

# Environmental Pollution: The Essence and Solution

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Received 8 April 2014; revised 8 May 2014; accepted 15 May 2014

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## Abstract

**Environmental pollution is the result of human activities, which causes carbon accumulation on the earth. The accumulated carbon resides not only in CO<sub>2</sub>, but also in urban garbage, aquatic weeds, agricultural refuses and other wastes. The forced carbon circulation (FCC) strategy aims to bringing the accumulated carbon back to the ecological cycle through carbonization and carbon reduction. The former changes all refuses to gaseous fuel (ca. 10 wt%) and inorganic carbon; the latter changes all acid/acidic gases (SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub>) to inoffensive/useful substances with the inorganic carbon. Application of FCC strategy will effectively alleviate environmental pollution in a simple way. However, the essence of environment pollution is the heavy population that cannot be sustained by the earth. Therefore, no technical measure, but politics can solve the problem thoroughly.**

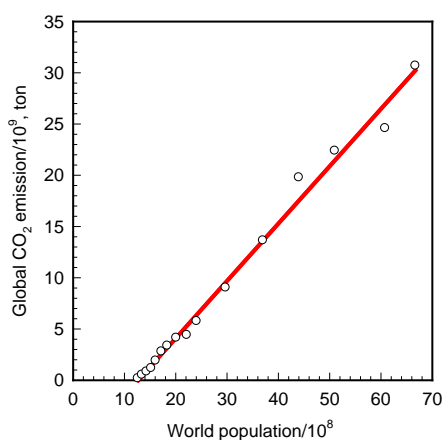
## Keywords

**Environment, Pollution, Essence, Strategy, Forced Carbon Circulation (FCC)**

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## 1. Environmental Pollution Is Due to Carbon Accumulation

The environment would not be polluted should human being be not alive on the earth; therefore, human activity is the origin of pollution. Two things are inevitable in human activities: food and fuels in order to satisfy energy needs. Both food and fuels are composed mainly of elements carbon and hydrogen, and the products of consuming energy are CO<sub>2</sub> and H<sub>2</sub>O. H<sub>2</sub>O is not offensive, but the accumulated CO<sub>2</sub> causes abnormal climate change. The author indicated [1] that the global CO<sub>2</sub> is linearly correlated with world population for the past 160 years as shown in **Figure 1** with a correlation coefficient of 0.99. It means more people, more pollution and zero CO<sub>2</sub> emission when the world population is less than 1.3 billion. In fact, CO<sub>2</sub> is only part of wastes generated in human activities. Many cities/towns of China are presently surrounded by urban garbage (**Figure 2**). Urban



**Figure 1.** Correlation between global CO<sub>2</sub> emission and world population since 1850.



**Figure 2.** The landfill garbage at suburb of a city in Zhejiang Province (Taken on November 7, 2009).

garbage is only part of solid wastes of human activities, and large quantity of agricultural refuses is generated in farming and relevant activities. Aquatic weeds flourish in lakes, rivers and oceans due to pollution with nutritious wastes (**Figure 3**). Different kinds of solid wastes generated in human activities are also a form of carbon accumulation, and carbon left after carbonizing the wastes. Accumulation of carbon above the earth broke up the ecological balance and was reflected in environmental pollution.

## 2. Forced Carbon Circulation (FCC)

Because carbon and hydrogen are the most abundant elements in food and fuels and in the products of consuming food and fuels as well, forced carbon circulation (FCC) is proposed to bring the carbon element back to ecological cycle from refuses through carbonization and carbon reduction. Most organic and/or biomass refuses can be carbonized at relatively low temperature (300°C - 500°C), and poisonous gases such as dioxins do not occur at such temperature. In addition, quite many heat sources of low heat value are available in industry. Inorganic carbon and flammable gas are major products of carbonization as shown in **Table 1** for an experiment with coal [2]. The inorganic carbon is used as reductant of acid/acidic oxides resulted in consuming fossil fuels. The FCC strategy is effective in treating urban garbage, agricultural refuses, aquatic weeds, and the flue gas of fuel combustion. It can also be applied to the FeO/Fe<sub>3</sub>O<sub>4</sub>/CO cycle for the production of hydrogen [2].

