

# A Chemical Reaction Can Save Mankind

## -A Review of Experiment Research on $\text{CO}_2 + \text{C} = 2\text{CO}$ and Application

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### Abstract

There are two contents of this article. The first is briefly to review the experiment research on the catalysis mechanism of Carbon Gasification Reaction-CGR( $\text{C} + \text{CO}_2 = 2\text{CO}$ ) from 60s -90s. The results show that the catalytic phenomenon is physical phenomenon rather than chemical, and the catalyst does not participate in the chemical reaction. The catalytic activity and selectivity of catalyst are related to the electronegativity or energy level of the catalyst. The second is to clarify the applications of CGR for save mankind. The lime is first proposed to capture  $\text{CO}_2$  in flue gas of power plant. The lime can be recycled. The coal is used to convert  $\text{CO}_2$  from cement steel produce into  $\text{CO}$ , producing both energy and lime and iron. The capture  $\text{CO}_2$  is used to treat waste such as firewood and plastic, eliminate white pollution. The author considers that using the CGR which has been used for a long time can solve the three problems which people worry about: energy exhaustion, environmental pollution and climate crisis.

**Keywords:** gasification, CGR, capture  $\text{CO}_2$ , lime

### 1. Introduction

The warming of the earth and the frequent occurrence of extreme weather have seriously affected the survival and life of human beings. There was a great deal of anxiety. The United Nations has held many meetings, especially in Paris. Scientists generally believe that the earth is warming as a result of massive emissions of carbon dioxide from industrial production. As a result, the capture and storage of  $\text{CO}_2$  on a global scale, known as the Carbon Capture and Storage-CCS technical route, has become the focus of research by many scientists and the strategy of governments. Zhang Dongxiao, director of the Clean Energy Research Institute at Peking University, said that the CCS technical route could become the single largest carbon reduction technology in the world. The UN's International Energy Agency (IEA) has repeatedly stressed that the CCS technical route remains an important solution for reducing greenhouse gas emissions. It calls for 200 CCS projects globally to be operational by 2020 and 3,000 by 2050. Between 2015 and 2050, the world should capture and store 120 billion tonnes of carbon dioxide. The CCS technical route from an American power plant seems to be the only one that can save the earth.

Since 2016, the author has published 6 articles on the use of Captured Carbon and Storage Energy-CCSE to save the earth in domestic and foreign journals. The contents involve climate change, energy, environmental protection and other major issues, this paper aims to further clarify the author's point of view, it is hoping to arouse people's attention.

### 2. A Briefly Review of Experiment Research

#### 2.1 Catalysis Mechanism of $\text{BaCO}_3$ in Solid Carburizing Agent (Jin Jia-Min 1963, 1966, 2000)

The catalysis mechanism of  $\text{BaCO}_3$  in solid carburizing agent was studied in 1960s. Solid carburizing on the surface of steel parts is an ancient technology, which has been used up to now. It completely relies on the CGR to complete the carburizing process. The reaction process is as follows:

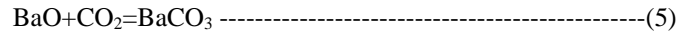
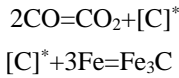
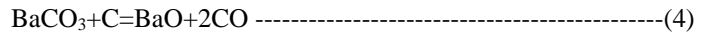
$\text{C} + \text{CO}_2 = 2\text{CO}$ ----- (1) it occurs on the surface of solid carbon.

$2\text{CO} = \text{CO}_2 + [\text{C}]^*$  ----- (2)  $[\text{C}]^*$ - active carbon, it Occurs on the surface of steel parts.

$[\text{C}]^* + 3\text{Fe} = \text{Fe}_3\text{C}$ ----- (3) carburizing, it Occurs on the surface of steel parts.

The reaction rate of CGR (1) is slower at the  $940^\circ\text{C}$  temperature, it is a control step. In order to speed up the Carburizing speed and improve the quality of the Carburizing layer, Catalyst  $\text{BaCO}_3$  must be added to the wood carbon. With regard to the catalysis mechanism of  $\text{BaCO}_3$  accelerating the carburizing process, it is opinions vary. All of which

are seen in the literature are the cyclic catalytic mechanism of the Chemical Reaction Mode-CRM, which is described as follows:



The idea core of CRM is that the catalyst has to participate in the chemical reaction, and while it has to produce an intermediate (BaO or Ba\*) (Du. G. H. & Yan. J. H. 2002), and the catalyst BaCO<sub>3</sub> is repeatedly decomposed and generated. In order to verify CRM, the reaction equilibrium pressure of reaction (4) is determined.

