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**SULFUR UTILIZATION PROSPECTS
IN SAUDI ARABIA**

by

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Purpose

The paper addresses the role of sulfur in Saudi Arabian hydrocarbon industry, its significance and the business prospects that it can potentially bring to investors with innovative sulfur utilization proposals or initiatives.

Background

Sulfur production in Saudi Arabia is the result of the recovery of sulfur dioxide at petroleum refineries and hydrogen sulfide at gas processing plants. This method of recovery of sulfur from hydrocarbon is considered to be non-discretionary production of sulfur versus the discretionary production of sulfur from pyrites and sulfur mining. Globally, approximately 75% of the sulfur production is non-discretionary and this percentage is likely to rise due to global hydrocarbon demand and stricter environmental regulations. In essence, the stability of the sulfur production and pricing is dependent on the level of hydrocarbon processing and this in itself is the reason why new applications and markets for the consumption of sulfur products is a prerequisite. New sulfur applications should be innovated to manage and control near term and long term surplus, for the benefit of hydrocarbon operating companies, its consumers and sulfur related downstream industries. In Saudi Arabia, approximately 95% of sulfur is non-discretionary, produced from the gas plants and as such a brief historical perspective of the Master Gas System (MGS) will follow.

MGS Historical Perspective

In the late 1970's, the Saudi Arabian government embarked on a program to gather the associated gas and its valuable associated products. The goals were to protect the environment by eliminating flaring, conserve the valuable gas resource, develop the foundation for an industrial base, and add value to the gas and its associated products. The MGS was launched, comprised of gathering systems, processing plants, fractionation plants, storage facilities, transmission pipelines, and export terminals. Exhibit #1 illustrates the MGS. While the initial MGS was designed to collect and utilize only associated gas, by the mid 1980's the amount of associated gas had declined caused by lower worldwide demand for oil, since associated gas exists in combination with oil and its rate of production is dependent on that of oil production. In order to meet the gas commitments and to provide secure supplies to customers, an exploration program targeting non-associated gas reserves was initiated, since non-associated gas exists independent of oil and may be produced as desired. Over the last decade, this program has added more than 1.5 trillion cubic meters (TCM) [54 trillion cubic feet (TCF)] of non-associated gas reserves to Saudi Arabia's resource base, more than doubling its proven non-associated gas reserves to about 2.75 TCM [97 TCF].

With 3.9 TCM [138 TCF] of associated gas reserves, the Kingdom currently holds the fourth largest gas reserves in the world of almost 6.65 TCM [235 TCF]. As these reserves were discovered, the country's national oil company, Saudi Aramco, executed plans for their expeditious development, doubling the raw gas processing capacity from 121 million cubic meters (MCM) [4.3 billion cubic feet per day (BFD)] in 1993 to the current 272 MCM [9.6 BFD].

Sulfur Production & Demand

Since associated and non-associated gases typically contain hydrogen sulfide and the governing environmental regulations are requiring the reduction of sulfur content of end products and ambient air, the amount of sulfur being produced will consequently rise with increased oil and gas production and processing. Sulfur production in Saudi Arabia is currently 2 million tonnes per year, increasing to 2.7 million tonnes per year in 2006 and in 2008, increasing by an additional 400,000 tonnes per year, resulting in total sulfur production of 3.1 million tonnes per year attributed to gas expansion projects and environmental regulations. Exhibit #2 illustrates the sulfur production in Saudi Arabia.

As an example, at Shedgum and Uthmaniyah Gas Plants sulfur recovery units are being upgraded to improve recovery efficiency to meet source emission and ambient air quality standards resulting in more than 300 tonnes per day of additional sulfur, at Riyadh Refinery two 70 tonnes per day sulfur recovery units are being installed to meet source emission and ambient air quality standards. Other projects include the installation of diesel hydrotreaters at Riyadh and Ras Tanura Refinery to produce low-sulfur diesel fuel for Saudi Arabia. As a result more than 600 tonnes per day or 219,000 tonnes per year of additional sulfur will be produced as a result of these environmentally related projects.

Currently only 60,000 tonnes per year of sulfur is being consumed locally while the remaining 1.94 million tonnes per year is exported. However, in year 2008 the local demand is projected to increase based on current sulfur allocation to Saudi Arabian Mining Company for the phosphate fertilizer complex at Ras Az Zawr in the eastern province of Saudi Arabia.

