**Syngas Production from Petroleum Coke Gasification**

University of Illinois

Chemical Engineering

Senior Design Project

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**Abstract**

Petroleum coke is a major byproduct that historically has been used as a substitute for coal in power production or as a fuel in cement manufacture. The decreasing quality of crude oil refined in the United States means that more petroleum coke is being produced, often with much higher metals and sulfur content. Our objective is to evaluate a better route for using low quality petroleum coke by converting it into a feed for our linked acetic acid production team while capturing all of the sulfur, metals and most of the CO2 from combustion. Since petroleum coke is linked to the refining of crude oil, it is available at much lower cost and in much larger quantities than bio-feeds. In addition, because petroleum coke is a byproduct, and not directly extracted from the environment, it lacks the negative land use impacts of bio-feeds.

In our process, petroleum coke along with oxygen and steam are fed into an entrained flow gasifier to produce synthesis gas, a combination of carbon monoxide, hydrogen, carbon dioxide and hydrogen sulfide. Sulfur is a poison to downstream chemical production catalysts and must be removed from syngas to ppm levels by the Claus process. A significant advantage of our process is that unlike burning petroleum coke for conventional power, the CO2 from combustion can be captured and sent via pipeline for sequestration, or enhanced oil recovery. Aspen, a thermodynamic simulation tool, is used to establish the material and energy balance for the overall process.

**Executive Summary**

We are producing 3000 tons per day of synthesis gas from the gasification of petroleum coke. Our linked acetic acid production team requires that the syngas come with a CO:H2 molar ratio

**1. Introduction**

**1.1: Petroleum Coke Background**

**1.2: Gasification Technology**

**Figure 1.2-1: Shell Gasifier System (Higman, Burgt 119)**

The ground, pressurized coke is transported along with Nitrogen gas (Because Nitrogen is an inert gas). This petcoke is supplied with 95% Oxygen and steam through nozzle of the burner on the wall. The temperature inside the reactor is about 2700 ⁰F and pressure is around 350-600 psi which speeds up the reaction. As a result, the syngas leaves the reactor from the top through the lock hopper .The steam that is left behind, leaves the reactor through the annular space at medium pressure.

The slag comes down in the reactor where it is quenched in a water bath. The Boiler Feed Water (BFW) supplied to annular wall of the gasifier is used as water bath. The huge temperature drop due to water bath results into hardening of the slag. This slag is ground by slag crusher. The granulated slag leaves the reactor through the lock hopper and the Boiler Feed Water (BFW) supplied to cool the slag, moves to heat exchanger. The BFW water is supplied that liquefies the slag.

The syngas goes into the heat exchanger where it’s cooled by supplied Boiler Feed Water (BFW). As a result, syngas moves down the heat exchanger and water leaves the heat exchanger as High Pressure Steam. Additional Boiler Feed Water (BFW) is supplied from the bottom nozzle of the heat exchanger that cools the syngas even more. This water comes out of the heat exchanger as medium pressure and the syngas leaves the heat exchanger at approximately 536⁰F and passes a candle filter unit where the solids from the gas are removed. About half the gas is then recycled via recycle gas compressor as quench gas and the other half is cooled in water scrubbing system.

|  |  |
| --- | --- |
| Syngas Quench (Maurstad 26) | |
| At the outlet of the gasifier reactor the temperature of the syngas is around 1500°C and the fly ash (or slag) is in liquid form. To protect downstream process equipment from fouling, a quench is needed to solidify the slag and make it non-sticky. | |
| Water Quench   * A water quench uses sensible heat from the syngas to vaporize water. * The quench may be total as in the simplest version of the GE gasifier where the syngas is saturated with water vapor, or it may be partial where the syngas is only cooled down to around 900°C. * In the latter case, heat recovery by production of HP steam would be included. * In both cases, the addition of water drives the water gas shift reaction to increase the H2/CO ratio which is beneficial in the case of CO2 capture. |  |
| Radiant Syngas Cooler   * The radiant syngas cooler is available in one version of the GE gasifier. * The hot gas flows into a radiant boiler where saturated steam is generated. * At the Tampa IGCC demonstration plant, problems with the seals protecting the cooler shell from hot syngas caused five forced outages from 1997 to 2001, but the operators felt a solution was close |  |
| Quenching by Recycle   * Quenching by recycle of cooled syngas is applied in the Shell gasifier. * After particle removal in the candle filter, about half of the syngas flow which has a temperature around 300°C is recompressed and recycled to the gasifier outlet. * By mixing the 1500°C hot syngas with the recycle stream, a cooling down to around 900°C is achieved. * Heat is then recovered in a convective syngas cooler. | N/A |
| Chemical Quench   * Chemical quench is a concept which has less experience, but offers some interesting advantages. * The principle is the addition of a second gasification step which uses the sensible heat in the hot syngas, and not oxygen, to gasify the coal feed with water. * This ensures that the second stage is non-slagging (slag is solid). Because the outlet gas temperature is decreased and has less sensible heat, the cold gas efficiency is increased. * A disadvantage is that some tars, which make gas cleanup more complex, may be formed. Conoco Philips’s slurry feed gasifier (E-gas) incorporates this principle. | N/A |

