Methane dehydroaromatization using Molybdenum-supported coal waste material catalyst

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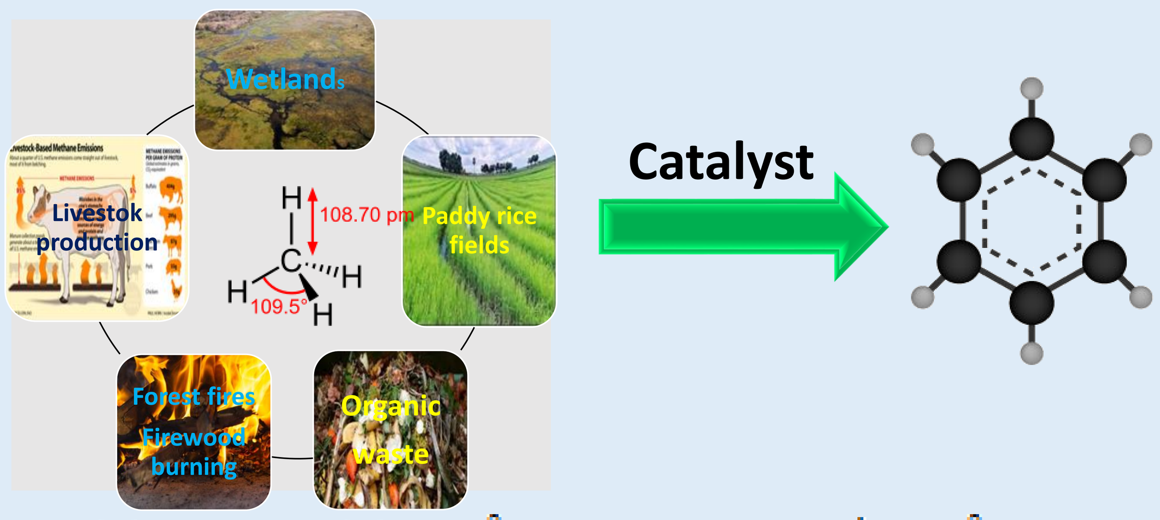
Introduction

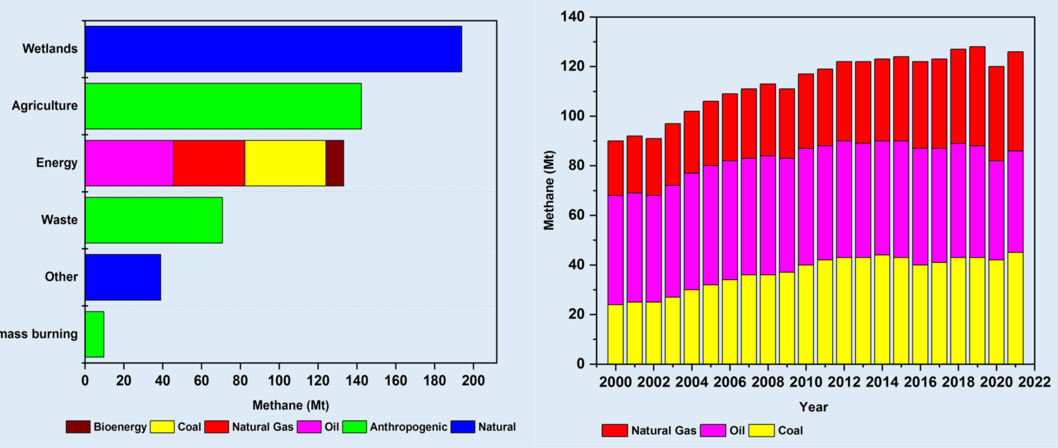
➢Methane is widely distributed gas around the globe. Also, the volumetric energy density of gas very low so it is being converted into shippable liquids as benzene.
➢The direct conversion of methane into aromatics is simple and cost-effective.
➢Methane dehydroaraomatization is endothermic reaction. The strong C-H bond makes, its direct conversion very challenging.
➢A combination of active metal and Si-Al based material makes the conversion better to some extent. Coal waste material containing 68–75 wt% silicon and aluminum are good source of Si-Al which are required for catalyst synthesis.