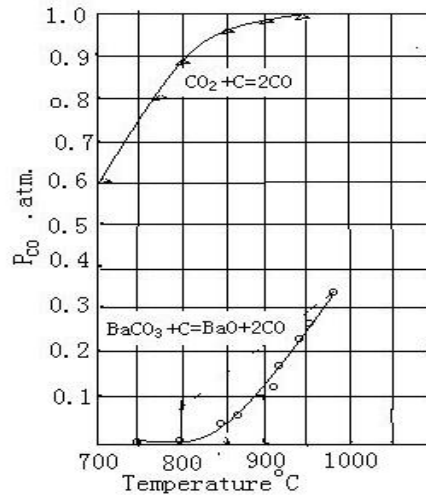


Fig.1. Equilibrium pressure of BaCO<sub>3</sub>+C=BaO+2CO reaction

From figure 1. The equilibrium pressure of reaction (4) is much lower than that of the CO in the carburizing box. The reversible reaction of the BaCO<sub>3</sub> repeated decomposed and generated in the carburizing box could never occur. So, the CRM is not credib.

2.2 Determination of Reduction Process of Iron Oxide Reduced by Carbon at 38.5m Tunnel Kiln (Jin Jia-min 1977)

At present, the world's production of sponge iron is between 50 and 60 million tons. Most of them are used to make steel in electric furnaces. Part of it is used in powder metallurgy production. There are more than 20 methods to produce sponge iron. However, converter and the tunnel kiln is still the main method. Both completely rely on CGR to produce sponge iron (C+CO<sub>2</sub>=2CO, CO+FeO=Fe+CO<sub>2</sub>).

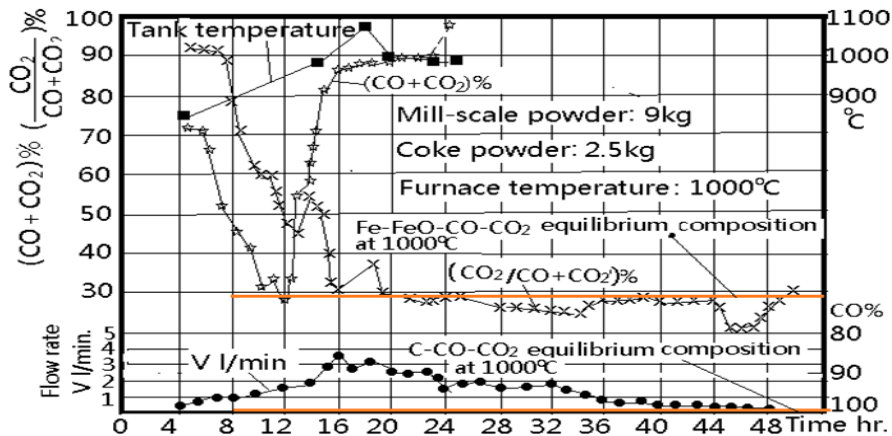


Fig. 2. Velocity and composition of gas released from the reduction reaction tank

Figure 2 is flow velocity and composition of gas released from the reduction reaction tank. The CO content in the gas is about 65%, and the CO<sub>2</sub> content is about 35% (Different reduction stages have different gas composition).

From Fig.2, we have obtained three conclusions:

a. The reduction process of oxide iron by carbon is carried out in stages, that is:

$Fe_2O_3 \rightarrow Fe_3O_4 \rightarrow FeO \rightarrow Fe$ . Among them, the FeO reduction process time is the longest, lasting nearly 30 hours.

b. When taking the CO<sub>2</sub> content in the gas is compared with the equilibrium gas phase composition of the  $C + CO_2 = 2CO$  and  $FeO + CO = Fe + CO_2$ , we have obtained that the CGR is the slowest and the CGR has controlled the speed of the whole reduction process. Using catalyst to accelerate the reaction rate of CGR can accelerate the reduction rate and increase the yield of sponge iron.

c. There is a "reduction end point" between the reduction process and carburizing process. The reduction process and the Carburizing process are absolutely separated.

2.3 Catalytic and Poison Mechanism of Mineral Impurities in Carbon on Reduction Iron Oxide by Carbon-A Experimental Study with Double Box (Jin Jia-Min, 1982,1988).

The above three conclusions have layed on the theoretical foundation for the experimental study of the double box.

During the 1970s, the catalytic and poison actions of Fe,Co,Ni,Cu,Ag,SiO<sub>2</sub>,S etc on iron oxide reduced by carbon have studied. The experimental method is to use a double box, that is, Fe-C (without catalyst), Fe-Cu, Fe-Ni, Cu-Ni, Cu-Ag, SiO<sub>2</sub>-C, S-C. In one box, a catalyst is added to the carbon layer, and in the other box, another catalyst or no catalyst is added.

The relative catalytic activity of the catalyst was judged according to the gas flow rate, carbon dioxide content in the gas and carbon content in the sponge iron.

The result is that both Fe, Co,Ni,Cu,Ag have catalytic activity and Fe have the largest catalytic activity. SiO<sub>2</sub>, S is Poison.

