# ADVANCED COAL-FIRED POWER CYCLES

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Critical Challenges. **Practical Solutions.**

# ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

- Nonprofit branch of the University of North Dakota focused on energy and environmental solutions.
- More than 254,000 square feet of state-of-the-art laboratory, demonstration, and office space.



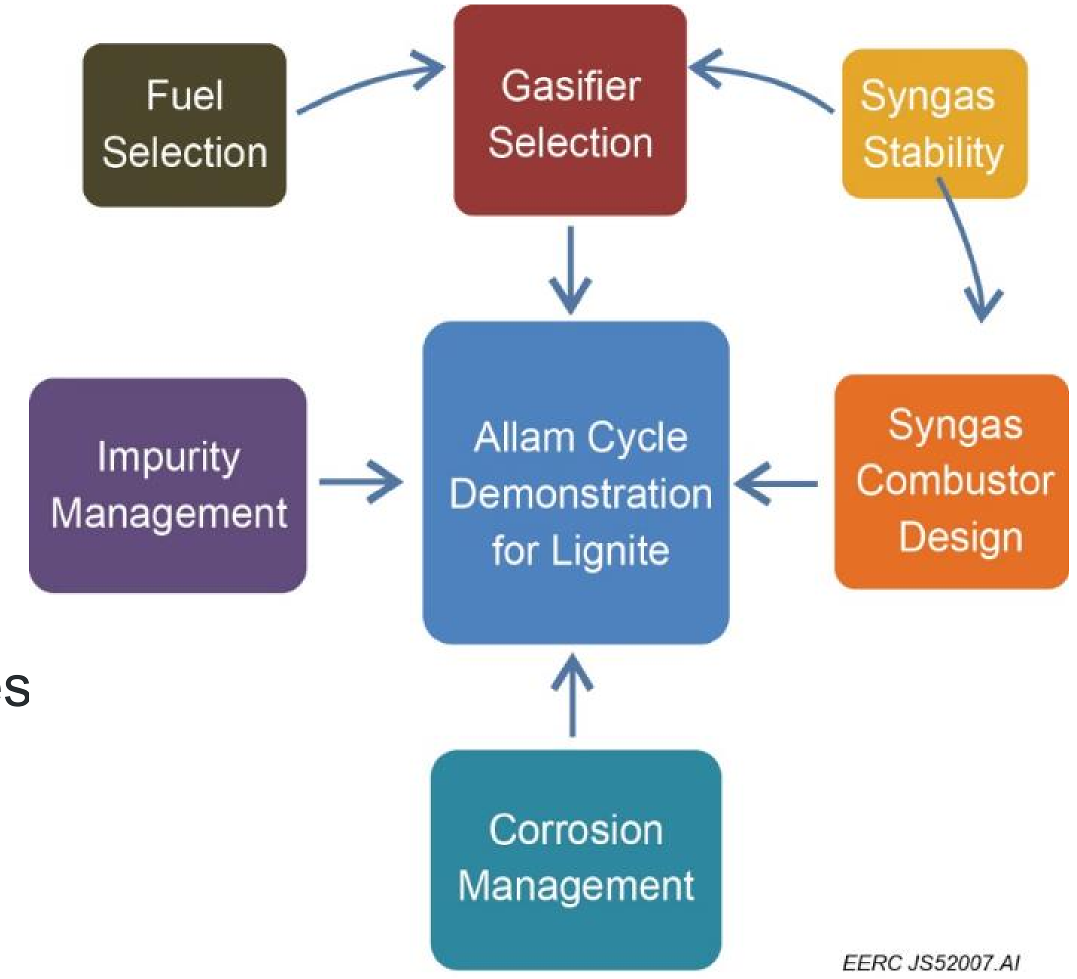
EERC

Heart of North Dakota Energy Industry

EERC | UND UNIVERSITY OF NORTH DAKOTA

# OUTLINE

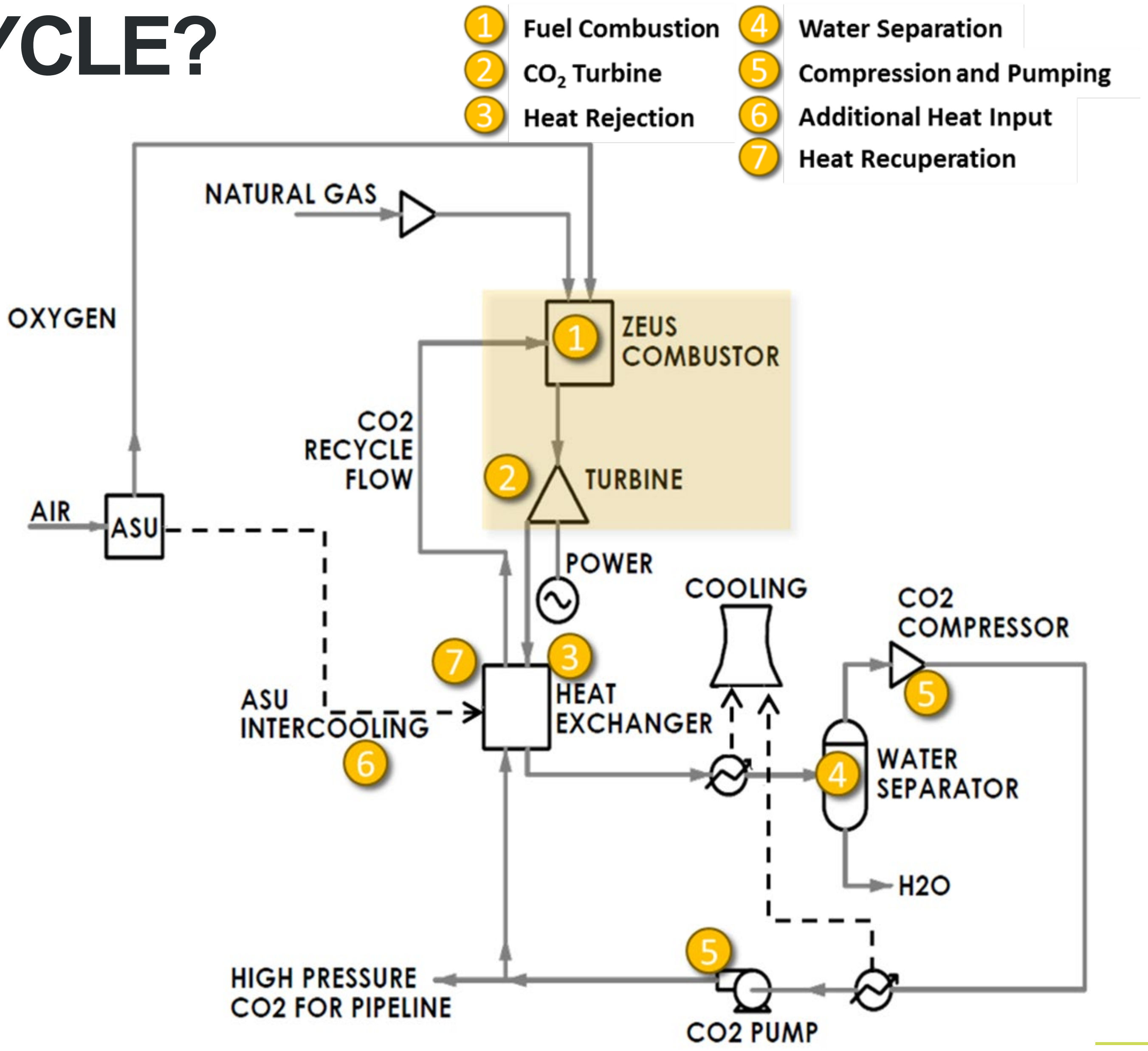
- Industry Need
- What Is the Allam Cycle?
  - History
  - Benefits
- Coal-Based Allam Cycle
  - Overview
  - Technology Development Activities
- Future Work



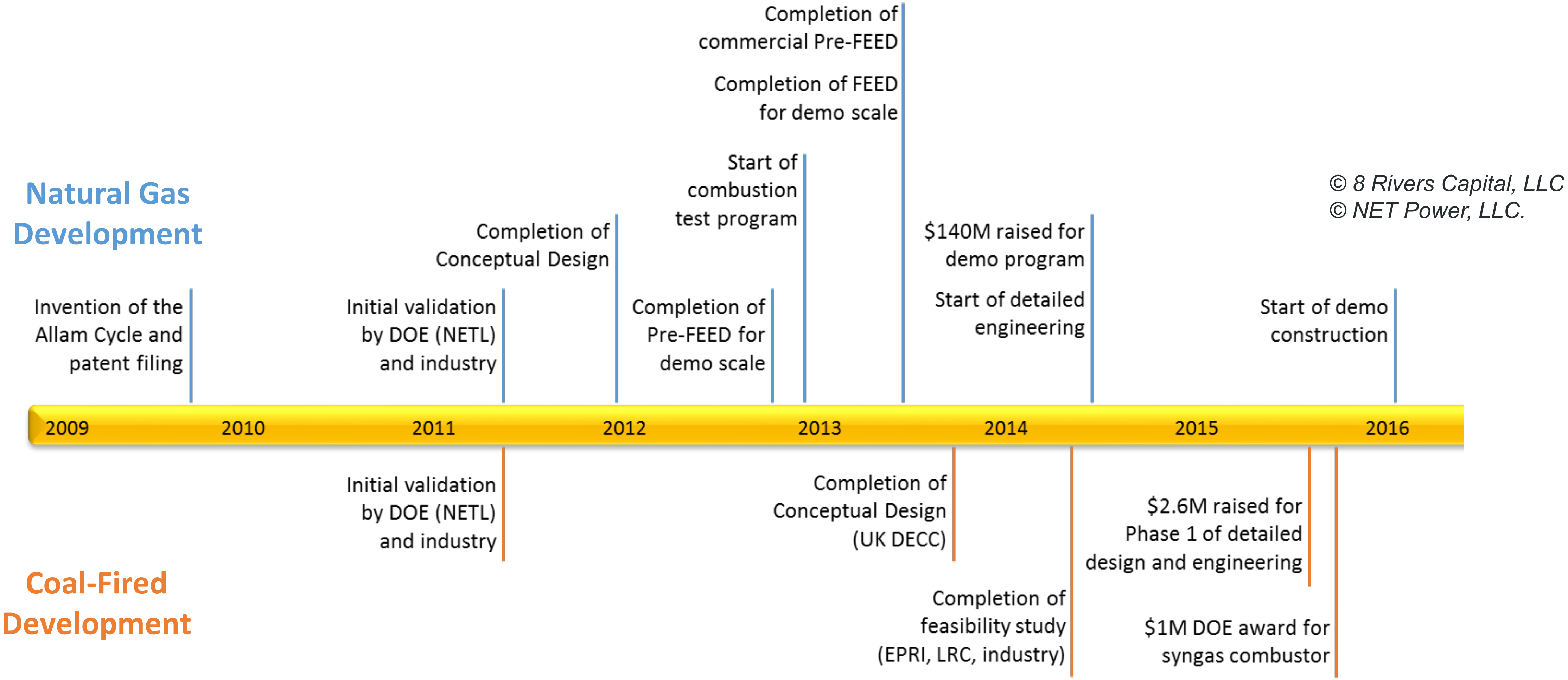
# WHAT IS THE ALLAM CYCLE?

