Advanced Reaction Systems Overview

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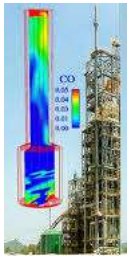
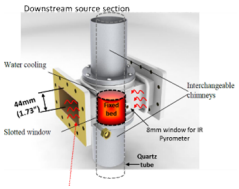
03/13/2017

Advanced Reaction Systems

Converting Fossil Fuels for Multiple Applications





Objective: Move away from "bigger is better" to a decentralized locality based processes that utilizes local feed stocks to create needed products in the most economic method

How to do this:

1. **Develop a toolset that can autonomously design a process that utilizes local feed stocks (coal, natural gas, biomass, and/or MSW) to produce locally needed goods (power, heat, liquids, etc.)**
2. **Utilize mass manufacturing for "common to all" parts to drive costs down while using Advanced Manufacturing to fabricate critical performance parts that enable high performance (e.g. fuel injectors).**
3. **Manufacture the process to fit and operate in standard ISO shipping containers such that untrained work force with common tools can construct**
4. **Operate remotely to reduce O&M costs and only require onsite for fuel stock feed.**

Key Advantages:

- **The financial risk associated with small-scale modular systems does not present as difficult a challenge as it does with large-scale central systems.**
- **Reduction in transpiration of feedstocks and end products will reduce CO_2 emissions, biomass and MSW can be used to also reduce emissions**
- **Advanced modular reactors will be designed to enhance reactions, e.g., microwaves, wall effects.**
- **Advanced computational techniques can reduce design costs and optimize reaction parameters to provide increased performance at lower costs.**
- **Advanced modular systems will be "right-sized" for each application or small units will be replicated for larger applications**

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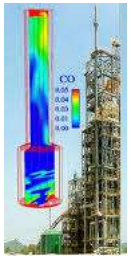
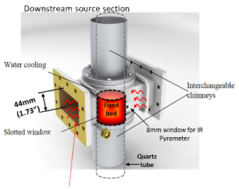
Project Overview





Task 1: Project Management

Task 2: Microbial Enhanced Coalbed Systems (MECS)

- Coal/Coalbed characterization
- Microbial community from 5 coal basins
- Microbial functional potential from Appalachian basin

Task 3: Process and Reaction Intensification

- Microwave enhanced reaction systems
- Non-traditional thermal systems
- Enabling materials
- Oxygen carrier development for chemical looping gasification

Task 4: Virtual Reactor Design, Validation, and Optimization

- Basic MFiX code development
- Test system validation with physical experiments
- Optimization toolsets

Task 5: Systems Engineering and Analysis

- Feasibility and baseline study
- Metric development
- Pathway studies

FY17 Advanced Reactions Systems FWP

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FY17 for R&IC

- Develop virtual toolsets
  - Assess new reactors performance → feed to future system analysis
- Gather information on new/novel reaction systems for system analysis
- Develop a "Baseline" 1-5 MW_e modular system for power and liquids
  - Compare to commercial SOTA at utility scale to develop programmatic targets (input from FY16 market analysis as well)

FY18 for R&IC

- Focus FWP on areas with most impact on driving cost down and performance up (based on FY17 TEA by SEAD)
- Target best performing reactors and continue a systematic study of reported reactor/reactions
- Prototype 1-2 hot reacting reactors optimized by virtual toolset

FY20 design of 1-5 MW_e power system with optimized reactors

FY22 design of 1-5 MW_e liquids system with optimized reactors

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