

THERMAL PROCESSING OF UNUSED WASTE PRODUCTS; THE SASOL PERSPECTIVE

J H Slaghuys*, A M Ooms*, H B Erasmus**

*Sastech R&D Division
P.O. Box 1
Sasolburg 9570

**Sastech Technology Transfer Division
P.O.Box 5486
Johannesburg 2000

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1. INTRODUCTION

The Sasol group of companies gasify approximately 28×10^6 metric tons of coal in their 97 Lurgi fixed bed gasifiers per annum. The syngas produced is used mainly in their Fischer-Tropsch plants for the production of transport fuels as well as a slate of other chemicals.

In a complex operation such as Sasol, various sources of unutilized products or waste exist. Tars produced during gasification contain a substantial amount of solid material, essentially fine char and ash. Through various steps of sedimentation and filtration most of the tar is recovered as a clear liquid ready for further work-up. However an amount of "dusty tar", high in solids (MIQ) is produced. In the operation of the Synthol (Fischer Tropsch) reactors, fine catalyst is carried over in the liquid product. This is also concentrated to form a waste product high in finely divided catalyst. Like any other large petrochemical facility from time to time waste from a number of sources is produced down-stream. Where re-working is not feasible, the material has to be disposed of.

In the 40 years of operation of Sasol One (now called Sasol Chemical Industries or SCN) as well as the approximately 15 years of operation of the Sasol Two and Sasol Three facilities (now collectively called Sasol Synthetic Fuels or SFF) substantial amounts of these unused products or wastes have been dumped in ponds. In the early days of the SCN operation, dumping was done rather ad-hoc in waste ponds which were not lined. In later years, properly lined disposal ponds were constructed. The SFF facilities were equipped with properly lined ponds from start-up.

In line with world trends, Sasol has adopted a stringent environmental policy and dumping of such materials is no longer acceptable. Furthermore, Sasol is signatory to the Responsible Care Program. It is now the official policy of the company, not only to eliminate dumping but also to clean up existing waste in an environmentally acceptable way. Thermal co-processing with coal has been identified as a means by which such waste can be upgraded to liquid and gaseous product with no additional toxic effluent.

2. THERMAL CO-PROCESSING WITH COAL: DEFINITION AND OPTIONS IN THE SASOL CONTEXT

Co-processing of waste with coal has to be compatible with the Sasol operations and business scenario. The often heterogeneous feed may not affect the integrity of Sasol operations. Furthermore, it is desirable that products, whether gaseous, liquid or solid are such that they can be upgraded in existing refining facilities and be compatible with products which are currently being marketed. No new toxic waste products are acceptable. Within the limitations of these requirements, Sasol has two options in terms of thermal co-processing of waste with coal: The use of existing fixed bed gasifiers or a dedicated reactor (Figure 1).

3 GASIFICATION

The 97 Lurgi gasifiers currently in operation offer an opportunity for co-processing waste with the existing coal feed. It makes economic sense in that it would significantly reduce the capital outlay needed otherwise. There is the further advantage that gas, liquid and solid products will be "automatically" worked away in the existing infrastructure, again saving on capital investment. Gases produced would end up in the gas loop of the factory. Liquids produced would be worked away in the current tar work-up systems. Both products would thus contribute to the net product yield of the factories and a money value could be attached to it. Exploratory tests on a single gasifier, replacing up to 3% of the coal with waste, had no apparent effect on the operability/stability of the unit. Unfortunately the gasifier had only limited monitoring possibilities and a large scale test involving 13 gasifiers is planned. A number of important but as yet unknown effects are to be investigated and monitored in this test:

3.1 Co-feeding of coal and waste

The gasifiers are fed by lump coal using conveyor belts. For technical reasons, it is desirable to feed the waste with the coal. This poses a problem as a large percentage of this material is liquid to semi-liquid. It has been found that mixing such materials with absorbents/binders such as fly-ash, cement or clay results in a product with a dry, crumbly appearance. Laboratory work has shown that, upon pyrolysis, a coarse char is formed which should move with the coal through the gasifier. The possible long-term effect of this material on the integrity of the conveyor belts is currently being investigated. Furthermore it is important that no "sticky" material is deposited in e.g. the coal bunkers and coal-locks of the gasifiers.

3.2 Effect on gasifier performance

Once inside the gasifier it may be expected that, in the hot upper part of the gasifier (450 - 550°C), volatile material will be flashed off together with the tar of pyrolysis of the feed coal. The effect that the solid carbonaceous residue containing the inorganic binder may have on the operation of the gasifier will have to be considered. Part of the solids may break up and be swept out of the gasifier. The rest will move down with the coal through the various stages of fixed bed gasification and end up as part of the ash. It is known that an increase in ash content of the coal increases the oxygen and steam requirements per unit gas. As up to 50%

inorganic binder is used with the waste, the average ash content in the gasifier increases by 1 - 1 ½ %. Furthermore, it needs to be established whether the added inorganic binder breaks up further down in the gasifying vessel as this may lead to gas flow constrictions.

3.3 Down-stream effects - Primary tar separation

Condensables, tar and gas liquor, are scrubbed down-stream from the gas phase. Coal used in the Sasol operation produces approximately 1 ½ - 2 % of Fischer-tar. The addition of 3% of a 50/50 mixture of "foreign" organic matter and inert binder may as much as double the net hydrocarbon yield. It is not expected that capacity should be a problem in the current primary tar separator system. However separator performance will have to be carefully monitored. It is especially the possibility of emulsion formation which is of concern as this would severely reduce the efficiency of the separators.

