

Membrane-Based Carbon Capture System for Long-Range Marine Transportation

Project Number: DE-SC0025205

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Project Overview

- Funding: DOE SBIR award \$256,500
- Project Performance Dates: 7/22/2024 – 4/21/2025
- Project Participants:
 - Zenith Purification LLC (prime recipient)
 - Lamar University (sub recipient)
 - The Ohio State University (consultant)
- Overall Project Objectives
 - a feasibility study & a conceptual design of an onboard carbon capture and storage system
 - a comparison of our conceptual design with alternative designs
 - a technology gap analysis and CO₂ membrane testing
 - a detailed life cycle analysis and technoeconomic analysis

Technology Background



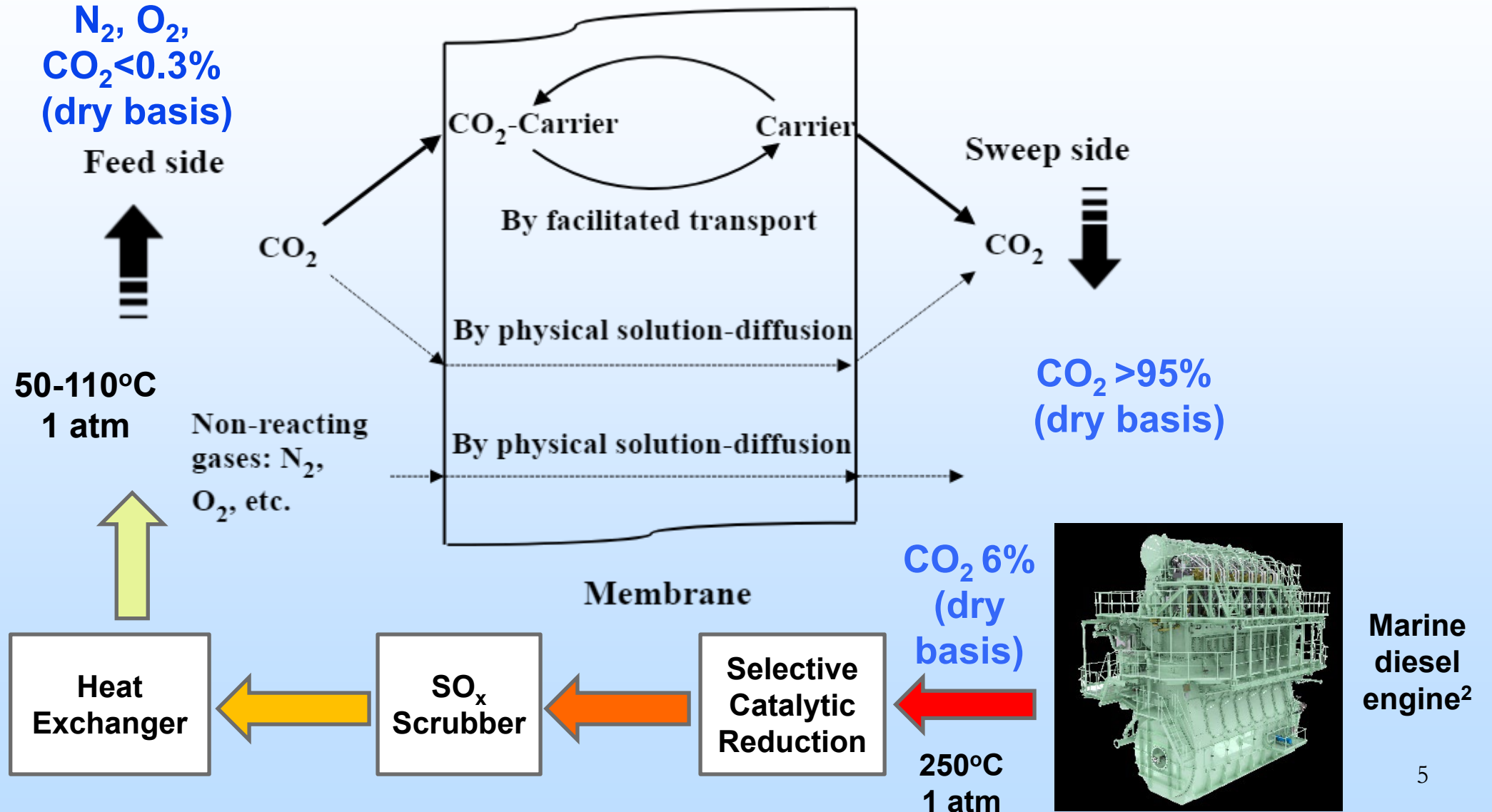
- Long-range marine transportation released ~1 billion tonnes of CO₂ in 2018, 3% of global man-made CO₂ emissions
 - Since Jan. 2024, EU's Emissions Trading System extended to cover CO₂ emissions from all large ships (>5,000 ton) entering EU ports¹
- This industry also released large amounts of SO_x, NO_x, & particulates
 - International Maritime Organization (IMO) **global fuel sulfur limit** requires low-sulfur fuel or exhaust gas cleaning systems (scrubbers)
 - **Tier III emission standards** set by IMO to reduce NO_x. Selective catalytic reduction (SCR) is a proven technology to reduce NO_x
- **Ship owners have incentives to cut CO₂, SO_x, NO_x emissions. They are willing to adopt new technologies e.g. scrubbers, SCR**

Technology Background (cont.)

