How is air fuel synthesis carried out, and to what extent

Environment, Air

How is Air Fuel Synthesis carried out, and to what extent is turning air into gasoline a viable fuel alternative for the future? Humans have been relying on fossil fuels since the 18th century, the creation of the first steam engine. Since then, the levels of fossil fuels have been extremely depleted and our continual use of them is becoming increasingly unsustainable. The ratios of world consumption to reserves for oil, coal and gas show if the world continues to consume fossil fuels at current rates, the reserves of oil, coal and gas will last a further 40, 200 and 70 years, respectively.

Fuels are needed for almost everything in today's technologically advanced society with everything ranging from the manufacturing, transport, heating and many other applications that enable us to live in such a developed way. Within this extremely limited time frame, there have been many methods employed to use other fuel resources, with particular importance being placed on renewable fuels so that there are alternatives once fossil fuels run dry. Bio-fuels, synthetic fuels, natural gas liquids, electric cars are all responses to the impending fossil fuel crises.

One relatively new field of research is in the usability of air-fuel synthesis, in which carbon dioxide is extracted from the air and together with water is made into synthetic hydrocarbon liquids from which fuels can be developed. One of the main advantages with this is the fact that the fuel is considered " carbon neutral". Carbon neutral refers to fuels that neither contributes to nor reduce the amount of carbon (generally in the form of carbon dioxide) into the atmosphere, so there is a carbon footprint of zero.

Having no net carbon dioxide emissions is a very important idea at the moment given the issues associated with roundhouse gases causing global warming. For this reason, if air-fuel synthesis could be implemented on an industrial scale, there would be many environmental advantages and it would be far less harmful than the current fossil fuels in use currently. Already, there is a company based in the UK that has recognized the potential of this process called the " Air Fuel Synthesis Ltd", located in Stockton-On- Tees.

It has very ambitious hopes for the technology and plans on producing the fuel on a mass scale starting in 2015. It mainly is interested in the possibility of using this eel for transport, and is keen to produce green aviation fuel to make airline travel more carbon-neutral than it is today. Although the process is still in the early developmental stages and requires electricity from the national grid in order to function, the company believes it will soon be possible to use power from renewable sources such as wind farms or tidal barrages.

However, being a relatively new concept, there are many flaws that have been criticized by scientists from around the world, with the main concerns surrounding the efficiency of production, something hat is holding the technology back. As well as this, the name of the process, " air fuel synthesis" is very simplified, and the process in reality requires far more chemicals to operate. For tans reason, In my project I wall De Lusciously winner tans plunger technology actually has potential to one day be a major source of fuel.

Carbon Capture CO is an imperative in the production of these synthetic hydrocarbons, as it provides the Carbon atoms that are present in the aliphatic and alcoholic hydrocarbons. CO capture technology is becoming more and more advanced to low carbon on a mass scale to be transferred from the atmosphere. There are three main steps to carbon capture and storage which are as follows: 1. Trapping and separating the CO from other gases, 2. Transporting this captured CO to a storage location, and 3. Storing that CO far away from the atmosphere (underground or deep in the ocean).

Capturing and re-using CO presents many environmental benefits and could be used to significantly slow global temperature rise, which is as a result of mass scale CO emissions. CO capture is generally performed at large point sources. These include places such s fossil fuel power plants, fuel processing plants and other types of industrial plants, such as those that manufacture iron, steel and the production of industrial chemicals. The main systems that are currently in use consist of 1. Capture from industrial processes 2. Post-combustion capture 3.

Ox-fuel combustion capture 4. Pre-combustion capture Figure 1. 0 CO capture systems [3] Capture from industrial processes There are several industrial applications involving process streams where the opportunity exists to capture CO in large quantities and at costs lower than from the there systems I will describe. Capture from these sources will not be the complete answer to the needs of climate change, since the volumes of combustion-generated CO are much higher, but it may well be the place where the first capture and storage occurs.

There are several industrial applications involving process streams where the opportunity exists to capture CO in large quantities and at costs lower than from the other systems I will describe. It has been shown that the power and industry sectors together dominate current global CO emissions, accounting for about 60% of total CO emissions. 1] Future projections indicate that the proportion of these emissions will decline to around 50% of global CO emissions.

The CO emissions in these sectors are typically generated by boilers and furnaces burning fossil fuels and are generally emitted from large exhaust " stacks". These stacks represent potential opportunities Tort ten Alton o CO capture plants I n volumes produced from these sources are usually large and the plants can produce a source of high-purity CO that can be stored away for a later date. However, not all power generation and industrial sites produce their emissions from a single point resource.