## 3. FCC Applied for Urban Garbage

Urban garbage is finely classified and reutilized in developed countries; however, garbage classification seems difficult in practice for developing countries as is the situation of China, and only minor part of refuses is reutilized. Garbage incineration relies on large quantity of additional fuel, and poisonous gases such as dioxins occur



**Figure 3.** Aquatic weeds covered Lake Dianchi, Kunming (left) and sea water at Tsingdao (right), Shandong Province.

**Table 1.** Result of catalytic carbonization of coking and lean coals.

Catalyst	Coking coal		
	Gas, wt%	Combustible Fraction, %	Tar, wt%
Ni/Ce-ZrO <sub>2</sub> /γ-Al <sub>2</sub> O <sub>3</sub>	13.62	89.37	4.29
9%Ni/10%MoO <sub>3</sub> /γ-Al <sub>2</sub> O <sub>3</sub>	13.92	91.93	4.57
Ni/La <sub>2</sub> O <sub>3</sub> -MgO/γ-Al <sub>2</sub> O <sub>3</sub>	15.12	90.38	3.59
	Lean coal		
Ni/γ-Al <sub>2</sub> O <sub>3</sub>	11.31	94.44	1.14
Ni/CeO <sub>2</sub> /γ-Al <sub>2</sub> O <sub>3</sub>	8.32	96.32	2.58
Ni/La <sub>2</sub> O <sub>3</sub> -MgO/γ-Al <sub>2</sub> O <sub>3</sub>	8.86	96.58	2.68

at the incineration temperature. Therefore, garbage incineration often encounters protest of nearby residents and most cities depend on landfills of garbage. It occupied quite large field and deteriorates the near-by environment. According to FCC strategy, garbage is classified just into two groups: that can be carbonized (CBC) and that cannot be carbonized (CNBC). The management of garbage becomes simple: carbonize CBC at about 300°C - 500°C and use CNBC to build up dams on sea coast or spread it over deserts. Additional fuel may not be required for carbonization since flammable gas is generated in the process of carbonization. The resulted inorganic carbon is directly applied in the reaction of carbon reduction as described in subsequent section.

#### 4. FCC Applied for Aquatic Weeds and Agricultural Refuses

How to deal with aquatic weeds is a headache for Dianchi Lake, Kunming, Yunnan Province and quite many other lakes, rivers, and coastal water of China. According to FCC, the aquatic weeds provide large quantity of energy in a simple way: get the aquatic weeds out of water, and dry them up, then carbonize them at relatively low temperature and normal pressure. About 10 wt% flammable gas is expected to obtain in addition to inorganic carbon. The same applies to agricultural refuses. Instead of *in-situ* burning, farmers may sell stalks to a professional contingent. As much as  $8.4 \times 10^7$  tons of flammable gas will be obtained in China if 1/10 of the total stalks transforms to. The obtained inorganic carbon can be used as chemical reductant or just back to cultivated land as potassium fertilizer. The carbonized agricultural stalks usually have developed porous structure with specific surface area ranged in an order of magnitude 10 to  $10^2$  m<sup>2</sup>/g. They deserve well of cheap adsorbent for waste water treatment and once again carbonization is resorted to when saturated.

#### 5. FCC Applied for Hydrogen Production

Fossil fuels will soon be exhausted and natural renewable energy cannot, as pointed out by David MacKay [3], satisfy human requirement when fossil fuels depleted. Hydrogen energy entails the hope of human future because it is theoretically renewable. The renewable hydrogen does come from water; however, cannot through

direct decomposition. Thermo-chemical cycles allow partial decomposition of water in such a way that the oxygen valence does not change while hydrogen escapes from water molecule so that the TEG (theoretical energy gain) [4] is larger than unity. The author proposed a FeO/Fe<sub>3</sub>O<sub>4</sub>/CO cycle where



