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Article

Innovative "Zeosinx" Method for Carbon Rebreath: Consequent Higher Mileage Energy System

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ABSTRACT

The present-day conventional energy is a consequence of burning of fossil fuels. During the process apparently, the fossil fuels do not burn completely. These incompletely burned fossil fuels produce greenhouse gases (GHGs). Furthermore, the energy thus produced will not be completely consumed. The present study elucidates an enhanced energy system with assurance of complete burnt of fossil fuels along with complete consumption of energy produced by any source. The versatile behavior of thermal energy storage applications of zeolites had led a pathway to Zeoengines. When compared to water, it can hold nearly 30 times more heat, thus it is the best and efficient way to store complete consumption of heat energy. Natural zeolites such as natrolite, analcime, apophyllite, chabazite, heulandite, and mesolite have a unique property of releasing heat by absorption of water and liberate water vapor on heating. The exhaust of the engine is passed through the specially prepared mixed bed phases resulting for trapping of unburned fluid and fluidized gasses. This trapped fuel is enhanced and enriched by wave blasting and reinjected into the engine by non-return valve system which is automated with integration of supervisory control and data acquisition. This system results an additional high energy, nearly 10–20% higher mileage along with low GHGs. By adopting this system in gas-based or diesel-based power plants, plant load factor can be increased. An integrated closed cycle of adsorption and liberation of heat manages industrial cooling and heating system, thus saves energy by complete consumption of heat produced by any energy system. The system is a proved long lasting, eco-friendly, and cost-effective system.

Key words: Zeolite, Thermal energy, Analcime, Apophyllite, Chabazite.

1. INTRODUCTION

In the present days, the usage of fossil fuel such as coal, kerosene, diesel, petrol, and natural gas became compulsory either directly or indirectly. During the process of combustion, they tend to release of greenhouse gases (GHGs) which generate problems such as air pollution, soil pollution, global warming, ozone depletion, weather pattern change, and rainfall pattern change. [1-5]. Naturally, GHGs are injected into the atmosphere from industrial sector, transport sector, thermal energy production sector, burning of waste crops residues before recropping, and improper handling of municipal solid waste (MSW) methods. In general, CO_2 rebreath is carried out naturally by the plants [3]. Due to deforestation, rebreath of CO_2 levels is not compensated. In the present study, biogas production has been taken as an example to explain the carbon rebreath. The use of biogas as fuel in various sectors will reduce the emission of GHG levels at a positive extent [1-3]. If biomethane is used as fuel in automotives, it reduces tremendously the GHG emission through automotive sector. The global GHG levels are shown in Figure 1.

Nearly 40–60% of CO_2 is present in the raw biogas. In whatever, method may use for its combustion such as wet fermentation or dry fermentation of either MSW or agriculture waste or biomass, CO_2 will be released into the atmosphere. In the present study, the reuse of CO_2 to nullify the adverse effects generated by improper burning of MSW is done through the application of zeolites [5-10]. The effective levels of GHG and future prediction are given in Table 1.

2. METHODOLOGY

The rebreath of CO_2 is carried out by three phases for effective results: (1) Less CO_2 generation during the process of handling MSW or agriwaste or biomass, (2) trapping of CO_2 from the mixture of raw gas or producer gas, and (3) reuse of CO_2.

3. RESULTS AND DISCUSSION

3.1. Less CO_2 Generation During the Handling of MSW or Agriwaste or Biomass

Less CO_2 can be obtained through a process called magnetic wave blasting. In this technique, two permanent magnetic of magnetic capacity 2500 Gauss are arranged opposite to each other in the outlet of the gasification tank. The raw gas evolved from burning the waste when passed through these magnets, it get ionized and called plasma state of gas. In this state, complex molecules split into simple molecules due to the repulsive forces between the identically charged ions and ultimately it will attain structure like double layers. The magnetized