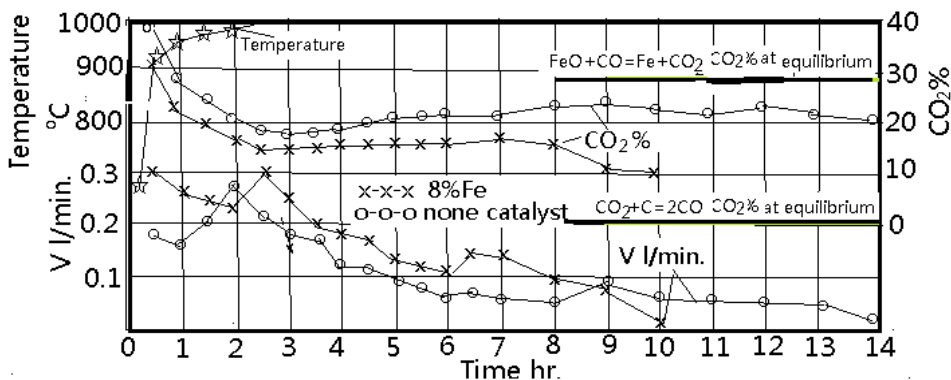


Fig. 3. Catalytic activity of iron in the reduction process with carbon

From Fig. 3, the iron exhibits a catalytic activity. However, the reversible reaction of reduction and oxidation of iron can not occur in the carbon layer. THE CRM can not explain at all this result.

The results of the experiment have obtained two conclusions:

- a. In the heterogeneous catalytic reaction, the catalyst does not participate in the chemical reaction. A large amount of iron oxide in the reaction box is reduced to Fe. A cyclic reaction of both reduction and oxidation of Fe,Co,Ni,Cu,Ag in the carbon layer are not never possible occur. It can prove that the widely popular CRM cyclic catalytic mechanism in the literature and high school textbook is not credible.
- b. The Cu appears catalytic activity for CGR, but it is poison to iron-based ammonia synthesis catalyst. It is proved that comparing the electronegativity of elements or compounds can be used to judge the activity or poison of materials. The electronegativity of Cu is less than carbon and greater than Fe. because it is between Fe and C in the periodic table. The electronegativity of Cu is less than carbon and greater than Fe. For carbon gasification, any element or compound with less electronegativity than carbon has catalytic activity, such as Fe, Co,Ni, Cu,Ag and noble metals. On the other hand, any element or compound whose electronegativity is greater than that of carbon is a poison, for example, SiO<sub>2</sub>,S,Al<sub>2</sub>O<sub>3</sub>. For an iron-based ammonia synthesis catalyst, any element or compound whose electronegativity is less than that of

iron has catalytic activity, and any element or compound whose electronegativity is greater than that of iron is a poison, for example: Cu, Ni, C, S, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>. There is a demarcation between the catalyst and the poison.

Experimental results prove that the catalysis mechanism of Electron Cyclic Donate-Adopt Mechanism-ECDAM or Electron Orbital Deformation-Recovery Mechanism-EODRM is reliable.

The core idea of ECDAM or EODRM is that catalytic phenomena are physical rather than chemical phenomena.

In the heterogeneous catalytic reaction, the catalyst does not participate in the chemical reaction, but only contact, electron donate-adopt or electron orbital deformation and recovery. Photocatalysis, electrocatalysis, microwave catalysis and laser catalysis are all physical phenomena. Selective catalysis is associated with electronegativity. Bioenzyme catalysis is also related to energy levels.

2.4 A Mechanism of Carbon Dissolving into Fe in Iron-graphite Powder Metallurgy Compact During Sintering (T.Hong ,1986)

In the 1980s, we studied the mechanism of carbon dissolution into iron during sinter steel sintering. This study includes the effects of density, vacuum degree, atmosphere, alloying elements, temperature etc. on the dissolution rate of carbon. The results show that CGR in the Fe-C compactis still the control step of carbon dissolution.