The Allam Cycle is any supercritical $CO_2$ Brayton cycle that:

- Is oxy-fueled and direct-fired.
- Recuperates turbine exhaust.
- Uses a heat source in addition to the turbine exhaust.
- Utilizes turbine temp >800°C (1000°–1200°C optimal)
- Inlet >80 bar (200–400 bar optimal).



# THE ALLAM CYCLE IS BEING ACTIVELY COMMERCIALIZED



# CORE NATURAL GAS ALLAM CYCLE DEMONSTRATION BY NET POWER

**50-MWth natural gas demonstration plant located in La Porte, Texas.**

- Commissioning has begun.
- First fire in May 2018.
- Will test performance, reliability, controllability, and safety.

**300-MWe commercial plant under development.**

- Pre-FEED study completed on commercial plant.
- Beginning FEED and early development work.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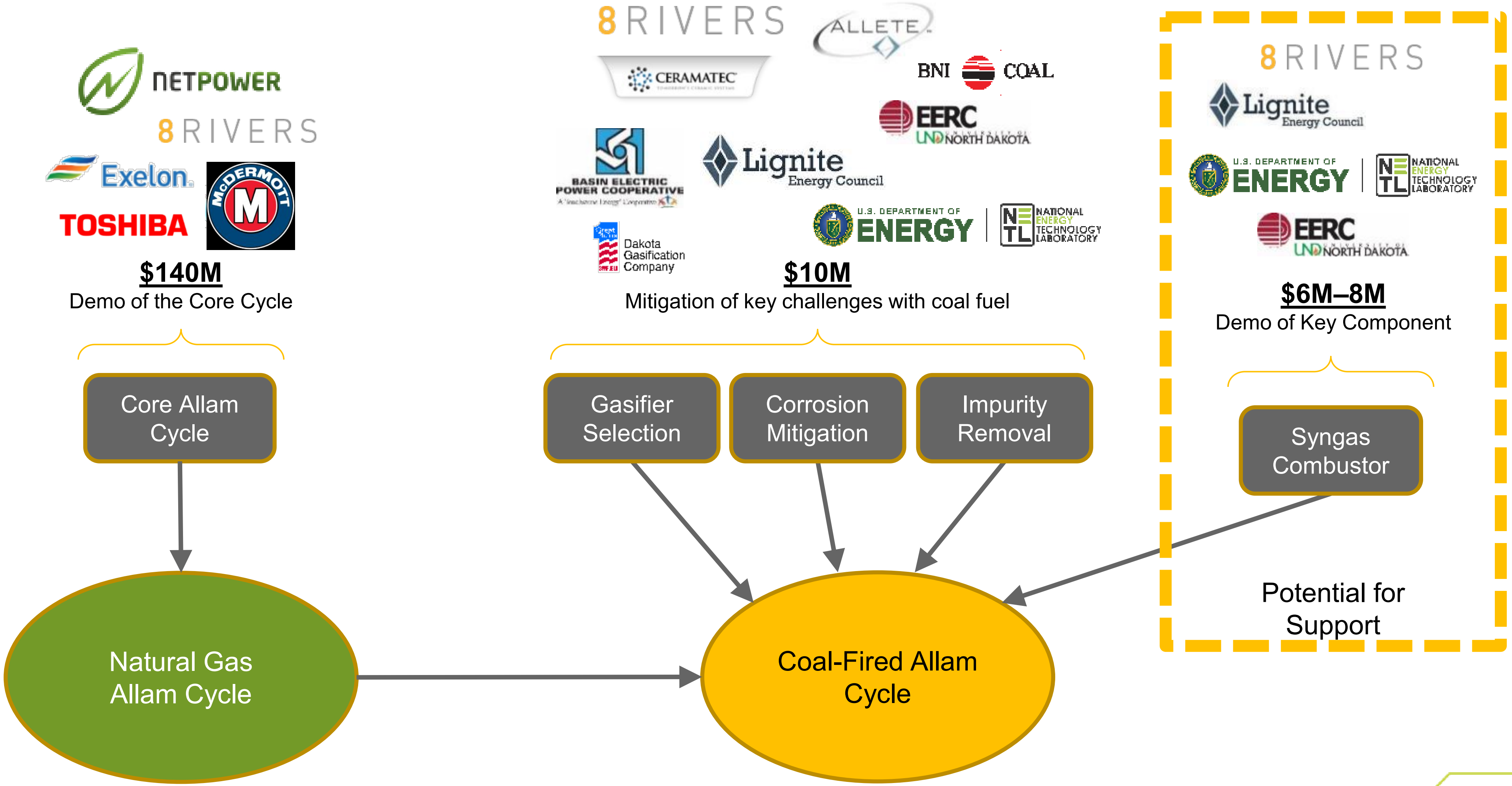
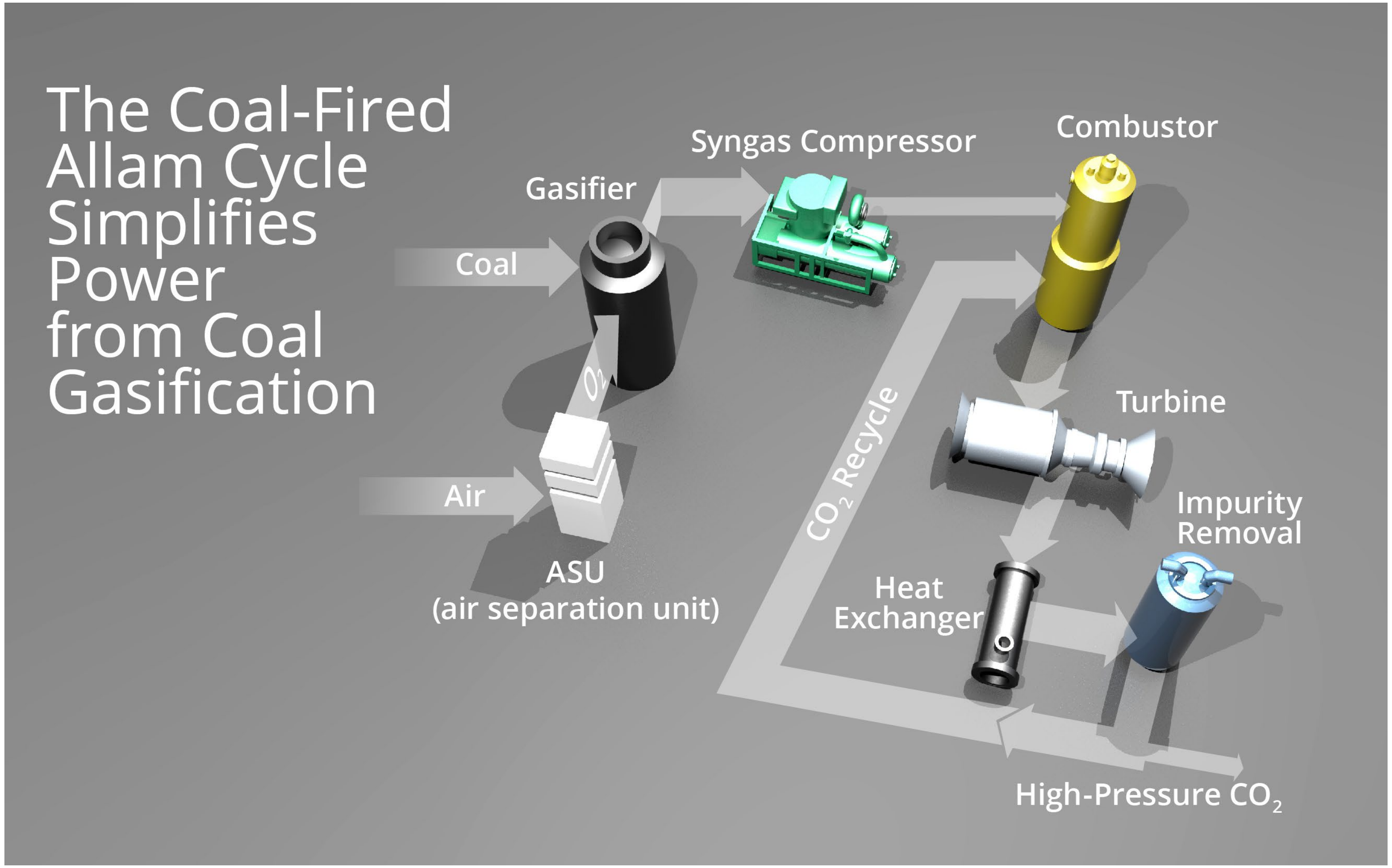
# ONGOING ALLAM CYCLE DEVELOPMENT OVERVIEW



