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REDUCTION OF CO_2 EMISSION TO METHANE USING HYDROGENATION WITH NICKEL (110) SURFACE CATALYST

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ABSTRACT

The day-to-day development in industries and manufacturing process, all the industries are using chemicals and fuel to produce a product. While manufacturing, they may release some harmful gas in the atmosphere like carbon dioxide, carbon monoxide etc. When compared with all other gases carbon dioxide will cause the environment and approximately the industries are releasing highest percentage of CO_2. To reduce the CO_2 emission there exist some methods like inject the CO_2 gas by dried up oil wells or deep in ocean or convert the useful organic compounds by using catalyst. The new procedure is proposed that the carbon dioxide is to convert methane by using hydrogenation process using catalyst which is less exe other catalysts like platinum, palladium, ZnO, CuO, Al_2O_3 etc.

Keywords: Co_2, Hydrogenation, Methane, Methanol, Nickel(110) Surface catalyst.

I. INTRODUCTION

In the presents days the pollution increases rapidly. Mainly, the air pollution came from traffic and industries. Because of industries the environment may effect with their released gases. Mostly, the manufacturing industries utilize chemicals to produce a product. While producing, it generate some harmful gases which may effect to nature. On the survey, the carbon dioxide will produce more when compared with other gases.

Table : List of Pollutants

Fossil Fuel Emission Levels - Pounds per Billion Btu of Energy Input			
Pollutant	**Natural Gas**	**Oil**	**Coal**
Carbon Dioxide	117,000	164,000	208,000
Carbon Monoxide	40	33	208
Nitrogen Oxides	92	448	457
Sulfur Dioxide	1	1,122	2,591

There are some methods for reducing the carbon dioxide in the atmosphere :

1) energy efficiency and conservation practices

2) carbon – free and reduced –carbon energy resources

3)capturing and storing carbon either from fossil fuels or from the atmosphere

Energy efficiency and conservation:

In general terms energy efficiency is achieved through the application of technology such as insulation upgrades, compact fiuorescent bulbs , high efficiency furnace. Energy conservation is achieved through behavioral changes such as turning off lights when it is not needed.

It is the one of the technique that reduce the consumption of carbon based fuel like natural gas, oil, coal and decreasing carbon dioxide emission.

Carbon – free and reduced –carbon energy resources:

Another way to reduce carbon dioxide emission is to use carbon-free or reduced-carbon sources of energy. Carbon free sources of energy as its own impact, these technology generate energy without producing and emitting carbon dioxide to the atmosphere. Carbon free energy sources include solar power, wind power, geothermal energy and nuclear power. Alternatively switching from high carbon fuel to low carbon fuel will also result in reduced carbon dioxide emission.

Capturing and storing carbon:

A third for reducing carbon dioxides in the atmosphere is carbon sequestration. It involves the capture and storage of carbon dioxide which is present in the atmosphere. Carbon dioxide can be removed from the atmosphere and stored within plants. another way to capture the carbon dioxide is done by burning either before or after fossil fuel, and then we stored within the earth.

The objective of proposal solution to reduce the carbon dioxide emission using hydrogenation with the help of nickel(110) surface catalyst. Other catalyst are also used in the hydrogenation process which are very expansive. the Ni(110) surface has a larger catalytic activity compared to the other surfaces, and that Ni is a better catalyst for hydrogenation of carbon dioxide

II. EXISTING SYSTEM

The carbon dioxide emission reduction using hydrogenation as follows:

1) **To Methanol**:

Methanol is produced from carbon dioxide dissolved in water by electrolysis followed by hydrogenation of the carbon monoxide formed. A method of producing methanol by reductive conversion of any available source of carbon dioxide, which comprises electrochemically reducing the carbon dioxide in a divided electrochemical cell comprising an anode in one cell compartment and a metal cathode electrode in another cell compartment that also contains an aqueous solution or aqueous methanolic solution of an electrolyte of one or more alkyl ammonium halides, alkali carbonates or combinations therefore to produce a reaction mixture containing carbon monoxide and hydrogen which can be subsequently used to produce methanol while also producing oxygen in the cell at the anode.

