Hydrogen Production at Natural Gas Wellheads

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Team Member

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Motivation and Background

- H_2 plays an indispensable role as a clean energy carrier in future decarbonized energy systems
- Steam methane reforming (SMR) remains a major route to produce H_2
- Existing SMR, gas production and CO_2 sequestration remain largely separated with little integration
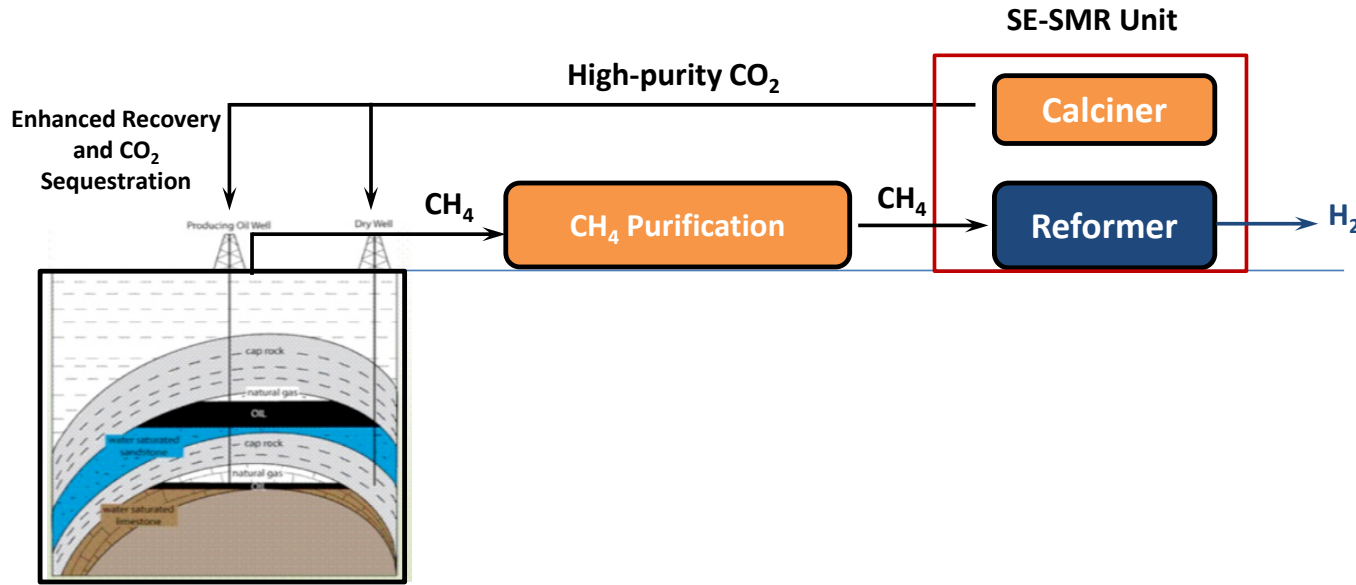

Gas Well
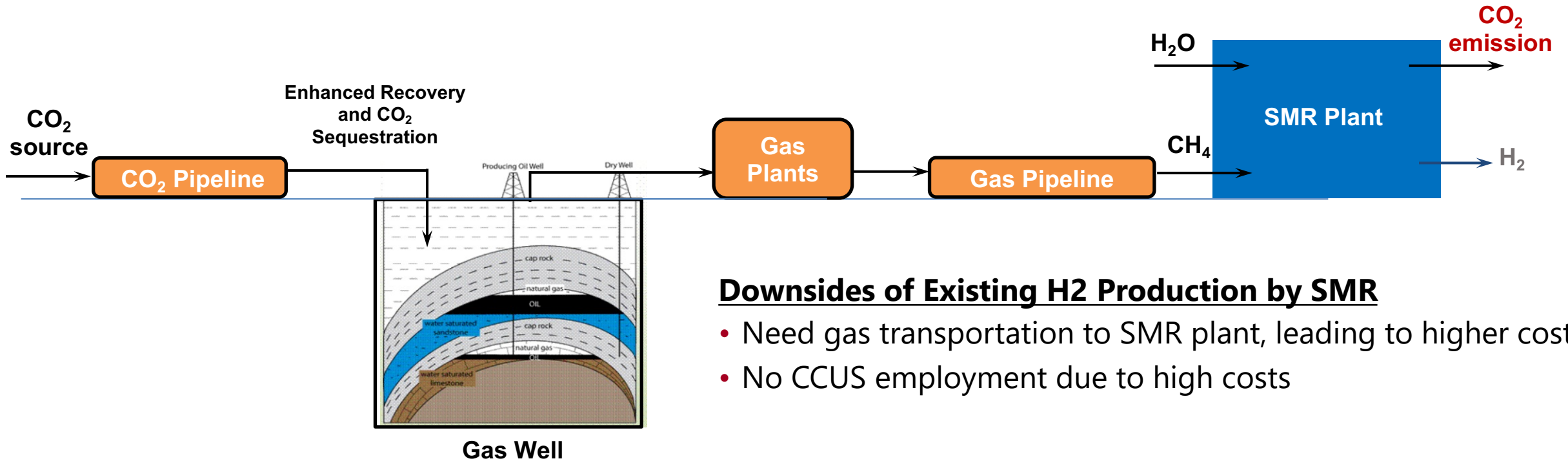
Downsides of Existing H2 Production by SMR
- Need gas transportation to SMR plant, leading to higher costs
- No CCUS employment due to high costs

Project Overview

- **Proposed work** - *an innovative process that integrates SE-SMR + gas production + CO_2 sequestration*

SE-SMR Unit

High-purity CO_2

Calciner

Enhanced Recovery and CO_2 Sequestration

CH_4

CH_4 Purification

CH_4

Reformer

H_2

Impacts and Significances
- Low-carbon H_2 production
- Simultaneous CO_2 sequestration/utilization
- Enhance gas production
- H_2 hubs in Texas
- Subsurface H_2 production technology

- **Task 1** - Develop reservoir models considering the effect of CO_2 injection on gas production
- **Task 2** - Identify high-capacity CO2 adsorbents for CO_2/H_2 separation
- **Task 3** – Conduct techno-economic analysis of the integrated process

Project Progress Updates

- **Task 1** - Develop reservoir models considering the effect of CO_2 injection on gas production
  - Established representative 2D reservoir models for gas recovery under CO_2 injection
  - Studied how permeability heterogeneity, formation thickness, CO_2 injection rate affect gas recovery

- **Task 2** - Identify high-capacity CO2 adsorbents for CO_2/H_2 separation
  - Designed and constructed an apparatus for testing the performance of CO_2 adsorbents
  - Conducted literature survey and identified a few adsorbent candidates for testing
  - Performed preliminary characterizations of adsorbent candidates (BET surface area, etc.)

- **Task 3** – Conduct techno-economic analysis of the integrated process
  - Completed the process simulation setup for conventional SMR and SE-SMR using Aspen Plus
  - Conducted sensitivity analysis of pressure, temperature, CH_4/H_2 ratio on CH_4 conversion