Sulfur Facilities

The main sulfur handling and exporting facilities are located in the Eastern province of Saudi Arabia. There are three refineries and five gas plants that produce molten sulfur. The molten sulfur is trucked, unloaded and stored at Berri Gas plant before being transported via a 21-kilometer-pipeline to Jubail export facilities for loading in ships. Saudi Aramco Shell refinery however, transports the molten sulfur directly via pipeline by injecting into the 21-kilometer-pipeline to Jubail export facilities. The Jubail sulfur export facility is the single major sulfur handling and exporting facility in Saudi Arabia. In the Western province of Saudi Arabia sulfur production from Rabigh, Yanbu, SAMREF, Jeddah, and Lubref are handled individually by each facility. Exhibit #3 illustrates the sulfur production, handling and exporting facilities in Eastern province of Saudi Arabia. These locations provide an indication of where potential new users of the sulfur may locate so that sulfur may be utilized to a greater percentage in Saudi Arabia.

Sulfur applications

Globally, more than 70% of the total global sulfur consumption is used in the fertilizer industries and the remaining 30% is used in non-fertilizer applications such as lead-acid batteries, detergents, rubber, pharmaceutical, paints and pigments. Historically the sulfur utilization in fertilizer businesses remains the largest single application of sulfur produced all over the world and new uses of sulfur have not been significant to stem the surplus situation of sulfur. Currently in Saudi Arabia, the sulfur is mainly used in fertilizer production by companies such as, the Saudi Arabian Fertilizer Company (SAFCO) and the National Establishment for Agricultural & Industry and in the future, the Saudi Arabian Mining Company (Ma'aden) will use sulfur to produce sulfuric acid which will be used in its production of phosphate fertilizers, such as diammonium phosphate (DAP).

To increase sulfur utilization locally, new sulfur based manufacturing opportunities need to be defined, capitalizing on the number and location of the various facilities that produce molten sulfur in Saudi Arabia. One such opportunity is the untapped market for Plant Nutrient Sulfur (PNS) which represents a major opening for increased fertilizer sales and the consumption of sulfur. The primary macronutrient for crops has been traditionally fertilizers that focus on Nitrogen, Phosphorus and Potassium (NPK), however, in terms of total volume requirements for plant growth, sulfur is typically considered as the fourth major nutrient for crops. Although NPK fertilizers contain sulfur element, their application is not adequate to satisfy soil and crop requirements, leading to dramatic world soils deficiencies of PNS based on studies and programs by "The Sulfur Institute & Marsulex Inc". They projected that the global PNS deficit will reach 12 million tonnes per year by 2010, while the current global PNS deficit is estimated at 8 million tonnes per year. In Asia and Africa they projected that PNS deficit will reach 7 million tonnes per year by 2010. By applying the required amount of PNS fertilizers an average of 15 - 20% increase in crop production was realized. Therefore PNS fertilizers offer an opportunity for increased sulfur utilization.

In non-fertilizer applications only 30% of the sulfur is used globally and currently Saudi Arabia mainly uses sulfur in producing soaps, detergents and acids from companies such as, the Modern Industries Company and Raez Sulphate Factory. Additional applications need to be identified in the future and one promising opportunity is Sulfur Asphalt which is understood to have been applied to some roads in Canada and other countries. The sulfur asphalt is a viable alternative to the normal asphalt cement which is the most common type of road binder. In June 2003 Saudi Aramco and ministry of transportation completed laboratory testing at King Fahad University of Petroleum and Minerals. Test mixture was prepared using commercially proven Sulfur Extended Asphalt Modifier (SEAM) binder from Shell-Canada, asphalt from Saudi Aramco and local aggregates. The laboratory testing showed that the technology is applicable to Saudi Arabia, especially for sulfur: asphalt ratio of 30:70 by weight (wt%) with acceptable stability, durability and with no noticeable short-term environmental hazards. With asphalt production of approximately 2 million tonnes per year for flexible road design using sulfur: asphalt ratio of 30:70 wt%, with about 5.2 wt% total binder of asphalt and SEAM content, the expected reasonable sulfur consumption is approximately 550,000 tonnes per year, which is a 25% increase in local demand of sulfur and with the reduction of sulfur prices, the sulfur asphalt future application shows promise.

