Re: Coal Gasification

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Coal gasification takes hydrogen from water and carbon from coal and makes simple hydrocarbons like CH4 methane, which is the principal component of natural gas! One way of doing this is by use of a Lurgi reactor, whose operation is described here;

http://www.dieter−ulber.de/gtc.htm

What my explanation above the URL and what tomcat's explanation below avoid discussing is how much CO2 is produced in creating natural gas in this way.

They hydrogen comes from the water−shift reaction. That is; a measured amount of carbon (coal) and oxygen and water are made to flow through a reactor, and heat is applied to the system by the burning of additional carbon. The burning of carbon to heat the water to superheated steam is the first source of carbon−dioxide in the process. The carbon and oxygen being heated are in a proportion so that carbon−monoxide and steam is produced;

CO + H2O

This is called synthesis gas, or 'syngas'. This gas is passed through a catalytic converter, similar to the converter in your car exhaust. The catalyst is also a pollution source as well as a large cost center in a practical system, and the availability of the rare metals in the catalyst is a limit on the scale of the process as well. Nevertheless, the system does work! In the presence of the right catalyst and the right conditions, nearly all the syngas gets converted through the water shift reaction to carbon dioxide and hydrogen gas. Here's how that works

CO + H2O −−> CO2 + H2

The carbon−monoxide scavenges the oxygen from the water to form CO2 leaving the hydrogen behind. The CO2 can then be removed by passing it through a cryogenic separator. These are usually run by electricity − sort of like a refrigerator or air conditioner. And in at a coal mine guess where this electricity comes from? That's right, a coal fired generator. And guess what that produces? A third source of CO2 for

process energy! lol.

Well, you can see that this source of hydrogen is very costly in terms of producing CO2. We have the CO2 produced by heating the coal, oxygen and water. We have the CO2 produced in the shift reaction itself (by far the largest component) and we have the CO2 produced to power the process to get our hydrogen. About 2/3 of the carbon comes from the shift reaction and 1/3 from the other sources. So, we can estimate the shift reaciton easily and from that figure the total Here's the net balanced chemical equation

C + O + H2O −−−> CO2 + H2

And C = 12 amu, O = 16 amu, H = 1 amu

12 + 16 + 18 −−−> 44 + 2

So, to produce a kg of hydrogen in a shift reaction I've got to react 6 kg of carbon and 9 kg of water and 8 kg of oxygen to produce 22 kg of CO2!!

Add another 1/3 to this total to account for process heat and power and you have 9 kg of carbon and 33 kg of CO2 for every kg of hydrogen!

Now, coal is typically 80% carbon and 20% other stuff. And if that other stuff happens to be poisonous, well,then you have that too! Also, you get NOx out the wazoo with this reaction (sure you can make some of it into ammonia! haha.. but not ALL of it! which is the problem. But we divide the 9 kg by .8 to obtain 11.25 kg of COAL to run this reaction, which produces 33 kg of CO2 and 2.25 kg of OTHER WASTE PRODUCTS to make one stinkin' kg of hydrogen!

You can quickly see this is a dirty source of hydrogen.

Okay, now NEXT the Lurgi reactor efficiently makes methane gas from the hydrogen and yet MORE carbonl! haha.. This is the net reaction

C + 2 H2 −−−> CH4

12 + 4 −−−> 16

Now this means that each kg of hydrogen requires the addition of 4 MORE kg of carbon,which means 5 MORE kg of COAL, and when the methane is burned it produces 11 MORE kg of CO2 and 1 MORE kg of other waste products!

So, for each kg of hydrogen processed this energy cycle produces an astounding 44 kg of carbon dioxide and 3.25 kg of other waste products.

At $50 per ton for coal and $18 per ton of CO2 (carbon credit cost) this is a total cost of $1.50 per kg of hydrogen. The cost of

sequestering the other waste products can add another $1.00 per kg of hydrogen. The volumes of waste are so large relative to the volume of hydrogen, the availability of sequestration locations is a problem.

So, this is what the Lurgi reactor has cost us. Its taken a relatively clean burning fuel, methane gas, that produces only 2.75 kg of carbon−dioxide for every kg of it burned and burdened it with the production of 11 kg of carbon−dioxide! Nuts!

This is why some have said that the Lurgi reactor is a carbon−dioxide production system that produces fuels as a byproduct!

With coal costing $50 per metric ton, we can see that the production of 1 ton of methane gas by this process costs $140 per ton of methane gas in coal costs alone, and another $140 in capital costs, and at $18 per ton for carbon credits, would pay another $200 per ton of methane gas produced this way for those. A whopping $480 per ton direct costs. Add another 15% for labor and maintenance and you can see that the profits of this sort of process are nil at best.

Which explains why these systems are not in wide use.

Another approach is to develop very low cost solar collectors to make DC electricity when the sun is shining. The cost of the collectors here is key. Making solar collectors for 7cents per peak watt means I can make energy when the sun shines at 1/3 cent per kWh. Since it takes 50 kWh to make a kg of hydrogen from 9 kg of water, producing 8 kg of oxygen as a byproduct. This means that a kg of hydrogen costs 16 cents.

What can we do with the hydrogen? Use the Sabatier reaction to take a source of CO2 and make methane gas out of it;

$CO_2 + 4H_2 \longrightarrow CH_4 + 2\,H_2O$
$44 + 8 \longrightarrow 16 + 36$

Water is a byproduct, and the process ABSORBS 2.75 kg of CO2 for each kg of methane made this way! This EARNS the process $50 per ton in carbon credits for each ton of methane produced this way, AND the cost of the hydrogen is only $320 per ton of methane produced. So, the NET cost is $270 per ton of methane produced. The cost of the equipment to run this simple process is about $80 per ton − and the maintenance costs add another 5% (lot less than coal since only gases, no solids, are handled) So, we're at about $375 per ton − HALF the cost of the Lurgi reactor!

A clearly superior system all around − because we're NOT burning coal and we're using SUNLIGHT to power everything cheaply.

Of course, we could also use hydrogen directly or the solar electricity directly, which is a benefit to this system.

tomcat wrote:

> Coal gasification is a process that converts coal from a solid to a gaseous state. The gas that is created is very similar to natural gas and can be used to make chemicals, fertilizer, and/or electric power.
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> Cleanest of all coal−based electric power technologies, gasification has significantly lower levels of air emissions (including volatile mercury), solid wastes, and wastewater.
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> Due to its high efficiencies, gasification also uses less coal to produce the same amount of energy, resulting in lower carbon dioxide (CO2) emissions. Some scientists believe that CO2 in the atmosphere contributes to a "greenhouse effect" that will lead to global warming.
>
> Coal gasification has proven technology for capturing CO2 at a fraction of the cost required for coal combustion technologies. The United States is debating whether CO2 abatement should be required for all new and existing coal power plants.
>
> Gasification provides the only economically feasible route for production of hydrogen from coal. Because hydrogen−powered vehicles are nearly pollution−free, many people favor a long−term program to convert America's cars, trucks, and buses to hydrogen.
>
> In summary, coal gasification is a proven technology that can utilize America's 250+ years of coal reserves to produce clean electricity, fuels, and chemicals, and to provide a bridge to a future hydrogen−based economy.

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