$$CO_2+2H_2O \rightarrow CO+2H_2 \text{ (at the cathode) and}$$
$$3/2O_2 \text{ (at the anode)}$$

The CO and H_2 produced at the cathode are subsequently reacted over Cu and Ni based catalysts to produce high yields of methanol (CH_3OH).

$$CO + 2H_2 \text{ —Hydrogenation-> } CH_3OH$$

Though this method is an efficient method of utilization of carbon dioxide the technology used is a little sophisticated. It involves the installation of a separate unit in an Industry. The carbon dioxide used should be as pure as possible for the method of conversion to be effective.

In another method the production of methanol from reactions between CO_2+ H_2 and CO + H_2 has been studied over platinum catalysts supported on Nb_2O_5, ZrO_2, MgO, SiO_2 and TiO_2. Zirconia- and niobia-supported Pt catalysts showed the highest activity for reactions of both CO_2 and CO. This method is also as effective as the previous method. But the disadvantage is that the carbon dioxide used should be very pure not containing any gaseous or particulate impurities. In such situation obtaining pure carbon dioxide from flue gases plays a major role

2) **Carbon dioxide hydrogenation to methanol at low pressure and temperature:.**

The measurements obtained were used to investigates the methanol synthesis reaction from pure carbon dioxide and hydrogen over binary (CuO/ZrO_2) and ternary supported catalyst ($CuO/ZnO/Al_2O_3$).

A comparison of different catalysts the influence of the most important reaction parameters, i.e temperature, pressure, space velocity and feed gas composition is examined at moderate temperatures(≤300°C) and pressure (≤20 bar)

The methanol synthesis was first performed over zinc oxide-chromium oxide catalyst. The catalyst , which was used at 250-350 bars and temperature 300-450°C , was highly stable to the sulfur and chlorine compounds present in the synthesis gas. In 1966, the copper based catalyst was introduced for the methanol synthesis for sulfur free synthesis gas containing a high proportion of carbon dioxide. This copper oxide and zinc oxide catalyst, thermally stabilized by alumina, was extremely active and highly selective. The synthesis could be carried out at 220-250°C and 50 bars, thereby avoiding premature aging of the catalyst due to sintering of copper.

All currently used low pressure catalysts contains copper oxide and zinc oxide with one or more stabilized additives.

Table 1: Summary of typical catalysts composition for low pressure methanol synthesis

Manufacturer	Components Cu [% at.]	Zn [% at.]	Al [% at.]	C (graphite) [% at.]
BASF	65 - 75	20 - 30	5 - 10	-
Süd Chemie	65 - 75	18 - 23	5 - 10	-
ICI	61	30	9	-
Du Pont	50	19	31	31
Haldor Topsøe	50 - 60	21 - 25	15 - 28	6 - 8

Methanol synthesis has nearly always been expressed in terms of hydrogenation of carbon dioxide using copper based catalysts

$$CO_2+3H_2O \Leftrightarrow CH_3OH+ H_2O$$

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Methanol synthesis has nearly always been expressed in terms of hydrogenation of carbon monoxide

$$CO+2H_2 \Leftrightarrow CH_3OH$$

The reaction between CO_2 and H_2 and CO and H_2 both are exothermic reaction. They are also thermodynamically unfavorable.

III. PROPOSED METHOD

The new concept is introduced for reduction of carbon dioxide emission to methane using hydrogenation process with help of nickel(110) surface catalyst. The highest percentage of carbon dioxide which is released from the industries, Because of industries using high amount of fuels and chemicals. Reduction of carbon dioxide emissions can be obtained by applying carbon dioxide removal. In this technique, CO_2 is separated during or after the production process and subsequently stored or disposed of outside the atmosphere. In some cases the recovered CO_2 can be used for other purposes.

