Experience with Low Value Feed Gasification at the El Dorado, Kansas Refinery

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Introduction

Texaco’s gasification technology offers significant flexibility by offering a process in which refinery secondary materials of very low or negative value may be beneficially used as a feedstock. In a refinery, the current choice for such reuse has been generally limited to a coker. However, a coker generally can not process all of the different types of refinery by-products and often has limitations regarding the amount of secondary materials that can be used. Texaco’s proprietary gasification technology has a broader processing capability than a coker and the syngas is generally a more valuable product than coke.

The use of Texaco’s gasification technology in an integrated refinery application was chosen at Equilon’s El Dorado, Kansas refinery because of the technology’s ability to produce valuable syngas from the lowest valued refinery streams. At El Dorado, syngas produced from zero or negative value materials displaces natural gas in the feed to a combustion turbine-generator.

In addition, the environmental benefits from the project have earned it support from the surrounding communities. The project has provided a method to utilize refinery residual streams that otherwise would have no or limited use within the refinery and has improved the refinery’s overall environmental performance. The project has also set an important environmental precedent, as it is the first gasification unit allowed to, without a hazardous waste permit, produce a syngas which is used as a fuel from secondary materials which would otherwise be hazardous waste if disposed. The numerous synergies between the facility and the existing refinery provided other benefits as well.

This paper gives background information on the application of Texaco’s gasification technology and focuses on El Dorado’s operating experience with low value feeds. Since startup, a wide range of different low value refinery materials has been successfully gasified. The gasification process has proven itself very flexible with regards to feedstock since the resulting syngas quality and the level of emissions are not affected by the different feedstock blends.

Technology Background

The Texaco Gasification Process was developed in the late 1940s. It was intended to produce hydrogen and carbon monoxide - syngas - for chemical plant and refinery applications. Originally designed to utilize natural gas, it was modified in the 1950s for heavy oil feeds and in the 1970s for solid feeds like coal and petroleum coke.

For gasification of solids, Texaco utilizes a wet feed system whereby the solids are ground with water to produce a slurry that is pumped to the gasifier. This system is considerably simpler and more reliable than dry feed technologies. It also allows more flexibility in feedstock selection since wet solids can be used and they can be combined with liquids such as oils or other low-value materials while not requiring multiple feed injector configurations. Texaco’s wet feed system allows plants such as El Dorado to simultaneously feed various moist solid and liquid oil streams using a single gasifier feed injector.

Among commercially proven technologies, Texaco Gasification Power Systems (TGPS) based
plants remain the most environmentally benign means of generating electricity from sulfur-containing feedstocks. TGPS plants emit a fraction of the NOx and SOx air pollutants that are produced from conventional or fluidized bed boiler installations. In addition, even the most advanced boiler systems produce solid wastes in quantities far in excess of those produced in TGPS plants.

The Texaco gasifier operates at pressures ranging from 300 to 1200 psig and temperatures of about 2500 degrees Fahrenheit. Feed and oxygen are mixed in the gasifier reaction zone through a specially designed injector where the hydrocarbons are converted to hydrogen and carbon monoxide. The reducing atmosphere within the gasifier prevents the formation of oxidized species such as SOx and NOx. Instead, sulfur and nitrogen in the feedstocks are primarily converted to H2S, ammonia, and nitrogen.

The very high operating temperatures in the gasifier prevent the production of any hydrocarbons heavier than methane. Even methane production is generally less than 0.5 percent of the syngas. Regardless of the feedstock, there are no tars or heavy oils produced which can cause environmental and regulatory difficulties.

A small percentage of the carbon in the gasifier feed is unconverted and exits the gasifier as a byproduct solids stream. Inorganic mineral matter in the feed is fused to form a molten glass-like substance called slag, which is non-leachable and non-hazardous. These solids may be marketed as a byproduct fuel or as a feed source for valuable metals recovery.

The remaining fine solids in the syngas are removed using a water scrubbing system. The material is separated from the water using a settler or filter system and is either recycled or combined with the byproduct solids stream described above.

Plant Overview

The El Dorado Gasification Plant is located at Equilon’s El Dorado refinery in El Dorado, Kansas (20 miles east of Wichita). A block flow diagram of the current configuration of the gasification unit is illustrated in Figure 1. The unit consists of a single train quench-type gasifier, an amine based acid gas removal unit, and a simple cycle power block. The gasifier is designed to operate at pressures between 300 and 400 psig.