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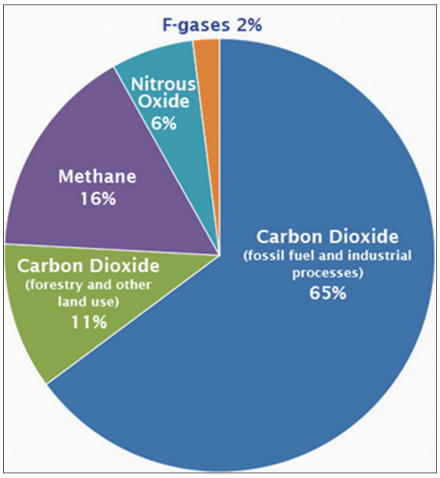


Figure 1: The global greenhouse gas levels (IPCC-2014).

Table 1: The GHG levels (Shulka, 2006)

Year	Emission (million tons)			
	CO_2	CH_4	N_2O	CO_2 equal GHG
2000	956	18.63	0.308	1454
2010	1507	20.08	0.505	2115
2020	2080	21.73	0.689	2839
2030	2572	24.36	0.807	3507

GHG=Greenhouse gas

oxygen with high negatively charged ions is passed through the beams or double layers of the plasma cause further decomposition to elemental molecular levels very quickly resulting further more high quality and quantity of producer gas or syngas and depletion of ash, tar, and CO_2.

3.2. Trapping of CO_2

The second stage of CO_2 rebreath is trapping of CO_2 from the mixture of CO_2, H_2S, and other natural impurities. There are four conventional methods of CO_2 trapping: (i) Natural method, (ii) chemical method, (iii) water scrubbing, and (iv) cryogenic or physical method. In the present study, a new technique is developed by adopting tailored zeolites for carbon rebreath. The process is named as "Zeosinx" method. In conventional methods, CO_2 will be trapped and nullified but cannot be reused, whereas in the new method of Zeosinx, CO_2 is trapped in the gaseous state and it will be reused.

3.2.1. Natural method of trapping CO_2

Natural method CO_2 trapping is done by the plants during the photosynthesis process. During this process, plants breathe CO_2 in the presence of sunlight and water and prepare carbohydrates and exhale O_2. This cycle is known as photosynthesis [3-9].

3.2.2. Chemical method

In this method, polyethylene glycol or monoethanolamines are passed in counter currents with the working pressure of 7 bar from the top of the container and CO_2 from the bottom of the container. The regeneration is carried out by means of thermal variations. However, the chemicals are costly and more energy consuming.

The basic reaction of CO_2 with monoethanolamine [4,8,10] is as follows (1).

$$1RNH_2 + CO_2 f\ RNHCOO^- + \underset{Cold}{\overset{Hot}{RNH_3^+}} [R = CH_2OH] \qquad (1)$$

3.2.3. Water scrubbing

Water is pumped as counter current in the direction opposite to CO_2 gas flow direction with a working pressure of 10 bar. Water is a good common solvent. In this process, water is passed from the top while the gas is liberated from the bottom of the container. The CO_2 dissolved in the water and carried out along with the water from the bottom of the container (Scheme 1). Hence, it is difficult to reuse CO_2. In addition, it creates of problem of diffusion. It is energy- and water-oriented process [6].

3.2.4. Cryogenic method

Cryogenic separation works on the principle of deference in boiling points of components of raw biogas mixture. The boiling points of composition of raw biogas are given in Table 2.

In cryogenic separation process, the raw biogas is passed in to the compressor to develop a pressure of 5–7 bar. The heat exchanger in the condenser allows the raw gas to lose heat by changing the temperature and pressure of the raw gas in expansion zone resulting temperature of −100°C. Thus, CO_2 separates from the mixture. In this process, nitrogen is used as a coolant. It is energy-oriented process and requires high maintenances. In the above-mentioned methods, there is a big disadvantage of regeneration system, due to that the CO_2 is carried away by liquids. Hence, the researchers of the present study have adopted a new technique to trap CO_2 in the gaseous form for reuse [1,2].