The CO_2 removal process can be split into three separate steps:

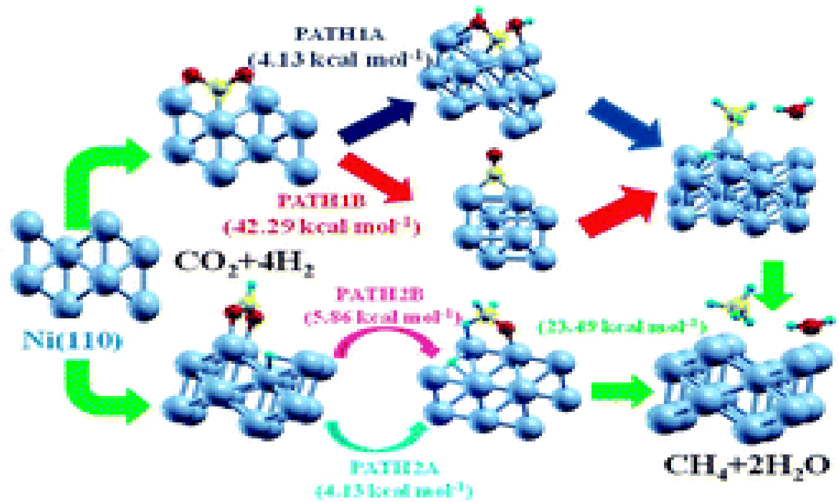
i) recovery of the CO_2 (often including drying and compressing),

ii) transport of the CO_2 to a location where it is handled further, and utilization,

iii) storage or disposal of CO_2.

The carbon dioxide emission reduction using hydrogenation with the nickel(110) surface was done in the following reaction

$$CO_2+4H_2 \Leftrightarrow CH_4+2H_2O$$



The complete hydrogenation mechanisms of CO_2 are explored on Ni(110) surface catalyst using density functional theory. the possible hydrogenation mechanism to form product methane from the stable adsorption–co-adsorption intermediates of CO_2 and H_2 on Ni(110) surface.Clearly it shows the methane formation *via* hydroxyl carbonyl intermediate requires a lower energy barrier than *via* carbon monoxide and formate intermediates on the Ni(110) surface.

The methanation reaction of CO2 have been conducted at low temperatures. It would be important to carry out CO2 reductions at lower temperatures(150-300°C), in order to improve the flexibility of the operation, especially when the CO2 and/or H2 sources are intermittent, and to improve the energy efficiency of the process.

IV. RESULTS AND COMPARISONS

The hydrogenation of carbon dioxide emission may produce methanol and methane. Hydrogenation of CO2 to methanol is thermodynamically more favourable, needing only six electrons. Methanol has the disadvantage that, compared to methane, there is no complete infrastructure already built to handle it for transport and end-user utilization.

Strategies for CO2 valorisation on CH4 or CH3OH , thermodynamic analysis was performed using the continuous Gibbs reactor model. Carbon dioxide equilibrium conversion was determined for hydrogenation into methane or methanol as a function of pressure and temperature.The carbon dioxide conversion into methanol over methane requires high pressures, particularly the active catalysts in industries. The following analysis on methanol and methane at different temperatures and pressures:

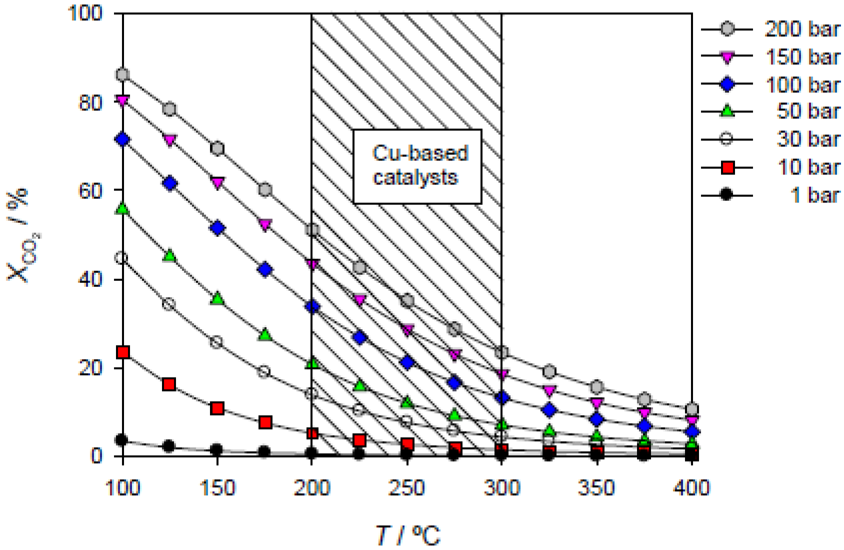


Fig: Conversion of Carbon dioxide to methanol at different temperature and pressure

The above graph represents the conversion of carbon dioxide to methanol based on copper catalyst with different pressures from 1 bar to 200 bar.

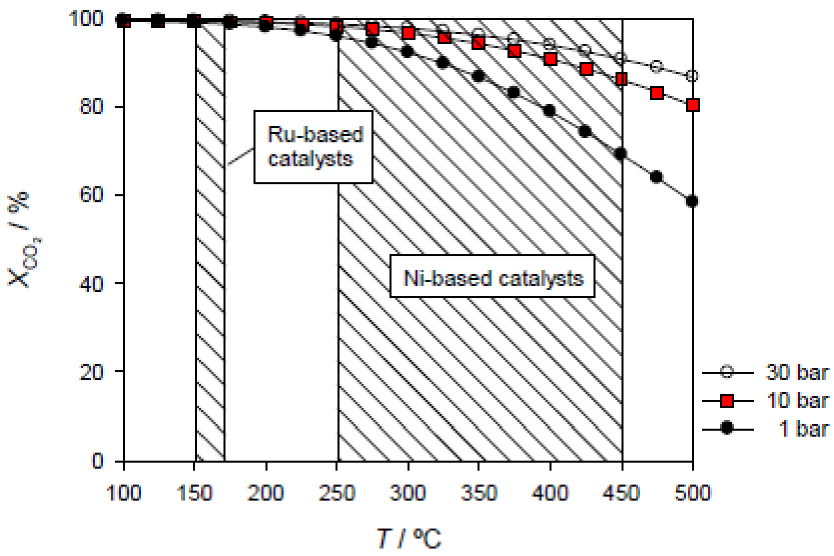


Fig: Conversion of Carbon dioxide to methane at different temperature and pressure

The above graph represents the conversion of carbon dioxide to methane based on Ru and Ni catalyst with low pressures which is less than 30 bar.

Methane can be used in organic chemicals, as fuel, and in the generation of electricity in fuel cells. Special applications have been proposed for space travel, to obtain drinking water by combining the on-board rocket fuel with carbon dioxide which is released.

The carbon dioxide conversion to methane can be done using different catalyst in the hydrogenation process which are Rh, Al_2O_3, SiO_2, TiO_2, Pd, Ru and also nickel. But when compared with all catalysts, the nickel is most effective and cheapest surface catalyst suitable for the carbon dioxide with hydrogenation.

V. CONCLUSION

In the growth of industries, while manufacturing the product when the carbon dioxide is released it immediately captured and stored by using carbon sequestration. That carbon dioxide is removed by converting into methane using nickel(110) surface catalyst in the hydrogenation process. Since hydrogenation process, the carbon dioxide is to convert the methanol and methane but methane has more advantages compared with methanol. Methane can generated with different catalysts but the nickel(110) surface catalyst is most effective and less expensive when compared with other surfaces.

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