# KEY AREAS REQUIRED TO MITIGATE ADDITIONAL RISKS FOR COAL

- Metallurgy/corrosion
- Gasifier selection
- Gas cleanup
- Syngas combustor



# CORROSION

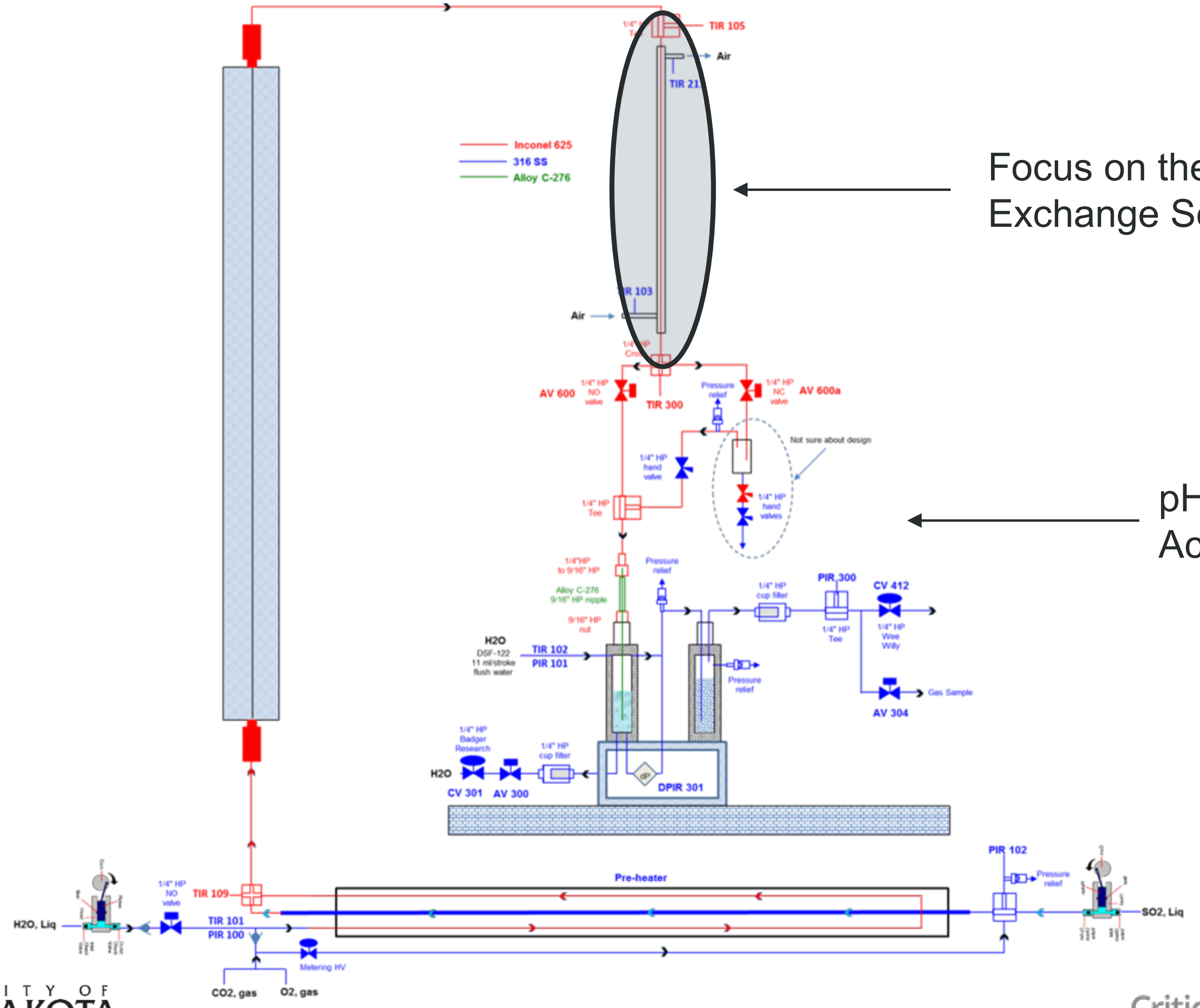
# FINAL FUEL SPECIFICATION

| | Average | Maximum | Minimum |
|---|---|---|---|
| Proximate Analysis, as-received, wt% | | | |
| Moisture | 37.5 | 40.0 | 35.0 |
| Volatile Matter | 26.0 | 31.0 | 21.0 |
| Fixed Carbon | 28.5 | 23.5 | 33.5 |
| Ash | 8.0 | 12.0 | 6.0 |
| Ultimate Analysis, as-received, wt% | | | |
| Carbon | 42.0 | 55.0 | 32.0 |
| Hydrogen | 7.0 | 8.0 | 6.0 |
| Nitrogen | 0.7 | 0.9 | 0.5 |
| Sulfur | 1.0 | 1.5 | 0.5 |
| Oxygen | 41.3 | 50.0 | 40.0 |
| Ash Composition, wt% as oxides | | | |
| $SiO_2$ | 25.0 | 35.0 | 15.0 |
| $Al_2O_3$ | 10.0 | 20.0 | 5.0 |
| $Fe_2O_3$ | 10.0 | 20.0 | 5.0 |
| $TiO_2$ | 0.5 | 1.0 | 0.1 |
| $P_2O_5$ | 0.5 | 1.0 | 0.1 |
| CaO | 22.0 | 32.0 | 12.0 |
| MgO | 6.0 | 11.0 | 1.0 |
| $Na_2O$ | 5.0 | 7.0 | 2.0 |
| $K_2O$ | 1.0 | 2.0 | 0.2 |
| $SO_3$ | 20.0 | 30.0 | 10.0 |
| Higher Heating Value | | | |
| As-Received, Btu/lb | 6600 | 7200 | 5800 |




# LOW PRESSURE/LOW TEMPERATURE

# DYNAMIC CORROSION TESTING – LOW PRESSURE/LOW TEMPERATURE

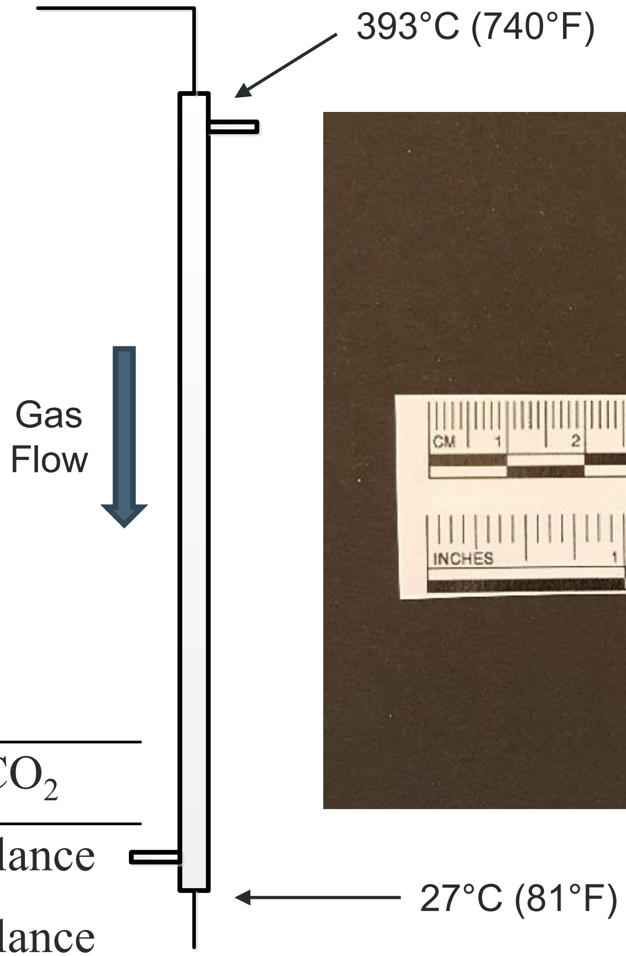


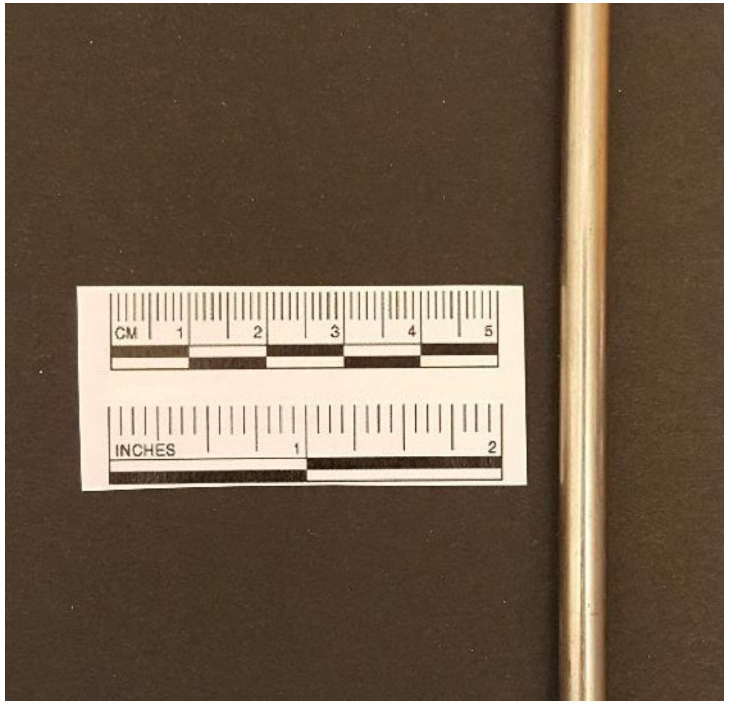

Focus on the Heat Exchange Section

pH of Condensed Acid Was Measured

# HEAT EXCHANGER

- Inconel 625 tubing.
- Two tests performed at 30 bar (435 psi) pressure.
- Both tests experienced tubing plugs in less than 50 hours.
- Physical plug occurred at the top of the heat exchanger.
- Sulfur attack seen throughout system.



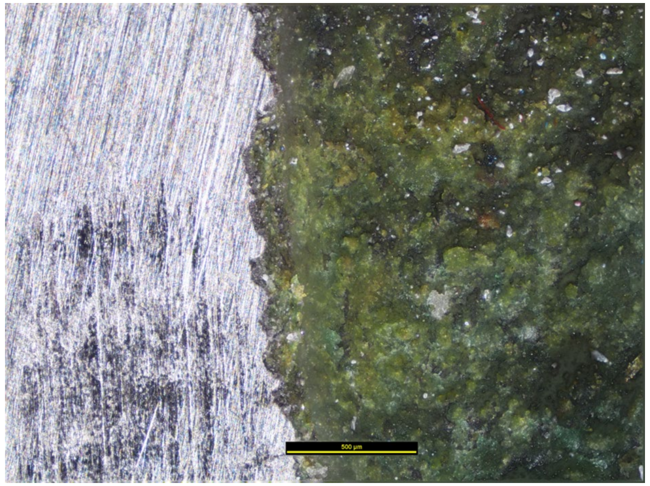

**Test Gas Compositions**

| | $SO_2$ | $H_2O$ | $O_2$ | NO | $CO_2$ |
|---|---|---|---|---|---|
| Test 1 | 600 ppm | 2% | 1% | 40 ppm | Balance |
| Test 2 | 600 ppm | 2% | 1% | 20 ppm | Balance |

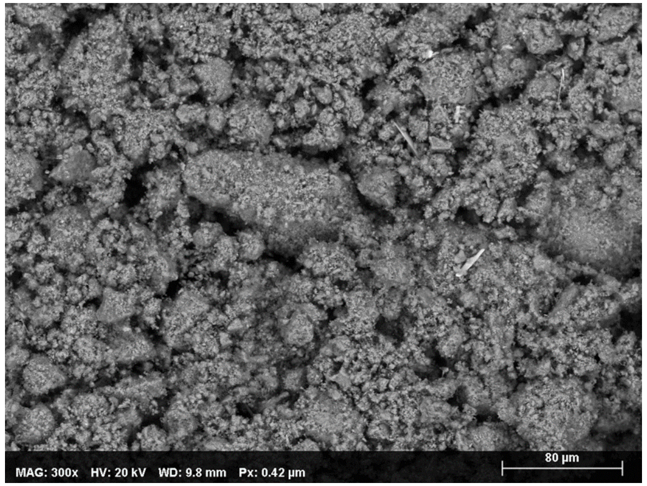
# COMPOSITIONS

**Average Composition (wt%) of the Plug Material and Base Alloy**

| | O | Al | Si | S | Ti | Cr | Fe | Ni | Ni/Cr | Cr/Fe | Ni/Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Plug Material | 52.0 | 0.02 | 0.07 | 16.6 | 0.07 | 5.23 | 1.05 | 24.8 | 1.49 | 5.00 | 23.7 |
| Alloy 625 | – | <0.40 | <0.50 | <0.015 | <0.40 | 20.0–23.0 | <5.0 | >58.0 | >2.52 | <4.60 | >11.6 |



Bar is 0.5 mm long (0.02 inches).




