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Water Can Protect the Earth and People-A Comparison of Two Energy Storage Reactions

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Absract

Two storage energy reactions, namely, carbon gasification $C+CO_2=2CO$ and Steam gasification $C+H_2O=H_2+CO$ reactions were compared. The results show that the Steam gasification reaction has many advantages, such as: higher caloric value of gas, high storage energy index, faster reaction speed, abundant resources, low price, low production cost, significant emission reduction, environmental protection. Convenient for rural promotion. Water naturally can protect the earth and mankind.

Keywords: water gas, energy storage index, gasification reaction

1. Introduction

Energy exhaustion, environmental pollution and climate warming have been troubling the survival and security of mankind. Facing energy, mankind is digging coal into the earth, drilling oil from the seabed, vigorously developing nuclear energy, light energy, wind energy, and geothermal energy. Facing environmental protection, waste incinerators are being promoted worldwide. Facing climate change, carbon capture and storage (CCS) is being promoted worldwide. The people do what they can.

The author has published several articles, Namely:《Making Use of CO_2 Capture for Saving the Earth and Human---A Comparison of "Carbon Capture and Storage-CCS" and "Carbon Capture and Storage Energy-CCSE"》(J.M.Jin, 2020). 《One chemical Reaction can Save human--A Review of Experiment Research on $CO_2+C=2CO$ and Application》(J.M.Jin, 2021), 《One Chemical Reaction can Protect the Earth》(J.M.Jin, 2022). In the article (J.M. Jin, 2022), although the two storage energy reactions are listed, the chemical reaction mentioned in the subject refers only to the carbon gasification reaction, namely $C+CO_2=2CO$. Using captured carbon dioxide to produce gas, stored energy and reduce emissions. The Steam gasification reaction is not discussed further. However, when we further have compared the two storage reactions, it is found that the Steam gasification reaction has more advantages than the carbon gasification reaction. This paper describes the comparative results of two storage energy reactions.

Actually, it is a supplement or extend to article published.

2. A Comparison of Two Storage Energy Reactions

2.1 Carbon

$$C+CO_2=2CO\ \Delta H^0_{298k}=+\ 41.21\text{kcal mol}^{-1}.\ \text{(JANAF,1971) (172538 kj/kg mol)}\quad ZN=3.31 \qquad (1)$$

$$C_{(\text{graphite})}+H_2O_{(g)}=H_{2(g)}+CO_{(g)}\ \Delta H^0_{298k}=+31.38\text{kcal mol}^{-1}.\ \text{(JANAF,1971) (131382kj/kg mol)}\quad ZN=4.35 \qquad (2)$$

Both reactions are endothermic or energy storage reactions. Where ZN is the energy storage index. ZN is defined as ZN= heat stored/heat consumed. For example, the heat absorbed (consumed) by carbon gasification reaction is 172538kj/kg mol, and the heat released after the complete combustion of the stored CO generated by the reaction is 570865kj/kg mol. The theoretical value of the storage energy index of this reaction is: ZN=570856/172538=3.308. Considering the heat loss of furnace wall, the heat loss of furnace gas away, and the heat loss of slag, the actual storage energy index is less than 3.308, but cannot be less than 3.0(suppose the heat loss reaches 10%). For carbon water gasification reaction, the theoretical value of energy storage index is: ZN=4.35, the actual value can not be less than 3.9.

It's important to note that ZN is a storage energy index, it doesn't mean to increase energy.

The CO_2 in equation (1) is captured CO_2. The production of gas does not require high purity of CO_2, and the flue gas of the power plant can also be directly used, which is the SSE technical route proposed by the author(J.M.Jin, 2020). The advantage of direct use of flue gas is that it can save the expensive capture cost (capture cost accounts for 2/3 of the

total capture and storage cost). Its disadvantage is that the gas produced contains a lot of nitrogen, and the caloricity of the gas is low.

