Using N_2O for oxidative coupling of methane (O.C.M) on Na_2WO_4Mn/SiO_2 catalyst at different operating conditions

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Introduction

During last 3 decades, Methane has faced a wide attention not only due to its ability for fuel and chemical feedstock but also as its potential environmental problem such as greenhouse effects. Economic benefits of methane conversion into higher valued chemicals have attracted researchers from many years ago. Methane can be converted directly or indirectly into more valuable chemicals through different methods. One of the relatively new and most encouraging routes for direct conversion of methane into higher hydrocarbons especially ethylene is the catalytic Oxidative Coupling of Methane (O.C.M) that was introduced by Keller in 1982[1].
The main concern in O.C.M process is low C2+ yields, which is due to low chemoselectivities of higher hydrocarbons that leads to high production of CO or CO_2 at higher levels of CH_4 conversion. Producing huge amount of CO_X, in addition to cause environmental problems does not commercialize the O.C.M process. Researches in this field are still being conducted to reach into higher yields of C2+ production and improve the performance of the process.
In this research, feasibility of O.C.M process in different experimental conditions is investigated. Effect of changing several parameters such as temperature, catalysts with different specific surface area, gas hourly space velocity (GHSV) and also Methane/oxidising agents ratios in feed stream on the yield and performance of O.C.M will be study and will try to reach to maximum selectivity and yield. In other hand, reducing the production of CO and CO_2 as main by-products is one of the important goals.

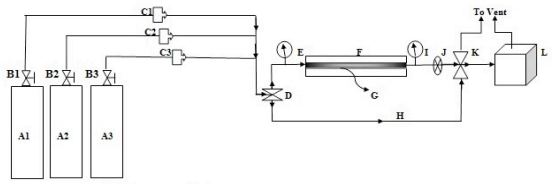
Materials and Methods

To gain our aim and objects, after surveying lots of previous works and researches the experimental setup has been performed to study O.C.M process in the lab. The schematic of experimental setup is shown in figure 1.
First step of the experiments consists of running O.C.M process at atmospheric pressure. At atmospheric pressure, experiments are performed at different operational conditions that are shown at table 1. The Na_2WO_4Mn/SiO_2 catalyst is used in the O.C.M reaction.

Table 1: Operational condition values for experiments at atmospheric pressure

Operational Parameter	Value
Catalyst bed Temperature(°C)	720- 870 (every 30 °C)
GHSV (hr^{-1})	8000- 14000- 28000
Catalyst surface area (m^2/g)	Catalyst A=0.1 – Catalyst B=111
N_2O/CH_4 ratio	20/10, 15/10, 10/15

As figure 2 shows at N_2O/CH_4 ratio=20/10, GHSV=14000 hr-1, BET surface area of catalyst=0.1m2/g and temperature=870 C the maximum yield=12.5% is gained.



- A1, A2, A3: Gas Cylinders
- B1, B2, B3: High Pressure Cylinder Regulators
- C1, C2, C3: Digital Mass Flowmeters
- D : 4-way Valve
- E: Pressure Gage
- F: Furnace
- G: Reactor
- H: Bypass Line
- I: Pressure Gage
- J: Electrical pressure controller
- K: 4-way Valve
- L: Compounds Separating and Analyzing system

Figure 1: Figure 19: Proposed laboratory setup for the process of Oxidative Coupling of Methane

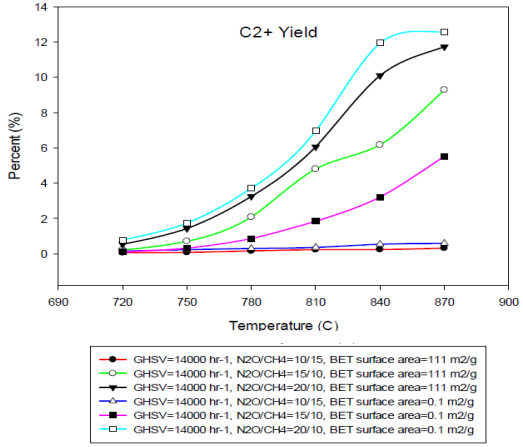


Figure 2: The C2+ yield as a function of catalyst bed temperature at different operational conditions when GHSV=14000 hr-1

Significance

This research will study the feasibility of performing O.C.M at different operational conditions and try to find the optimum condition to gain maximum yield and performance in O.C.M process. Beyond all the results, significant outcomes of this study are listed as below.
• Find the effect of N_2o/CH_4 ratio, G.H.S.V, catalyst surface area O.C.M process
• Find the performance of N_2O in O.C.M process
• Find the performance of $Na2WO_4Mn/SiO_2$ in O.C.M process

References

[1]- Keller, G.E. and M. Bhasin, Synthesis of ethylene via oxidative coupling of methane: I. Determination of active catalysts. Journal of Catalysis, 1982. 73(1): p. 9-19.