Environmental concerns and the limited availability of the crude oil reserves are the main driving forces for a future shift toward more sustainable feedstocks for the chemical industry. Methane, the main component of the abundant natural gas reserves, is being considered as an alternative feedstock to those derived from the oil industry [1].

Methane is a very stable component and its conversion to higher hydrocarbons requires an elevated temperatures (>700 °C) to obtain reasonable level of conversion, and these temperatures cause a significant problems such as the coke formation and rapid catalyst deactivation [2]. Although the utilization of supercritical water (SCW) as a reaction media could be useful to overcome some of these problems associated with the catalytic processes, only a few researchers have tried partial oxidation of methane (POM) in SCW [3].

In this research, the non-catalytic and catalytic POM with various metal catalysts (Fe, Mn, Co, Mo and Cu) in oxide form was studied under the SCW conditions at regions of CH₄/H₂O & O₂/CH₄ ratios that have not been explored before. At this untouched region, methanol was the main product in the liquid phase, while H₂, CO and CO₂ and hydrocarbons up to C₄ components with ethane as the major component were detected in the gas phase.

The products distribution was clearly depending on O₂/CH₄ ratio, and the maximum yield of methanol (0.80 %) was obtained at 0.05 O₂/CH₄. A significant increase in methane conversion for all reactions as well as hydrocarbons yield were observed at region of 0.15 O₂/CH₄. The catalysts influence was obvious at this region and with Fe₂O₃ catalysts a reasonable yield of hydrocarbons (> 3.7%) were obtained at a very low temperature (385 °C), and this was an order of magnitude larger than hydrocarbons yield from non-catalytic reactions. Further increase in O₂/CH₄ up to value of 0.27 led to an increase of methane conversion, but decrease the hydrocarbons yield and the total oxidation of methane becomes predominant.

References