KP ENGINEERING

A SHAW GROUP COMPANY

Integrated Gasification and Electrolysis: Opportunities and Challenges

October 9th, 2024

Topics

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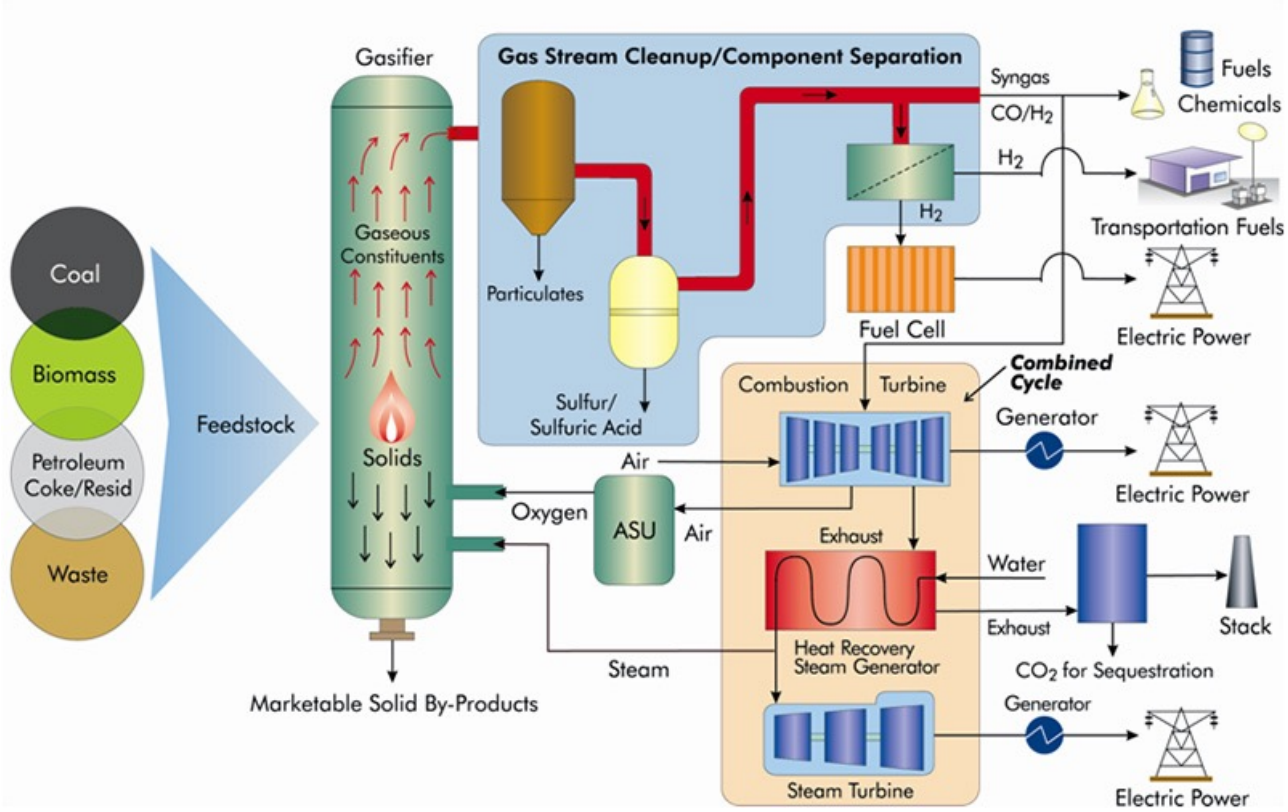
KP Engineering (KPE) is an engineering, procurement, fabrication, and construction management firm focused on decarbonizing the energy industry.

