Sustainable Aromatics Manufacturing from Methane via Oxidative Coupling and Aromatization

Presented by
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at
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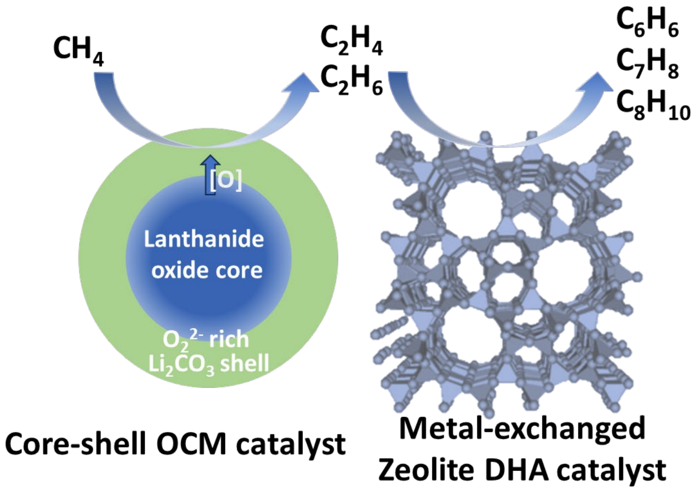
Technology characteristics



$2CH_4+MO_x \rightarrow C_2H_6 + H_2O + MO_{x-1}$ Reaction 1a
$2CH_4+2MO_x \rightarrow C_2H_4 +2H_2O + 2MO_{x-1}$ Reaction 1b
$3C_2H_4 \leftarrow \rightarrow C_6H_6 + 3H_2$ Reaction 2
$MO_{x-1}+Air \rightarrow MO_x+N_2$ Reaction 3

- Stranded methane is converted into aromatics (BTX) in a 2-steps
  - CL-OCM (Rxn. 1 a&b): Methane is oxidatively coupled over a chemical looping catalyst to form ethane or ethylene
  - DHA (Rxn. 2): The C_2 products are reacted over a zeolite to form aromatics
- To close the chemical looping mass balance the CL-OCM catalyst is regenerated in air (Rxn 3)
- The OCM/regeneration steps provide heat allowing for autothermal operation.
- The hydrogen byproduct can be used to hydrogenate CO_2 to improve ultimate yields
- The feasibility of the chemical looping OC-DHA catalyst was recently validated in DOE-NETL funded project and NCSU and WVU (DE-FE0031869: PM Anthony Zammerilli)