3.2.5. Zeosinx method

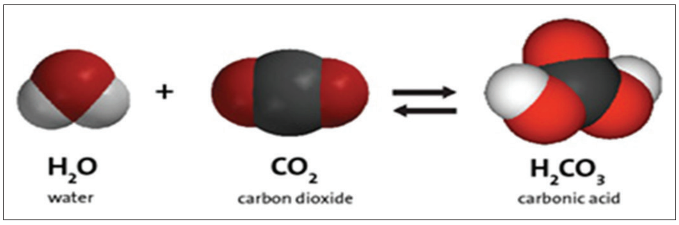
It is an innovative method proposed and through this paper. In this method, tailored zeolites are adopted for the separation of CO_2 form H_2S and other impurities to provide high purity CO_2. Zeolites are more stable even after several thousand cycles of operations, eco-friendly, non-toxic, and thermal withstanding. Composition of 98–99% and H_2S levels is around 50 ppm. Even these minimal quantities of H_2S are removed for the CO_2 reuse. Rejected gas of refinery is connected with two interconnected vessels through pump, solenoid valve, and pressure switch. The two vessels each measuring a height of 750 mm and width of 250 mm are filled with 5A zeolite pellets. These vessels are connected with raw gas inlets, purified gas containing CO_2 outlet, regeneration outlets of 25 NB along with timer programmable logic controller-based solenoid valves, and suction pump. They act simultaneously in alternate mode, when first vessel is in adsorption mode, the second vessel will be in regeneration mode, i.e., removal of adsorbed H_2S gas. Raw gas is passed with a flow rate of 4 m^3/min. Now, the first vessel will adsorb H_2S till its saturation, leaving CO_2, whereas the second vessel is isolated from inlet raw gas and purified gas outlet, suction pump is switched on to activate regeneration mode. Entire process is repeated in a cyclic manner keeping both the vessels in adsorption and regeneration mode alternatively. The gas collected from the outlet is analyzed with geotech, has shown that the H_2S levels are reduced to <1 ppm from 30 ppm of raw gas.

3.3. Factors Affecting the Carbon Rebreath

Factors such as temperature, pressure, water content, and CO_2 exposure time will have their role in carbon rebreath. Temperature plays a main role in maintaining the microbial action. The temperature enhances the diffusion of CO_2 and makes the cell membrane more permissible, thus causing the inactiveness and mortality of the bacteria. The high pressure stimulates the more dissolution of CO_2 in the feed slurry which develops shearing between the bacteria resulting high inactiveness [5]. However, there may not be dissolution of CO_2 after saturation level even though there is high pressure [11]. The presence of water causes the dissolution of CO_2 and produces carbonic acid (H_2CO_3) which dissociates and releases H^+ ions creating lower pH of the suspended media. The lower pH helps an increase in cell wall permeability of CO_2

Table 2: Boiling points of compositions of raw biogas

S. No.	Name of the gas	Boiling point °C
1.	H_2S	−60
2.	CO_2	−78.5
3.	CH_4	−161
4.	N_2	−195



Scheme 1: Schematic representation of dissolving CO_2 in H_2O.

which generates additional pH drop in the intracellular membrane. Thus, results inactivation of enzymes and finally the life of the microbes [7]. The exposure of CO_2 in pre-treatment stage depends on the time of exposure. This increases the inactiveness of microbes [12,13].

4. CONCLUSIONS

The process of producing an increased yield of CH_4 from the evolved CO_2 is called carbon rebreath. To overcome the drawbacks in the conventional methods of carbon rebreath, a new technique has been developed in the present study known as "Zeosinx" method. In this method, zeolites were tailored and used for trapping and reuse of CO_2. Temperature, pressure, water content, and time of exposure to the light will play an important role in carbon rebreath. The temperature enhances the diffusion of CO_2, whereas the high pressure stimulates the more dissolution of CO_2, but there may not be dissolution of CO_2 after saturation level even though there is high pressure. The quantity of CO_2 produced during the waste handling process is fully reused, so net injection into the atmosphere by this method is almost nil or zero. By adopting the carbon rebreath technique, the researchers of the present study have measured an increase of 30–40% of CH_4 yield with respect to conventional system.

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