- Acquired by The Shaw Group (largest pipe fabrication company in the world) in 2023 and now part of Shaw Projects & Modules
- Headquarters and execution centers are in Texas, Louisiana, Middle East, and North Africa
- Focused on decarbonizing the energy industry:
  - Solutions from syngas pathways
  - The refining/fuels sector
- Service offering includes:
  - Technology Licensor Support
  - Front-End Loading (FEL)
  - Engineering and Procurement
  - Fabrication
  - Integrated EPF/EPFCm/EPFC
  - Commissioning and Start Up

Overview of Gasification

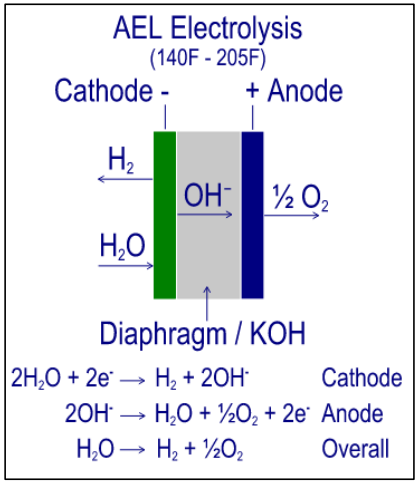
- The gasification process is used to transform a carbonaceous fuel into a syngas product.

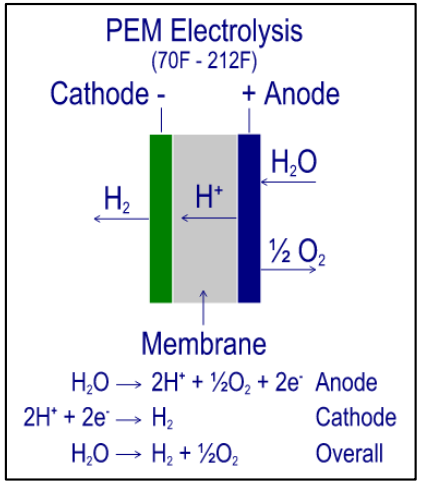


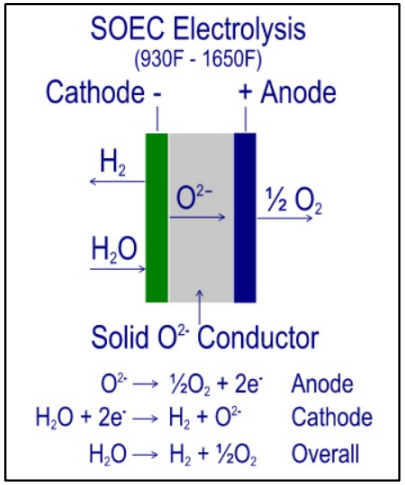
Source: netl.doe.gov/research/coal/energy-systems/gasification/gasifipedia

Overview of Electrolysis

- Electrolysis is the process of using electricity to split water into hydrogen and oxygen.
- Three types of electrolysis currently considered commercially viable:
  - Alkaline Electrolysis (AEL)
  - Proton Exchange Membrane (PEM)
  - Solid Oxide Electrolysis (SOEC)