Bar is 0.08 mm long (0.003 inches).

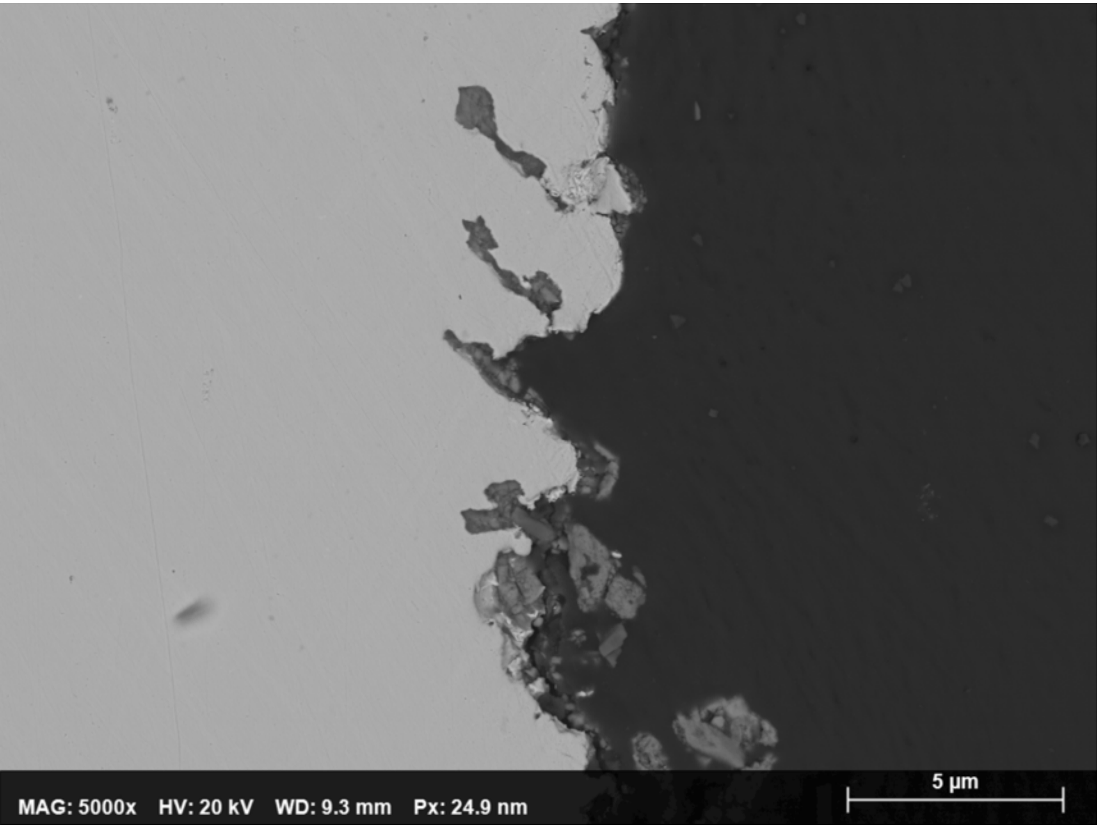
**Condensed Liquid Analytical Results**

| Element/Compound | Concentration, mg/L |
|---|---|
| Chromium | 2700 |
| Iron | 670 |
| Nickel | 7490 |
| Nitrate | <100 |
| Nitrite | <100 |
| Sulfate | 143,000 |
| Nickel/Chromium Ratio | 2.77 |
| Chromium/Iron Ratio | 4.03 |
| Nickel/Iron Ratio | 11.2 |

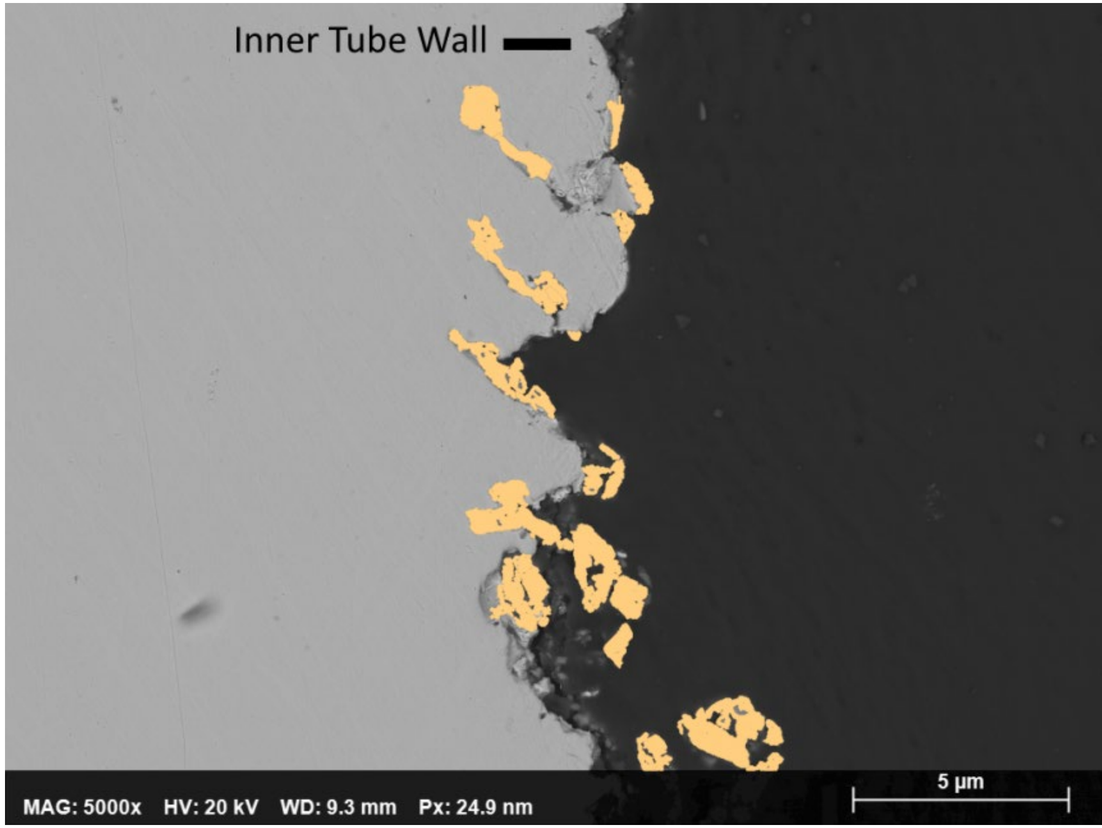
Measured pH was below 1.0.