The next step is the construction of a trial road section of approximately 1 kilometer in length starting in October 2004 with the objective of demonstrating the technology in the field and training local contractors. It is our understanding that trials by the sulfur institute have indicated that sulfur enhanced roads are stronger, resist rutting in the roads and are resistant to high local temperatures. Finally, building a binder plant in Saudi Arabia could be pursued, since the sulfur asphalt roads and the binder plant offer an opportunity for increased sulfur utilization.

Saudi Aramco New Business Development Organization

Sulfur applications are concentrated in the production of fertilizers globally and currently, limited applications exist to fully exploit this and other available resources from Saudi Aramco.

Accordingly, Saudi Aramco's New Business Development organization (NBD) was established in February 2003, to aggressively leverage Saudi Aramco's vast resources and capabilities to maximize private sector participation in Saudi Arabia. Encourage third party investment by acting as a catalyst or a partner and be single point contact for third parties proposing to pursue new and innovative business proposals with Saudi Aramco that will be established in Saudi Arabia.

Establishing new business in Saudi Arabia is made easier by the Saudi Arabian Government enabling framework. This enabling framework is based on pragmatic market liberalization, balanced with appropriate regulatory oversight, which best serve the long-term national interest. The Saudi Arabian Government has adopted efficient and transparent regulatory and fiscal framework to attract private investment, protect investor interests, and help achieve the Kingdom's vision for a booming and progressive private sector. Some key initiatives were the passage of the Foreign Direct Investment Law in April of 2000; the establishment of the Saudi Arabian General Investment Authority; the restructuring of both the electricity and telecommunication sectors; the reduction of import tariffs by half; the elimination of import barriers; the free movement of capital; and the well established protection of private ownership.

Conclusions

In Saudi Arabia sulfur production will increase with increasing sour gas production and even with projected growth in utilization of sulfur, there will still be ample supply of sulfur available to create new sulfur based industries in Saudi Arabia. Saudi Aramco NBD is looking for innovative proposals to develop new markets for sulfur utilization in Saudi Arabia by leveraging its resources and capitalize on the excellent investment environment that exists in Saudi Arabia.