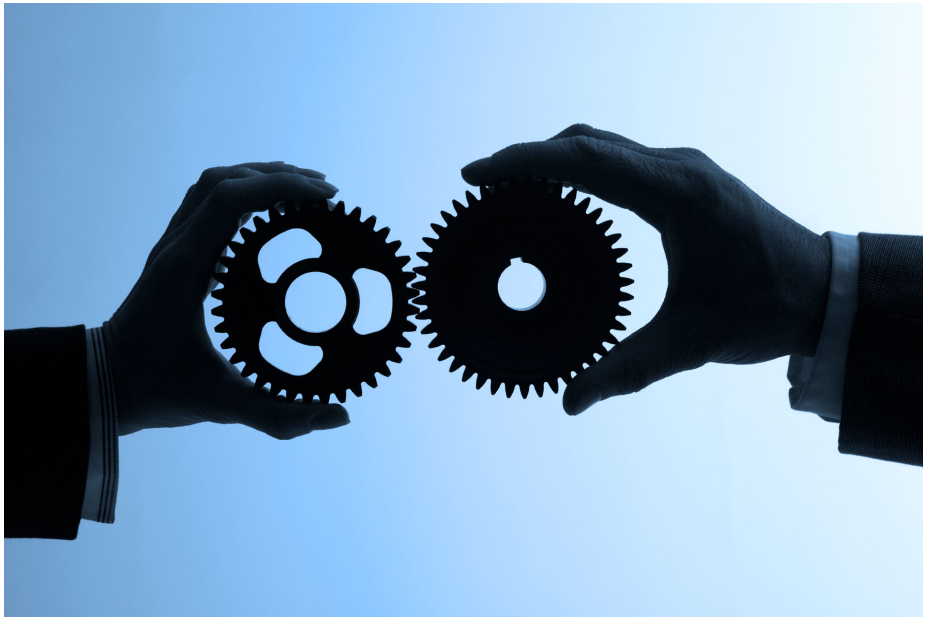






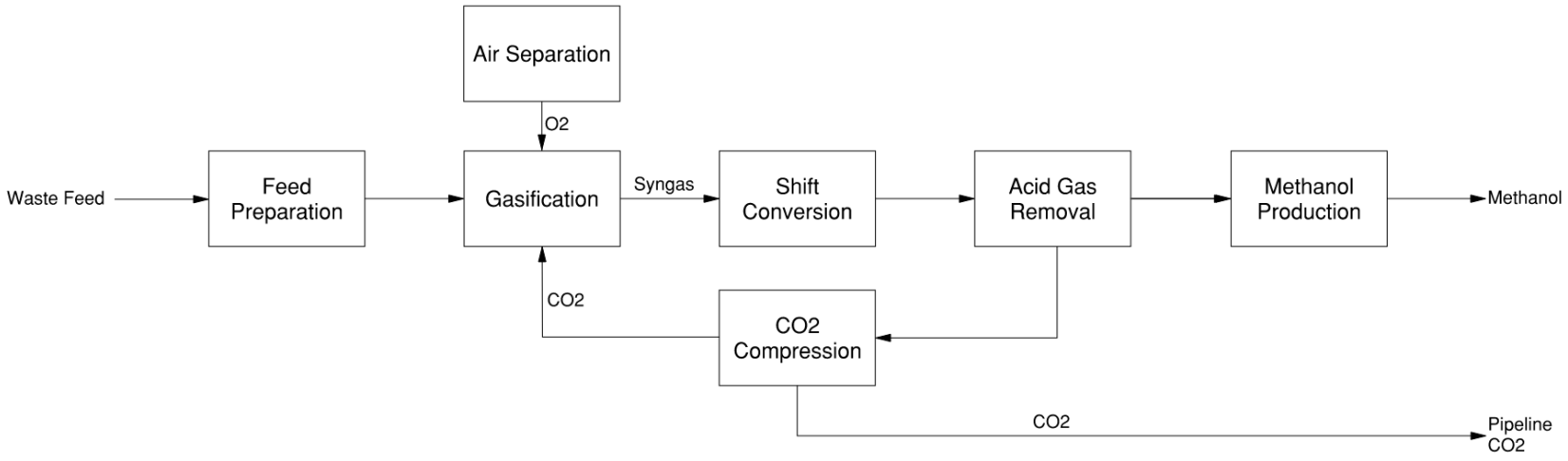
Synergies

- Renewable fuel technologies utilizing gasification for syngas production makes use of both electrolysis products (hydrogen and oxygen).
- Oxygen from the electrolysis unit can be used within the gasification unit.
- Hydrogen from the electrolysis unit can be sold as a product or used as a feedstock in the downstream system, depending on the final product.
- KPE's evaluation has focused on facilities where methanol was the final product.