Research Objective



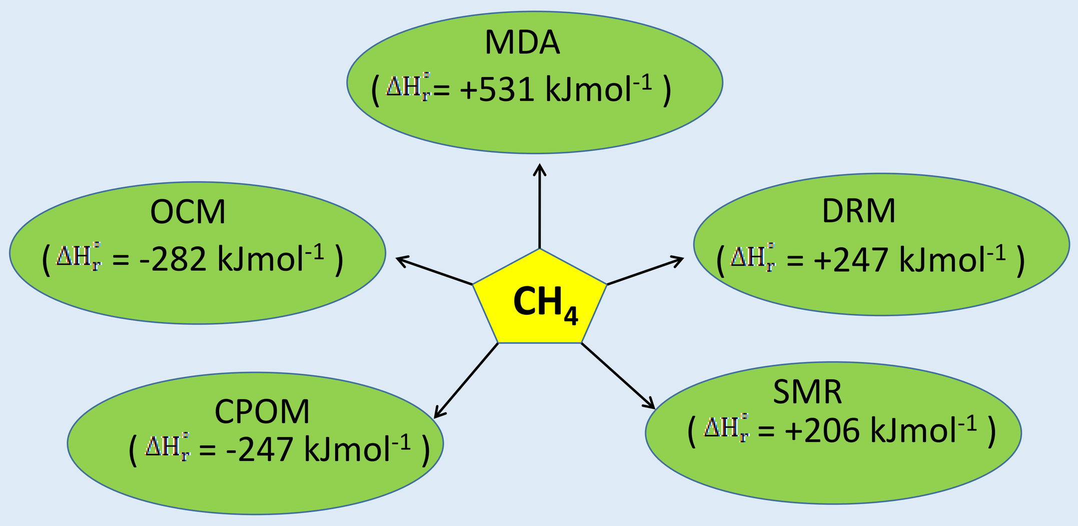
$$6CH_4(g) \rightarrow C_6H_6(g) + 9H_2(g), \Delta G_r^\circ = 433 kJ\ mol^{-1}, \Delta H_r^\circ = 531 kJ\ mol^{-1}$$