References:

Higman, Chris, and Maarten Van Der. Burgt. *Gasification*. Amsterdam: Gulf Professional Pub./Elsevier Science, 2008. Print.

Maurstad, Ola. *An Overview of Coal Based Integrated Gasification Combined Cycle (IGCC) Technology*. Rep. Cambridge: Massachusetts Institute of Technology, 2005. *For Energy and Environment*. Scribd. Web. 2 Feb. 2011. <http://www.scribd.com/doc/35269273/24/Syngas-quenching>.

**2.4: Water Gas Shift Reactors**

A water as shift reaction is a reversible exothermic reaction where the reactants are carbon monoxide and steam and the desired products are hydrogen gas and carbon dioxide. The reaction is show below.

COH2O CO2 H2 (-39.01BTU/mol)

The reason this reaction process is necessary in the process is because the syngas must be at a 2: 1 molar ratio of H2: CO. The feed stock petcoke has a large carbon content and therefore mainly produces CO and CO2 with very little H2 being produced in comparison. Since such a large amount of CO is produced the syngas stream will be split and one part will remain with its high concentration of CO while the other is feed into water gas shift reactors to convert the CO to H2. The two streams will be combined in order to produce the desired molar ratio.

The kinetic of the reaction are important in order to determine the amount of desired products produced. The two main variables in the kinetic are temperature and pressure. The pressure does not affect the reaction significantly since both sides contain the same moles of gas. The equilibrium constant (products over reactants) is highly affected by temperature and can be shown by the graph below.



**Figure 2.4-1: Shows equilibrium relation to temperature (# reference)**

The equilibrium constant is also calculated with the empirical equation shown below.



The graph and equations show a favorable leaning toward low temperature reaction settings.

Water gas shifts are typically conducted in two stages an initial high temperature shift (HTS) then followed by a low temperature shift (LTS). Both of these reactors contain a certain amount of catalyst in relation to the feed amount. There are a variety of catalyst technologies that cater to specific shifting requirements. The following are a few of the catalyst bases available, Ferrochrome, Copper-Zinc and Cobalt – Molybdenum.

**2.5: Hydrogen Sulfide and CO2 Removal Process**

After the syngas has had any particulates removed it is then sent to the section of the plant to remove H2S and CO2. This is a pretty lengthy processes involving multiple absorbers and stripping columns to ensure that the final syngas is primarily H2 and CO­2. The most important component in this system is the absorption solvent, Selexol, which is physical solvent. Which means it does not react with the components it is removing as compared to a chemical solvent, like the commonly used MDEA. Selexol is a mixture of dimethyl ethers of polyethylene glycol with the empirical formula of CH3(CH2CH­2O)nCH3 where n is between 3 and 91. Another key difference between chemical and physical solvents is their relationship with partial pressure and their solvent loading capacity. Chemical solvents tend to plateau off at higher partial pressures unlike chemical solvents which just increase linearly with increasing partial pressure1. In the case of our system it is necessary to use a physical solvent such as Selexol to ensure that the final syngas has as little sulfur as possible and also because our process is on such a large scale where the partial pressure will be factor in the overall loading capacity. Selexol will also insure that our acid gas to the Claus plant is greater than 45% H2S, which is necessary for the Claus process to perform properly.

The process begins by sending the cooled, particulate freed syngas to the H2S absorption column where the gas is contacted with already pre-loaded Selexol which is from the CO2 absorber. The solvent is pre-loaded with CO2 ­to ensure that the CO­2 ­in the incoming gas is not absorbed on the Selexol which minimizes the temperature rise across the column1. The H­2S rich solvent then is removed through the bottom of the absorption column and sent to the regeneration cycle while the syngas and CO2 exits through the top of the absorber and is sent to the CO2 absorption process.