The water in reaction furmula (2) can be sewage or toxic water. It is expected that the Organic or inorganic poisons in water will be completely decomposed in 1000^0C high temperature and strongly reducing atmosphere.

The carbon in the two reaction formulas includes both organic and inorganic carbon-containing materials. Such as peat, lignite, white coal, wood carbon, firewood, plastic, rubber, seaweed, dung, animal carcass and so on. According to equation (2), One ton of carbon requires 1.5 tons of water for producing 3,730 m^3 of nitrogen-free gas,The content of CO and H_2 in gas is 50% each. The energy storage index of both reactions is greater than 3, which means that the production process has zero energy consumption and has the energy storage function. ZN=4.35, it means that you have used one part of energy, but you have stored 4.35 parts of energy, so the ideological barrier of not willing to use electricity to produce gas should be removed.

2.2 Plastics C_2H_4 and C_3H_6

$$\text{PE type plastic: } C_2H_4+2H_2O=4H_2+2CO \quad (3)$$

$$C_2H_4+2CO_2=2H_2+4CO \quad (4)$$

$$\text{PP type plastic: } C_3H_6+3H_2O=6H_2+3CO \quad (5)$$

$$C_3H_6+3CO_2=3H_2+6CO \quad (6)$$

According to equation (3) and (5), one ton of PE or PP type plastic requires 1.3tons water for producing 4800 m^3 of nitrogen-free gas, and the hydrogen content in the gas is 67%. The gas produced by the plastic-CO_2 reaction contains only 33% hydrogen .

2.3 Rubber C_5H_8

$$C_5H_8+5H_2O=9H_2+5CO \quad (7)$$

$$C5_5H_8+5CO_2=4H_2+10CO \quad (8)$$

According to equation (7), one ton of waste rubber requires 1.32 tons water for producing 4600 m^3 of nitrogen-free gas with a hydrogen content of 64%.

2.4 Starch C_6H_{1995}

$$2\ C_6H_{1005} + 12\ H_2O = 1017\ H_2 + 12\ CO \quad (9)$$

$$2C_6H_{1005}+12CO_2=1005H_2+24CO \quad (10)$$

According to the equation, one ton of starch requires only 0.1 tons water for producing 10700 m^3 of nitrogen-free gas with a hydrogen content of 98.83% hydrogen. almost all hydrogen.

2.5 Fat $C_{57}H_{11006}$

$$C_{57}H_{11006}+ 57\ H_2O = 5560\ H_2 + 57\ C \quad (11)$$

$$C_{57}H_{11006} +57\ CO_2 = 5503\ H_2 +114\ CO \quad (12)$$

According to equation (11), one ton of fat requires 0.0877 tons water for producing 10760 m^3 of nitrogen-free gas. The content of hydrogen in gas is 98.98%, The Gas is almost entirely hydrogen.

3. The Results of Comparison

From above, the comparison results are:

(1) Water gas has a higher calorific value

The higher calorific value of water gas is due to the fact that water gas contains more than 50% hydrogen. If waste plastic is used as raw material, the content of hydrogen is 67% and that of fat is 99 %. The higher the content of hydrogen, the higher the calorific value of gas.

(2) Water gas has higher storage energy index

The theoretical storage energy index is 4.35 for steam gasification reaction, it is higher than that of 3.308 for carbon gasification reaction.

If the production raw material is plastic, rubber or fat, the ZN value is estimated to be more higher.

ZN=1, which means that the energy consumption of the production process is 0. ZN=4.35, which means that one part of energy is consumed, but 4.35 parts of energy is stored, and the increarsed energy comes from the carbon gasification.

Calculations show that it fully obeys the energy conservation law. This result tells also us that people are not willing to use electricity to produce gas thinking concerns are Completely unnecessary.

It also tells people that if water gas are used for electricity generation, the coal consumption can be reduced to less than 200 grams per kwh.

(3) The reaction rate of steam gasification is faster.