Methane and its conversion at a glance

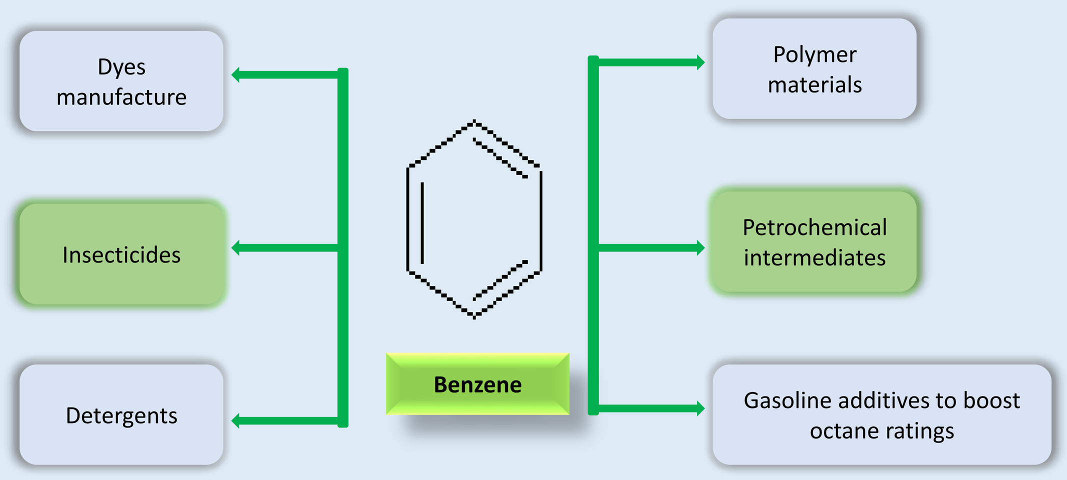


Sources of methane emissions

Methane emissions from fossil fuels

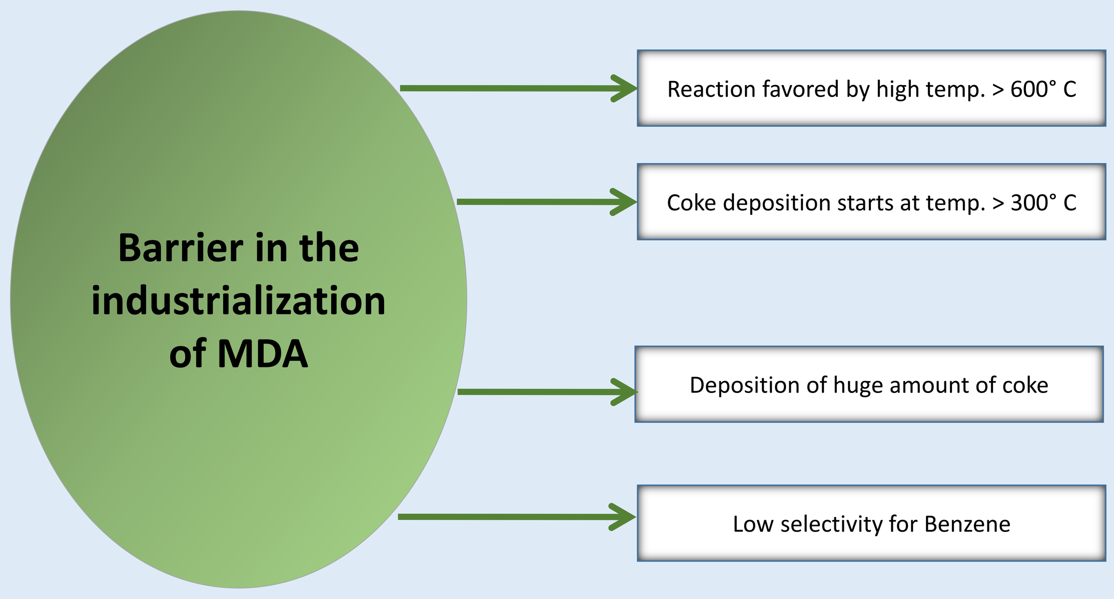


Applications of Benzene

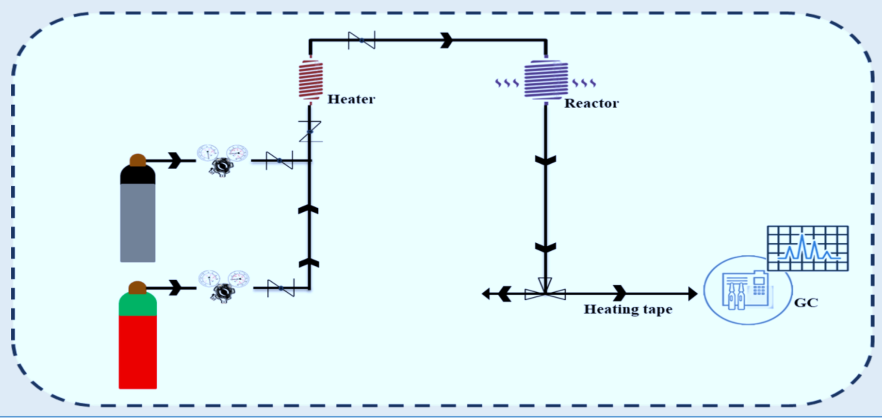


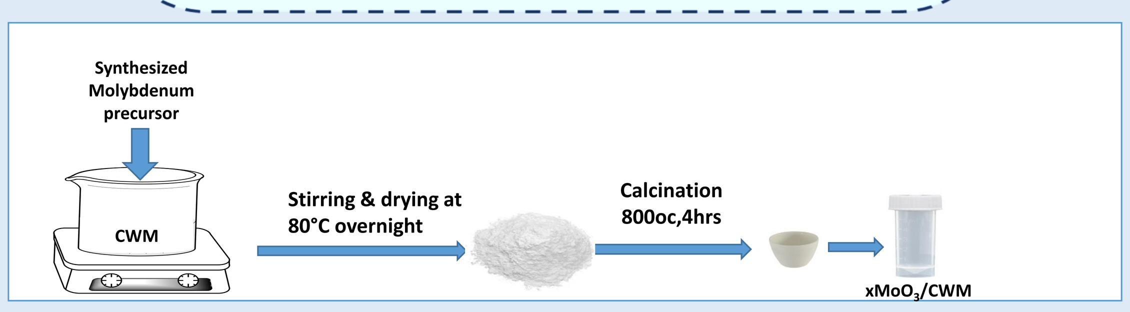
Benzene: Industrial routes of formation and MDA industrialization