**Figure 2.5-1: H2S Absorption Column1**

The H2S rich solvent is then sent through a rich/lean solvent heat exchanger where the rich solvent is heated and the lean is cooled. The H2S rich solvent is then sent to a concentrator which runs at a greater temperature than the H2S absorber to remove the CO­2 to be recycled back into the feed stream for the H2S absorber1. The concentrated H2S rich solvent is then flashed to a lower pressure where the flash gas contains a higher proportion of CO2 which is then recompressed and sent back to the feed of the H2S absorber. The concentrated H2­S rich solvent then leaves the flash and is sent to the top of the H­2S stripping column where the solvent will be regenerated. The stripper removes the H2S from the Selexol where it exits through the top of the column as acid gas containing >45% H2S which will then be used in the Claus plant deal with the sulfur1. The now lean solvent leaves the stripper through the bottom and is sent to same rich/lean solvent exchanger as before where it is cooled and then cooled even more by NH3 refrigeration.



**Figure 2.5-2: H2S Regeneration Process1**

This lean solvent is then fed into the top of the CO2 absorption column where it removes the CO2 from the partially treated gas from the H2S absorber. The final syngas then exits the top of this absorber and is almost ready for use in chemical production. CO2 rich solvent comes out of the bottom where the stream is split so some is sent to the H2S absorber as the CO2 ­saturated solvent feed and the other is sent to the CO2 solvent regeneration.



**Figure 2.5-3: CO2 Absorption Column1**

This CO2 solvent regeneration is comprised of three flash vessels. The first flash vessel is the same pressure as the one used in the H2S regeneration step so that only one compressor is required that could handle the loads of both streams1. The other objective of this first flash is to recover and H2 that has been absorbed in the Selexol. The second flash takes off most of the CO2 where it is then sent to the purification process to make an end product that is 99% pure CO21. The final flash sends any remaining CO2 to the atmosphere and then sends the semi-lean solvent back to be used in the CO2 absorber.



**Figure 2.5-4: CO2 Flash Regeneration1**

The final step in this cleaning process is CO2­ purification. The raw CO2 feed gas is sent over a zinc oxide catalyst where any COS present is converted to H2S and then absorbed onto the ZnO catalyst. These reactions are the following:

COS + H2O 🡪 CO2 + H­2S

H2S + ZnO 🡪 ZnS + H2O

The gas leaving the ZnO bed is then sent over a platinum oxidation catalyst where the following reactions take place:

CO + ½ O2 🡪 CO2

H2 + ½ O2 🡪 H2O

CH4 + 2 O­2 🡪 CO2 + 2 H2O

This then leaves the remaining gas with 99% pure CO2 to be used where ever seems necessary.



**Figure 2.5-5: CO2 Purification1**

References:

(1) Breckenridg, William, Allan Holiday, James O Y Ong, and Chris Sharp. *Use of SELEXOL Process in Coke Gasification to Ammonia Project*. *Use of SELEXOL Process in Coke Gasification to Ammonia Project*. 1 Mar. 2000. Web. <http://www.uop.com/objects/92SelexCokeGasifAmm.pdf>.

**2.6 Claus Process**

The Claus process takes place after the H2S removal steps to convert the H2S into elemental sulfur so it can be easily managed. The acid gas that is produced off of the stripping column in the H2S regeneration step is fed into the Claus furnace where it is combusted at 2000°F3. This combustion reaction then coverts roughly half of acid gas into sulfur and the remaining into a mix of H2S, SO2, and water vapor. The following reaction takes place in the furnace:

H2S + 1½ O2 ←→ SO2 + H2O

Upon leaving the furnace the gas is passed through a waste heat boiler to produce steam at approximately 482°F. The gas is then cooled in a condenser to pull the elemental sulfur out with the condensate. Next the gas is then reheated and passed over an alumina catalyst where the following reaction takes place in the Claus reactor:

2 H2S +SO2 ←→ 2 H2O+ 3/8 S8

Once again on leaving the reactor the gas is then condensed to remove any of the elemental sulfur. This catalytic reactor process will be repeated three times to ensure the greatest removal of sulfur. This process can be seen in the figure B-6 in appendix B. The overall reaction in the Claus process is the following:

