MERIT RESEARCH JOURNALS
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Merit Research Journal of Environmental Science and Toxicology (ISSN: 2350-2266) Vol. 2(1) pp. 009-011, January, 2014
Available online http://www.meritresearchjournals.org/est/index.htm
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Short Communication

The dilemma on the underground coal gasification at the Thar field of Pakistan

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Abstract

Coal power generation was first experienced in Pakistan at Lakhra coal field which was operated with lignite from the Lakhra but those three 50 MW power stations were shutdown due to high Sulphur as well as medium to high ash contents. Sulphur had corroded all the plant very badly and making them in-operational. The underground coal gasification process is not new in the world (Underground Coal Gasification, 2009; Exergy optimisation of reverse combustion linking in underground coal gasification, 2008; Forward and reverse combustion linking in underground coal gasification, 2008; Theory of reverse combustion linking, 2007; Underground Coal Gasification with Carbon Capture and Storage, 2006; The Exergy Underground Coal Gasification Technology As A Source Of Superior Fuel For Power Generation, 2006; The Exergy UCG technology for Power Generation, 2006; The Application of Underground Coal Gasification in South Africa, 2005; Reverse Combustion Linking in Underground Coal Gasification, 2005; The Exergy UCG Technology and the Chinchilla Project: an alternative IGCC pathway, 2005; The Exergy Underground Coal Gasification Technology and Its Application in Commercial Clean Coal Projects, 2005) as practical proof and USSR, USA, Germany and China have much experience in this regard. In Pakistan, the team of the world renowned scientists has done the same successfully at Thar and on their advice; the prototype was also practiced at the lab giving the same conditions. The gas was successfully evolved and power generators were then operated. The technique is in-expensive and can be adopted everywhere in Pakistan same as biogas plants for household use. The contradiction in the national policy with respect to funding on the UCG is very painful for the scientists in promoting this technique at the Thar to achieve the target as it is now essential to make an alternate of Sui gas for our gas requirements in future as well as power generation.

Keywords: Underground Coal Gasification, Dilemma, Thar field, Lignite, Lakhra, Power stations, Gas

INTRODUCTION

A lot of research (Underground Coal Gasification for Power Generation, 2004; Eskom's Underground Coal Gasification Research Program, 2004; UCG for Power Generation, 2003) concerning UCG has been done in various countries resulting great breakthrough in this field. It is the in-situ conversion (The Exergy UCG Technology as a Source of Raw Materials for Chemical Syntheses, 2005) of coal into composite combustible

Table 1. Experiment made on Lakhra coal.

Analysis of Lakhra Coal (Raw)	
Inherent Moisture %	30.45
Volatile Matter %	32.45
Ash %	17.49
Fixed Carbon %	19.61
Total Sulfur %	5.89
Gross Calorific Value Btu/lb	4638

Table 2. Composition of the syngas evolved during UCG Experiments (Underground Coal Gasification, 1984)

S. No.	Components	Test Result of Experiment 1 (Lakhra coal)	Test Result of Experiment 2 (Lakhra coal)	Powder River Basin Coal
1.	Oxygen / %	14.018	1.719	
2.	Carbon dioxide / %	0.095	40.644	23.1
3.	Nitrogen / %	53.078	48.380	0.7
4.	Methane / %	26.943	6.055	3.8
5.	Ethane / %	2.959	0.588	0.3
6.	Propane / %	1.430	0.522	
7.	iso-butane / %	0.758	Nil	
8.	n-butane / %	0.377	0.165	
9.	iso-pentane / %	0.149	Nil	
10.	n-pentane / %	0.140	Nil	
11.	Hexane / %	0.024	Nil	
12.	Heptane / %	0.029	Nil	
13.	Hydrogen / %	Not analyzed	Nil	24.5
14.	Carbon mono-oxide / %	Not analyzed	1.927	15.2
15.	Hydrogen Sulphide / mg/L	Not analyzed	Nil	0.1
16.	Oxides of nitrogen / %	Not analyzed	Not analyzed	0.2
17.	Gas gravity	0.9033	1.1741	
18.	Gross heating value/Btu/ft^3 of dry gas @ 14.65 PSI and 60^oF	410.45	95.95	
19.	Net heating value /Btu/ft^3 of dry gas @14.65 PSI and 60^oF	375.48 Btu/ft^3	88.34	

gases and has complex process. It differs from coal to coal, involving chemical reactions, heat and mass transfer, pressure and complex dynamics. The most common technology being used today for the extraction of coal is however classical mining irrespective of its well defined drawbacks i.e., big cost, dangerous job due to environmental hazards as well as high risk factor for human life. The studies also alarm that the extraction of coal through this means will not be feasible at Thar as it has thick layer of water on coal seams and also its coal has moisture content (40 – 50%). The Federal Government is now interested in modern clean coal technologies especially underground coal gasification (UCG) to overcome the difficulties of classical mining and to adopt it for future power generation and household gas substitute from the Thar resource of 175.5 billion tones reserves which are spread over an area of ten thousand square kms.

Chemically UCG can be defined in the form of complex reactions such as combustion of Carbon, partial oxidation, water gas shift, methanation, hydrogenation and reactions between steam and carbon etc. The said process utilizes injection and production wells narrow drilled from the surface and linked together through coal seams whereas air is injected in controlled manners to ignite underground coal to evolve composite / syngas. This gas may be a mixture of methane, hydrogen, carbon mono and dioxide gases in different proportions and may further be converted into liquid hydrocarbons feedstock.

The main target of the study is to identify the potential of UCG for Thar lignite (How to Turn Thar Desert Lignite into Power, Oil and Energy, 2005) which is either

uneconomic to work through conventional mining or unfeasible due to geotechnical facts and other environmental safety practices. A prototype was designed to conduct the UCG at lab. Scale where volatiles had been transformed into composite gases on the other hand, the remnant was converted to low grade coke.

Experiment

Laboratory scale experiment was performed using Lakhra lignite of mesh size -4 and +16 along with the fittings in a grave type tank and overburdened by sand. Two ceramic coated special type electrical heaters having 1000W power were put between inlet and outlet pipes under the coal bed whereas permeability was created through pressurized oxidants (air and oxygen) along with thermocouples to read temperature rise ranging from 0 – 1300^{O}C. The analyses were according to ASTM D – 1945 and D – 3588.

Proximate, Sulphur and Gross Calorific Value determinations were made on prior and post gasification for further research along with stack gas analysis and Gas Chromatography.

RESULT AND DISCUSSION

The experiment made on Lakhra coal (Table 1) was observed that initially moisture present in raw coal was evolved first and as it exhausted, the temperature shoot to the range of volatile release. This volatile could be seen for a short period with some of residual moisture then after a clear gas appeared and ignited with flame. Samples were taken for detailed analysis (Table 2). The situation had been controlled through regulators of air, oxygen and electrically through switches on panel for gas heaters. The gas was found suitable for house hold use and for driving electrical generators for illuminating bulbs. The gas evolved was continued whole working day (08hrs) to operate 5kw generator producing electricity on consumption of 2.5kg coal to be gasified whereas 03kw was spent on electric heater and other accessories.

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