The hydrogen is a active catalyst for C-CO_2 reaction, , which is the result of Hon`s research (H.Tao, 2017).

This result is perfectly consistent with ECDAM or EODRM.(J.M.Jin, 2019).

Mckee thinks that the catalyst is absence, the reaction occurs sluggishly at temperatures below 1000^0C. The uncatalyzed reaction is generally somewhat faster than the C-CO_2 reaction under the same conditions(Mckee.1971).

(4) Rich resources, low production costs.

According to Equation (1), one ton of carbon requires 3.67 tons of carbon dioxide, and the cost of capturing carbon dioxide is 183 dollars (about 1,283 RMB yuans) at 50 dollars per ton. According to equation (2), one ton of carbon needs 1.5 tons of water. The price of domestic water is 2.4 yuan one ton, and the cost of water is 3.6 yuans. The production cost of water gas is much lower than that of carbon capture and storage energy.

More importantly, it can be popularized into the vast countryside to

make full use of firewood, animal carcasses and other wastes to produce energy necessary for human beings, while it is protecting the environment.

(5) Significant emission reduction effect

From the equation (1), the C-CO_2 reaction directly uses the captured carbon dioxide as raw materials to produce gas, achieving the purpose of emission reduction, at a glance, it is very obvious. However,from the equation(2), water replaced carbon dioxide, there is no carbon dioxide in the equation (2), so water seems to have no emission reduction effect. However, once the water gas produced by C+H_2O reactions is used as boiler fuel in power plants, the carbon dioxide emissions in flue gas can be reduced by at least 50%. The global emissions of about 8 billion tons of carbon dioxide from thermal power plants can be reduced by more than 4billiontons. So it is well above the International Energy Agency's requirement for capturing 3.3 billion tons CO_2 every year. If it superadd the emission reduction from iron and lime produce by the technical route proposed by the author, namely, Lime and gas was produced at the same time, iron and gas was produced at the same time, which can reduce the emission of carbon dioxide by 3.1 billion tons. When added together, the emission reduction of carbon dioxide reaches more than 7 billion tons, which is likely to result in over-capture phenomenon. Expensive carbon capture job is unnecessary.

(6) Protect the environment

According to Equation (2), one ton of carbon requires 1.5 tons of Water as raw material. The dirty water, toxic water can be used as raw materials into production. The organic or inorganic toxicants in water will be decomposed by quenching in a reductive atmosphere at high temperature. Oxidizing gases SO_2 and NOx often seen in flue gas are unlikely to appear in gas. So that's why it's clean gas.

Using water gas as boiler fuel in power plant may save maybe the desulfurization and denitrification units.

Everyone is worried about the white pollution, a worldwide problem, the Queen of Britain has issued a call to solve as soon as possible. Because on the ground, in the oceans are polluted with plastic. The authors boldly believe that using water, waste plastic and electricity can quickly solve the problem.

Fortunately, laboratory research for producing water gas with plastic and other waste as raw materials has been completed(J.M.Jin, 2022).

4. Economic Efficiency

Economic efficiency is one of the biggest concerns. Calculated from the equation:

$$C+H_2O_{(l)}=H_2+CO \quad -39488 \text{ kcal/kg mol (Glinkof,1953) (165328kj/kg mol)}$$

$$C+H_2O_{(g)}=H_2+CO \ -28380 \text{ kcal/kg mol (118821kj/kg mol)}$$

According to 1 kwh=3.6x106 joules, it turns out that 1.025 degrees of electricity (water) or 0.74 degrees of electricity (steam) are required to produce 1 cubic meter of gas. This is the result of a theoretical calculation， heat loss is not taken in to account.