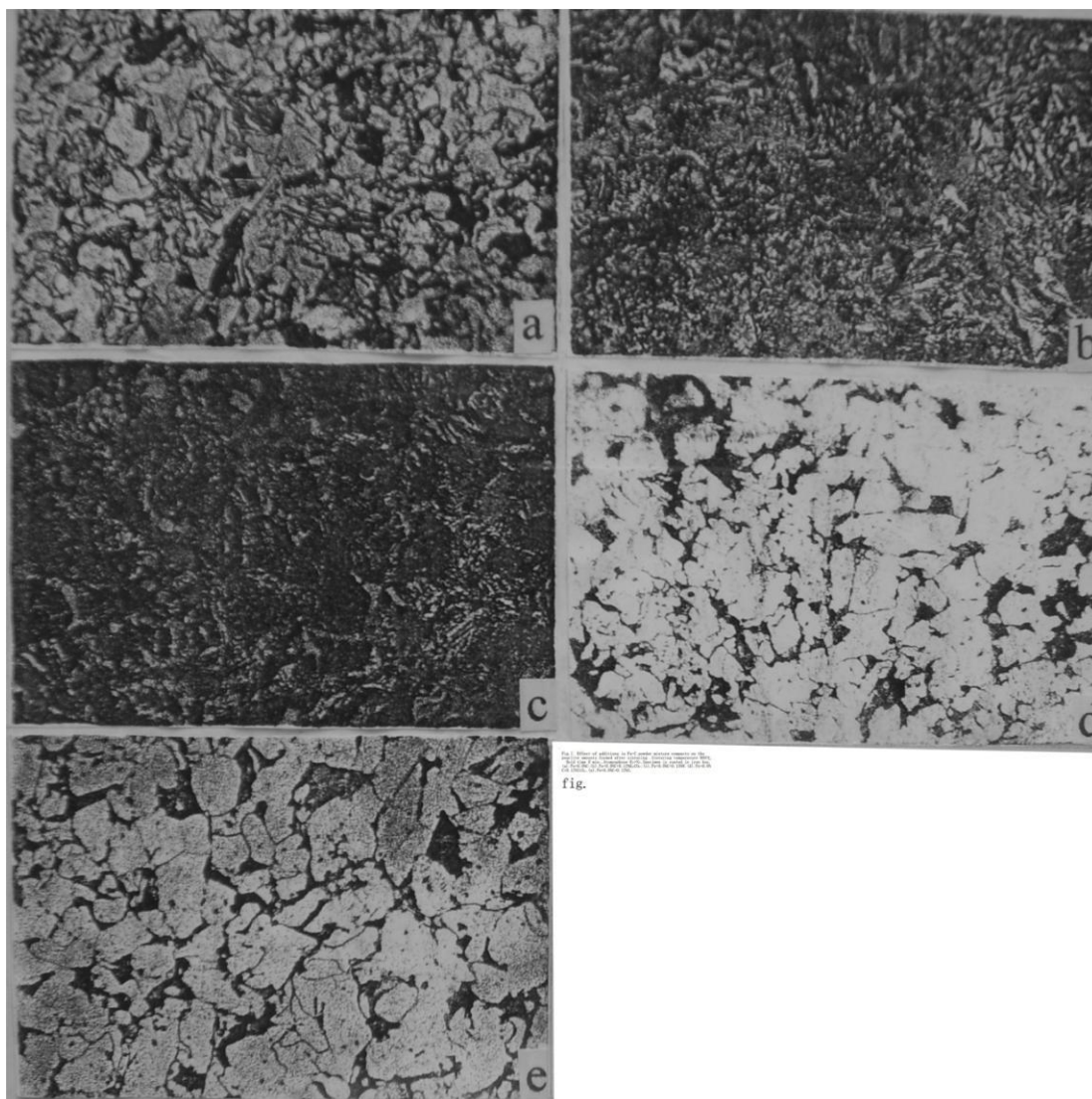


Figure 4. The effect of additives in the Fe-C powder metallurgy compact on the pearlite amounts formed after sintering Sintering temperature; 9 8 0<sup>0</sup> C, time: 8 minutes, atmosphere: decompose ammonia, specimen is coated in the iron box. (a) Fe+0.8%C. (b). Fe+0.8%C+0.12%K<sub>2</sub>CO<sub>3</sub> (c). Fe+0.8%C+0.14%W. (d). Fe+0.8%C+0.12%SiO<sub>2</sub> (e). Fe+0.8%C+0.12%S.

From Figure 4, it is surprising to compare the metallograph of (a),(b),(c),(d),(e). It can be found that the photos (b),(c) of putting some  $K_2CO_3$  and W are full of pearlite, and the photos (d),(e) of putting some S and  $SiO_2$  are almost a white vision field, especially  $SiO_2$ . These results are clear to tell that the dissolution of carbon is almost entirely indirect dissolving, and that there is almost no direct solution, and the solid-solid reaction in the Fe-C compact is almost completely absent.

There are many serious problems in chemical production according to ECDAM or EODRM. (J.M.Jin .2015) . For example:

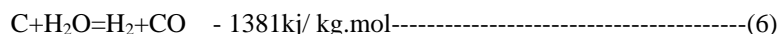
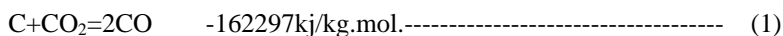
Alumina in iron-based ammonia synthesis catalyst. Active carbon after graphitization as support material in ruthenium-based ammonia synthesis catalyst. Automotive exhaust catalytic converter TWC has used the cordierite honeycomb. carbon black as support material in fuel cell noble metal Pt etc. The  $Al_2O_3$ , carbon, cordierite is all a poison on the Fe,Pt,Ru(AiKa.1985). The result is an increase in energy consumption and consumption of noble metal

From the above, although my research has been around catalysis mechanism of catalyst on CGR for decades. Unexpectedly, the catalysis mechanism research of the CGR is closely involved to energy, climate change and environmental protection. The author believes that the research results of catalysis mechanism are still of great significance for the utilization of  $CO_2$  capture to save the earth and mankind, and energy production, especially the catalysis and poisoning of iron, hydrogen and sulfur, which are of great theoretical and practical significance.

### 3. Carbon Dioxide Capture and Application (J.M.Jin 2016,2017,2019,2020)

#### 3.1 The Energy Storage Reaction and the Energy Storage Index -ZN

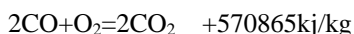
There are two common endothermic reactions; namely



Both of these reactions are endothermic or energy-storing reactions. These two reactions exist in the gas generator furnace.

Equation (1) is the carbon gasification reaction, also known as Boudouard reaction. It is very important reaction. Many industrial products rely entirely on this reaction. such as Fe,Cu etc..