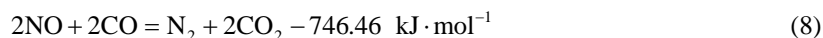
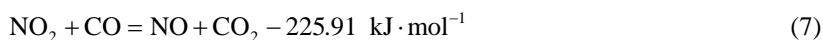
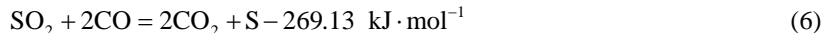
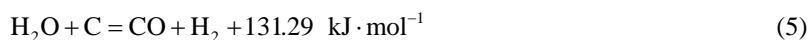
The yielded CO<sub>2</sub> disappears in the reaction of carbon reduction at 900°C:



All reactions proceed at ambient pressure without the aid of catalysts. The carbon generated in FCC can be here used as reductant. The net product of the cycle is H<sub>2</sub> and CO. They are normally obtained through SMR (steam methane reforming) process at 700°C - 1100°C from natural gas with the aid of catalysts and used for the synthesis of chemical products such as methanol, fertilizer, artificial fiber, plastics, etc.

## 6. FCC Applied for Flue Gas of Coal Combustion

Coal is a major energy source and a major pollution source either. It provides the largest share of total energy used for electricity generation, for example, 78% in China, 69% in India and 50% in the United States. Removal of acid gases (SO<sub>2</sub> and NO<sub>x</sub>) from the flue gas of coal combustion doubled the cost of power generation, and the capture of CO<sub>2</sub> costs at least equivalent to double the market price of power coal [5]. The extremely high cost means abandon of capture. Zero emission is possible if FCC applies to the coal-combustion flue gas. In addition to minor content of SO<sub>2</sub> and NO<sub>x</sub>, the major products of coal combustion are CO<sub>2</sub> and H<sub>2</sub>O. All of them can be reduced by carbon to useful or inoffensive substances:



Reactions (4) and (5) are endothermic, and their conversion can be calculated based on fundamental thermodynamic data as that listed in Table 2 [6]. The calculated theoretical conversion of the two reactions is shown in Figure 4 as a function of temperature. Complete conversion is expected at 900°C. Reactions (6)-(8) with minus thermal effects are exothermic and complete conversion is theoretically assumed at ambient temperature whenever reactions initiated. The carbon monoxide here generated can be sent to the FeO/Fe<sub>3</sub>O<sub>4</sub> oxidation/reduction cycle for the production of hydrogen as above mentioned, and the carbon here used can be provided by carbonization of solid garbage/aquatic weeds or agricultural refuses.

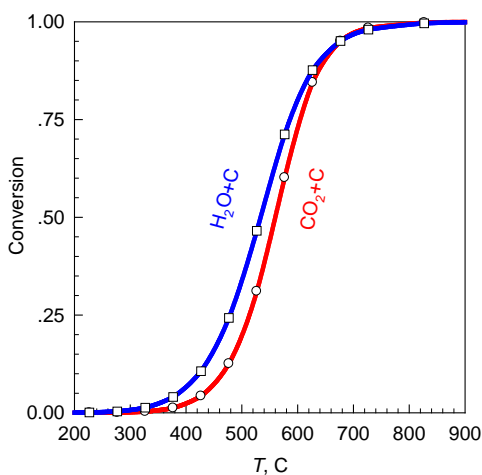
## 7. Discussion and Conclusion

Technical strategy and/or methods known to us are essentially useless for the elimination of carbon emission and the abnormal climate change it caused. The CCS strategy is not practical because the capture cost is too high to be applied in practice and it can only capture the centralized emission. However, the centralized emission accounts for only 1/4 to 1/3 of the total. Electricity driven vehicles are something like that said by a proverb: plug one's ears while stealing a bell because the electricity is most likely produced in burning coal so that the global carbon emission unchanged while some places are locally cleaned. Natural energy cannot satisfy the energy needs presently and even for the future. Compared to them, the FCC strategy is practical and efficient to alleviate environmental pressure.

