

Chapter 1

Advanced Desulfurization Technologies and Mechanisms

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ABSTRACT

This chapter describes different desulfurization technologies used for the removal of sulfur from petroleum products or from refined products. These technologies include hydrodesulfurization and non-hydrodesulphurization such as extractive desulphurization, adsorptive desulfurization, precipitative desulphurization, oxidative desulphurization, and desulfurization by membranes. Types of reactors including batch and fixed bed reactors are discussed. The chapter also highlights some of the common mechanism to explain the desulphurization process.

INTRODUCTION

Overview of the Process of Crude Oil Refining

The oil and gas industry can be simply classified into three major divisions: upstream (or exploration and production- E&P), midstream and downstream.

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1. Upstream division involves exploring for crude oil deposits and the production of crude oil. The upstream division includes searching for potential underground or underwater crude oil and natural gas fields, drilling exploratory wells, and subsequently drilling and operating the wells that recover and bring the crude oil or raw natural gas to the surface. Examples of firms that would belong in the upstream segment of the industry include companies that own rights to drill for oil and companies that provide support services to the drilling segment of the industry.
2. Midstream division involves the distribution of crude oil to refiners; the refining of crude oil into saleable products; and the distribution of products to wholesalers and retailers. The midstream operations are often taken to include some elements of the upstream and downstream sectors. For example, the midstream sector may include natural gas processing plants that purify the raw natural gas as well as removing and producing elemental sulfur and natural gas liquids (NGL) as finished end-products.
3. Downstream division involves the refining of petroleum crude oil and the processing and purifying of raw natural gas, as well as the marketing and distribution of products derived from crude oil and natural gas. The downstream division reaches consumers through products such as gasoline or petrol, kerosene, jet fuel, diesel oil, heating oil, fuel oils, lubricants, waxes, asphalt, natural gas, and liquefied petroleum gas (LPG) as well as hundreds of petrochemicals. Gasoline stations are perhaps the most visible downstream companies, but companies that deliver heating oil or propane would also fall into this category. Note that some of the midstream operations are often included in the downstream category and are considered to be a part of the downstream sector.

The overall well-to-consumer supply chain for petroleum products can be illustrated as shown in Figure 1.

Desulfurization

After the crude oil is being treated in the distillation unit followed by several refinery processing, various refined products are obtained, Figure 2. Several sulfur-based compounds are available in refined products or petroleum. Examples are listed in Figure 3. Desulfurization is a chemical process for the removal of sulfur from petroleum. It involves the removal of sulfur from a molecule and/or the removal of sulfur compounds from oil/gas refinery streams. Desulfurization provides the bulk of sulfur used in industry (Claus process and Contact process), sulfur-free compounds that could otherwise not be used in a great number of catalytic processes, and also

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