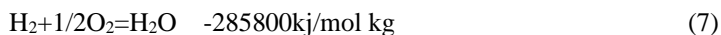
The heat released by the combustion of carbon monoxide from the CGR is the heat stored.



The energy storage index ZN is the ratio of the energy stored by gas after the chemical reaction to the energy consumed during the chemical reaction, which is used to measure the energy storage efficiency of different carbonaceous materials.

For the CGR, the storage value is compared with the consumption value, namely (3)/(1),  $570865/162297=3.517$ , deduct about 3% of the furnace wall heat loss. The energy storage index ZN of CGR is  $ZN=3.4$ . This data means that the energy stored after gasification is 3.4 times that consumed. It is known that the direct combustion to indirect combustion, especially compared with the rural hearth, can significantly improve the thermal efficiency, thermal efficiency can completely offset the heat loss of the furnace wall, so the electric heating gas generator can be called zero energy electric heating gas generator. In terms of economy, it is very economical to use electric heating furnace to produce gas.

The raw materials for the production of gas always contain water, and  $C+H_2O=CO+H_2$  is also an endothermic or energy-storage reaction.



$[(4)+2/1(3)]/(2)$ , namely  $ZN= [285800+285432]/131381=4.35$ .

When  $ZN > 4.0$  and the thermal efficiency of the thermal power plant increases to 50% (the highest thermal efficiency of the thermal power plant is 46% at present), the energy stored in the gas produced by valley electricity can fully meet the energy required for peak electricity generation, which alone can save half of the thermal power coal consumption. The reduction in carbon dioxide emissions by nearly half is staggering, I should say. On this basis alone, the amount of gas that needs to be stored may be small.

The United States and China account for 52% of global carbon dioxide emissions, China accounted for 35%. If China and the United States can work together, so it can save half of the coal consumption of the thermal plant, the problem of global warming will maybe solve.

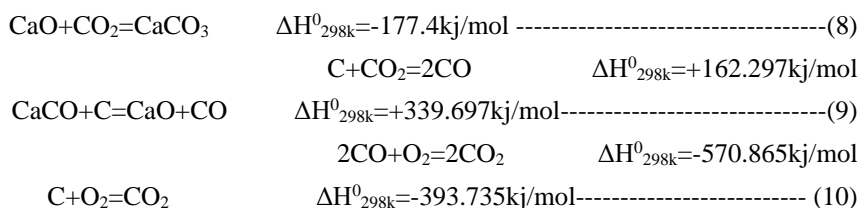
Energy storage index  $ZN=3.52$  is a very reliable and important data. The  $ZN$  tells you very clearly, although electricity is in short supply around the world, there are two things that people should understand. First, it is not willing to use electricity to produce gas, which may be that many scientists so far has not proposed the electric gas generation furnace thought concerns. This concern now seems unnecessary. Second, because of the  $Zn > 4$ , people would naturally think that the first use of electricity in lighting, electrical machinery and so on seems unreasonable. Electricity shall first be supplied to a zero-energy electric heating gas generator. It can both consume large amounts of carbon dioxide, plastic waste, eliminate white pollution and the ability to control the climate warming that people are so worried about.

### 3.2 Using Lime to Capture CO<sub>2</sub> expelled from Power Plant

Thermal power plants are large emitters of CO<sub>2</sub>. Global coal production in 2018 was 8.01 billion tons, based on 2/3 of coal used for power generation. Power plants emit 19.6 billion tons of CO<sub>2</sub>, it is 59% of total global emissions of 33 billion tons. Therefore, capturing CO<sub>2</sub> in the flue gas of power plants naturally becomes the main target.

There are many methods to capture CO<sub>2</sub> from the internet. The author believes that using lime or centrifugal-gravity separation may be the most economical method.

Using lime to capture CO<sub>2</sub> related chemical reactions:



Formula 8 is an equation for capturing CO<sub>2</sub> emitted from power plants with lime. It is an exothermic reaction. The product is limestone. The limestone has two uses. One is storage, the other is calcination. To control climate by regulating limestone storage. This method is better than the regulating ratio between the application and storage of carbon monoxide for controlling climate. CaO and CO<sub>2</sub> were obtained after calcination. The CaO can be used as raw materials for cement production or recycling. CO<sub>2</sub> can be sold as a commodity. Because the use of wood, plastics and other garbage for gas producing needs a lot of carbon dioxide.

Formula (9) is a reaction of limestone and carbon to produce lime and gas simultaneously when limestone is calcined. It is an endothermic reaction or energy storage reaction, and its energy storage index  $ZN=1.66$ . The 1.66 means that one unit energy is consumed and 1.68 unit energy is stored, So It is very cost-effective to coproduce both lime and gas.

