CATALYTIC REACTION OF CARBON DIOXIDE WITH METHANE ON SUPPORTED Co/Mo CATALYSTS

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Abstract
In this work the reforming of methane with carbon dioxide has been investigated at 773 K on supported Mo-Co/ Al_2O_3 catalysts with different loading 1%, 5% and 10 %. of Mo. The catalysts were characterized by XRD and TEM methods before and after the reaction. The results revealed that 10%Co/Al_2O_3 had the highest conversion of CH_4 and CO_2 and highest syngas formation rate among the mentioned catalysts. In addition, the mentioned catalysts characterization before and after the reaction showed no differences.

Introduction
Some carbon-containing fossil fuel combustions, such as coal, natural (stranded or shale) gas, and petroleum, have emitted significant amounts of greenhouse gases, which can cause global climate change as well as environmentally hazardous pollutant emissions. [1]. Renewable energy development and greenhouse gas emissions reduction have become increasingly crucial global issues in recent years [2]. The conversion of CH_4 and CO_2, the two primary components of biogas and the principal greenhouse gases into synthesis gas is in the focus of academic and industrial research. Reacting the CH_4 and CO_2 is one option for achieving this goal [3]. The CH_4 can react with CO2 as a reductant - by the techniques including Dry reforming (DR), Steam Reforming (SR) and Combining SR and DR -to produce the industrially important syngas ($CO+H_2$ mixture) [4]. From the $CO+H_2$ mixture both fuel and methanol or a variety of other products can be produced using currently available technologies [5].

Experimental
In this research, the DR reforming of methane with carbon dioxide has been investigated atmospheric pressure, at 773 K, using 10%Co/Al_2O_3, 1% Mo+10% Co/Al_2O_3, 5% Mo+10% Co/Al_2O_3 and 10% Mo+10% Co/Al_2O_3 catalysts, which were prepared by incipient wetness method and calcined at 773 K. The experiments were carried out in a fixed-bed continuous flow reactor. The amount of the catalysts used were 150 mg. The flow rate of the reactants was 30 ml/min. The catalysts were oxidized for 30 minutes and reduced for 60 minutes at 773 K and the catalytic tests were carried out at 573- 873K. The catalysts were characterized by XRD and TEM methods before and after the reaction.

Gas Chromatograph (Agilent 6890)

MiniFlex II
DESKTOP X-ray
DIFFRACTOMETER
(Rigaku)

FEI TECNAI G2 20 X-Twin high-resolution transmission electron microscope (HR-TEM)

Results and discussion

The results indicate that 10%Co/Al_2O_3 had the highest conversion of CH_4 and CO_2 and highest syngas formation rate among the mentioned catalysts. Furthermore, Mo promoted 10%Co/Al_2O_3 was found to be more active in 1% amount than the 5% or 10% Mo/Al_2O_3.

