

# LIQUID COAL AS A GREEN ENERGY: A REVIEW

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**Abstract**— Fuel market is growing more rapidly than the fuel production of the world. Simultaneously coal to liquid fuel technology is growing and covers some of the fuel demand of the world. A cost effective technology uses the coal with low carbon value, which is not much useful in its natural form and the manipulated form leads to the development of liquid coal. Most of process have not been industrialized. The raw gas is converted into liquid is an idea along with removal of sulphur, phosphorous impurities which does not pollutes air so, ultimately environmentally safe.

**Index terms**—Bergius process, fischer- tropesch reactor, liquefaction, liquefied coal, syngas.

## I. INTRODUCTION

Liquid coal is a manipulated component used as a fuel by the process of liquefaction of coal. Liquid coal is used as an alternative to oil. Coal liquefaction is particularly suited to countries that rely heavily on oil imports and have large domestic reserve of coal [1]. The basic method of producing liquid coal is gasification of coal with little oxygen and water vapour [2]. Through this hydrogen, carbon mono oxide, carbon dioxide along with the oxides of impurities of sulphur, phosphorous, etc is obtained. After purification this gas is sent to a catalytically synthesis unit that will produce hydrocarbon along with carbon chains. Secondly the hydrocarbon is separated from the rest, then saturates the hydrocarbon fraction with extra hydrogen and then cracking of heavy molecule gives liquid. A fischer- tropesch process is used to convert Syngas mixture into liquid hydrocarbon[2]. Liquid coal is manufacture from the coal having less carbon content and have low ignition and emits less carbon which is essentially safe unit. Liquefied coal is used as fuel for production of various types of energy. Liquid fuel from coal provide ultra clean cooking fuels, alleviating health risk from indoor or air pollution. As it is derivative of coal, so costs more than the naturally occurring coal but on the other hand the liquefied coal minimises the areas of environmental pollution and proves itself better than naturally occurring coal. Converting coal to liquid fuels provides ultra clean, sulphur free products, low in aromatic hydrocarbons, and

offers significant reductions in vehicle emissions such as oxides of nitrogen, volatile organic compounds and carbon mono- oxide.

## II. METHODOLOGY

The process of liquid coal production is coal to liquid or gas to liquid conversion. There are mainly two methods of liquid coal production.

A. *Direct coal liquefaction process.*

B. *Indirect coal liquefaction process.*

A. *Direct coal liquefaction process:*

The direct coal liquefaction processes are hydrogenation and carbonisation[3].

a) *Hydrogenation:*

Bergius process developed by Friedrich bergius in 1913 , is a method for direct conversion of coal to liquid by hydrogenation process. Heavy oil is recycled and mixed with dry coal. A catalyst is added to mixture, reaction occurs at 725° F to 932° F at 20 to 70 Mpa hydrogen pressure[3].

The oil or liquefied coal obtained by the process is very much eco- friendly and emits least emission to the environment.

b) *Carbonization or Pyrolysis:*

The process of carbonisation conversion occurs through destructive distillation or pyrolysis, produces coal tar, oil, water vapour, solid residue char and non considerable synthetic gas. The processing of oil and coal tar removes sulphur and nitrogen species by hydro-treatment[4].

The karrick process is also used for carbonisation in which the coal is heated at 680° F to 1380° F in absence of air which optimize the coal tar production, gives out semi coke and liberate liquid as a bi product. Semi coke is smokeless and solid fuel[5]. The liquid produced is of low quality to use as motor fuel, requires further treatment for using as a liquid fuel.

B. *Indirect Coal Liquefaction Process:*

Indirect conversion of coal converts into syngas, which is purified mixture of carbon monoxide and hydrogen gas, which is converted into light hydrocarbon through the

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process is known as methanol synthesis, is a process which converts the syngas into methanol which polymerised it into alkenes by zeolite which is used as a catalyst [*Process developed by Mobil in early 1970s*] Another process is methanation which converts the syngas into synthetic natural gas[6].