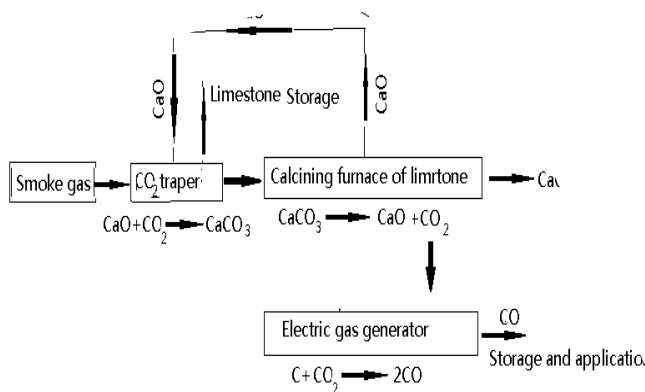


Fig. 5. Cyclic reactions between gas production and CO<sub>2</sub> capture by CaO

FIG. 5 shows the cyclic reaction of capturing CO<sub>2</sub> from flue gas with CaO and producing nitrogen-free high calorific clean gas with CO<sub>2</sub> from limestone decomposition. The CO<sub>2</sub> trapper is a steel drum, the structure of the drum depends on the flue gas flow. The capture temperature is estimated at about 500<sup>0</sup> C and the drum speed is about 5 rpm. There are no strict requirements for capture efficiency. Because the capture reaction is an exothermic reaction, does not need to be heated, and the mechanical operation consumes little energy, it is possible to use lime to capture CO<sub>2</sub> as one of the most economical methods.

The advantages of using lime to capture carbon dioxide in power plant flue gas are: low energy consumption, low cost, recyclable, permanent storage, and unlimited storage space.

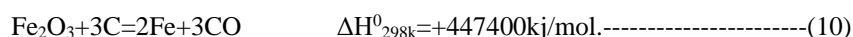
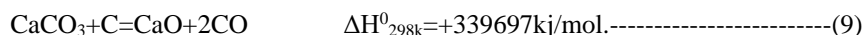
The centrifugal-gravity separation method mentioned above is based on the difference between the specific gravity of carbon dioxide and nitrogen. The specific gravity of CO<sub>2</sub> is 1.98 kg/m<sup>3</sup>, the specific gravity of N<sub>2</sub> is 1.25kg/m<sup>3</sup>.

Modern technology can separate U<sup>235</sup> from U<sup>238</sup>. It is expected that centrifugal-gravity method can improve the content of CO<sub>2</sub> in flue gas. Fortunately, gas production has no strict requirements for the content of carbon dioxide in raw materials, only for stability. Predictably, using centrifugal-gravity separation to capture carbon dioxide should be a very economical method

### 3.3 Coal Is Used to Convert CO<sub>2</sub> Emitted From Cement and Steel Production into CO

The CO<sub>2</sub> emitted from steel and cement production are second only to power plants. It accounts for about 10% of the total emissions.

Two chemical formulae for capturing CO<sub>2</sub> with coal are as follows:



Both reactions are endothermic or energy storage. The energy storage index is ZN=1.66 and ZN=1.78, respectively. The increased energy also comes from carbon consumption.

According to the reaction formula, a ton of lime is produced. consumed 0.214 tons of carbon while producing 800 m<sup>3</sup> of gas, reducing about 0.8 tons CO<sub>2</sub> emissions. one ton of iron is produced, consumed 0.321 tons of carbon while producing 600 m<sup>3</sup> of nitrogen-free high calorific value gas, reducing about 0.6 tons CO<sub>2</sub> emissions. So using coal to capture CO<sub>2</sub> from steel and cement production has many benefits. Natural resources will be fully utilized, and a large amount of energy will be produced. The production cost of cement and steel will be greatly reduced, and the environment will be protected.

From the Internet, In 2017, Global limestone production is 5.8 billion tons, By molecular formula, Carbon dioxide is 2.552 billion tons, it is can produce 2552 billion m<sup>3</sup> nitrogen-free high calorific value gas. In 2018, Global iron ore production is 2.2308 billion tons, Based on the average iron content of 48.8%, The output of refined iron ore is 15, 500 million tons, The oxygen content is 465 million tons, After reduction combustion, the amount of CO<sub>2</sub> produced is 640 million tons. It is can produce 640 billion meters nitrogen-free gas. Total CO<sub>2</sub> emissions from cement steel production are 3.192 billion tons, It accounts for 9.67% of the total emissions of 33 billion tons.

According to the calculation of chemical reaction formula ,31.92 billion tons of CO<sub>2</sub> can be converted into CO with 870 million tons of carbon (about 1 billion tons of coal) and about 3192 billion kwh, and 3192 billion m<sup>3</sup> of nitrogen-free high calorific value clean gas can be obtained. Global 7.8 billion people, each person can use 409 m<sup>3</sup> of high calorific value gas per year China's current cement production accounts for 50% of global production of 5 billion tons. Steel production accounts for 53%. CO<sub>2</sub> emission should be 1.6 billion tons. When we convert 1.6 billion tons CO<sub>2</sub> carbon gasification (C +CO<sub>2</sub>→2 CO) into CO, Can produce 160 billion m<sup>3</sup> gas, which is almost three times as much as the Russia-German Nord Stream 2 line. Based on 1.4 billion people, the high calorific value gas per person per year is 1143 m<sup>3</sup> gas. Far more than residents use gas. A large amount of gas can be used in industrial production such as power generation, The car on the road run may be a gas car.