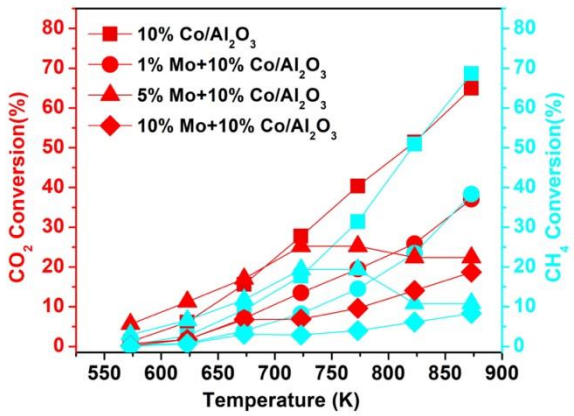

Fig.1. CO_2 and CH_4 Conversion in heating phase

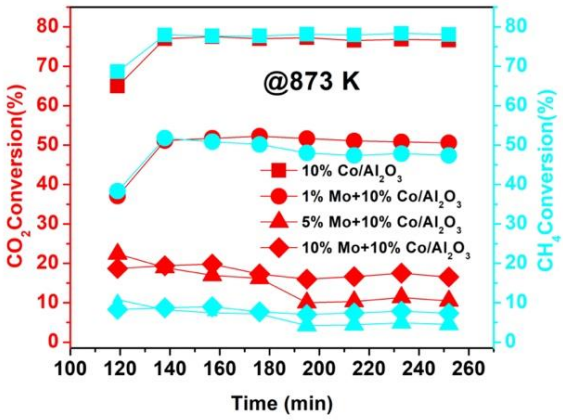

Fig2.CO_2 and CH_4 Conversion in isotherm phase

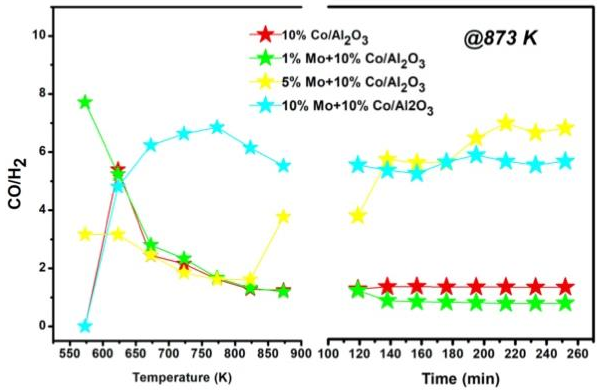

Fig.3.CO/H_2 in heating phase and isotherm phase

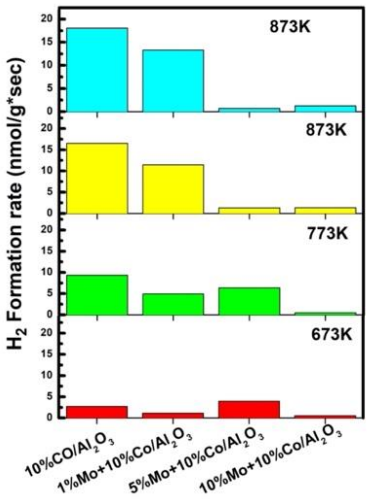

Fig.4.H_2 Formation rate in different temperatures

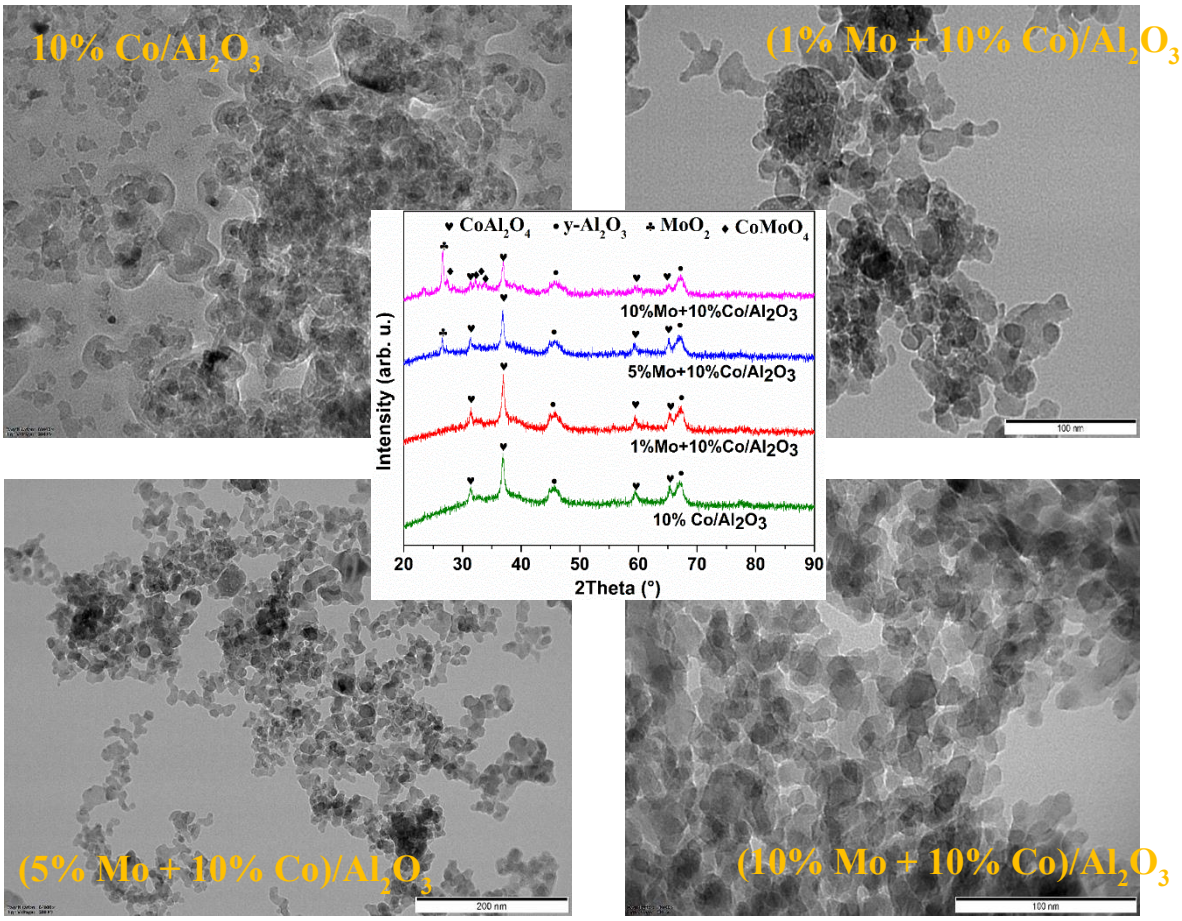

Fig.5. TEM pictures & XRD graph

Conclusion

- The 10%Co/Al_2O_3 reforming catalyst had the best performance in terms of CH_4 and CO_2 Conversion. In addition, among the promoted catalysts by Mo, 1% Mo+10%Co/Al_2O_3 was more active (Fig.1-2.)

- The main products of the reaction were H_2 and CO. The 10%Co+1%Mo/Al_2O_3 showed the highest ratio of CO/H_2 in heating phase, while the 5%Mo+10%Co/Al_2O_3 showed the highest ratio in isotherm phase. (Fig.3.)
- The 10%Mo+10%Co/Al_2O_3 had the fast-increasing CO/H_2 ratio in the heating phase and had the steady trend in the isotherm phase. (Fig.3.)
- The catalysts were characterized before and after the reaction with XRD and TEM which no differences were found before and after the reaction (Fig.5.).

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References

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