At large industrial complexes like refineries there will be multiple exhaust stacks, which are an additional technical challenge in terms of having to construct complex exhaust CO gathering system in an already congested factory, adding to capture costs The iron and steel industries are the largest energy-consuming manufacturing process in the world, accounting for 10-15% of total industrial energy consumption. The production of direct-reduced iron involves reaction of high oxygen content Iron ore with H2O and CO to form reduced iron plus H2O and CO.

As a result, many of the erect reduction iron processes could capture a pure CO stream, which could later be used in the reactor of the air fuel synthesis process. Iron and steel are an example where industrial CO has already begun being captured, both from CO recovery from blast furnace gas and direct reduction of iron ore. It is also possible to capture of CO from the exhaust gases that are released by the combustion of fossil fuels, and this process is referred to as post-combustion capture. Instead of being discharged directly to the atmosphere the exhaust is passed through equipment which isolates the majority of the CO.

The CO is fed to a storage reservoir and the remaining gases are then discharged to the atmosphere. Another revolutionary method that has become more widespread for obtaining CO is by capture from the air. " Air capture" is the extraction of carbon dioxide from atmospheric air Capturing CO directly from the air on a mass scale would present many environmental benefits, and alleviate the threat that the current Carbon Dioxide levels pose for earth as a whole. Air capture is a tool for managing the buildup of CO in the atmosphere that is causing climate change.

Air capture squires an energy source, such as natural gas, concentrated solar power, and it produces a stream of pure CO as its output. This CO can be used in industrial applications or stored in geological formations deep underground. The creation of the hydrocarbon fuel Production of synthetic hydrocarbon fuels from renewable energy a potential solution to reduce oil consumption and carbon dioxide emissions without the need for modifications of existing infrastructure like petrol stations. The raw material for synthetic hydrocarbon fuels is synthesis gas ($H2O$ + CO), which generally is produced wrought reforming of natural gas [2].

Both processes consume fossil fuels and emit greenhouse gases. Through the electrolysis of steam and carbon dioxide using renewable energy sources an alternative route can be made for producing synthesis gas without consuming fossil fuels or emitting greenhouse gases. After having collected the CO, the next important resource that needs to be collected is water. Large-scale Implementation AT any resource like tans will use large volumes AT water. Generally, the most sustainable source that is used is non-potable water, particularly sea water.

To supply the quantity of water needed for dissociation (to provide the hydrogen atoms that are then incorporated into the fuel), generally fresh river and reservoir water is used, however if improvements desalination occur, whereby salt water is turned into fresh water using reverse osmosis techniques and the excess salt and minerals from water are removed, then this could be the method in which water is obtained. In reverse osmosis, a solvent, usually Just sodium chloride, is forced from a region of high solute concentration through a membrane to a region of low solute concentration by applying a pressure.

It does this by pushing a solution through a filter that traps the solute from one side and allows the obtainment of the pure solvent from the other side. With plentiful supply of both water and carbon dioxide, processes are then carried out which remove oxygen from CO and $H2O$ (known as dissociation), and then the subsequent synthesis of the fuel. Production The production of synthetic fuels all follow similar stages of production. First there is the collection of the energy needed to carry out the whole process.

Then there is the collection of the oxides, which in this case is water (H2O) and carbon dioxide (CO). Next there is the dissociation of the H2O and/or the H2O and finally the synthesis of the hydrocarbon using the products of the dissociation in the previous step. The diagram above summarizes the continuous closed loop carbon cycle through air capture of CO, resulting in zero net emissions, with energy sourced renewable. While renewable energy sources for the process is ideal from an environmental point of view, there are other options too.

There are many possibilities as to where the energy can be supplied from. Fossil fuels: Fossil energy sources can provide the electricity needed for the association. While they are definitely practical, as can be seen by their current widespread use in primary energy supply, they do present issues related to their depletion, which makes them unreliable for the future. Fossil fuel combustion for the production of heat results in the release of CO and so if a carbon neutral system is trying to be achieved, sustainable use of fossil resources depends on CSS technologies that are put into place.

Thus electricity from fossil resources can be rendered carbon neutral by capturing CO emissions at the production plant itself and storing the CO. Renewable energy sources: These include solar (mainly through photovoltaic cells), wind, geothermal, and hydroelectric systems. These sources are typically associated with sustainability. However, these sources do have issues associated with them. They require very specific regions which have suitable conditions for energy capture. As well as this, wind and solar power are very unreliable due to clouds and weather patterns.

