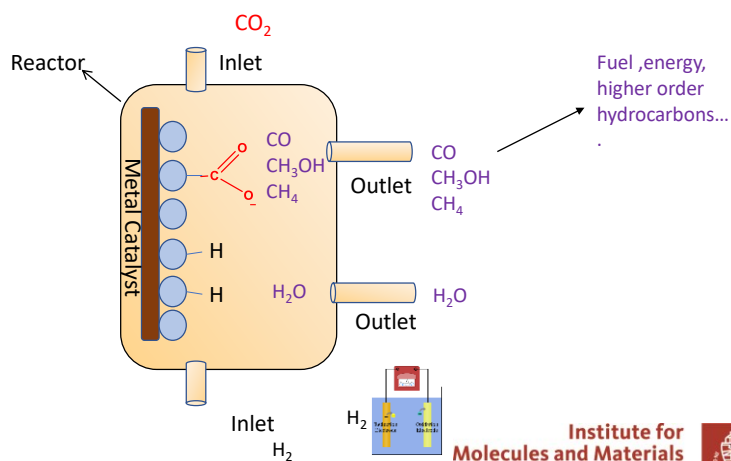
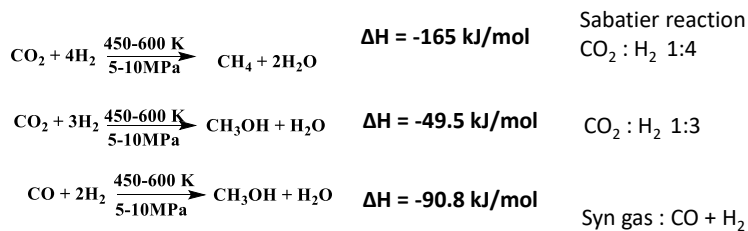


Methanol Synthesis



Syn gas or Sabatier's Reaction



Metal Catalysts Used

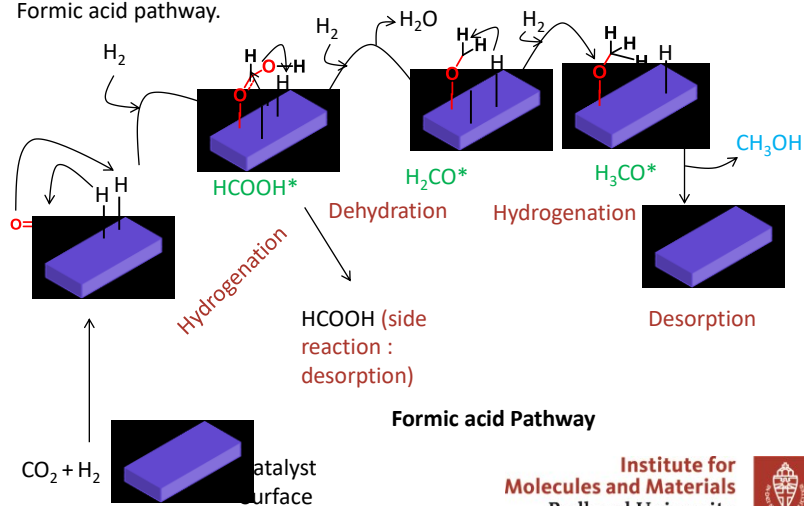
- Heterogeneous Catalysts.
- Non-scarce metals like nickel or copper on different supports like SiO_2 , ZrO_2 etc.
- E.g. $\text{Cu/ZnO/Al}_2\text{O}_3$, Ni/ZrO_2

Mechanism : CO₂ hydrogenation



Two Possible pathways

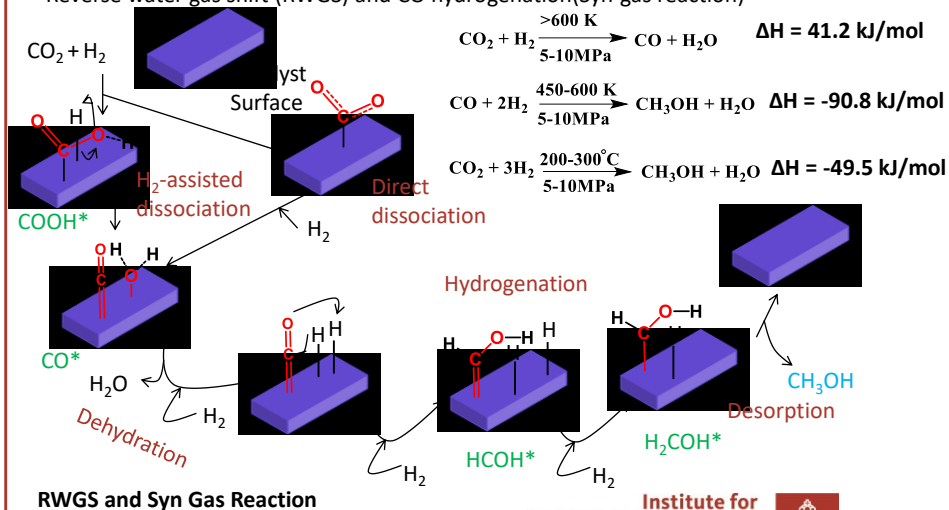
- Formic acid pathway.