3 H2S + 1½ O2 ←→ 3 H2O+ 3/8 S8

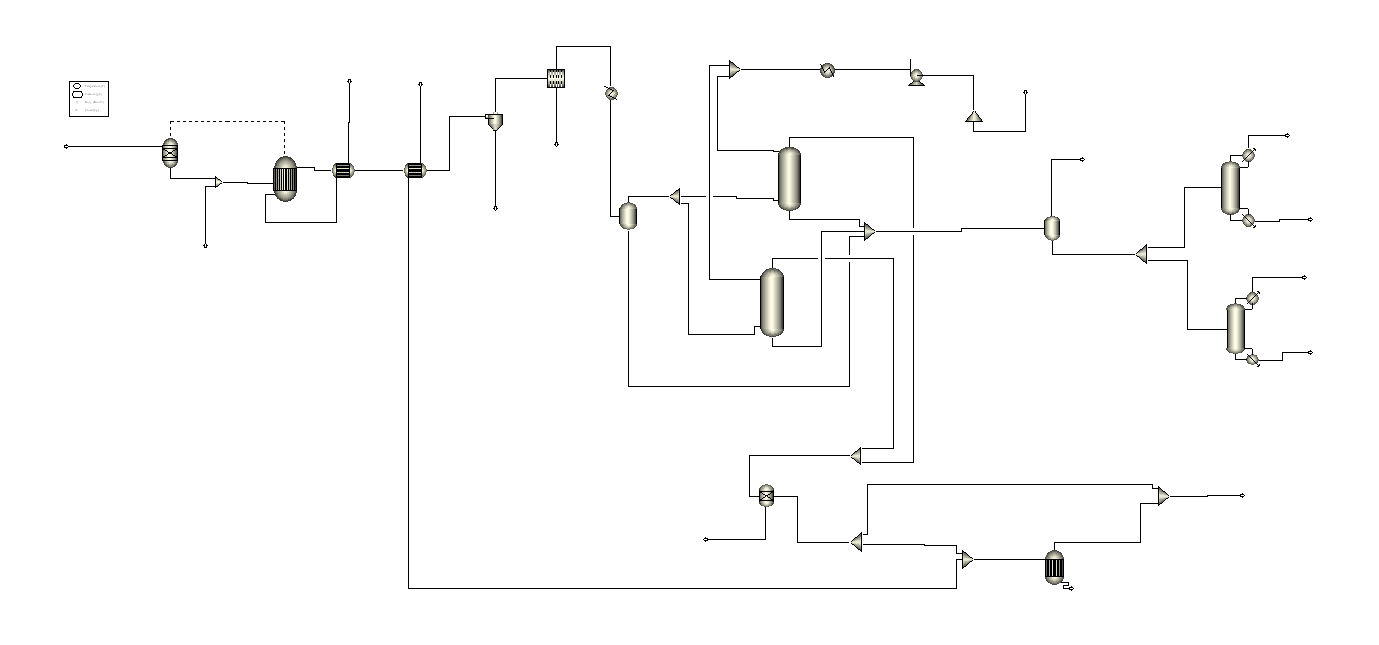
Another catalyst can be implemented in the final reactor to increase the overall conversion of the remaining acid gas to sulfur called the Superclaus. This catalyst oxidizes H2S to sulfur with 85% efficiency4. However it is mentioned that this high selectivity and conversion comes at a modest cost.

References:

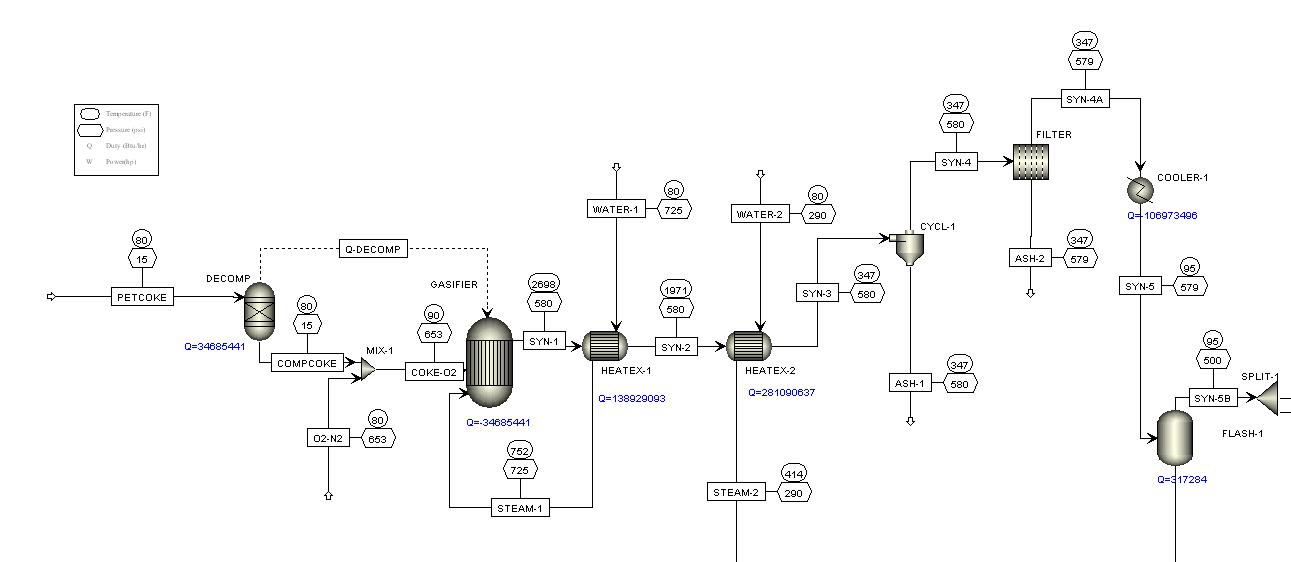
(3) Higman, Chris, and Maarten Van Der. Burgt. *Gasification*. Amsterdam: Gulf Professional Pub./Elsevier Science, 2008. Print.

