Novel Catalyst for Carbon Dioxide Conversion to Methanol

Carbon dioxide, a major greenhouse gas, is being transferred from the lithosphere to the atmosphere for more than two centuries due to human activity. Carbon dioxide concentration in the pre-industrial era was only 250 ppm whereas currently it is at 380 ppm[1]. Conversion of CO_2 to useful chemicals is of paramount importance due to its immediate application and life cycle benefits. It leads not only to reductions in greenhouse gases but also prevents any additional emissions. Methanol is a major product of the chemical industry and also a feedstock for many chemicals. However CO2 conversion to methanol is challenging.

Most important challenge is that of the catalyst. The current commercial catalyst, supported Cu-Zn oxide is optimized for syngas conversion. Under identical conditions, if the commercial catalyst is used for CO_2 conversion the yield of methanol is much lower than that of syngas conversion. *The equilibrium value is one-third compared to syngas conversion, and below 520 K, equilibrium is hardly attained*[9].

Ceramatec's Technology

Ceramatec's proprietary catalysts showed significantly higher CO2 conversion over commercial Cu-Zn-Al2O3 catalyst. The results of CO_2 conversion to methanol are summarized in Exhibit 1. With hydrogen available from renewable sources (water electrolysis using solar or wind energy), the methanol formed will be completely renewable. Ceramatec is also developing renewable hydrogen production technology.

Exhibit 3: Results of CO_2 Conversion

Catalyst	CO_2 conversion to methanol (Single pass)
Cu-Zn-Al2O3	2.23%
Cu-**pormoterA**-Al_2O_3	24.12%
Cu-**promoterB**-Al_2O_3	30.58%

Commercial Potential

According to the IPCC the cost is expected to at $43 per Ton of CO_2[2]. Using CO2 for manufacture of methanol will be commercially feasible.

Methanol is a feedstock for scores of chemicals such as formaldehyde, acetic acid and biodiesel. All of these derivative chemicals would be considered completely renewable. Thus renewable methanol serves a much broader segment of market. The application of this technology is global. Countries with highest GHG emission and higher consumption of methanol (e.g. China) would benefit significantly from such a technology. A potential cap-and-trade market would be served by methanol and would be in favor of entities using the proposed technology.

As the proposed process becomes economically more attractive, methanol can be further converted to gasoline by the commercial MTG process of ExxonMobil. For example, methanol price below $1 per gallon would make it feasible to convert it to gasoline which is being sold at $3 per gallon (approximately equivalent to crude oil price of $80 per barrel). Thus the proposed project has impacts on both chemicals and fuels markets.

Bibliography

1. X. Xiaoding, J.A. Moulijn, Energy Fuels 10 (1996) 305.

2. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Climate Change 2007: Impacts, Adaptation and Vulnerability, Cambridge UK