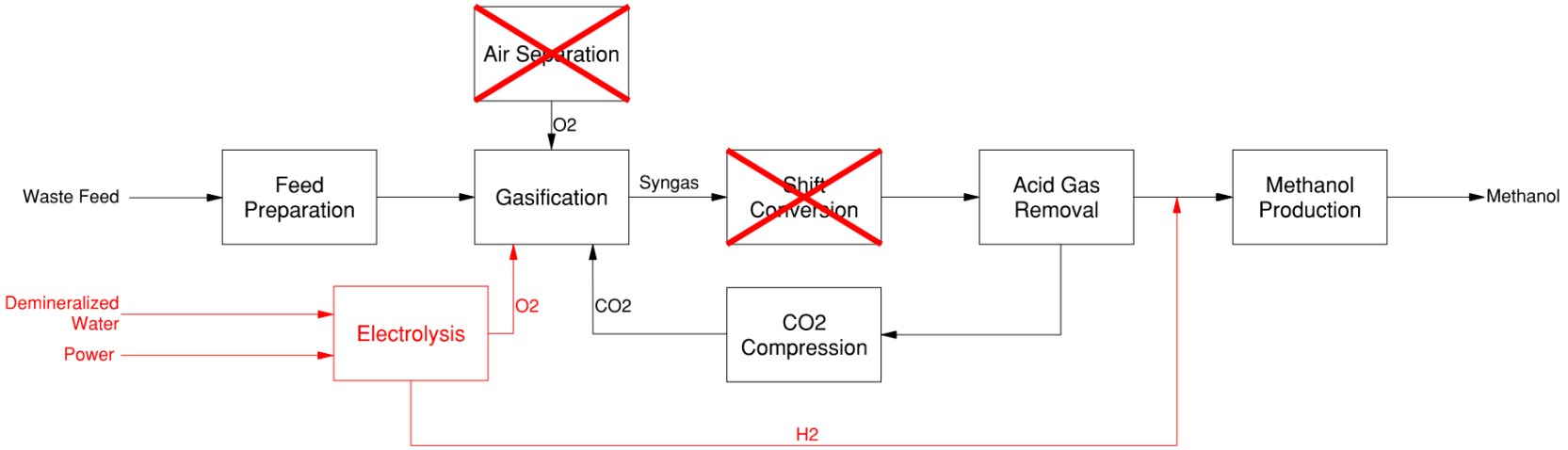
Flow Schemes

- Typical waste to methanol plant
  - Oxygen provided by cryogenic air separation unit
  - Shift conversion and acid gas removal of syngas before feeding the methanol unit