(4) "SUPERCLAUS." *Jacobs Engineering : Providers of Professional, Technical, and Construction Services*. 2011. Web. 28 Feb. 2011. <http://www.jacobs.com/products.aspx?id=6292>.

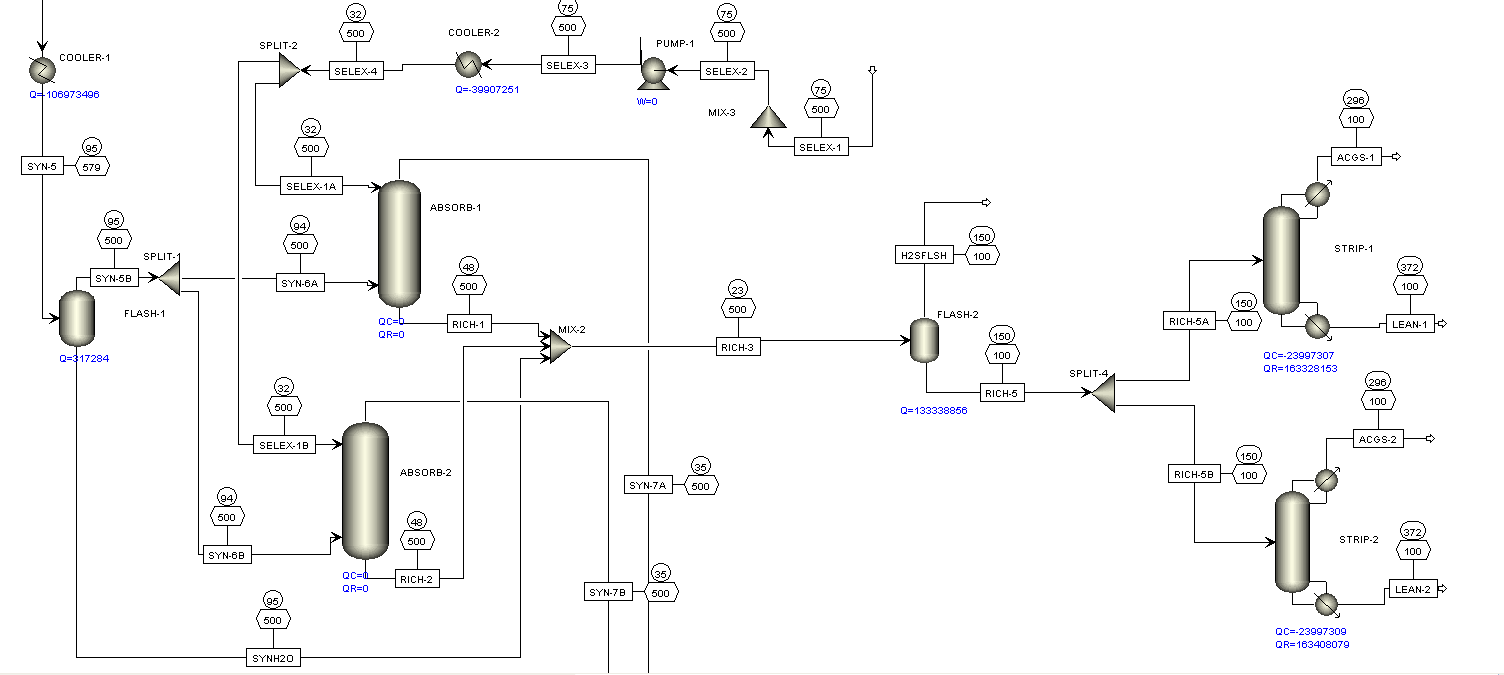
**3. Aspen Plus Simulation**



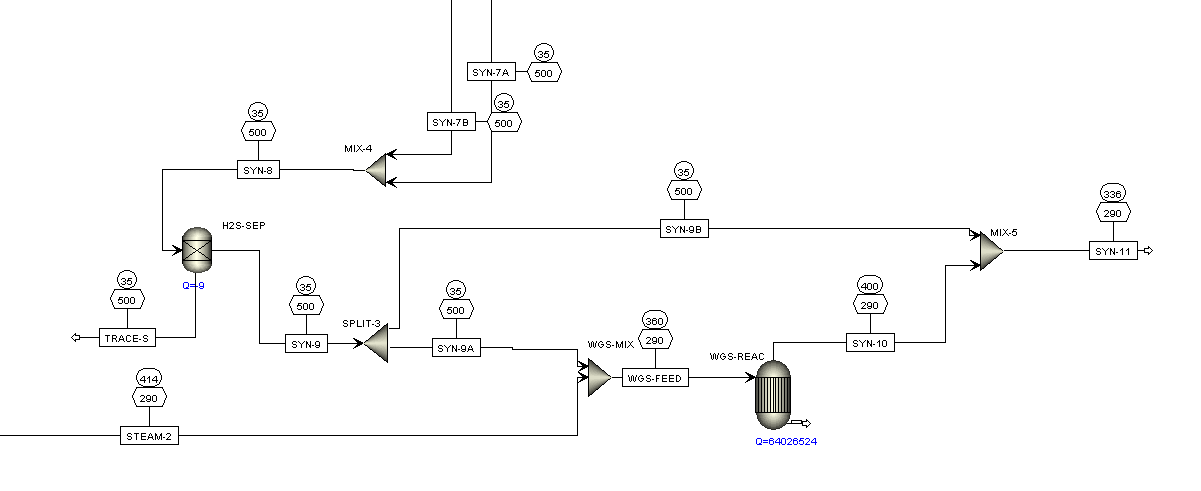
Overall process (not including the Claus process, CO2 recovery and petcoke crushing and ASU unit if necessary)



This is the Gasification section, its stops after Cooler-1. From there it goes to theH2S Scrubbing section. Top number attached to stream is temperature (F) and bottom is pressure (psi) the blue is heat duty.



This is the H2S scrubbing along with the solvent (Selexol) regeneration columns. The two main parts are the exiting clean syngas going to the WGS and the Acid gas leaving the strippers. NOTE: The lean solvent has to be recycled back to the absorbers by meeting up with Mix-3 that is not shown yet because of convergence issues.



This is the WGS section. We don’t need a rigorous modeling of this because this isn’t a power plant where we have to make as much H2 as possible.

**APPENDIX A: Design Basis**

The objective of our process is to design a gasification system to produce synthesis gas for a downstream acetic acid production team (Team Golf). We have decided to use petroleum coke as our feedstock in this process since petroleum coke, petcoke, has a high carbon content and a cheaper price. However it does have its drawbacks as well, primarily its high sulfur content. This creates a challenge when trying to clean the syngas well enough to be used for chemical production. Therefore our process contains many steps to ensure that the sulfur content is reduced to ppm levels. These steps consist of absorbing the sulfur, which is mostly in the form of H2S after the gasifier, and then converting it into elemental sulfur through the Claus process.