The gasifier is designed to be fed by 165 short tons per day (TPD) of delayed petroleum coke and about 15 TPD of other low-value refinery streams, including a small amount of inert material which is added to the coke as a fluxing agent. The unit has two separate gasifier feed systems – a solids slurry system and a liquid hydrocarbon feed system.

Oxygen for the gasifier is provided by a cryogenic air separation unit (ASU) that was built by Praxair and is owned and operated by the refinery. The ASU provides oxygen at 350 to 400 psig and 95 percent purity for use in the gasification reactor.

The gasification unit is also designed with the ability to add high pressure steam to the oxygen stream just prior to the gasifier. The steam provides the operators with further flexibility in control of the syngas composition and gasifier operating conditions.
The syngas produced in the gasifier is water quenched and scrubbed in both the bottom of the gasifier vessel and in a syngas scrubber. These steps remove most of the fine solids in the syngas. After water scrubbing, the syngas is cooled in a series of steps and condensed water is removed and recycled to the process. Low pressure steam (exported to the refinery) is produced in the gas cooling equipment.

**Figure 1 – Gasification Unit Block Flow Diagram**

Slag produced in the gasifier quench chamber is drawn by a circulating water stream into a lockhopper, which is periodically isolated, depressurized, and dumped into one of two concrete basins. The slag dewateres in the concrete basins and the recovered water is recycled to the process.

Water from the gasifier quench chamber and syngas scrubbing equipment is treated by flashing to remove dissolved gases. Solids in the water are settled in a clarifier and dewatered by filtration. Clarified water is recycled to the process with a portion sent to the refinery’s wastewater treatment unit as needed to maintain overall water balance.

After cooling, H₂S in the syngas is removed by contact with lean amine (MDEA) in an absorber tower. Rich amine is sent to the refinery for regeneration in the sulfur recovery unit. The clean syngas is then reheated and fed to a General Electric Frame 6B combustion turbine-generator along with natural gas. By heating value, the turbine is loaded with one-third syngas and two-thirds natural gas. By volume, the reverse is nearly correct.

The plant is fully integrated, as extraction air from the combustion turbine is fed to the ASU. The ASU, in turn, supplies oxygen to the gasifier and nitrogen to the combustion turbine for power augmentation and NOx emissions reduction. Nitrogen is also provided to the refinery. The ASU does not have an air compressor so it is only able to operate when the combustion
turbine is running.

Products of the unit are 35 MW of net power, 180,000 lb/h of steam, and instrument/plant air, nitrogen, and oxygen. The produced power is intended to account for the total power needs of the refinery with no normal export power, about 25% of its steam requirements, all of its nitrogen requirements, and supplementary oxygen for refinery operations.

The combustion turbine is also designed to operate on 100% natural gas as a backup fuel when syngas is not available. Steam injection is used to control NOx emissions during natural gas only operation. The unit uses the existing boiler feed water preparation, waste water treating, sulfur recovery, and flare systems in the refinery.

The construction of the unit was completed in approximately 17 months from January 1995 to May 1996. The construction schedule was accelerated to allow an early startup of the combustion turbine before the remainder of the unit was mechanically complete. Startup of the combustion turbine was in January 1996. The air separation unit was started in March 1996 and the first gasifier startup was in June 1996. In September 1996, syngas was fed to the combustion turbine for the first time.

Environmental Issues

Texaco asserted that the refinery sludges, tank bottoms, and other secondary materials which would otherwise be a hazardous waste if disposed could be used as a feedstock at the refinery in the Texaco gasification system under existing regulations without the necessity of a hazardous waste permit for the gasifier. Both the Kansas Department of Health and Environment (KDHE) and the U.S. Environmental Protection Agency (EPA) agreed with Texaco’s conclusion.

This ruling made it possible for various refinery low-value and negative-value secondary materials to be part of the feedstock mix for the Texaco gasifier. In addition, the EPA also concurred that the syngas produced from these secondary materials can be utilized as a clean fuel in a gas turbine without the requirement of a hazardous waste permit for the turbine.

Low Value Feedstocks

The gasifier is designed to process the lowest value feedstocks available within the refinery. A summary of the compositions of the gasifier feedstocks is provided in Table 1. The gasifier is designed to handle all of these feeds, however due to changes in the overall refinery economics, the gasification of API separator bottoms and primary wastewater sludges has not yet been realized.