# TUBING SECTION EXPOSED TO 700°F – PLUGGED AREA

- SEM Micrograph

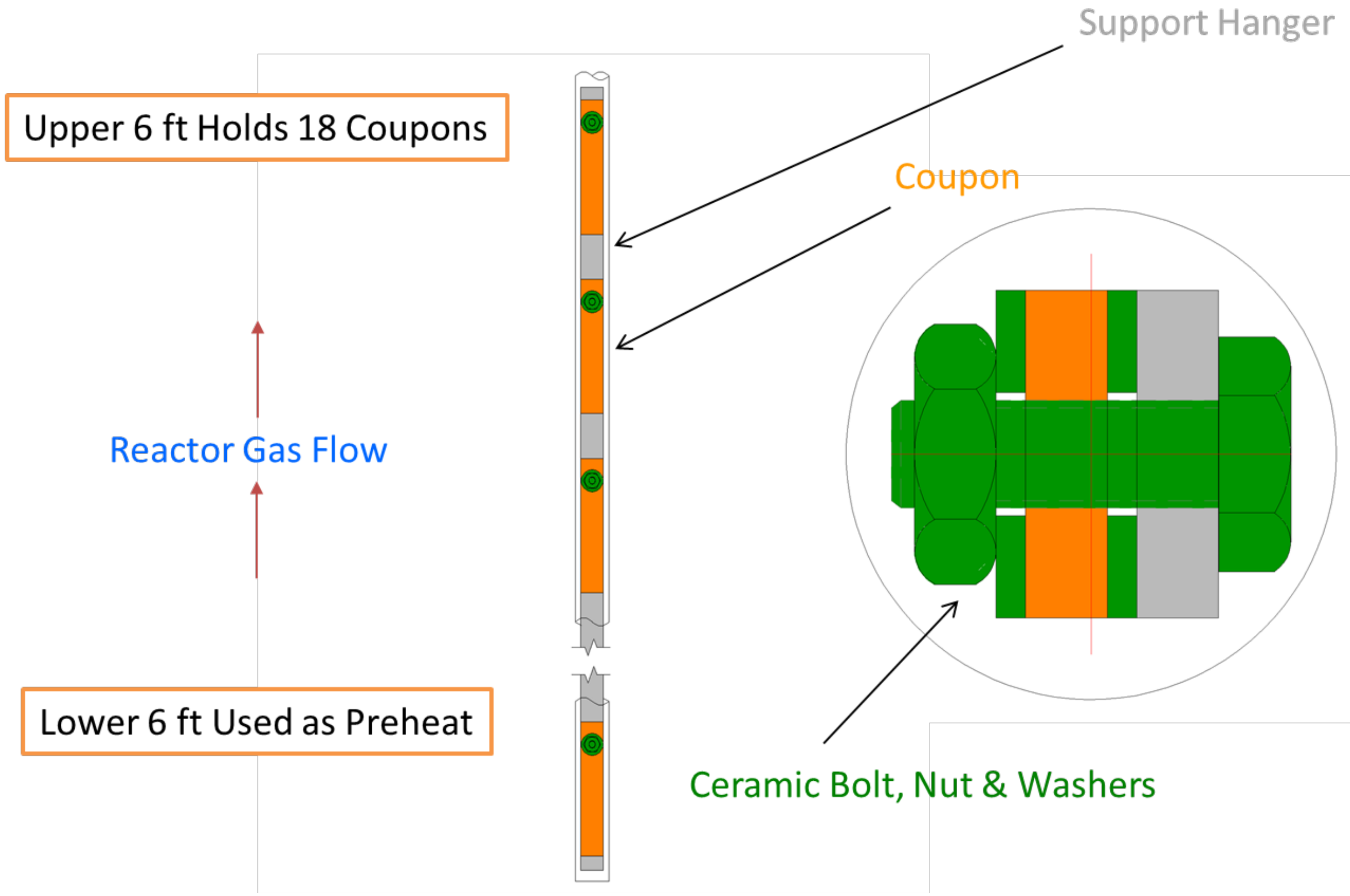


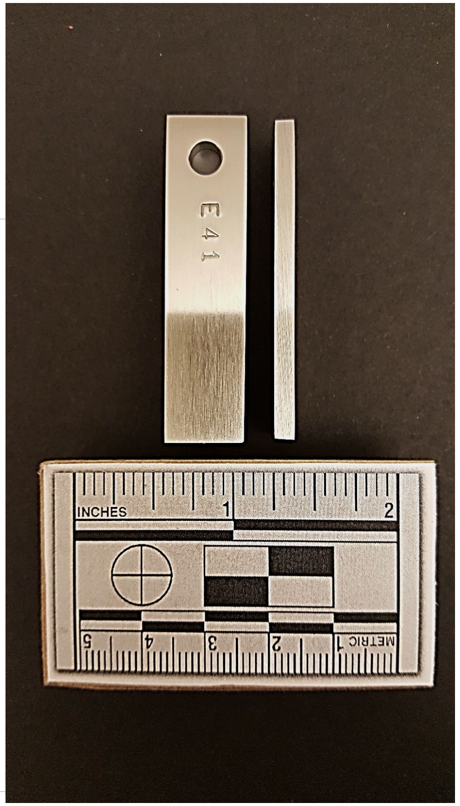

- SEM Micrograph Showing Presence of Sulfur Species – Colored Areas



# HIGH-PRESSURE/HIGH-TEMPERATURE PRECOMBUSTION SULFUR REMOVAL

# INCONEL REACTOR



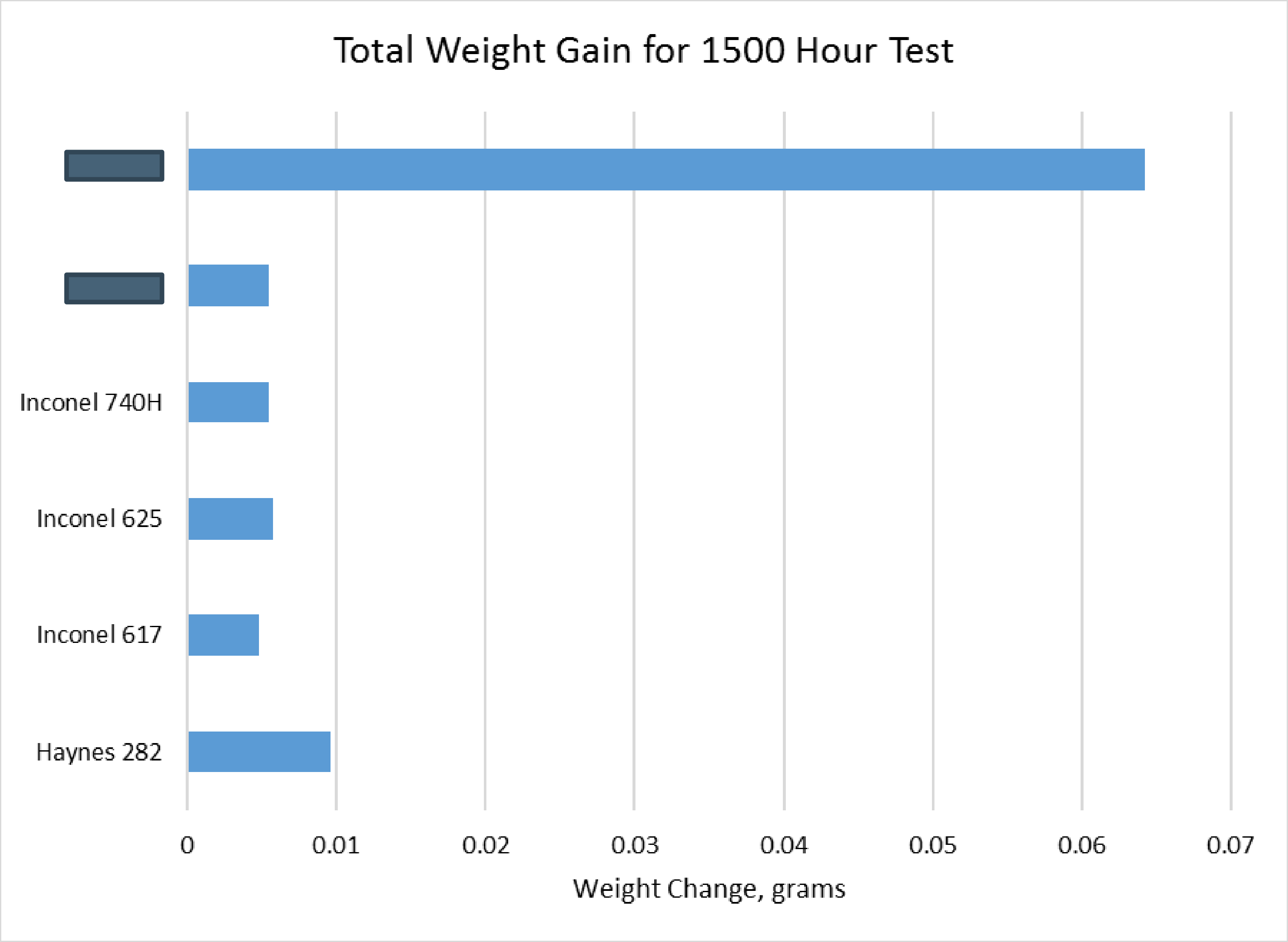



# ALLOYS BEING TESTED IN REACTOR – HIGH PRESSURE/HIGH TEMPERATURE

| Alloy | Cr | Ni | Fe | Mo | Co | Al | Nb+Ta |
|---|---|---|---|---|---|---|---|
| G130 | 24.0–26.0 | Balance | 1.5 max. | 0.5 max. | 18.0–22.0 | 1.0–1.6 | 0.75 max. |
| 740H | 23.5–25.5 | Balance | 3.0 max. | 2.0 max. | 15.0–22.0 | 0.2–2.0 | 0.5–2.5 |
| 617 | 20.0–24.0 | Balance | 3.0 max. | 8.0–10.0 | 10.0–15.0 | 1.5 max. | – |
| 230 | 20.0–24.0 | Balance | 3.0 max. | 1.0–3.0 | 5.0 max. | 0.2–0.5 | – |
| 625 | 20.0–23.0 | Balance | 5.0 max. | 8.0–10.0 | 1.0 max. | 0.4 max. | 3.2–4.2 |
| 282 | 18.5–20.5 | Balance | 1.5 max. | 8.0–9.0 | 9.0–11.0 | 1.38–1.65 | – |

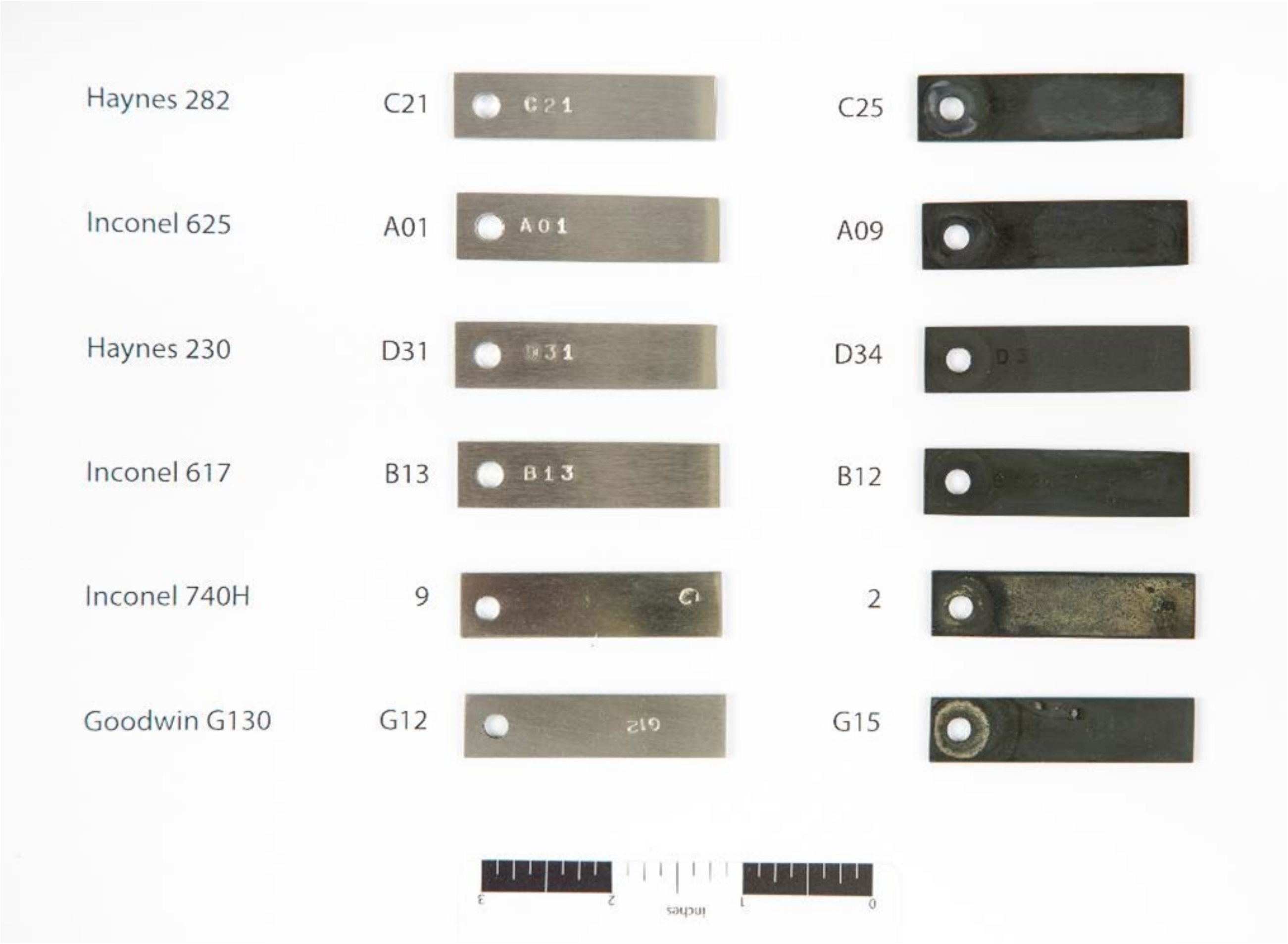
- Selection based on results of prior testing.
- 1500-hour test.
- 269 bar (3900 psi) pressure, 750°C (1383°F).