References

1. The sulfur Institute
2. Marsulex Inc.; Peter Reineck
3. U.S. Geological Survey

Exhibits

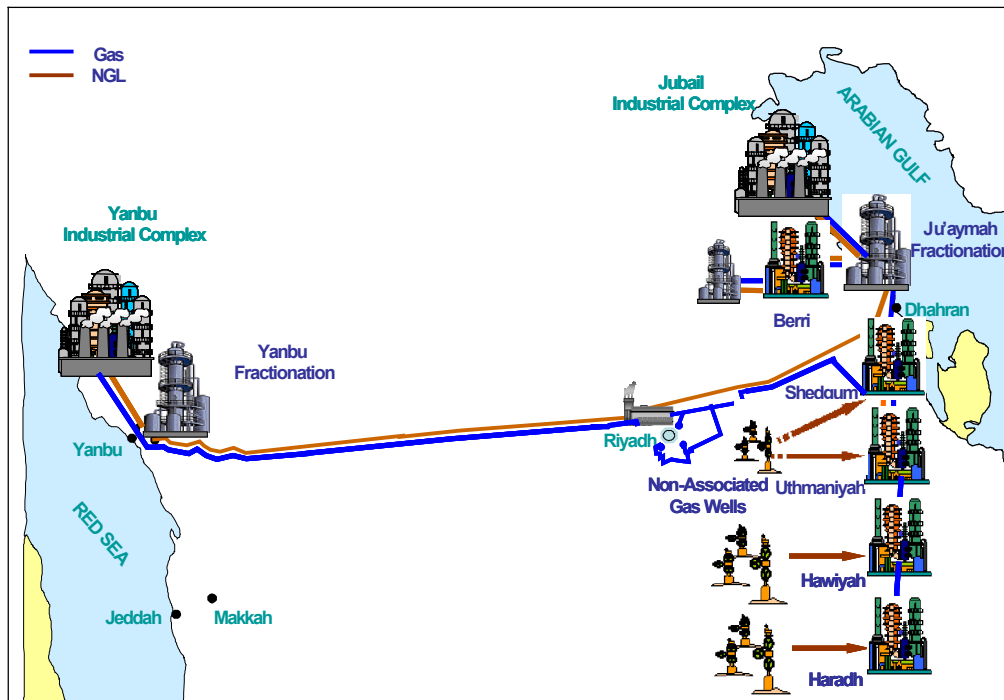


Exhibit-1. The Master Gas System

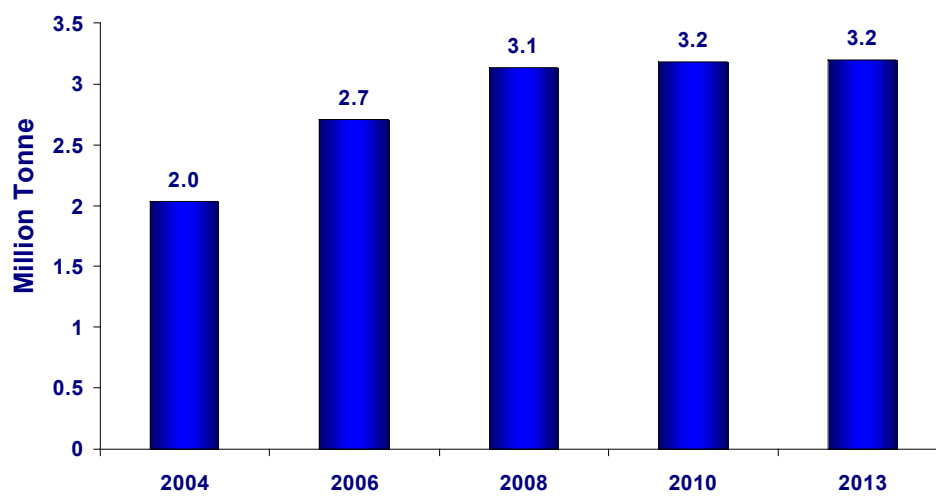


Exhibit-2. Sulfur Production

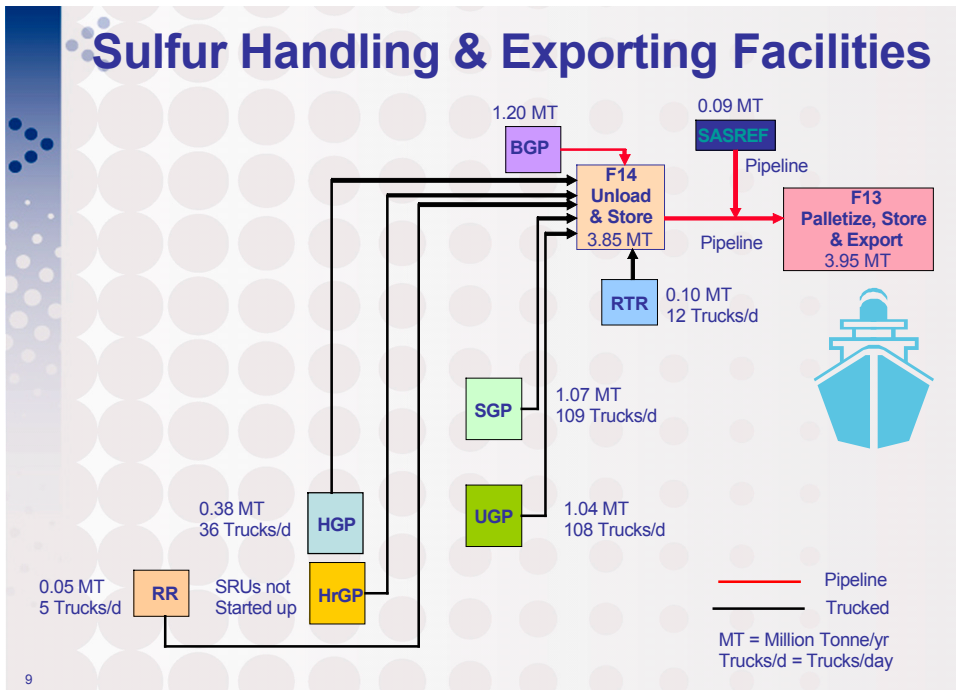


Exhibit-3. Sulfur Facilities