Petroleum Coke

The base feed is petroleum coke, generated in the refinery’s delayed coker. The refinery coker produces about 800 TPD of petroleum coke, most of which is sold offsite at a profit. However, at least 15% of the total (or 120 TPD) was being sold at break-even or lower prices. In addition, in order to improve the coker efficiency, the coker’s operating temperature was increased in recent years. This has increased the hardness of the petroleum coke and made it less desirable for
outside sales.

**Acid Soluble Oils**

Acid soluble oils (ASO) are heavy polymers formed in the refinery’s hydrofluoric acid alkylation unit. The alkylation unit produces a high-octane gasoline blending component from a reaction between isobutane, propylene, and butylenes. These heavy polymers are not suitable for blending and were previously sent off site for use as a cement kiln fuel. Most of the hydrofluoric acid in the ASO is neutralized with potassium hydroxide prior to being pumped to the gasification unit, however the pH can vary from 2 to 11. If disposed, acid soluble oils are classified by the EPA as D001 or D018 hazardous waste.

**Phenolic Residue**

Benzene is generated at several points in a typical refinery process. At the El Dorado refinery, the bulk of the recovered benzene is converted to cumene. The cumene is then converted to phenol and acetone, both of which are products of the refinery. The product phenol is purified in a distillation column. The bottoms of this column are a heavy residual oil called phenolic residue. The phenolic residue is either consumed in other refinery processes or accumulated for periodic transfer to the gasification unit. If disposed, phenolic residue is classified by the EPA as K022, listed hazardous waste.

Permanent facilities and pump capacity to handle the phenolic residue as a gasifier feed were not included in the unit design due to permitting uncertainties early in the project. After construction was underway, the EPA agreed that phenolic residue could be used as a feedstock to the gasifier and that a hazardous waste permit would not be necessary. It was decided not to include the additional equipment to handle this feed under the original project scope and instead to consider adding it after startup.

**Recycled Filter Cake Blend**

The unconverted carbon from the gasifier is recovered in a gravity settler and dewatered by a rotary vacuum filtration system. Although it has a water content of nearly 50 percent, it has the appearance of dry material and can be handled as a dry solid.

Due to its high carbon content, the filter cake has a heating value high enough to be used as a fuel (approximately 13,000 btu/lb). It has also been proven as non-hazardous and non-leachable through testing. However, the refinery could not locate an acceptable buyer for this material. Since it has become another low value item for the refinery, the filter cake is now recycled back to the gasifier. This has dramatically reduced the amount of byproduct solids produced by the gasification unit.
Table 1 – Analysis of El Dorado Gasifier Feedstocks

<table>
<thead>
<tr>
<th></th>
<th>Petroleum Coke</th>
<th>Recycled Filter Cake</th>
<th>Fluxing Additive</th>
<th>Acid Soluble Oil</th>
<th>API Separator Bottoms</th>
<th>Primary Sludge</th>
<th>Phenolic Residue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (as received), wt%</td>
<td>5 – 10</td>
<td>50</td>
<td>5</td>
<td>1.4</td>
<td>20 - 75</td>
<td>20</td>
<td>0.8</td>
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<tr>
<td>API Gravity @ 60F</td>
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<td>N/A</td>
<td>N/A</td>
<td>18.2</td>
<td>N/A</td>
<td>N/A</td>
<td>-0.3</td>
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<tr>
<td>Heating Value (dry), BTU/lb</td>
<td>15,400</td>
<td>13,000</td>
<td>~ 0</td>
<td>18,900</td>
<td>6,300</td>
<td>&lt; 1,000</td>
<td>15,700</td>
</tr>
<tr>
<td>Ultimate Analysis (dry), wt%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon</td>
<td>89.5</td>
<td>88.9</td>
<td></td>
<td>86.4</td>
<td>32.8</td>
<td>0 – 5</td>
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<tr>
<td>Hydrogen</td>
<td>3.9</td>
<td>0.1</td>
<td></td>
<td>12.0</td>
<td>4.3</td>
<td></td>
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<td>Nitrogen</td>
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<td></td>
<td>0.02</td>
<td>0.5</td>
<td></td>
<td>0.1</td>
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<td></td>
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<td>2.7</td>
<td></td>
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<td>7.9</td>
<td>100</td>
<td>0.4</td>
<td>57.6</td>
<td>95 – 100</td>
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<tr>
<td>Oxygen (by difference)</td>
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<td></td>
<td></td>
<td>0.9</td>
<td>1.8</td>
<td></td>
<td>9.6</td>
</tr>
</tbody>
</table>
Fluxing Additive