# HIGH-PRESSURE/TEMPERATURE RESULTS



# CORROSION SUMMARY

- Precombustion sulfur removal will be necessary.
- Materials exist that will survive nominal Allam Cycle conditions.
- Selective acid condensation will need to be monitored.



# GASIFIER SELECTION

# TASK 2 – GASIFIER SELECTION

- Gasifier selection will impact all areas of the Allam Cycle.
- Lignite fuel spec developed.
- Selection process.
- Systems modeled.

# SELECTION CRITERIA

- Selection of a suitable gasifier is highly dependent on two key aspects:
  - Ability to gasify North Dakota lignite
  - Integration with the overall Allam Cycle
- Team ranked gasifiers based on these performance criteria.

# GASIFIER SELECTION

The team ranked 22 gasification systems and narrowed the list down to four.

## 22 Systems Initially Considered

| No. | Gasifier Name | Commercial Readiness | Operational History with Lignite | Applicability to Lignite | Notional Cost | Thermal Integration | System Reliability | Total Score | Rank |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCGP | 4.6 | 1.7 | 3.4 | 1.5 | 4.3 | 3.5 | 18.9 | 10 |
| 2 | SFG | 4.3 | 1.5 | 3.6 | 1.8 | 4.3 | 3.8 | 19.2 | 8 |
| 3 | OMB Slurry | 4.8 | 1 | 1.3 | 4.8 | 2.8 | 4.3 | 18.9 | 9 |
| 4 | OMB Dry | 3.6 | 2 | 3.5 | 4.5 | 4 | 4.3 | 21.9 | 4 |
| 5 | MHI | 2.4 | 0.7 | 3.2 | 3 | 3.3 | 2 | 14.6 | 18 |
| 6 | Prenflo | 3.3 | 1.2 | 3 | 2.5 | 4 | 3.3 | 17.3 | 11 |
| 7 | GE | 4.7 | 0.8 | 1.3 | 2.8 | 2.3 | 3.4 | 15.2 | 15 |
| 8 | E-GAS | 4.1 | 0.8 | 1.2 | 3 | 2.5 | 3.5 | 15.1 | 17 |
| 9 | E-STR | 1.8 | 1.2 | 3.5 | 3 | 3.3 | 3 | 15.9 | 14 |
| 10 | GTI | 1.4 | 1 | 2.8 | 3 | 3.5 | 2 | 13.7 | 19 |
| 11 | HT-L | 3.7 | 0 | 1 | 3 | 2.7 | 2 | 12.3 | 20 |
| 12 | MCSG | 4 | 0 | 1 | 3 | 2 | 2 | 12 | 21 |
| 13 | OSEG | 3.3 | 0 | 1.3 | 3 | 2 | 2 | 11.7 | 22 |
| 14 | TPRI | 3 | 1 | 3.7 | 3.5 | 3.3 | 2 | 16.5 | 12 |
| 15 | U-GAS | 3.4 | 2.4 | 3.8 | 3.1 | 3.1 | 3.5 | 19.4 | 7 |
| 16 | HTW | 3.3 | 3.2 | 3.7 | 2.8 | 3.1 | 3.7 | 19.8 | 6 |
| 17 | TRIG | 3 | 2.6 | 4.6 | 3.4 | 3.1 | 3.7 | 20.3 | 5 |
| 18 | AFB | 2.3 | 2 | 3.1 | 3.2 | 2.9 | 2.8 | 16.2 | 13 |
| 19 | KRW | 1.7 | 1.3 | 3.7 | 3 | 3.5 | 2 | 15.2 | 16 |
| 20 | BGL | 3.9 | 3.9 | 4.8 | 3.3 | 3.8 | 3.3 | 23 | 3 |
| 21 | Lurgi | 4.9 | 5 | 4.9 | 3.8 | 2.1 | 4 | 24.6 | 1 |
| 22 | SEDIN | 5 | 4.5 | 4.7 | 5 | 2 | 3 | 24.2 | 2 |

## Nine Systems Selected for Further Study

| Gasifier Name | System Type | Ash | Vendor | Efficiency Rank | Cost Rank | Sodium Rank | Vendor Responsiveness Rank | Commercial Deployments Rank | Average Rank | New Ranking |
|---|---|---|---|---|---|---|---|---|---|---|
| Lurgi | Fixed Bed | Non-slaggi | Air Liquid | 8 | 2 | 1 | 7 | 1 | 3.8 | 4 |
| BGL | Fixed Bed | Slagging | Envirotherm | 1 | 3 | 2 | 8 | 4 | 3.6 | 3 |
| SE | Entrained F | Slagging | Sinopec/EC | 2 | 1 | 4 | 1 | 3 | 2.2 | 1 |
| TRIG | Fluid Bed | Non-slaggi | KBR/South | 3 | 8 | 8 | 6 | 8 | 6.6 | 8 |
| HTW | Fluid Bed | Non-slaggi | ThyssenKru | 6 | 4 | 7 | 4 | 6 | 5.4 | 6 |
| U-GAS | Fluid Bed | Agglomerat | SES | 5 | 5 | 6 | 3 | 5 | 4.8 | 5 |
| SCGP | Entrained F | Slagging | Shell | 4 | 7 | 3 | 2 | 2 | 3.6 | 2 |
| Prenflo | Entrained F | Slagging | ThyssenKru | 7 | 6 | 5 | 4 | 7 | 5.8 | 7 |

## Final Four Systems

| Gasifier Name | System Type | Ash | Vendor |
|---|---|---|---|
| BGL | Fixed bed | Slagging | Envirotherm |
| SE | Entrained flow | Slagging | Sinopec/ECUST |
| U-GAS | Fluid bed | Agglom. | SES |
| SCGP | Entrained flow | Slagging | Shell |

# DETAILS OF SELECTED SYSTEMS

- The team is working with vendors and partners of the gasification technology to develop pre-FEED-type data on each system with North Dakota lignite and integrated with the Allam Cycle.

| Gasifier Name | System Type | Ash | Vendor | Pre-FEED Partner | Status |
|---|---|---|---|---|---|
| BGL | Fixed bed | Slagging | Envirotherm | University of Freiberg | Proposal received, working on contract |
| SE | Entrained flow | Slagging | Sinopec/ECUST | ECUST | Contract nearly finalized |
| U-GAS | Fluid bed | Agglom. | SES | Jacobs Engineering | Waiting for proposal |
| SCGP | Entrained flow | Slagging | Shell | Shell Global Solutions | Working on NDA |

# KEY PROCESS INFORMATION

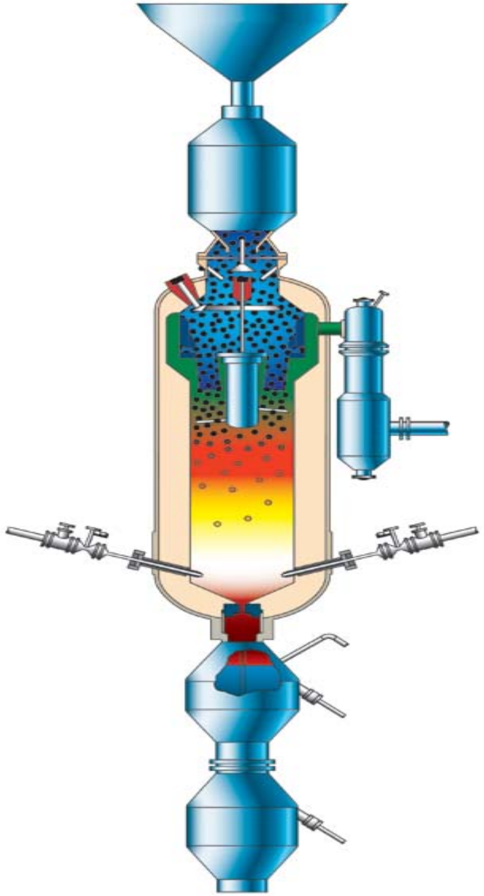
- Process block diagrams and equipment arrangement
- Auxiliary power, oxygen, and utility requirements
- Process flow diagrams (P&ID)
- Operating conditions of coal drying, gasifier, and treatment areas
- Stream data
- Start-up and partial load
- Cold-gas efficiency
- Start-up fuels
- Overall Allam Cycle integration

# SUMMARY OF VENDOR DATA

| | | | |
|---|---|---|---|
| Gasification Technology | SE (ECUST) | BGL | SES SGT |
| Overall Allam Cycle Efficiency, HHV | 39.6% | 39.0% | 40.3% |
| Design Output, MW (thermal) | 500 | 500 | 583 |
| Gasifier Units, trains required | 2 | 3 | 1 |
| Gasifier type | Entrained flow, slagging | Fixed-bed, slagging | Fluid bed, agglomerated |
| Syngas Flow (after cleanup), kg/h | 165,818 | 144,910 | |
| Gasifier Operating Pressure, bar | 40 | 43 | |
| Gasifier Operating Temperature, °C | 1300 | 717 | |
| Syngas Composition at Outlet, dry basis | | | |
| $H_2$ | 27.5% | 24.9% | 32.8% |
| CO | 65.2% | 58.2% | 30.3% |
| $CO_2$ | 6.1% | 6.0% | 27.2% |
| $H_2S$ | 0.5% | 0.6% | 0.5% |
| COS | 0.04% | 0.02% | 0.01% |
| $CH_4$ | 0.05% | 8.5% | 8.5% |
| $N_2$ + Ar | 0.5% | 0.9% | 0.4% |

# GASIFIER SELECTION – FINAL LIST

- Finalizing studies for all three vendors.
  - SE gasifier – entrained flow – study complete.
    - ♦ $113M capital costs
    - ♦ Two gasifiers
  - BGL gasifier – fixed bed – Freiberg – study complete.
    - ♦ $218M capital costs
    - ♦ Three gasifiers
    - ♦ Higher methane content in syngas
  - SES gasifier – fluid bed – study complete
    - ♦ $188M capital costs
    - ♦ One gasifier