The above explanation shows that making use of the coal captures CO<sub>2</sub> expelled from cement steel production, not only does not need the capture cost, but instead brings huge economic benefits. Furthermore, the production technology is simple, as long as the furnace tank or furnace body is closed, so let that these two reactions can only occur in the furnace.

### 3.4 Using Captured Carbon Dioxide and Waste such as Firewood, Plastic, Rubber etc. to Produce Gas, Eliminate White Pollution

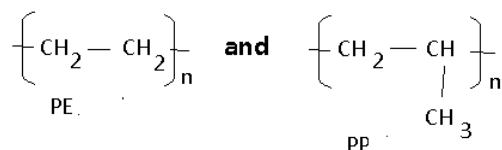
Firewood, plastics, rubber, seaweed and other garbage have mainly contained the hydrocarbon elements, and they have stored a large number of energy. Plastic is one of the greatest inventions of mankind. Bring convenience to human life. But at the same time bring us a problem, it is plastic pollution, also known as white pollution. More than 75% of plastic products can not be recycled after one use. At present ,4 billion tons of plastic are buried underground or stacked on the ground. After 10-20 years, it is decomposed turn into micro particles and it flows into the ocean. At present, there are 8 -10 million tons of plastic which flows into the ocean every year, it is swallowed by marine life and hurted it. The Queen of England has issued also a serious warning to save the earth.

According to the newspaper, Scientists at Oxford University have reported using microwave technology to break down plastics into clean energy hydrogen (97%) and high-value carbon nanotubes, saying they have successfully solved the worldwide problem of white pollution.

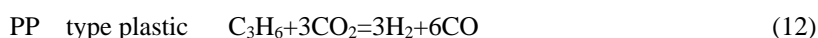
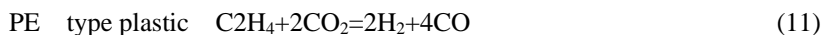


The author believe that using captured CO<sub>2</sub> can solve the white pollution.

The molecular structure of PE and PP type plastics is as follows:



The plastics can react with CO<sub>2</sub> to produce H<sub>2</sub> and CO at 1000<sup>0</sup>C.



The clean gas with high calorific value 4800m<sup>3</sup> nitrogen-free can be obtained after the reaction of 1 ton PE or PP plastic with CO<sub>2</sub>. Clean gas is because after 1000<sup>0</sup> C of high temperature refining, plastic waste harmful and toxic materials are completely decomposed. As for the harmful elements such as S, Cl, F contained in plastic and rubber, it remains to be solved by research.

Firewood, plastic, rubber and other waste, its volume is huge, storage has a lot of energy. The carbon gasification is used to convert these carbon-containing wastes into CO, and plus the CO of the cement and steel produce, it is estimated that there are more than 1500 m<sup>3</sup> of high-quality gas per person per year which can be used by all mankind, which may be sufficient for the needs of all mankind. The feared energy depletion may be unnecessary.

### 3.5 The Cinerator Should Be Transformed Into an Electric Heating Gas Generator

At present, the cinerator is widely used worldwide. The author considers that the operation is very unreasonable. It wastes both fuel and electricity, wastes resources and pollutes the environment.

Worldwide, about 150,000 man and large numbers of animals died each day. There is a lot of energy in animal remains. A 50-kilogram animal carcass can produce about 120 m<sup>3</sup> Nitrogen-free high calorific value clean gas. If these is used to produce gas, A rough estimate, 18 million m<sup>3</sup> of high-calorific value clean gas could be produced each day. It can produce 6.57 billion m<sup>3</sup> a year. If we add animal carcasses, it's even bigger. It regretted that these energy are completely abandoned at present, and it seriously pollutes the environment.

The transformation of the cinerator into an electric gas generator should be said to be very simple in terms of technology. Just a Fe-Cr-Al heat-resistant steel furnace about 3 meters long and 0.5 X0.5 meters high wide. Furnace power is about 150-200KW. 60m<sup>3</sup>. On the economic side, the electricity consumption is about 130 kwh, about 100 yuan RMB, the gas price is estimated to be 360 yuan RMB, the energy storage index ZN) 4, it is to produce energy, protected the environment, and the economy is very cost-effective. Governments should order changes.

Finally, the author suggests to promote forest cemeteries around the world, bury the ashes under a tree, every year Qingming Festival, family members' sacrifice, can touch the growing trees, feel more cordial.

### 3.6 About the Furnace Type and Other

The equipment used captured carbon dioxide to produce gas is only the gas generator. The type of furnace may be varied. Such as vertical, horizontal, converter etc. No matter which type of furnace is used, However, it must meet the following conditions:

- It is that the furnace chamber or furnace body must be sealed;
- The flow direction of raw materials and CO<sub>2</sub> must be in the same from low temperature to high temperature;
- It must be operated at positive pressure to prevent air from entering the furnace;
- It must have a good measuring instrument, according to the gas composition check results, adjust the CO<sub>2</sub> intake and furnace charge.