A small amount of low-value inert material is utilized to assist with the creation of a glassy slag, which facilitates the removal of solids from the gasifier chamber. At the El Dorado gasifier, a mixture consisting primarily of soil is used. The plant has used both commercially available fill dirt and miscellaneous soils from around the refinery.

API Separator Bottoms

Process water from the refinery passes through the API separator, where heavier components drop to the bottom of the separator and form a concentrated sludge. If disposed, API separator bottoms are classified by the EPA as K051, listed hazardous waste. The refinery’s delayed coker is also capable of processing API separator bottoms.

Primary Wastewater Sludge

Primary sludge is generated from the gravitational separation of oil, water and solids during storage or treatment of process wastewaters and oil cooling wastewaters. Most of these sludges are recovered from the refinery wastewater system upstream of the API separator and some from refinery tanks, ditches, or impoundments. If disposed, this sludge is classified as F037 or F038.

The gasifier was not designed to handle the entire refinery production of primary sludge. The design intent was to gasify all the available API separator bottoms and then gasify as much sludge as possible. The refinery’s delayed coker is also capable of processing primary sludge.

Feed System Design

The gasification unit was designed to allow feed flexibility. A simplified sketch of the current feed system is illustrated in Figure 2. The feed system has been modified several times since startup to allow the unit more flexibility in feedstock handling. Additional modifications to handle more feeds have been proposed, but are on hold due to capital restrictions resulting from the anticipated ownership changes of the refinery.

The feed system is divided into two sections. One system is designed to process all of the solids containing feeds and the other handles all of the liquid feeds. The solids feed system is considerably larger than the liquid feed system, by about a 30 to 1 ratio. Consequently, the solids system is the base feed system for the gasifier and is always in operation. The liquid feed system is configured to allow it to be turned on and off while the gasifier is operating.

The solids feed system consists of a wet grinding mill and feed silo, which is supplied by a single conveyor. All of the solid feeds, such as the petroleum coke, recycled filter cake, and fluxing additive are mixed in the proper proportions at the feed end of the conveyor.

In the wet grinding mill, all of the solids are mixed with recycled process water and ground to the desired particle size distribution. Slurry of approximately 60 to 65 percent solids content is made and transferred to an agitated feed tank prior to being fed to the gasifier. Slurry is pumped from this tank to the gasifier by a positive displacement metering pump.
In the original plant design, the API separator bottoms and primary sludge were to be brought to the gasification unit by vacuum truck and placed in an agitated tank. These materials would then be transferred into the coke slurry feed tank to mix with the slurry and be pumped to the gasification reactor. This system was later modified to use the agitated tank as another feed tank for liquid hydrocarbon materials.

**Figure 2 – Current Gasifier Feed System**

The liquid feed system was originally designed to be used only for acid soluble oils (ASO). It has since been modified so that it can handle multiple liquid hydrocarbon feedstocks, such as acid soluble oil and phenolic residue at the same time. Two tanks feed a single positive displacement metering pump. Flow control of the oil to the gasifier is accomplished by the use of a variable speed drive on the pump.

**Gasifier Feed System Controls**

The gasification control system was designed to allow flexibility in the auxiliary fuels that are fed to the gasifier. Process controls are implemented on a Honeywell TDC 3000 system and all safety critical functions and sequences are monitored by a Triconex triple modular redundant programmable logic controller (PLC). Texaco Power & Gasification provided both the conceptual design and detailed programming of these systems.

The controls consider the solids slurry stream as the “base” feed and the liquid hydrocarbon stream as the “auxiliary” feed. The gasifier is always started up using only the solids slurry stream. After the gasifier is operating, the auxiliary feed is introduced.
Since syngas is only a portion of the total fuel for the combustion turbine, the controls are designed to maximize the production of syngas by using all of available oxygen from the air separation unit. Maximizing the syngas production reduces the amount of natural gas that must be purchased to operate the combustion turbine at base load.