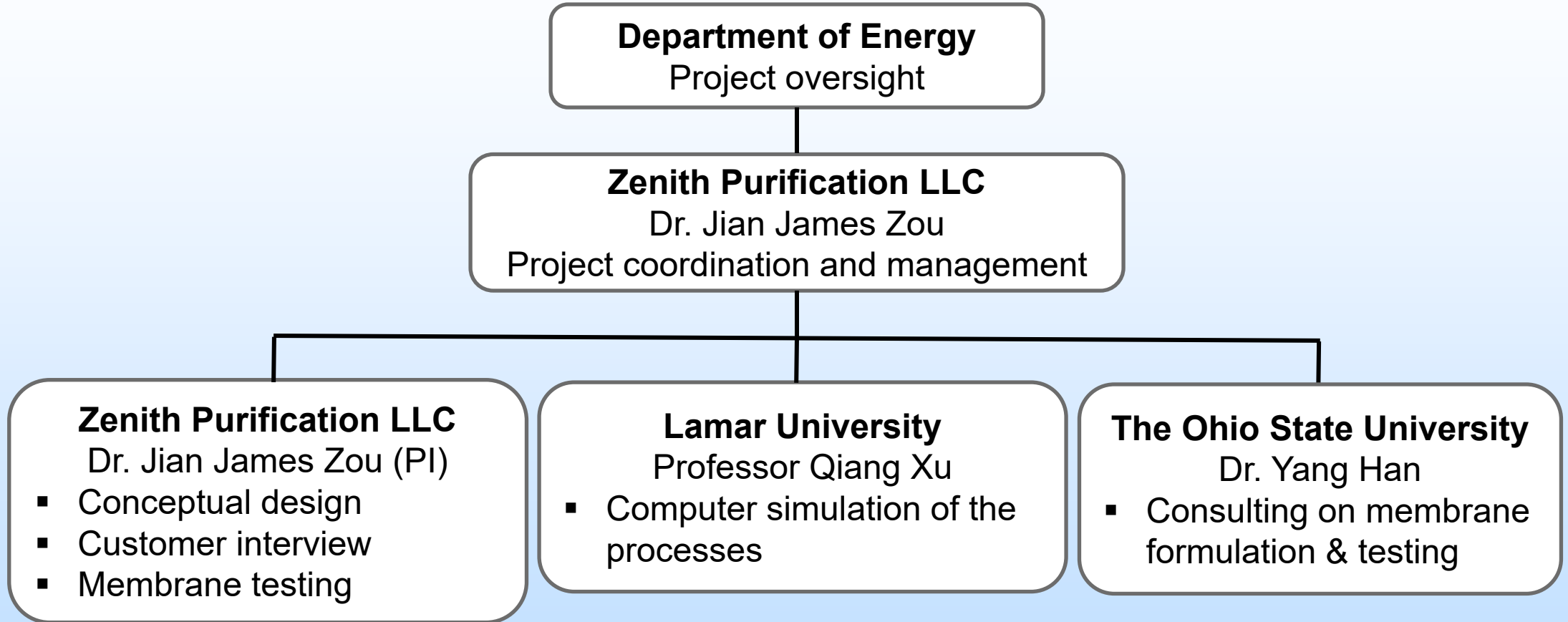


- Technical challenges for carbon capture on a container ship:
 - Size (smaller size means more cargo, more revenue)
 - Weight (smaller weight, lower fuel costs)
 - Durability & reliability (harsh marine environments, constant motion)
- Carbon capture tech can be divided into three main categories:
 - Solvents/sorbents such as amine scrubbing & pressure swing adsorption (PSA)
 - cryogenic distillation process
 - membranes
- **The proposed system combines a new generation of polymeric CO₂-removal membranes and commercially available gas cleaning systems to capture 95% CO₂, reduce 99% of SO_x and 90% of NO_x emissions**

Our Proposed Process



Organization Chart



Acknowledgement

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Reference

1. European Union, https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector_en
2. MAN B&W 8S60ME-GI engine, <https://www.man-es.com/company/press-releases/press-details/2024/04/16/world-s-largest-car-carriers-ordered-with-man-energy-solutions-propulsion-package>