### III. INDUSTRIAL TECHNOLOGY OF COAL TO LIQUID PROCESS

The dried coal is sent to a gasifier for gasification. In the gasifier the carbon contained in the coal reacts with water vapour and oxygen to form mostly carbon mono oxide and hydrogen. Then the raw gas is sent into a heat exchanger. In exchanger raw gas is cooled by counter floating cold water and at the same time steam is generated from water. After that the raw gas is sent into a deduster which removes ash particle through a deduster and passes the raw gas to water gas shift reactor. The reactor is employed to adjust the hydrogen and carbon mono oxide ratio. In a reactor carbon mono oxide react with water vapour to form carbon di oxide and hydrogen. The raw gas is then send into scrubber which removes sulphur and release a pure gas called syn gas. The syngas is then send to Fisher- Tropsch reactor, which catalytically converts carbon mono oxide and hydrogen into long paraffin's chains. It is the main chamber of liquid processing. After this the mixture of hydrocarbon and water is separated and liquid hydrocarbon is send to hydrocracker that produces short chains paraffin such as diesel and gasoline, finally syncrude is stored[7].

### IV. ENVIRONMENTAL OBLIGATION

The coal liquefaction process is associated with carbon dioxide emission which results in the process of gasification or heat and electricity generation. Another environmental impact is high level of water consumption in water gas shift and reforming of methane steam. The liquid coal tend to be cleaner than naturally occurring crude as hetero atom compounds are removed from final products.

Carbonisation which occurs through paralysis, produces polycyclic aromatic hydrocarbon which is also called carcinogen[8]. There is also possibility in comparison to global warming, necessarily if coal liquefaction is conducted without carbon capture and storage technologies[9].

The fuel produced by coal liquefaction is sulphur free which is good for environment, on further processing it get convert into electricity or other energy resources[10]. the inorganic residue obtained in liquefaction process can be used as an aggregate for fertilizer, building construction materials, tyres of motor vehicles, landfills material, etc[10].

### V. FUTURE SCOPE

Liquid coal technology plays a vital role on economy of a country by fulfilling the huge energy demand. Liquid coal is utilized to meet urgent energy need specially in developing countries. Liquefied coal is produced from non renewable resources but can easily produced which fulfils the present fuel requirement of a country up to some extent. liquid coal

requires vast inputs of coal that would limit the amount of fuel that could be produced [11].

Today fossil fuel source account for 80% of energy demand of the world in which coal covers 25% which is a larger proportion[12]. India plans to use gasified liquid to access an estimated 350 billion tonnes of coal, whereas South Africa is producing coal derived fuels since 1955 and is the country having industry of coal liquefaction in operation today along with 30% of gasoline diesel need of South Africa produced from indigenious coal[1] Moreover, China has approximately 30 projects using underground coal gasification. In Benhal, North Dakota, The Great Plain Gasification plant is in operation since 1984, which produces 160 million cubic feet synthetic natural gas per day [6].

### VI. CONSTRAINT

Coal is used as a raw material for production of liquid coal and coal is non renewable resource of energy as it is fossil fuel so it is not long lasting and is a problem for continuous liquefied fuel production. Coal utilized for fuel production degrade the soil which unfits for sustainable agriculture practices. The ashes and dust releasing from coal industry leads to air pollution which causes several lungs and health disorder. moreover combustion of liquefied coal release some harmful gases which is harmful for environment. The technology used for production of syncrude or liquefied coal is costlier and the diesel produced is in low quantity, liquid coal requires huge inputs of both coal and energy. In fact, one ton of coal produces only two barrels of fuel [13] and also it is unfit for direct use as machine fuel.

### VII. CONCLUSION

The fuel producing from liquefaction and gasification of coal is very much useful because the combustion of fuel does not emits gases in comparison to coal burning. The technology utilised in extraction of liquid coal makes it useful also when the carbon content in the coal is low.

A large production of liquefied coal from low grade coal can solve the fuel crisis of the world and can give a better challenge to the other developing fuel sources and products.

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