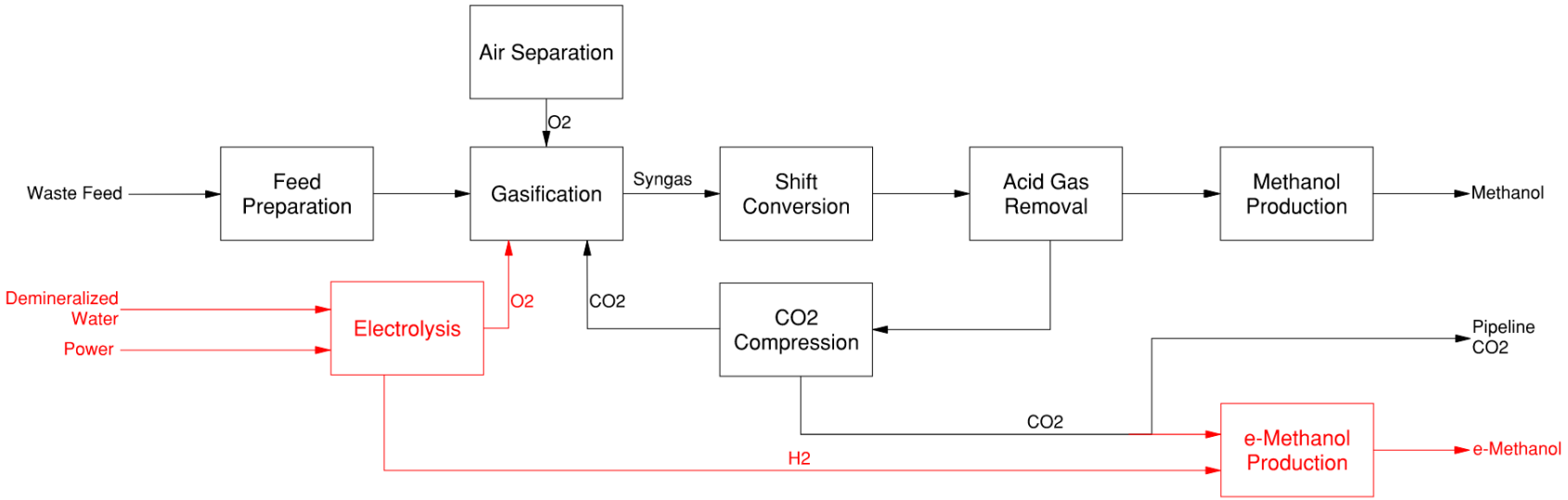
Flow Schemes

- Electrolysis integration with hydrogen injection into the syngas
  - Air separation unit and shift conversion are not required
  - Size of acid gas removal (AGR) unit can be reduced
  - Assumes electrolysis is integrated in the original design of the plant



Flow Schemes

- Electrolysis integration with hydrogen combined with carbon dioxide from the AGR
  - Plant can be designed and operated without electrolysis
  - Air separation unit, shift conversion, and full-sized AGR are still required
  - Separate e-methanol units are required to convert carbon dioxide and hydrogen to methanol



Project Applications

- The "Stage Gate" process is used to frame project economics as well as risks and opportunities
- Risk workshop is typically held early in project development
  - Define project objective and what constitutes success
  - Involve all decision-makers
  - Consider direct and indirect project risks
  - Determine mitigation strategies for each risk
- Risk register is maintained and reviewed throughout the project lifecycle

Project Applications

- Methanol end product capacities -
  - Gasification only: from 400 Metric TPD to 1,700 Metric TPD
  - Electrolysis, achieving full carbon conversion: 900 Metric TPD to 4,000 Metric TPD
  - Perspective: large coal-based methanol plant approximately 7,200 Metric TPD
- Opportunities and Risks -
  - Increase production through incorporation of electrolysis
  - Overall economics
  - Utility availability

Project Applications

Key Project Metrics	
Hydrogen Consumption	100,000 NCMH to 225,000 NCMH
Number of Electrolysis Units Required	20 to 45
Power Consumption	Up to 6.4 kWh/NCM
Total Power Required	Up to 1.21 GW

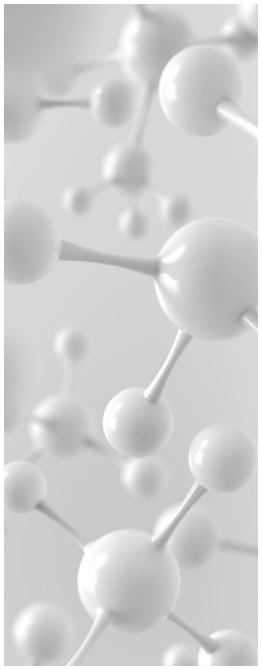
Project Applications

Challenges & Opportunities

Challenges	Opportunities
Technology Integration	▪ Select best electrolysis technology to integrate with plant process
Green Electricity Demand	▪ Geographic location with higher green energy availability ▪ Green energy innovation over time
Capital Cost	▪ Transfer scope from the electrolysis units and combine the balance of plant in the most economic way
Lead Time for Electrolysis Unit	▪ Repackage electrolyzer unit to require fewer modules and integrate into the overall construction strategy for the plant

Key Takeaways

- Electrolysis can be used to increase production in biomass-to-methanol units
- Technology integration faces some challenges
- Many opportunities for innovation and further development



Thank you.

Ray Wortham: RWortham@KPE.com | Sara Brown: SBrown@KPE.com