Heat loss includes wall heat loss, gas heat loss and slag heat loss. The wall heat loss of large heating furnace is usually about 3%. The heat loss of furnace gas can usually be recovered by cooling water. As for slag heat loss, different raw

materials have different slag amount. Using firewood, plastic, rubber, dung and so on as raw materials, the estimated amount of slag is very small, so can be ignored. After accounting for the 3% heat loss, the power consumption is 1.056 and 0.76, respectively. The former applies to use water as raw materials, while the latter applies to with steam as raw materials。The large amount of water vapor emitted from the steam turbine can be used as the raw material for gas production. Thus, the electricity consumption per cubic meter of gas produced by the thermal power plant using this technology is estimated to be below 0.8 degrees.

One ton of carbon plus 1.5 tons of water can produce 3733 m^3 of nitrogen-free high calorific value clean gas, which requires 3942 degrees of electricity (water) or 2837 degrees of electricity (steam).

One ton of plastic plus 1.32 tons of water can produce 4,800 cubic meters of gas, which requires 5070 degrees of electricity (water) or 3650 degrees of electricity (steam).

At present, the price of water is 2-3 RMB . the price of natural gas is 3-5 yuan per M^3.the electricity price is 0.4 yuan per kwh of valley electricity.According to the calculation of 1m3 gas produced by 1 kwh electricity, it is very obvious that the economic benefit is very good.

If we take energy, environmental protection and weather warming into consideration, we can say that this is a perfect technological route. Economical and feasible, water can protect the earth and mankind , and achieve universal harmony.

People are very worriabout the white pollution, the worldwide problem, the use of water is expected to solve.

5. Type and Power of Water Gas Generator

Gas generator is the only equipment to produce water gas, it can be large or small. Small to household gas generator, large to thermal power plant gas generator . Furnace type can be a variety of, vertical, horizontal, well type, looped type all can be, the only requirement is that the furnace hearth must be sealed.

As for the heat source, it can be electric heat, or it can be fuels like coal.

For small furnaces, it is more convenient to use electric heating. For large stoves, such as heat plant,it is more appropriate to use fuel heating like coal,wood.On account of, to build a supper big power electric gas generator may encounter difficulties.

6. Environmental Protection

The slag and washing info water produced in the process of water gas production may pollute the environment.

If waste plastics, paper, rubber, firewood, dung etc. as raw materials are used to produce gas, it is estimated that the slag produced is both small and fine, and the quenching slag by high temperature can be used as soil to sprinkle farmland, without polluting the environment.

If coal is used as the raw material for gas production, the amount of slag is relatively large, you can refer to the slag treatment method of coal-fired furnace.

In my article, I repeatedly mentioned “nitrogen free high calorific value clean gas”. Clean gas means that oxidizing gases, such as SO_2 and NOx, are not possible in gas. By this reasoning, expensive desulfurization and denitrification units may be unnecessary if water gas are used as fuel for thermal power plants.

Some plastic raw materials contain chlorine, fluorine etc.active elements, although it is impossible to appear oxidizing gas in gas, but it is likely to appear hydrides, such as HCL, HF, H_2S, these hydrides may appear at the same time in washing info water, can be removed by alkali solution.

7. Conclusion

Both reactions are endothermic reactions or energy storage reactions, and both reactions on energy storage index ZN is greater than 3. Although the carbon capture and storage energy technology route (CCSE) is far better than the CCS technology route , the steam gasification reaction (2) is far better than the carbon gasification reaction(1). The expensive captured CO2 is insteaded by water ,the production costs is smart reduced , and it is especially valuable in the vast countryside, wrhere waste is used everywhere. It should be known that the sun sends energy to the earth day and night, and the plants and animals on the ground are growing day and night, it is storing energy all the time. The amount of stored energy is enormous. Once this biological energy is fully utilized, the three problems of energy exhaustion, environmental pollution and climate warming will naturally be alleviated or completely alleviated. Abundant water naturally can save the earth and man kind. It is a great pity that the author has repeatedly proposed using captured carbon dioxide to save the earth and people. Comparing the results of the two storage energy, it is concluded that using "water to save the earth and people" is more economical and reasonable, and moreover the laboratory research work has been completed.

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