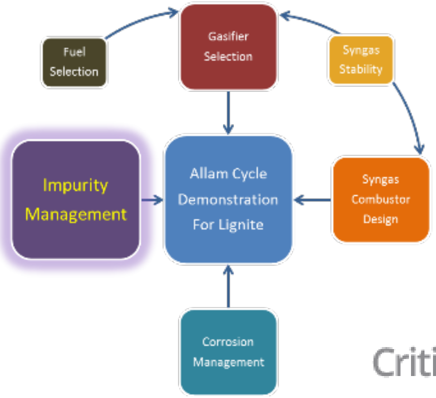


# IMPURITY REMOVAL

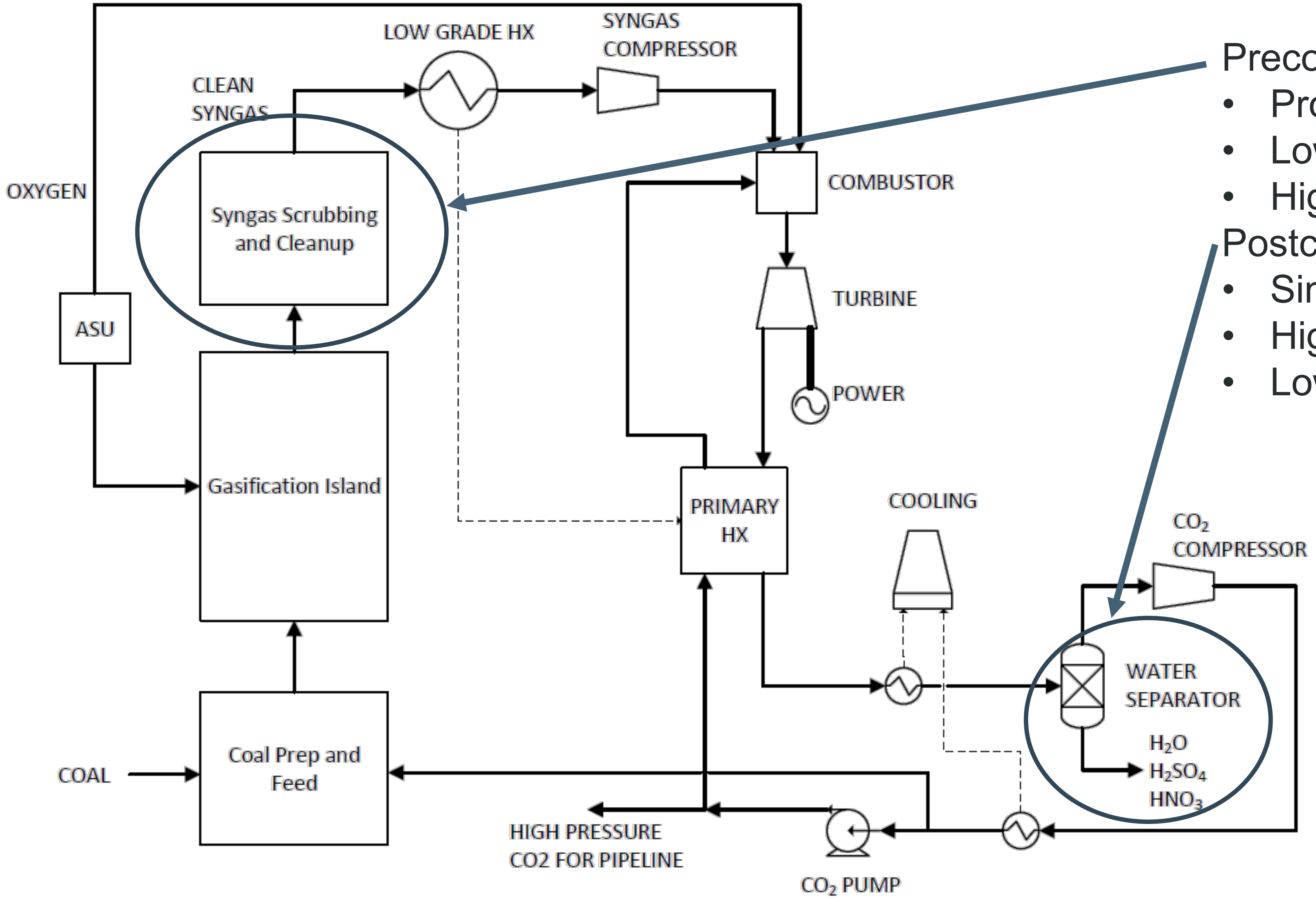
Critical Challenges. **Practical Solutions.**

# IMPURITY MANAGEMENT

- Optimize and select economically viable near-commercial technologies to support the removal of impurities.
- The Allam Cycle lends itself to cost-effective postcombustion removal.
- Precombustion technologies are commercially available.
- The team reviewed options for both technical fit in the process and commercial readiness.



# IMPURITY MANAGEMENT




Precombustion

- Proven technologies
- Low risk
- Higher cost

Postcombustion

- Simplified removal
- Higher risk
- Lower cost

# SULFUR REMOVAL CHEMISTRY FOR DESNO$_X$ POSTCOMBUSTION TECHNOLOGY

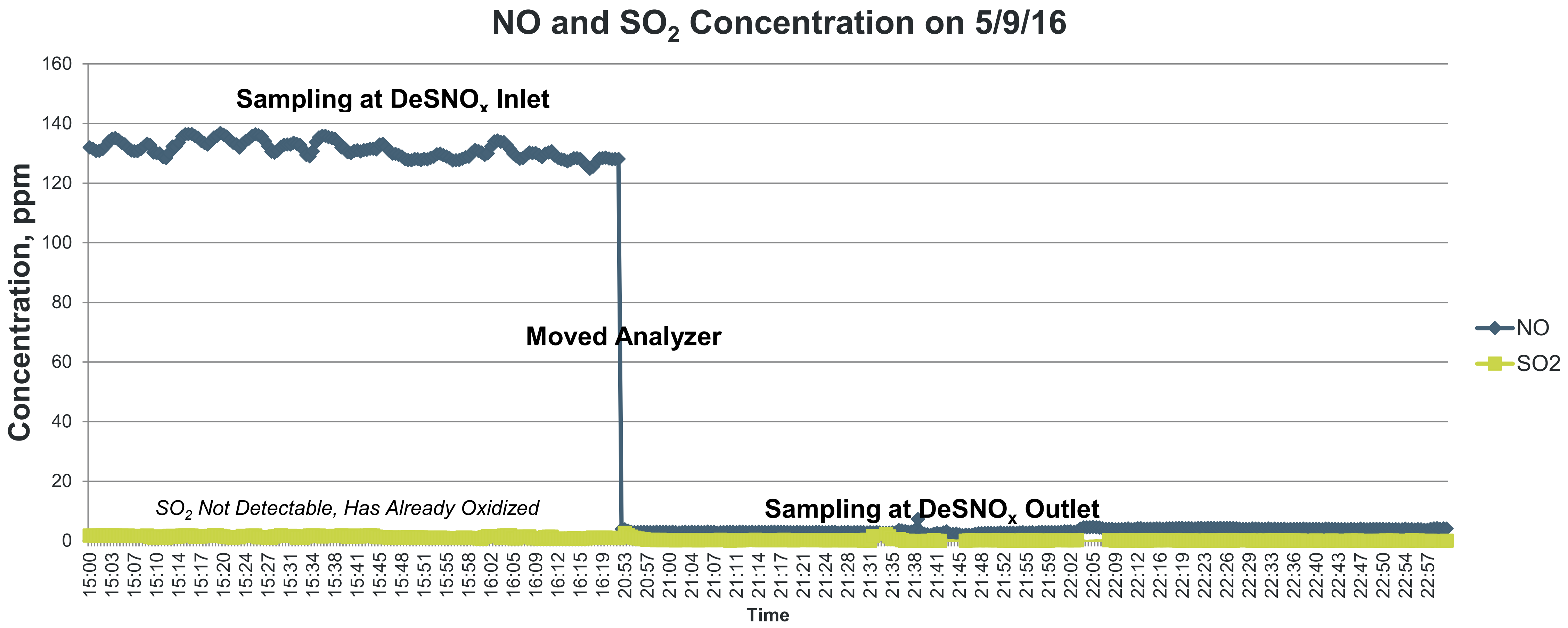
- DeSNO$_x$ postcombustion removal – under pressure (>15 bar)
  - $2NO + O_2 \leftrightarrow 2NO_2$
  - $NO_2 + SO_2 \rightarrow SO_3 + NO$
  - $SO_3 + H_2O \rightarrow H_2SO_4$
  - $2NO_2 \leftrightarrow N_2O_4$
  - $3NO_2 + H_2O \leftrightarrow 2HNO_3 + NO$
  - $N_2O_4 + H_2O \leftrightarrow HNO_2 + HNO_3$
  - $2\ HNO_2 \leftrightarrow NO + NO_2 + H_2O$

# KEY FINDINGS – IMPURITY REMOVAL

- Initial testing of the 8 Rivers DeSNO$_x$ process.
- Existing equipment at the EERC was used to generate an Allam Cycle flue gas from lignite coal and to test the process.

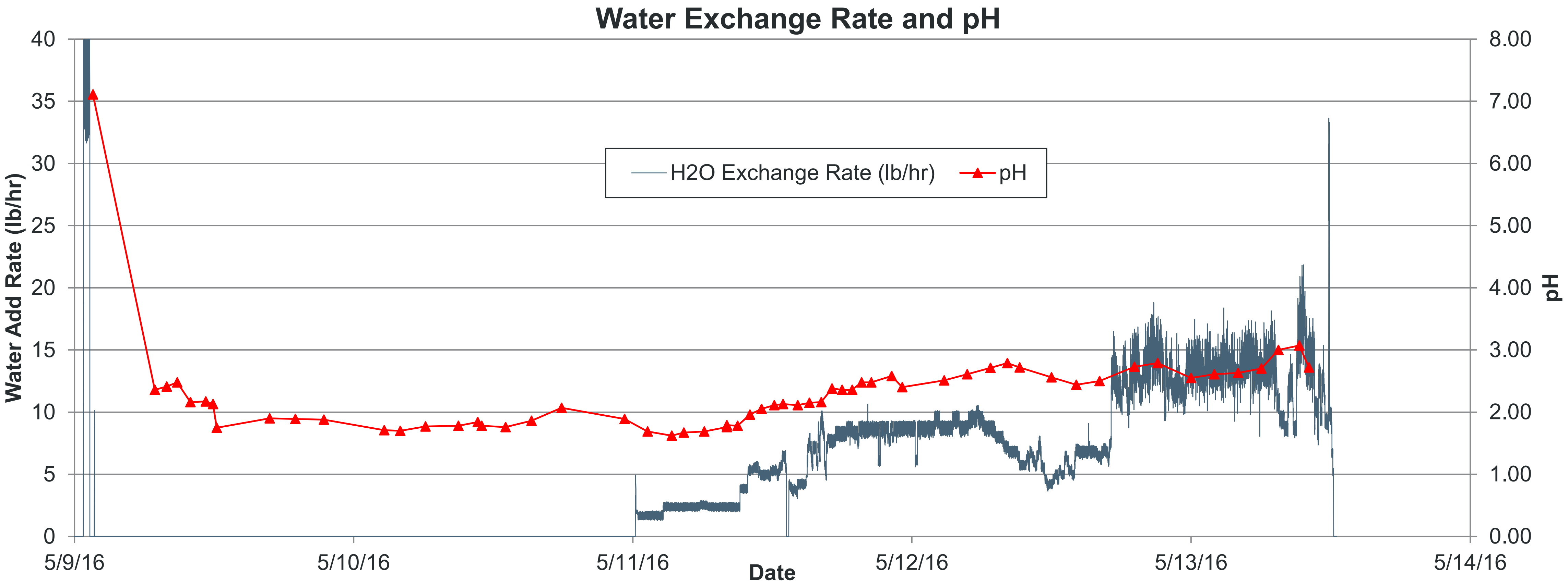
- The DeSNO$_x$ process uses only water in a packed spray column to remove sulfur and nitrogen species through oxidation reactions.
- Test results show that high levels of SO$_x$ and NO$_x$ removal have been achieved:
  - SO$_x$: >99% removal
  - NO$_x$: ~95% removal