Our process will be on a large scale, processing approximately 2800 tons of petroleum coke a day to meet the requirements of our linked acetic acid production team. It has been specified that they need 3000 tons per day of syngas with a CO:H2 mole ratio of 0.40 and a C:H mole ratio of 0.23. They also want the incoming syngas to be at 460°F and below 725 psi. Since this is such a large operation and one that has some strict requirements we have chosen to use an entrained flow gasifier produced by Shell. This gasifier has a unique membrane wall inside to produce steam because it is run at 2900°F.

There are many environmental issues that must be addressed when running this process. One of which is the sulfur removal. After combustion in the gasifier there are large amounts of H2S produced that cannot be released to the atmosphere. This must be removed downstream in an absorber where it is then separated from the raw syngas and converted into elemental sulfur in the Claus process. Once converted to elemental sulfur it is easily manageable and can be sold off. Another environmental issue is managing what happens to all of the CO2 produced throughout the entire process. During the sulfur removal step the CO2 will also be absorbed in a separate column of Selexol and after the Selexol regeneration step the CO2 will be removed from the solvent and will be capture ready.

Like was mention before we are using an unconventional feedstock for our process, petroleum coke. Petroleum coke is a byproduct of petroleum refining that is high in carbon content but also high in sulfur, on average 6.14% by weight sulfur. An advantage of using petroleum coke is its somewhat cheaper price as compared to coal averaging about $55 per ton2. Other benefits are its large supply do to the many refineries in the Gulf Coast and lack the negative environmental destruction such as coal or bio-feeds.

References:

(2) "Petroleum Coke Market Prices, News and Analysis." *Energy Argus Petroleum Coke*. Argus Media Group, 10 Dec. 2008. Web. <http://web04.us.argusmedia.com/ArgusStaticContent/snips/sectors/pdfs/argus\_petcoke.pdf>.

