SASOL : CONTINUED VALUE ADDITION TO COAL THROUGH GASIFICATION TECHNOLOGY

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1. INTRODUCTION

When the world heard that a South African enterprise was to build the world’s first large-scale commercial coal to synfuels operation, it seemed astonishingly far-fetched. This project surged ahead on schedule in the 1950’s and is still today a profitable producer of pipeline gas and chemicals. Similar sentiments were expressed when Sasol announced the massive scale projects during the 1970’s known as Sasol Two and Three.

Through the years the list of achievements expanded including diversification into chemicals, a globalization drive and much more.

On the technology front the highlights include the development of Fischer-Tropsch synthesis processes such as the high temperature Sasol Advanced Synthol (SAS) process as well as the low temperature Sasol Slurry Phase Distillate (SSPD) process.

In the gasification environment Sasol has been actively involved in ongoing development and has also recently announced the signing of a Memorandum of Understanding with Lurgi to investigate the establishment a joint venture company.

The presentation will focus on the ongoing activities to add value to coal through gasification technology.

2. GASIFICATION DEVELOPMENT AT SASOL

2.1 SASOL ONE

Gasification development at Sasol is an ongoing activity and numerous developments can be listed. Some of the achievements at Sasol One in Sasolburg over the past three years in terms of gas production is given below.

- In the three-year period up to 2000 the pure gas load at Sasol One was almost 6% higher than in the previous three-year period.
• Pure gas loads achieved in the last six months were record highs in the history of Sasol One.

• The current pure gas load at Sasol One is more than 10% higher than in the mid 1990’s.

One of the projects, which contributed to the above-mentioned achievements, is described below.

2.2 A DISCRETE SIMULATION MODEL FOR MIXING COAL SOURCES IN THE BUNKERS AT SASOL ONE IN ORDER TO MINIMIZE VARIATION IN COAL PROPERTIES

2.2.1 Background

In 1999 Sasol One in Sasolburg utilized up to 5 different coal sources with an ash content (air dry) varying between 20% and 39% with an average of 32%. This coal was loaded into five adjacent bunkers using one bunker car, located at the top of the bunkers, and extracted by two cars, at the bottom of the bunkers, onto a conveyor belt for transportation to Gasification. Minimum variation in coal properties is required for Gasifier stability and optimum performance.

A project was identified to decrease the variation in coal properties by installing a blending plant at Sasol One. The estimated cost of this project at the time was around R70 million (ca. $ 10 million). As an alternative a simulation study was initiated to evaluate if proper coal blending could be achieved by only optimizing the existing bunker operation without the addition of an expensive blending plant. The model was based on the ash content of the coal because this property is currently used as one of the quality management parameters. The assumption was made that if variation in ash content could be decreased significantly; variation in other coal properties will also decrease.

2.2.2 Research approach and results

A base case model was built with the software package Arena, which is a discrete simulation tool with the ability to capture stochasticity. Multiple scenarios for optimizing blending were evaluated, including:

• Addition of a third bunker car at the bottom of the bunker.
• Uniform addition of coal to the bunkers with an automatic bunker car with staggered extraction of coal from the bunkers.

The base case model was compared to the actual plant situation by using laboratory analyses of the coal added to and extracted from the bunker. It was established that the model closely approximates reality, which made it possible to use the model as a
predictive tool. Data available at the stage when the model was developed (September 1999) was used as input to the Arena simulation. It was found that the variation in experimental data of the base case situation was in close proximity of the variation of the ash content as predicted with the Arena model. The model predicted a 43% decrease in variation and this was confirmed by experimental results where a 44% reduction in variance was achieved.

It was decided to implement the scenario of uniform addition of coal to the bunkers with an automatic bunker car with staggered extraction of coal from the bunkers. It was evident that variation in coal properties can be reduced by distributing coal with similar properties in multiple thin layers over as many bunkers as possible. A 54% decrease in ash content variation was achieved during the first test run done after the operational changes in the bunker procedure were made. Over an extended period of time the ash content may vary, but the resulted mixture fed to the gasifiers contains much less variation than was the case in the past. This is illustrated by the results depicted in Figure 2.

![FIGURE 2: VARIATION IN ASH CONTENT](image)

2.2.3 Conclusions

Better mixing of coal sources was obtained without any additional costs by optimal utilization of the existing bunker storage space.

Positive results from the implementation of the bunker mixing proposal are clearly visible. All indications with respect to the bunker operation are that the coal variation is smaller than normal. The newly implemented bunker operation that supplies coal to gasification with less variation also contributed to the latest gas production records at Sasol One. Minimum variation in coal properties normally results in increasing stability of gasifier operation. Complementary to the advantage of decreasing variation in coal
properties, fragmentation and segregation are also minimized. According to the proposal for implementation, the bunkers are running at full capacity. This also implies that the coal drop from the conveyor into the bunker is shorter, which minimize mechanical fragmentation. The segregation of coarse and fine coal inside the bunkers is also minimized.

