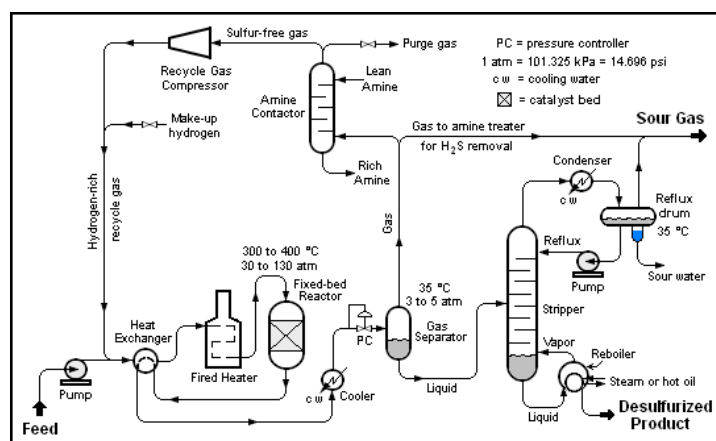
The following are the desulfurization processes currently in use, underlining in red which allow to reach a sulfate content of ~10 ppm.

Hydrodesulfurization (HDS)

Removing sulfur (S) from natural gas and from refined petroleum products (such as gasoline or petrol, jet fuel, kerosene, diesel fuel, and fuel oils) is widely done by HSD (catalytic chemical process). Removing the sulfur reduces the sulfur dioxide (SO_2) emissions that result from using those fuels in automotive, residential, industrial furnaces, etc.

Usually, the HDS process converts a number of organo-sulfur compounds to H_2S and sulfur-free organic compounds. This can be done through catalytic treatment with hydrogen at elevated pressures, between 150 and 3000 psi, and elevated temperatures, between 290 and 455 °C, using metal catalysts such as $CoMo/Al_2O_3$ or $NiMo/Al_2O_3$ ³.

Refineries may produce the ultra-low sulfur diesel (ULSD), controlling hydrotreating conditions and appropriate catalysts. For diesel, a two-stage deep desulfurization process is sufficient to meet the 10ppm sulfur target. The first stage reduces the sulfur level to below 250 ppm and second stage produces diesel product with 10 ppm sulfur about.



³Biodesulfurization of Petroleum Distillates-Current Status, Opportunities and Future Challenges, Olawumi O. Sadare, Franklin Obazu and Michael Olawale Daramola, Environments 2017, 4, 85.