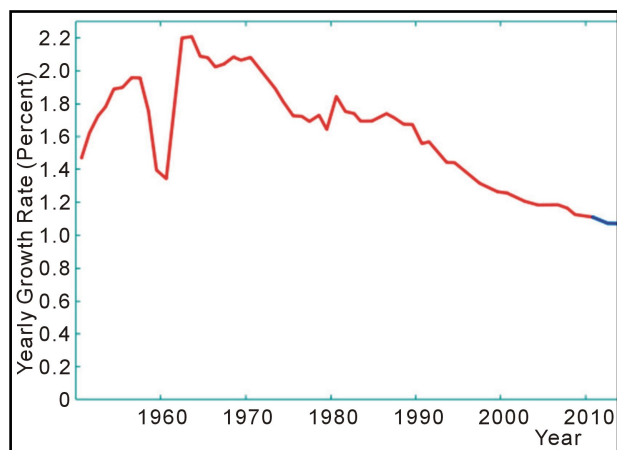
However, as the linear relationship between global CO<sub>2</sub> emission and world population revealed that the essence of environment problem is the problem of population. People must realize the crisis, the living crisis, is stepping closer and closer if considering environmental problem in connection with the depletion schedule of natural resources. Think about the situation 65 years later. The world population will be doubled (more or less

**Table 2.** Thermodynamic data required for conversion calculation of Reactions (1) and (2).

25°C	C (s)	CO <sub>2</sub> (g)	CO (g)	H <sub>2</sub> O (g)	H <sub>2</sub> (g)
$\Delta_f H_m^\circ/\text{kJ}\times\text{mol}^{-1}$	0	-393.51	-110.53	-241.826	0
$\Delta_f H_m^\circ/\text{kJ}\times\text{mol}^{-1}$	0	-394.36	-137.17	-228.6	0
$T, K$	$C_{p,m}/J\cdot K\cdot\text{mol}^{-1}$				
298.15	8.536	29.141	37.135	33.598	28.836
300	8.61	29.142	37.22	33.606	28.849
400	11.974	29.34	41.328	34.283	29.181
500	14.537	29.792	44.627	35.259	29.26
600	16.607	30.44	47.327	36.371	29.327
700	18.306	31.17	49.569	37.557	29.44
800	19.699	31.898	51.442	38.8	29.623
900	20.832	32.573	53.008	40.084	29.88
1000	21.739	33.178	54.32	41.385	30.204
1100	22.452	33.709	55.423	42.675	30.58
1200	23	34.169	56.354	43.932	30.991
1300	23.409	34.568	57.144	45.138	31.422
1400	23.707	34.914	57.818	46.281	31.86
1500	23.919	35.213	58.397	47.356	32.296

**Figure 4.** Theoretical conversion of major reduction reactions at different temperature..

around 14 billion) if the present growth rate (1.14%) is keeping on, and the global emission of CO<sub>2</sub> is almost doubled either. Oil and natural gas have been run out, and the other natural resources are also either empty or closing depletion. Fresh water may be in very short since glaciers may have been disappeared and rivers lost headstreams and draught. Food may also be in very short because most farm land might have been severely polluted. Competition and fighting for the last living resources to survive would be severer year by year. The earth likes just a ferryboat. It would sink when the ferryboat passengers are overloaded. People can imagine what would happen on the boat when it is sinking. The most important for us to do is not the development of economy following conventional model, but to survive human civilization gently, *i.e.*, switching the growth rate of world population to negative immediately. The curve of world population growth rate (Figure 5) [7] shows a downward peak at the end of 50's and early 60's last century, which is largely due to the ridiculous "Three Red Banners" policy that led to a great famine in China and quite many people died in hungry [8]. A re-



**Figure 5.** World population growth rate since 1950 (red).

markable yet gentle decrease is shown for 1970's due largely to the "One Child Policy" of China issued in 1975. Of course nobody wants Mao's policy returned, but the world's attention must switch from "carbon emission" to "breeding control". The personal right and freedom to breed must subordinate the world No. 1 target of surviving human civilization. Lao Tzu told people "following nature (Dao Fa Zi Ran)". It means human activities must be compatible with natural limitation. Any theory or policies are not valid or harmful if it does not consider the compatibility of its consequence with nature.

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