2.3 SASOL TWO and THREE

Since the start of operations in the Sasol Two and Sasol Three facilities, numerous improvements have been made which resulted in production rates and equipment availability way beyond the original design intent.

In summary these improvements mainly concern enhanced preparation and specification of feed coal, improved reliability of mechanical equipment and the development of highly sophisticated plant control systems. The continuous application of new management systems also contributed and is still playing a major role in improved operational efficiency.

2.3.1 Gasifier availability

As a result of the above mentioned, inter alia, gasifier on-line availability for the financial year 2000 was 90%, (on-line availability is defined as producing gas above a certain minimum), including low availability periods of planned factory shut-down. For the financial year 2001, this figure was once again increased, on the same basis, to 90,7%. In practice this implies another more than one half gasifier available to Operations.

2.3.2 Overview of major recent developmental activities

- **Gasifier grate reliability**

  By setting very high standards for reconditioning activities, quality control (QC) of material suppliers and integrity, applying innovative design changes to original grates, the aim is now to move towards a 4 year general overhaul cycle, compared to the original 18 month cycle. In addition, a newly designed grate (patented Uniflo grate) has been developed and tested.

- **Gasifier jacket**

  Gasifier jacket failure frequency is continuously being reduced by the recent implementation of the so-called 5th generation jackets. The focus is mainly around very strict control of tolerances and quality control during installation. Improved management systems to ensure optimal water circulation, etc. also makes a significant contribution. Extensive modeling of cooling system and jacket buckling analyses, as well as fracture analyses have been done over the last year. In addition, detailed measurements of process
and mechanical parameters have been obtained. This information was applied in the design of a complex new jacket design, which is currently in the prototype phase.

Highly sophisticated new technology, for instance thermal barrier coating, composite wall technology and others, are also being evaluated.

- **Gasifier control systems**

Intensive study and eventually modifications were made to gasifier automatic control and cutback systems, resulting in a dramatic reduction of gasifier trip-outs and load cutbacks. These result in largely improved operational efficiency, less stress on mechanical equipment and obviously, fewer fluctuations on the total integrated factory. Financial benefits of this will become evident in the longer term.

3. **THE RELATIONSHIP BETWEEN SASOL AND LURGI**

Sasol-Lurgi Fixed Bed Dry Bottom (FBDB) coal gasification is a key technology employed by Sasol in their three coal conversion plants. Without the successful commercial and economic operation of 97 of these gasifiers it would not have been possible for Sasol to develop and grow to the large petrochemical concern that it is today.

The process was developed in Germany as early as 1933 by the Lurgi Gesellschaft für Wärmetechnik, Frankfurt-am-Main. The initial pilot plant was built in 1936 at Hirschvelde in central Germany. In 1938 the construction of commercial plants began. A total of 18 gasifiers of 2.5m internal diameter were built up to the time Sasol’s first plant was established in 1954. Sasol appointed Lurgi as process designer, licensor and engineering contractor at that time. The 10 gasifiers installed were the largest at the time. Internal diameters were scaled up by 47%. Subsequently another three gasifiers of similar design were added in 1966. In 1978 three bottom driven gasifiers, 54% scale up from the original design, were added and one gasifier, scaled up to 88% of original design, was added in 1980. The second and third Sasol plants were built and commissioned in the late 1970’s and early-1980’s each with 40 gasifiers of the same 54% scale up version.

Sasol and Lurgi worked closely together during those years to build and operate these plants and develop the process. The contributions of Lurgi as licensor, designer and engineer during this period were complemented by Sasol as the owner and operator, a unique combination resulting in great achievement.

In subsequent years Sasol progressively built up an extensive body of practical know-how and initiated many developmental projects to improve the process.

During the period of the late 1960’s to the mid-1980’s Sasol, working closely with Lurgi, acted as a major consultant to several potential SNG projects.
The development of a design basis for such coal gasification plants needed confidence that the process would be able to gasify the various types of coal under consideration. To ensure this the commercial scale testing of a large batch of coal (order of 15 000 t) was essential. Sasol was able to provide the necessary facility to conduct such large-scale tests. During this period Sasol together with Lurgi representatives conducted at least 5 tests at the Sasolburg facility. This exercise entailed extensive logistics to transfer the coal by ship to a suitable port in South Africa and from there by rail to Sasolburg. The coal had to be offloaded, stockpiled and screened before testing in a single gasifier. Comprehensive test reports based on the results achieved were produced. This then served as the basis on which the new plants were designed.

One of the conceptual SNG plants, the ANG plant, was eventually designed in detail (1979), constructed and commissioned (end 1984) assisted by a combined team from Sasol and Lurgi. Since 1984 Sasol and Dakota Gasification Company, as it is known today, continue to exchange experience and technical developments.

4. **FUTURE**

It is clear that numerous achievements have been made in the past in the field of gasification.

The history over the past 50 years also indicates a very strong relationship between Sasol and Lurgi, which has been maintained up till today. The planned establishment of a joint Sasol-Lurgi Technology Company, to develop the technology even further, is therefore a logical next step in this long-term partnership.