1. Catalytic reforming
2. Toluene disproportion
3. Steam cracking
4. Toluene hydrodealkylation



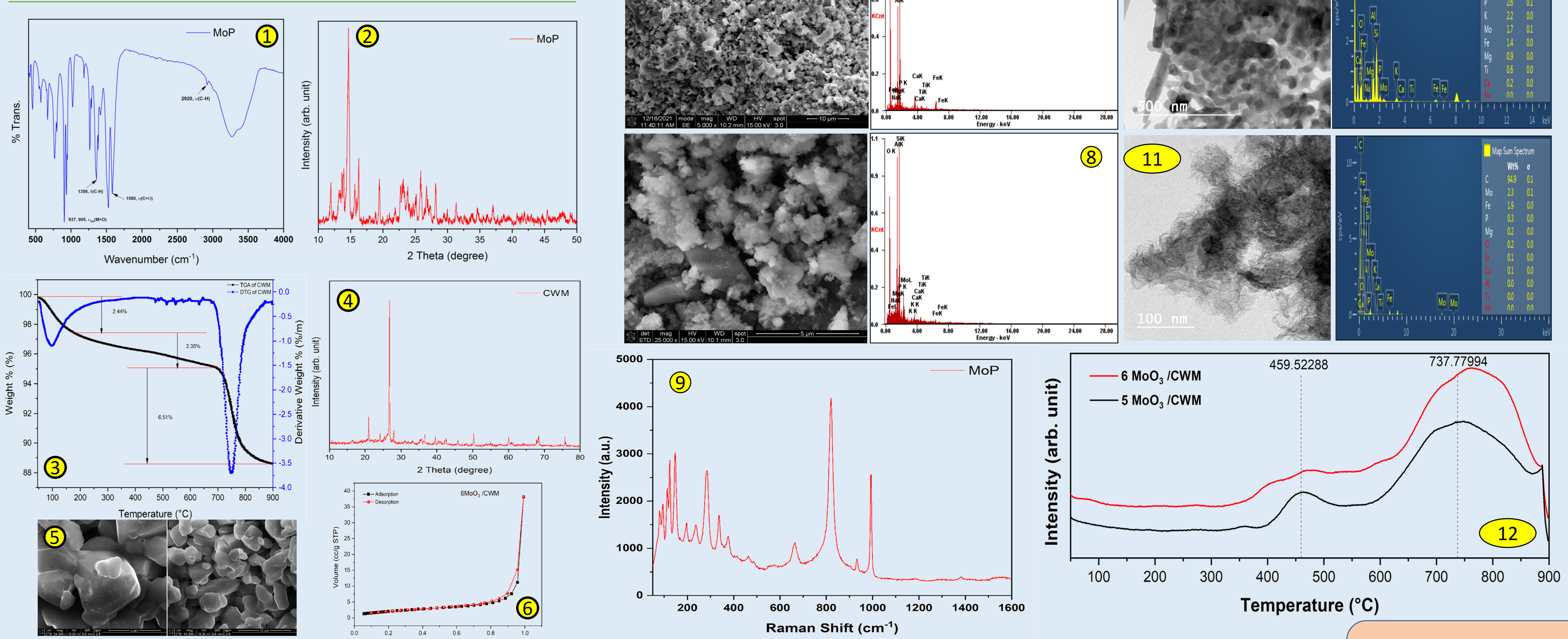
Reactor Setup and Catalyst Synthesis





Catalyst Characterization

	Si	Na	K	Ti	P	Ca	Mg	Fe	Al
	%								
CWM	24.20	0.46	0.53	1.41	0.87	2.67	0.29	5.53	14.00