One of the most important parameters of gasifier operation is the ratio of oxygen to carbon in the combined feeds. This ratio is used to control the conversion of carbon to syngas and indirectly affects the gasifier temperature. The control algorithms maintain this ratio at the target value that is input by operations.

The control system varies the amount of slurry feed in order to maintain the target carbon flow to the gasifier. The carbon content of the combined feeds is determined by a combination of operator-input information and field transmitter data.

These controls successfully maintain the gasifier at steady conditions regardless of the feedstock blend, rate changes, or other transient conditions.

The Triconex PLC system controls the sequencing of the feed systems during startup and shutdown as well as safety monitoring during normal operation. The operator interface with the PLC is done via the Honeywell distributed control system.

The Triconex programming is designed to allow flexibility for operations with regards to the use of the auxiliary feed in the gasifier. The system allows the auxiliary feed to be turned on and off as desired without stopping the gasifier operation. In addition, the Triconex continuously monitors the flow of the auxiliary feed and will isolate the auxiliary feed system from the slurry system if the auxiliary feed flow rate drops below a pre-determined value.

The basic design of both feed systems with respect to how they are configured upstream of the gasifier is the same. Prior to introducing either feed into the gasifier, the desired flow of the feed is established through a recirculation bypass line back to the feed tank. When all of the required safety permissives are met, the Triconex will allow the flow of the feed to be diverted from the recirculation path to the gasifier feed injector.

Process Performance on Low Value Feeds

When the blend of feeds to the gasifier is changed, surprisingly few process modifications are required. The distributed control system maintains the oxygen to carbon ratio at the desired value regardless of the feeds used in the gasifier. Periodic feed sampling is required, however, so that the carbon and water contents in the feedstocks can be updated in the DCS.

Feedstock and slag ash constituents are monitored regularly by operations to adjust the gasifier operating conditions. These adjustments help to optimize the gasifier performance and maximize the lifetime of the gasifier’s refractory lining.

There has been no noticeable change in the syngas composition or quality during any combination of solids or liquid feeds tried in the unit to date.
Low Value Feedstock Operating History/Experience

The gasification unit at El Dorado was intended to be flexible to meet the ever-changing needs in the refining business. Consequently, since startup the unit has undergone several feedstock and configuration modifications to maximize synergies with the refinery.

Petroleum Coke & Fluxing Additives

Petroleum coke has been fed to the gasifier since the initial startup of the unit in June 1996. The gasifier consumes an average of 165 TPD of coke, however feed rates up to 180 TPD and down to 110 TPD have been successfully gasified on a continuous basis.

Since startup of the unit, the refinery coker has raised its operating temperature to improve its conversion. This has caused the hardness of the petroleum coke to increase considerably, which has affected the performance of the grinding equipment. Because the wet grinding mill was designed for softer material, the product slurry characteristics have changed with respect to the original design. Therefore, minor modifications to the slurry agitation and pumping equipment were made to overcome the problems that developed due to the changes in the slurry.

In addition to coke, a blend consisting primarily of soil has been used since the initial startup as a fluxing additive. The composition and quality of this blend has varied considerably. Soils from around the refinery have been successfully used, however the presence of tramp metal (such as nails and welding rods) caused problems with the slurry pumping equipment during initial operations. Improved screening and the addition of a magnet above the feed conveyor reduced the amount of tramp metal to a tolerable level. A purchased fill dirt is currently used since its lower handling cost offsets the purchase price when compared to the handling cost of using miscellaneous refinery soils.

Acid Soluble Oils

The gasification of acid soluble oil was begun on a continuous basis in 1997. The ASO handling and pumping equipment all performed as designed and no modifications to this system have been required. The auxiliary feed logic in the Triconex PLC has worked perfectly to provide orderly fuel introduction/removal and to insure safe operation while ASO is being fed to the gasifier.

Consumption of ASO in the gasifier is adjusted to try to match the production rate from the alkylation unit to avoid having to periodically shutdown and re-start the auxiliary feed system. Since 1997, over 13,000 barrels of acid soluble oil have been converted to syngas.

API Separator Bottoms & Primary Sludge

As mentioned previously, the gasification of API separator bottoms and primary sludge has not been started at this unit because processing these streams in the refinery coker is currently deemed more cost effective.