The converter type which is widely used in cement and sponge iron production, its advantage is that the furnace charge in the furnace is constantly turned back, so it reacts fast. For easily broken processing of raw materials, such as coal, firewood, plastic and so on, it is more appropriate:

The ancient tunnel kiln type electric gas generator has the advantages of mature technology, simple structure, small investment and small operation energy consumption, among which the biggest advantage is that raw materials such as



firewood, garbage and corpse do not need to be processed and can be directly put on the kiln car. Its disadvantage is that the reactants such as coal are fixed on the kiln boat and therefore the reaction speed is slower.

Push-rod electric gas generator (FIG. 1) should be the simplest type of furnace and minimum investment. Furnace body can be large or small. It can be generalized in the countryside.

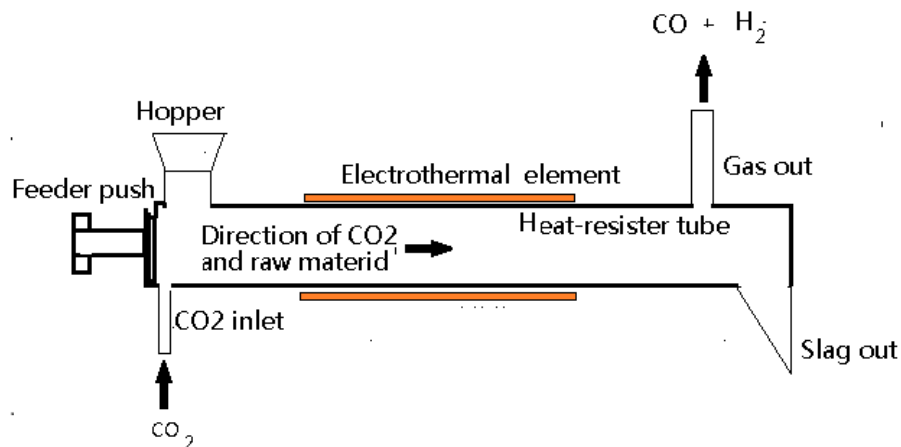


Fig. 6. push-rod type electric gas generator view diagram

Because the composition of raw materials such as firewood cannot be stable. Therefore, a pulverized coal injection device should be installed at the end of the furnace. According to the analysis results of the gas composition, the CO<sub>2</sub> content in the gas should be guaranteed under 2% to ensure the stable calorific value of the gas.

The power of furnace depends on the output. It takes about 1kwh (1.06 kwh) to produce 1m<sup>3</sup> of CO, and 1000kW of power to produce 1,000m<sup>3</sup> of CO an hour.

### 3.7 Gas Is Used in the Vast Countryside

The countryside is a vast world. as far as the eye can reach. Every plant and animal on the ground, growing day and night, have stored a great deal of energy, which people should make full use of.

As shown in Figure 6, push-rod type gas generator is most suitable for general promotion in rural areas. A small 20KW electric stove can produce 480m<sup>3</sup> of gas per day, which can supply thousands of farmers. It's also very economical.

Rural coal gasification, not only the use of resources, and the protection of resources, and the protection of the environment. Beautiful scenery, heaven on earth.

### 3.8 About Over-Capturing

The author worries about the possibility of "over-capture" situations. The reason of "over-capture" is that the technology is simple, the investment is small, the energy consumption is small, and the economic benefit is remarkable. In particular, putter electric furnace in rural areas, it is likely to appear "over-capture" situation. The result of over-capture is that plants wither and animals are hard to survive. So scientists must set a standard for carbon dioxide in the air. Ensure the safety of animal and plant growth.

## 4. Conclusions

### 4.1 Energy Can Be Produced Using Captured CO<sub>2</sub> and Carbonaceous Materials

CGR ( $C + CO_2 = 2 CO$ ) is an endothermic reaction or energy storage reaction. Storage energy index  $ZN=3.4$ . Industrial production has been used in the production of gas, iron, copper for more than 100 years old. Theory and production practice should be without suspense. Captured CO<sub>2</sub> will become the raw material for the production of nitrogen-free high calorific value clean gas. Coal, firewood, seaweed, plastics, rubber and other animal and plant discards can be used as raw materials for gas production, which not only protects the environment, eliminates white pollution, but also produces a large amount of energy.

4.2 *The Advantages of Using Lime to Capture CO<sub>2</sub> in Power Plant Flue Gas Are Low Energy Consumption, Economy and Recycling of Lime*

4.3 *Using Captured CO<sub>2</sub> And Plastic Waste Can Both Produce Energy and Eliminate White Pollution*

4.4 *Using coal to Capture the CO<sub>2</sub> Produced from Cement and Steel Plants*

Use coal to convert CO<sub>2</sub> emitted from cement steel production into CO. The natural resources are fully utilized, and it produces both energy and protects the environment, and the steel and cement production costs have dropped significantly.

The author's core idea is to make use of a simple chemical reaction, make full use of a large number of animal and plant discards that growing at day and night and store energy at all times, to solve the great concerns of energy depletion, environmental pollution, climate crisis, save the earth and mankind.

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