Technology advantages

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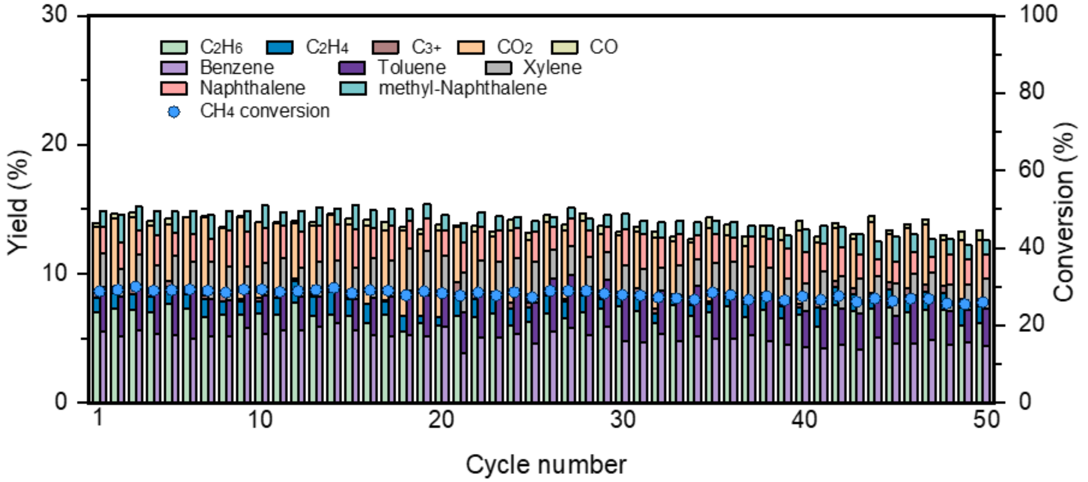
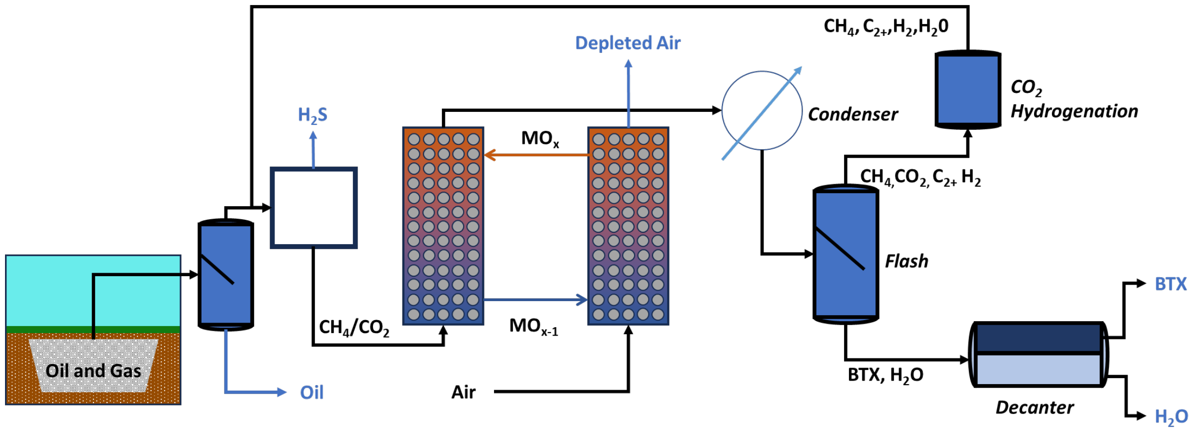


Long-term stability test of the OCM+DHA reaction; DE-FE0031869



- 1. Simplified feedstock preparation; The OC-DHA redox catalyst will simultaneously convert C_1-C_3 components in shale or bio/landfill gas.
- 2. Increased single pass yield and productivity; existing DHA is limited by thermodynamics with 8% single pass CH_4 conversion at 650 °C vs 75% CH_4 conversion for CL-OCM within a single pass. Aromatic yields of ~15% have been demonstrated;
- 3. Simplified product separation and recycle scheme; OC-DHA results in an easy-to-separate product slate consisting of liquids (aromatics and water) and gas (gaseous alkanes and alkenes with small amount of CO_x and unconverted H_2).
- 4. High robustness; The cyclic process periodically regenerates the catalysts.

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Planned project approach

- Process Modeling and Techno Economic Analysis
  - The preliminary ASPEN+ model will be evaluated and refined. Literature review and stakeholder outreach will be used to update TEA parameters.
  - The cost of a commercial-scale DHA plant will be estimated and the potential ROI will be estimated.
- Life Cycle Analysis
  - Process modeling will be used to update the cradle-to-gate GHG emissions by using International Standards Organization (ISO) 14040/14044 standards.
- Experimental Process Data Collection and TEA/LCA Driven Experimental Validation
  - Previous experimental data will be evaluated for completeness and used as the basis for process modeling.
  - A limited amount of experimental data will be collected in cases where there are gaps in available data/conditions.
- EH&S Risk Assessment, Gap Analysis, and Project Planning
  - A high-level screening hazardous operations review will be done by the project team to identify potential hazards in the conceptual plant and develop mitigation strategies.
  - Based upon the conceptual plant design, TEA, LCA, and stakeholder outreach will be conducted to identify remaining gaps that need to be addressed in phase 2 and beyond.
  - These gaps will be integrated into project planning and detailed scope of work for phase 2.