3.4 Down-stream effects - Quantity and compatibility of products

If the co-processed waste is of a coal tar origin, no problems, except for capacity down-stream, would be expected. However, if "non-coal" waste was to be present in the feed mixture, serious consideration should be given to the effect of interaction of species in the reactive vapour phase. The net product slate (including the raw gas composition) may change substantially which would affect down-stream processing as well as marketability of the final products. Homogeneity/miscibility of liquid materials will also have to be carefully investigated.

3.5 Down-stream effects - Gas liquor treatment

Gas liquor is treated in a Phenosolvan unit. The possibility of a change in gas liquor quality cannot be overlooked as this may have detrimental effects on plant performance as well as on the quality of the products. Finely dispersed solid material finds its way via the gas liquor system to the Phenosolvan plant where filters are used to clear the feed. Performance of these filters will have to be monitored to ascertain whether additional fine solid material originating from the waste mixture, find its way down-stream.

3.6 Down-stream effects - Tar work-up plant

Tar filtration is a critical pre-preparation step in the tar work-up plant. An increase in fine solid material in the tar feed, due to carry-over in the gasifier, may slow down filtration rate which in turn could limit the capacity of the work-up plant.

The possibility of a change in the composition of the tar feed (Par. 3.4) may also reduce existing plant capacity as well as product quality.

4. DEDICATED REACTOR

A number of proprietary thermal processes have been developed with the purpose of recovering hydrocarbons from solid materials. These distillation/pyrolysis processes (pyrolysis units) are typically designed to remediate contaminated soils or for the recovery of oil from tar sands and

oil shales. An in-depth study into the suitability of such processes for application in the Sasol scenario has been made. Following in-house research up to process development unit (PDU) scale, it was concluded that the only feasible processes were those where direct heating is applied. These processes include inter-alia the Lurgi-Ruhrgas process, the AOSTRA-Taciuk process and the TOSCO process.

Pilot plant testwork has shown that up to 80% of the quinoline soluble material could be recovered as a liquid with a minor amount of gas make. The residual char was shown to exhibit a high-enough heating value to fuel the processes making them energy self-sufficient. Following primary Pilot plant work a number of important criteria had to be assessed:

4.1 Co-processing with coal

This not only has to be technically feasible but should make economic sense as well. Of the processes mentioned, use is often made of a solid heat carrier. Testwork has shown that properly graded coal could serve this purpose. Sasol's gasification coal produces a relatively small amount of Fischer-tar (Par. 3.3) which would contribute little to the net liquid yield during co-processing. However some small coal deposits, yielding up to 12% of Fischer-tar, are present in the Secunda (SFF) coal field. These coal types have been shown to be suitable for co-processing with some of the waste material increasing the net yield of liquids.

4.2 Product compatibility with existing business

A dedicated pyrolysis unit has the distinct advantage that it does not interfere with the core Sasol operations. Products are collected independently and can be marketed on their own. In the Sasol operation it could be economically advantageous to co-process the products of pyrolysis in the existing tar work-up facilities. However the aspects of plant capacity and more important, product compatibility as described in Par. 3.4 will have to be carefully considered. Although pyrolysis units operate on a continuous basis, feed preparation can be done batch-wise. This creates the opportunity of diverting incompatible feedstocks away from the existing tar work-up facilities. Such products could be sold as fuel oils. The option of co-processing with coal could be considered on such a "batch system" as well.

5. SOIL REMEDIATION

Many pyrolysis units have shown to be eminently suitable for remediating contaminated soils. This is a distinct advantage. Treating such soils in the Lurgi gasifiers is technically feasible if a low feed rate is maintained. This becomes impractical if the amount of soil needing thermal remediation is high.

6. CONCLUSION

R&D work at Sasol has shown that thermal co-processing of coal and coal products will have a distinct role to play as part of a waste recovery project. Using the existing Lurgi gasifiers will result in a substantial saving in capital provided that due care is taken to preserve the integrity of current plant operation. The installation of a dedicated pyrolysis unit will be capital intensive. However, these costs could be off-set by, inter alia, avoiding the risk of production losses in current business. Pyrolysis units have the

added advantage that they are eminently suitable for the remediation of contaminated soils.

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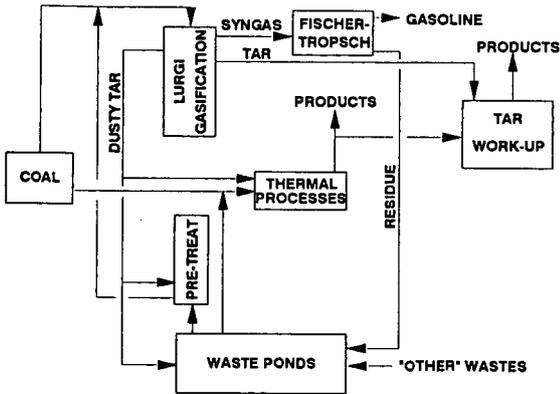


FIGURE 1 THERMAL CO-PROCESSING OF COAL AND WASTE THE SASOL OPTIONS