I Nils does not mean Tanat teen snouts not De Implemented as ten energy source, however their limitations must be taken into consideration, especially if the air fuel synthesis is intended to be performed on a large scale. Http://orbit. TU. Dc/fedora/bob]sects/orbit: 83036/datagram's/file_5193307/content http://rest. royalsocietypublishing. Org/content/368/1923/3343. Full Dissociation of CO and H2O There are many methods currently available to dissociate water and carbon dioxide, with the most common being Thermopiles, Electrolysis, and Photoelectrons.

The chemical reaction for what occurs is shown below: The equations above show that the minimum energy required to undergo the reaction are the enthalpy changes. It is possible to split H2O and CO solely with the direct use of heat at extremely high temperatures. CO and H2O dissociation shows that thermopiles occurs fully only at temperatures that 3000 and 4000 co, respectively however often a temperature range of 2000-2500 co for H2O thermopiles is used [2]. The product gases, hydrogen and oxygen, must be separated effectively at high temperature, and it is important to avoid recombination of the ions.

Recombination greatly reduces the efficiency of the H2O and CO dissociation. 2500 co is a reasonable upper limit because high- temperature materials begin to decompose at higher temperatures. Such high temperature heat could generally only be supplied through the combustion of other eels, however for thermometric fuel production this would be very ineffective because more fuel would be used for heat than is produced by the process. A CO thermopiles chamber driven by concentrated sunlight has been developed, and if it is done this way, the thermopiles could be carried out at lower temperature than H2O.

An electromagnetic field can also be used to excite the gaseous H2O or CO to extremely high temperatures (tens of thousands of degrees), which results in a decomposition of the molecules. " Air Fuel Synthesis Ltd", the company in Stockton on Tees which is carrying out this recess, has released their method of producing the fuel, with the chemical steps involved to reach the final product. They use a similar method of CO capture as I have described previously, with use of an electrolysis chamber to obtain Carbon Dioxide. Air is blown up into a tower and reacts with a sodium hydroxide solution.

The carbon dioxide in the air is absorbed by reaction with some of the sodium hydroxide to form sodium carbonate. The sodium hydroxide/carbonate solution that results from Step 1 is pumped into an electrolysis cell through which an electric current is passed. The electricity results in the release of the carbon dioxide which is collected and stored for subsequent reaction. The diagram above shows the technology flowchart that the company are Implementing The next important stage in the process is the fuel reactor, in which the fuel itself is finally synthesized. This can be done in various ways.

While some methods react the carbon dioxide with the hydrogen, others involve the dissociation of carbon dioxide first into carbon monoxide, and subsequently react it with the hydrogen. The latter reaction is done using the Fischer-Tropics process, which converts a suture of carbon monoxide and hydrogen, which is known as " gangs", into liquid hydrocarbons. The general equation for the reactions that take place are as follows: (an + 1) H2O + n CO -+ n H2O This shows that there are many possible hydrocarbons that can be produced through this reaction, most of which are straight chain, and thus are suitable for use as fuels.

One issue surrounding the reaction however is the production of methane. The formation of methane, which in the case of the general equation would be " n= l", is generally unwanted as methane is gaseous at standard temperature and pressure. As well as the formation of Alaskan however, the reactions will give small amounts of alikeness, as well as alcohols and other oxygenated hydrocarbons, which are unwanted side products. Generally, the Fischer-Tropics process is operated in the temperature range of 150-300 co.

Despite the fact that higher temperatures lead to faster reactions and higher conversion rates, they also tend to favor methane production. For this reason, the temperature is usually maintained at the lower side of the range. Increasing the pressure leads to higher conversion rates and also favors formation of Eng-chained Alaskan both of which are desirable, so pressure is kept at around 10 atmospheres. Pressures higher than this would be more effective, but the benefits may not be worth the additional costs of high-pressure equipment and other costs.

As previously discussed, another way to synthesis the fuel is to react the same gangs mixture (carbon dioxide and carbon monoxide) and hydrogen into methanol. This can be produced by catalytic hydrogenation of CO with H2O. CO + UH -+ COUCH + H2O Similarly, UH + CO COUCH Since the latter reaction is exothermic, low temperatures favor conversion to methanol. On the other hand, the rate of reaction increases with increasing temperature. Pressure wall also affect ten position AT ten equilibrium, Walt Increasing pressure favoring the formation of methanol.

The final conditions used involve a copper oxide catalyst at around 50 atmospheres of pressure and about 270 degrees The methanol formed can then be converted to gasoline by the Mobil process. This crude methanol is initially preheated, vaporized and then superheated to between 300- 320 degrees C in a series of heat exchangers. The vapor is then sent to a demolisher reactor containing a dehydration catalyst (alumina) where approximately 75% of the methanol is partially dehydrated Tao mixture of DEEM, water and methanol. The reaction is rapid, reversible and exothermic.