**APPENDIX B. Block Flow Diagrams**



**Figure B-1: Simplified Block Flow (With Tons/day)**



**Figure B-2: Block Flow (With Stream Numbers)**



**Table B-1: Component Material Balance for Figure A-2**



**Table B-2: Element Balance for Figure A-2**



**Figure B-3: Overall ProcssFloe**

**Figure B-3: Overall Block Flow Diagram**

**Figure B-4: Gasifier Close Up**



**Figure B-5: Basic Absorption Close Up**



**Figure B-6: Claus Process Close Up**

**APPENDIX F: Simulation Blocks and Stream Results**

**Screenshots of Aspen Plus Data (Mass)**

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**Screenshots Aspen Plus Data (Mole)**

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**APPENDIX H: Communication File**

**UIG Response to Team Hotel:**

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| --- | --- | --- | --- |
| |  | | --- | | https://mail.google.com/mail/images/cleardot.gifhttps://mail.google.com/mail/images/cleardot.gif  **Walt Dwarnick**   to me | |  |  |

Lipi,  
  
This size plant would be in the US $ 100 million range.  It would also  
require about 40 megawatts of power to operate.  
  
Good luck with your project  
  
Best Regards,  Walt  
  
Walter Dwarnick  
Universal Industrial Gases  
Sales and Marketing Manager  
Office: 610-515-8585  
Mobile: 484-894-4262  
Website: [www.uigi.com](http://www.uigi.com/)  
  
-----Original Message-----  
From: Penny Kornet [mailto:[olil@uigi.com](mailto:olil@uigi.com)] On Behalf Of [pkornet@uigi.com](mailto:pkornet@uigi.com)  
Sent: Monday, February 28, 2011 9:08 AM  
To: Walt Dwarnick  
Subject: FW: Yahoo! WebHosting Email

I am a senior student in Chemical Engineering field at UIC, IL

We are working on a project for Senior Design Expo.

We are using Shell Coal gasifier as our role model to gasify petroleum coke in order to achieve pure synthesis gas.

As shell Gasifier is an Entrained bed, it requires 95% pure Oxygen for the reaction.

Part of our project is to find out the cost of this AIR SEPARATION UNIT PLANT.

I was wondering if you can help me with my project by giving me an estimate of how much it would cost us to install an CRYOGENIC AIR SEPARATION OXYGEN PLANT that generates 3000 metric tons/day 95% pure Oxygen continuously every day.

We value your time and privacy.

We only need an estimate as a part of our project.

We appreciate your response and help.

* Lipi Vahanwala  
  Senior Design Group, Hotel  
  Undergraduate Chemical Engineering Student at UIC, IL

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | https://mail.google.com/mail/images/cleardot.gif  **I made contact with KFO to find out the cost for Zinc Oxide catalyst. Export Manager got back to me with the response below:**  [**sale@global-global.com**](mailto:sale@global-global.com) to me | | |  |  |
|  |  | | |  |

Dear Lipi Vahanwala,

Thank you for your email!

We would quote our best favourable price for Zinc oxide desulfurizar TS-308:

90% 4mm--------------FOB China USD18/kg

Package: 35kg/drum

Our product can meet your need.

Additionally, please let me spend a little time to introduce our company. KFO Japan Co. Ltd. is biotech laboratories founded inJapan in 2001 and China in 2003, KFO focuses on research and development of chemical & nutritional technologies. Our manufacturing and quality in China are supervised by Japan.

We hope you will find us as your reliable partner with consistent quality + competitive price.

I 'm looking forward to your reply!

Thank you in advance and best wishes,

Mr. Daniel Lee    (Export Manager)

Ms. Molly         (Assistant)

KFO Japan Co. Ltd.

Tel: +86 152 8026 8510

Fax: +86 592 376 1310

[sale@global-global.com](mailto:sale@global-global.com)

http://www.[catalyst-catalyst.net](http://catalyst-catalyst.net/" \t "_blank)

NOTE: We will reply your email within 24 hours, if you can't receive our emails in time, it would be the problem of the email system, please resend email to bk.technology@hotmail.com