Prior to the startup of the gasification unit, the refinery added facilities at the coker to process both API separator bottoms and primary sludge. These facilities can handle the entire refinery
production of these materials, whereas the gasifier is only designed to handle a portion of their total production. Therefore, the refinery is saving on transportation costs.

In addition, when the gasifier was designed the size and variability of the material in these streams was not properly defined. It was assumed that this stream did not need grinding and that it could be added directly to the petroleum coke slurry at the feed tank. Further investigation of this material showed that grinding or fine screening would be needed. Modifying the system to add this material into the grinding mill would be a simple piping re-routing, however this project has been deferred so that the refinery could use the equipment to pursue the gasification of phenolic residue.

Phenolic Residue

As mentioned earlier, no facilities were included in the original design to handle phenolic residue. In 1997, it was determined that gasifying phenolic residue would be beneficial to the refinery due to the negative impact that processing phenolic residue was having on other refinery units. The plant decided to conduct a test run on phenolic residue to determine the feasibility of gasifying this stream on a continuous basis.

Since the gasification of API separator bottoms and primary sludge was deferred, the tank originally intended for these materials was modified for use with phenolic residue. The suction of this tank was re-routed to tie into the suction line from the ASO tank upstream of the charge oil pump. No other modifications to the feed system were necessary.

A successful test run was performed in August 1998. The test proved that phenolic residue could be successfully gasified. It also proved that low-value liquid feeds (in this case ASO and phenolic residue) could be switched “on the fly” without interrupting the auxiliary feed flow to the gasifier. During the test run, data was collected to conclude that gasifying phenolic residue had no effect on the syngas, byproduct solids, or water streams.

Since the existing feed system was designed for only acid soluble oil, the current charge pump does not have enough capacity to handle both ASO and phenolic residue on a continuous basis. A project to increase the pump capacity and to construct a pipeline from the phenol unit to the gasification unit has been developed. Plans to implement these modifications are currently on hold due to a freeze on capital expenditures in the refinery.

Recycled Filter Cake Blend

The recycle of byproduct solids back to the gasifier was begun in April 1999. Fines from the rotary vacuum filter are combined with fines collected in the concrete slag basin in the coke storage area. These solids are then mixed into the petroleum coke for recycle to the gasifier. The gasification process is flexible enough to allow various mixing ratios between the recycle solids and petroleum coke. This flexibility allowed the refinery to consume their complete inventory of stored solids.

Recycling of the unconverted carbon and ash has worked well. In fact, because the recycled material contains ash, the unit has been able to reduce the amount of fluxing additive required.
As always, periodic monitoring of the blended feed ash composition is critical in order to maintain proper gasifier operation.

Environmental Results

The Texaco gasifier at El Dorado successfully processes the blended secondary low-value streams with emissions no different from a traditional single-fuel gasification unit. Data has shown that all of the measured streams, including syngas, water blowdown, solids byproducts, and heat recovery steam generator (HRSG) stack gases have the same analysis no matter what blend of feeds is sent to the gasifier.

More specifically, during initial operations with both acid soluble oils (ASO) and phenolic residue, special analytical tests were performed. Toxicity Characteristic Leachate Procedure (TCLP) testing was done on both the fine material from the rotary filter and the coarse material from the slag basin. Both samples passed TCLP testing during operation with ASO and phenolic residue.

In addition, during the test run using phenolic residue as a gasifier feed, several samples of the water blowdown were analyzed for traces of phenol. No phenol was detected in any of these samples, proving that all of the phenol was converted in the gasifier.

Future Plans

Looking forward, the refinery is considering several options to add flexibility to the gasifier’s feed system. These modifications would increase the number and quantity of low-value materials that could be processed, such as the continuous gasification of phenolic residue.

In addition, the refinery has investigated the possibility of utilizing low-valued materials produced by local industries. Other materials, such as crude oil by-products from oil exploration and production sites, are also being considered.

Conclusions

The experience gained from the Texaco gasifier at the El Dorado refinery has proven that the gasification of blends of low value feeds is technically feasible. The gasifier is very flexible with regards to feedstock composition while producing syngas of a constant composition.

Consequently, a Texaco gasifier can be an asset in the overall refinery configuration. It can provide the refinery with an environmentally superior option for the utilization of low-value and secondary hazardous materials as feedstock to produce syngas, which can be used to produce steam and electricity.