Sustainable CO_2 Capture and Methanol Production Unit In Container Ships

Team: 25

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Elevator Pitch

The shipping industry faces a problem with maintaining low CO_2 emissions. So, for the shipping industry, who need to comply with the CO_2 emissions target by 2030, our technology EcoMarineCapture (EMC) captures CO_2 and converts it to methanol. Unlike our competitor MAN Energy Solutions, which only captures CO_2 without the conversion to methanol.

Introduction

Problem Statement:

This project introduces a CO_2 capture and conversion system for maritime use, transforming ship emissions into methanol to meet environmental regulations and generate economic value.

Constraints:

1- Attaining CO_2 emissions reduction target.
2- Two-phase flow challenges.
3- High flammability of methanol.
4- High corrosivity of CO_2.

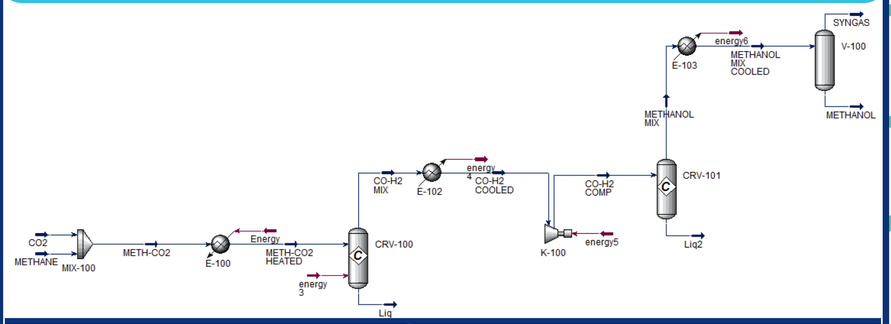
Target Specifications:

1- Capture 70% of CO_2 emissions
2- Reforming of methane reaction temperature must be 600-900 °C
3- Catalyst capacity should operate for more than 300 hours.
4- Flowrate from exhaust gas must be 3400 kg/h.
5- Methanol storage tank must be at least 300 m^3.

Project Impact:

This project reduces maritime CO_2 emissions by converting them into sustainable methanol, promoting environmental sustainability in the shipping industry.

Simulation / Prototype Design

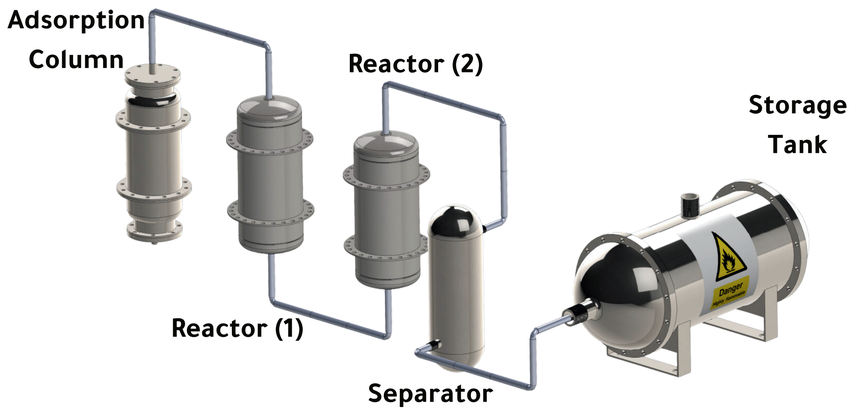


Reaction 1 $CO_2 + CH_4 \rightarrow 2CO + 2H_2$

Catalyst: Ni-supported on Al_2O_3

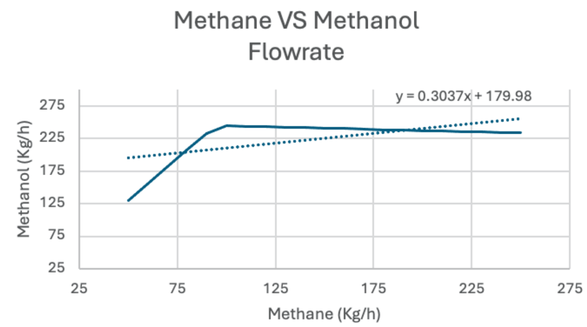
Reaction 2 $CO + 2H_2 \rightarrow CH_3OH + Syngas$

Catalyst: ZnO



Risk Matrix		Severity				
		Insignificant	Minor	Moderate	Major	Severe
Likelihood	Almost Certain			Project Delay		
	Likely		Technical Glitches in System Operation	Operational Complexity	Cost Overrun	
	Possible			Operational Delays from Prototype Adjustments	Material Failure	Failure to Meet CO2 Reduction Targets
	Unlikely			Catalyst Degradation		
	Rare				Severe Weather Impact	

Testing / Validation



Stream	Mole Fraction		Molar Flow (kgmole/h)	Mass Flow (kg/h)	Temperature (°C)	Pressure (kPa)
CO_2	CO_2	1	9.2	408	600	400
Methane	CH_4	1	7.4	120	50	101.3
$CO-H_2$ MIX	CO_2	0.05	31.5	528	900	101.3
	CO	0.46				
	H_2	0.46				
METHANOL	CO_2	0.01	7.99	256.7	75	1000
	CH_4O	0.99				
SYNGAS	CO_2	0.14	12.5	271.2	75	1000
	CO	0.35				
	CH_4	0.01				
	H_2	0.35				
	CH_4O	0.14				

For the adsorption unit, Cu-BTC (HKUST-1) exhibits promising adsorption capacity, with the potential to adsorb an impressive 958.37 mg of CO, NO_x , and SO_x per gram of the material.

Conclusion

- Advanced CO_2 capture and conversion unit tailored for container ships.
- Efficiently converts CO_2 emissions into valuable methanol fuel.
- Integrates seamlessly with onboard operations.
- Showcases a multifaceted strategy to enhance sustainability in the maritime sector.
- Produces synthesis gas (syngas) as an intermediary product.