Research project and supervisory team

Supervisory Team	Supervisor Name (better to hyperlink staff profile page) Prof. John Zhou Prof. Jun He
Short introduction & description of research project	This project addresses how heavy industries (steel, aluminium, cement), critical yet responsible for 30% of global CO_2 emissions, can decarbonize by synergizing hydrogen (H_2) production, carbon capture, and waste heat recovery. It tackles three research questions: (1) How to develop durable catalysts and calcium looping (CaL) sorbents with optimal regeneration strategies to sustain efficiency; (2) How to design an integrated system that optimizes energy-mass flows across H_2 production, CO_2 capture, and industrial flue gas streams; and (3) What techno-economic conditions enable scalable deployment. The project aims to develop a novel process integrating Ni-based catalysts for methane reforming and dolomite-derived CaL sorbents for CO_2 capture, leveraging waste heat from flue gases to enhance efficiency. Phase 1 involves testing catalyst and sorbent longevity, regenerating catalysts via calcination and sorbents through hydration-repalletization when performance thresholds (e.g., CO_2 capture <8 mmol/gCaO) are breached. Phase 2 uses Aspen Plus to model energy-mass flows, optimizing heat recovery and CO_2/H_2 synergies using industry-specific flue gas profiles (temperature, CO_2 concentration). Phase 3 evaluates scalability by assessing H_2 yield, energy savings, and carbon avoidance costs across operational scenarios. Expected deliverables include high-performance catalysts/sorbents with regeneration protocols, an optimized system design for simultaneous H_2 production and CO_2 capture, and a techno-economic framework with guidelines for industrial adoption. Outcomes will advance net-zero goals by providing strategies to abate emissions in hard-to-decarbonize sectors, supported by annual high-impact publications on material innovation, process integration, and scalable decarbonization pathways. The research bridges gaps in isolated carbon capture and energy-intensive H_2 production, offering a unified solution to reduce costs and emissions while recovering wasted heat, thus aligning with global priorities for industrial sustainability.
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