----- Original Message -----

**From:** [Lipi](mailto:lipiv98@gmail.com" \o "Lipi" \t "_blank)

**To:** [sales@catalyst-catalyst.net](mailto:sales@catalyst-catalyst.net)

**CC:**

**Sent:** 2011-02-26 07:14

**Subject:** Re:price for Zinc oxide desulfurizar TS-308

|  |
| --- |
| * I am currently a Chemical Engineering student at University of Illinois at Chicago. * We are currently using Shell Coal Gasifier (SCGP) as a role model to produce syn gas as a part of my project. * Since we are using petroleum coke as our feed-stock which contains sulfur, the part of our project is to get rid of that sulfur using Zinc-Oxide. * I have read the information provided on your company’s website and it seems to me that Zinc Oxide desulfurizer TS-308 is a better fit for our need. * However, we operating sulfur removal operation at 750 F and 437 psi which is relatively higher in pressure and temperature.      * I was wondering if you can help me out with my project by giving me an estimate of how much would it cost to purchase 10 lbs/day of Zinc Oxide desulfurizer that is capable of removing sulfur from the raw syn-gas at approximately 750 F and 437 psi. |

**To Exxon, Asbury, and Oxbow**

Hello,

My name is Russell and I am a chemical engineering student at University

of Illinois at Chicago. Some classmates and I are working on a senior

design project and would like to look into your Petroleum Coke product.

Listed below are several questions that I have regarding your product.

What type/grade of petroleum coke do you offer?

What size supply can you satisfy?

What is the composition?

Pricing?

**2/8/11**

Russel,

Please define "low" sulfur. In other words, are what is the maximum

amount of sulfur your syngas unit can handle, or what is the maximum

allowable S content allowed in the coke?

AVT

Albert V. Tamashausky

**2/8/11**

Hello Albert,

Thank you for your response. As part of my senior design class my group

and I are trying to design a a gassification process that will yield

syngas from petroleum coke. We need a calcinated coke that is low in

sulfur and as fine as possible. We will need about 2000 tons per day. If

you can get an approximate price that would be great.

Also, if you could please provide a general overview of the coke. Any sort

of knowledge on the coke would be fine. For instance: what is the end

sulfur conent (i.e. sulfur oxide output), hardness of the coke,

approximate and ultimate composition.

I don't know if you would be able to answer this question but would you

also happen to know what the general cost of a gasifier (or even a

gasification plant) would cost?

Any other sort of information that you feel would be useful would also be

much appreciated.

Thanks

**2/11/11**

Hello Russell,

6% max is good because it opens the door to some of the lower cost

petroleum coke materials.

2000 tons/day of any single coke is quite a bit. Do you mean 200 tons

a day? A standard coke barge only holds 1500 tons.

Please double check the amount. I'm not sure anyone could supply that

amount of the same coke.

AVT

Albert V. Tamashausky

**2/14/11**

Albert,

It is supposed to be 2000 tons, but 1500 tons will also suffice. Is it

possible to get any rate?

-Russell

**2/14/11**

Russell,

Assume about $75-$95/ton. This is for green (uncalcined ) coke. This is

a very volatile material, price wise, at this time. Last year this same

product was about 1/2 the cost. Higher demand, as in your application,

will probably up the price.

Keep in mind that 1500 tons/day is all or most of the total output from

a single, larger refinery. I assume you would be installing your unit

in the refinery to save shipping cost and to take advantage of their

handling and distribution system.

AVT

Albert V. Tamashausky

**To Conocophillips**

I am a chemical engineering student at the University of Illinois at Chicago and I have a few questions regarding your petroleum coke refinery in Sweany, Texas.

1) How much petroleum coke do use annually?

2) Who supplies the petroleum coke?

3) What is your energy output?

4) What was the start up cost of the refinery?

Any input would be much appreciated

- Russell

**To ZEEP (Building Gasification Unit in Beaumont, TX)**

Hello,

I'm a student in the chemical engineering department at the University of Illinois at Chicago and for my senior design project my classmates and I will be designing a gasification plant using petcoke. I read that you will be building a gasification unit using petcoke in Beaumont, Texas. I was wondering if you could answer a few questions of mine.

What suppliers do you get your petroleum coke from?

What is the composition of the petcoke you will be using?

Were there any sites that you were looking into before you settled on Beaumont? and what were your qualifications?

How do you plan on transporting your final product?

Are you shipping in or making the gases needed for your operation (i.e. oxygen needed for gasification)?

Did you require any steps for sulfur removal? If so what were they?

What type of gasifier will you be using?

I realize that you will not be able to answer some of the questions but any input would be much appreciated.

**To Port of Victoria**

Tony Rigdon   
Executive Director  
tonyrigdon@portofvictoria.com

Hello,

I am a chemical engineering student at the University of Illinois at Chicago and for my senior design project my classmates and I will be designing a gasification plant. For our theoretical plant we will need about 200 acres of land and I was wondering if you would be able to give a ballpark estimate to what that would cost. We would need access to the railways and waterways.

Any input on the matter would be much appreciated.