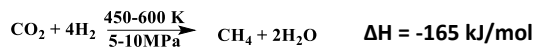
Mechanism : CO₂ hydrogenation

Two Possible pathways

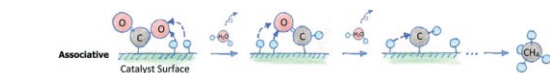
- Reverse water gas shift (RWGS) and CO hydrogenation (Syn gas reaction)



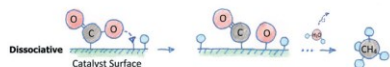
Sabatier Reaction



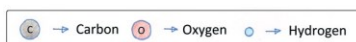
Sabatier reaction
 $\text{CO}_2 : \text{H}_2$ 1:4



Refer last slide



Refer Fischer
 Tropsch Reaction
 video.

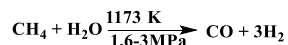


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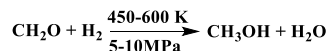
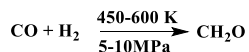


ICI process : Steam Reforming of Methane

- ICI: British Company
- Methane obtained from sources like coal mining, wastewater treatment, Sabatier process etc.
- Steam reforming or wet reforming is a reaction of methane and water at 1173K in presence of Ni/Al₂O₃ catalyst to form carbon monoxide and hydrogen in mole ratio 3:1.



- Syn gas (CO + H₂) is hydrogenated to methanol by following pathway:



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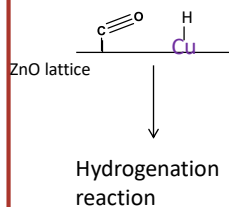
Factors affecting reaction

- Deactivation of metal catalyst.

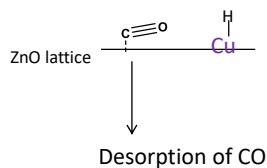


- Binding of CO with catalyst.

In case of strong binding



In case of weak binding

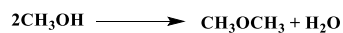


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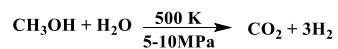
Methanol Utilization

- Methanol to dimethyl ether.



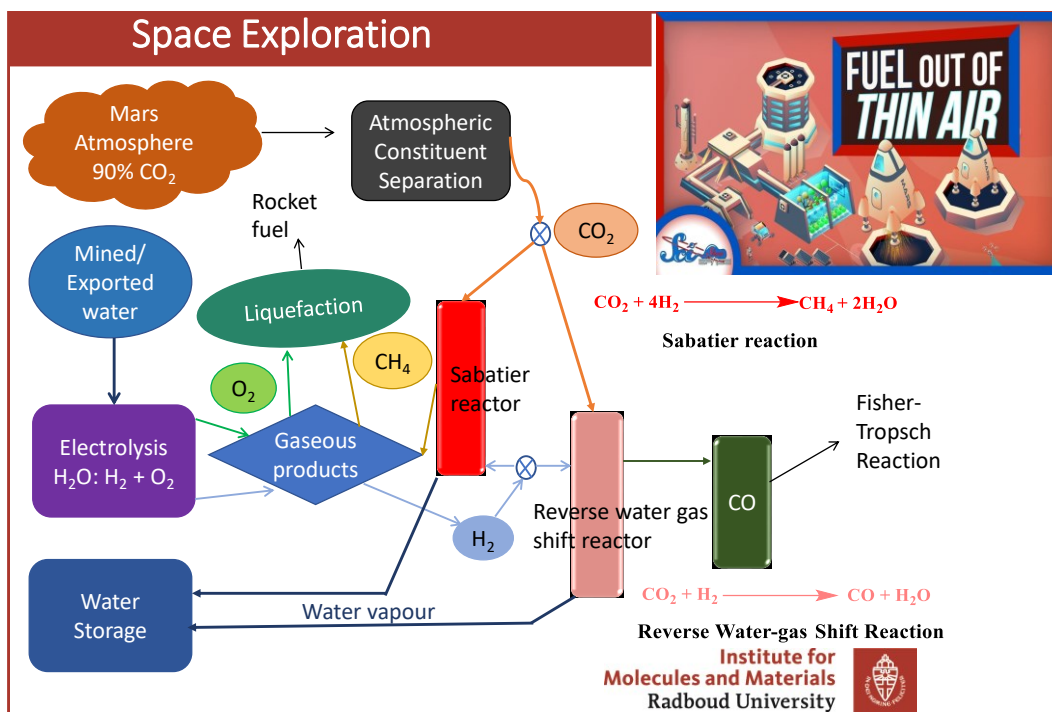
- Methanol utilization as a hydrogen carrier

Methanol steam reforming (MSR) is reaction of methanol and water at 500 K using Cu-based catalyst.



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Summary

- Methanol can be synthesized using Sabatier reaction which depends upon mole ratio of CO₂ : H₂ or CO methanation using transition metal catalyst mostly nickel or copper.
- Mechanism can follow either formic acid or carbon monoxide pathway depending on catalyst.
- Industrially steam reforming of methane used.
- Methanol can be utilized as a hydrogen carrier: Methanol steam reforming (MSR) reaction.
- Sabatier reaction can let you live on mars.