Catalytic Activity test

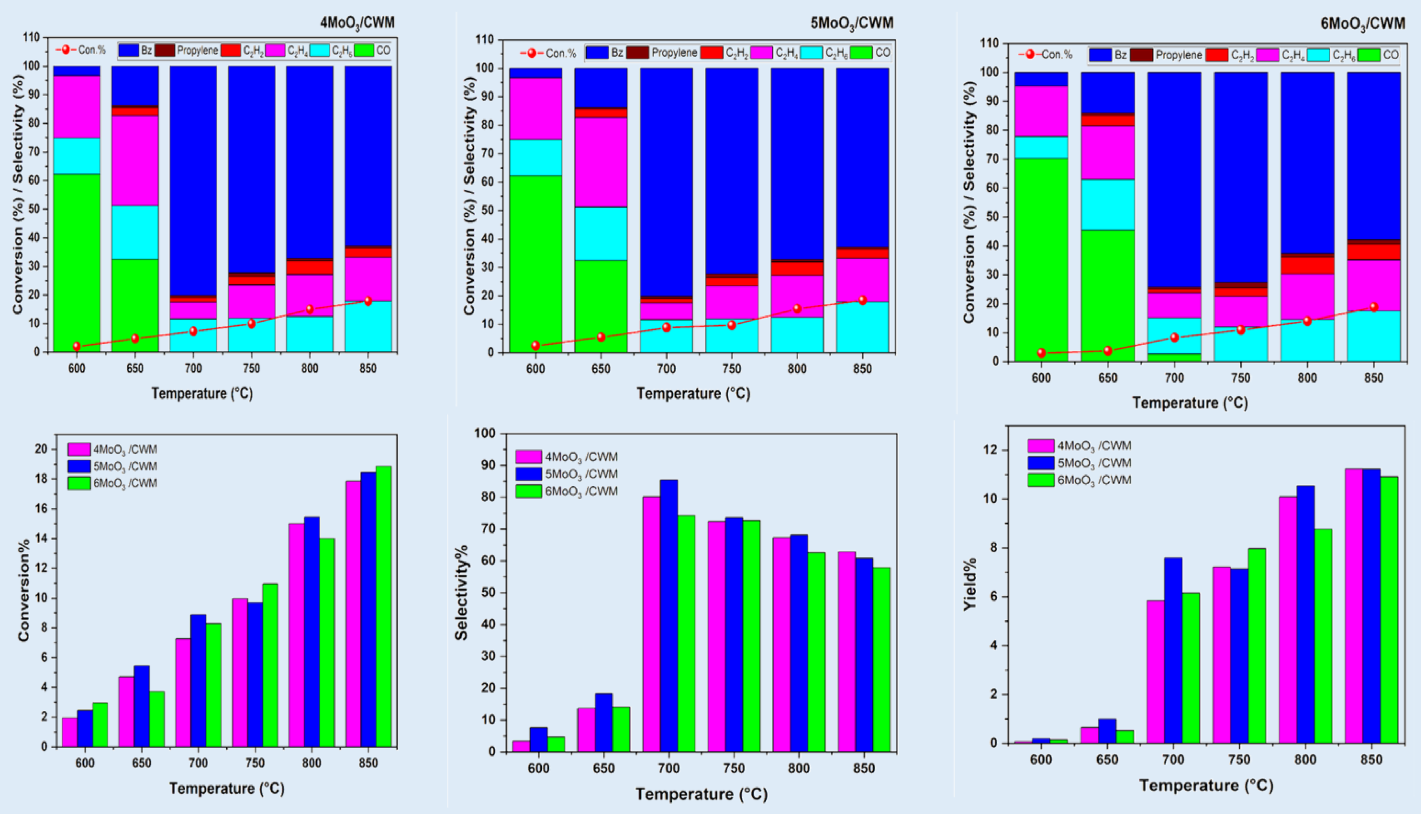


Fig Details.
(1) IR of Mo Precursor **(2)** XRD of Mo Precursor **(3)** TGA of CWM **(4)** XRD of CWM **(5)** SEM image of MoP **(6)** BET of 6MoO$_3$/CWM **(7)** SEM image of CWM **(8)** SEM image of 6MoO$_3$/CWM **(9)** Raman of Mo Precursor **(10)** TEM image of 6MoO$_3$/CWM catalyst **(11)** TEM image of spent 6MoO$_3$/CWM catalyst **(12)** TPR of 5MoO$_3$/CWM and 6MoO$_3$/CWM catalyst

Results and Conclusion

➢Mo/CWM catalyst prepared using the wetness impregnation method gives the 8% conversion and 85% benzene selectivity at 1700 ml g^{-1}h^{-1} gas hurly space velocity (GHSV) & 700^{0}C temperature with 0.3 gm catalyst loading.
➢The MDA reaction gives by-products, including carbon monoxide, ethane, ethylene, propylene, and hydrogen.

Indo-French Seminar on Catalysis for Sustainability

10-13 December 2023

References

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Acknowledgement

A.C.K. thanks DST-INSPIRE, New Delhi, India for fellowship support. The Director, CSIR-IIP, is acknowledged for his encouragement and help. ACK and RRB are thankful to the Analytical Science Division, CSIR-Indian Institute of Petroleum, for providing analytical support.