# DESNO$_X$ PERFORMANCE



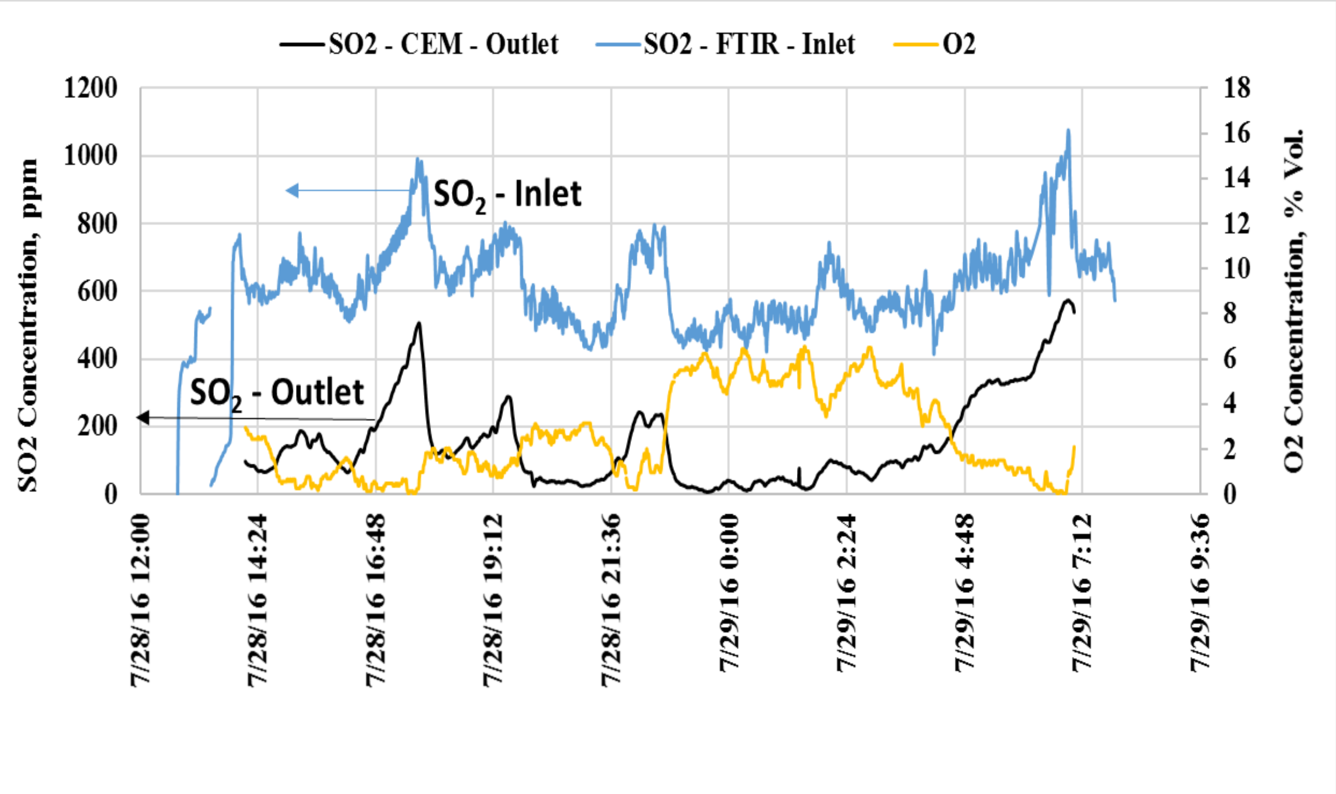
# DESNO$_X$ OPTIMIZATION

- The pH in the process drops as $NO_x$ and $SO_x$ form nitric and sulfuric acid.
- The EERC is developing data to maintain pH around 3, which will help to ensure consistent removal.



# DESNO$_X$ TEST RESULTS FROM SYNGAS OXY-COMBUSTION IN EFG

- Very little NO formation in oxy-fired EFG because of limited syngas firing rate.
- $SO_2$ removal highly dependent on excess $O_2$ in flue gas.
- Need better control of $SO_2$ and NO concentrations in oxy-fired flue gas to better understand DeSNO$_x$ process, especially at low excess $O_2$ concentrations.



# FACTORIAL TEST IMPURITY MANAGEMENT

| | Low | Middle | High |
|---|---|---|---|
| $NO_x$ | 15 | 37.5 | 50 |
| $O_2$ | .5 | 2.75 | 5 |
| RT | 20 | 40 | 60 |

| $NO_x$ | $O_2$ | RT | Notes |
|---|---|---|---|
| Low | Low | Low | Factorial Point |
| High | Low | Low | Factorial Point |
| Low | High | Low | Factorial Point |
| High | High | Low | Factorial Point |
| Low | Low | High | Factorial Point |
| High | Low | High | Factorial Point |
| Low | High | High | Factorial Point |
| High | High | High | Factorial Point |
| Middle | Middle | Middle | Center Point |
| Middle | Middle | Middle | Center Point |
| Middle | Middle | Middle | Center Point |

# IMPURITY MANAGEMENT – SUMMARY

- Sulfur removal highly dependent on residence time.
  - >99% of sulfur can be removed with adequate residence time.
    - Approximately 40 seconds of residence time was sufficient.

- $NO_x$ removal is dependent on oxygen concentration.
  - 90% of $NO_x$ is removed if oxygen levels are 5%.
  - With low oxygen concentration, about 50% of $NO_x$ removal is expected.

- Under nominal Allam Cycle conditions, 99% of sulfur and 50% of $NO_x$ removal are expected.

# COST ESTIMATION

# INTRODUCTION

- The team of the Energy & Environmental Research Center (EERC) and 8 Rivers Capital (8RC) has contracted Jacobs Engineering (Jacobs) to develop a conceptual design for a commercial-scale Allam Cycle coal system.

- The focus of the study is to develop the definition of the coal gasification-specific portions of the flowsheet and to prepare overall Class IV CAPEX and levelized cost of electricity (LCOE) estimates.
  - Stage 1 – Technology Screening
  - Stage 2 – Conceptual Design
  - Stage 3 – Plant Cost Estimation

# CASE STUDIES

- Case 1 – SES SGT Gasification
  - Fluid-bed gasifier technology provided by Synthesis Energy Systems (SES).
  - Commercial technology that has several deployments in China; however, 4000 tons/day single train unit has not been commercially deployed yet.
  - Technology originally developed by GTI.
  - Uses a Selexol unit for sulfur removal.
- Case 2 – ECUST SE Gasification
  - Entrained-flow gasifier technology provided by Sinopec-ECUST.
  - Hundreds of commercial deployments of the slurry-fed gasifier in China, with a few commercial deployments of the dry feed system.
  - Technology originally developed by East China University of Science and Technology (ECUST).
  - Uses an amine solvent for sulfur removal.

# CAPEX METHODOLOGY

- Combination of unit capacity factoring, equipment factoring, and budget quotes from licensers/vendors.
- CAPEX accuracy commensurate with a Class IV estimate.
- Base estimate developed on a U.S. Gulf Coast (USGC) basis, fourth quarter 2017.
- USGC costs updated for a Beulah, ND, site accounting for efficiency factors, local wage rates, and winterization costs.
- Greenfield plant location but excludes owner costs.

| CAPEX (MM$) | Case 1 | Case 2 |
|---|---|---|
| North Dakota | 1,485 | 1,373[6] |
| US Gulf Coast | 1,115 | 1,031[7] |

**Note:** The Case 2 CAPEX estimate is based on costs for the gasification island provided by the Licensor, ECUST. Jacobs was not able to verify that cost as its basis, scope, assumptions, and exclusions were not provided to Jacobs. For the purpose of the LCOE calculation the CAPEX value for Case 2 was adjusted to allow for the ECUST SE gasifier.

# OPEX METHODOLOGY

- Fixed costs
  - Operating labor
  - General and administrative
  - Maintenance
  - Property taxes
  - Insurance
- Variable costs
  - Feedstock
  - Utilities
  - Catalyst and chemicals
  - Waste disposal

| OPEX (MM$/year) | Case 1 | Case 2 |
|---|---|---|
| North Dakota | 58.8 | 53.6[8] |
| US Gulf Coast | 43.7 | 39.8[9] |

# LEVELIZED COST OF ELECTRICITY

- CAPEX and OPEX values reported
- Income tax assumed flat rate of 20%
- Nth of a kind facility interest rate
- $CO_2$ sold for 10$/t
- Project start 2018, start-up 2021

| Case 1 $/MWh | Case 2 $/MWh |
|---|---|
| 83.4 | 103.6 |

$$\text{LCOE} = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t - R_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

Where:
$I_t$ = Investment cost in year t
$M_t$ = Maintenance and operational costs in year t
$F_t$ = Fuel costs in year t
$R_t$ = non-electricity revenue in year t
Et = Energy generated in year t
r = Return on equity
n = Plant life in years

# CONCEPTUAL COST

- Based on a 250-MWe system:
  - Case 1-SES Gasifier.
  - Case 2-SE Gasifier.
- Updated $CO_2$ sensitivity:
  - SES
    - ♦ No $CO_2$ sales, LCOE = $91.50.
    - ♦ $50/ston $CO_2$ sales, LCOE = $50.90.
  - SE
    - ♦ No $CO_2$ sales, LCOE = $111.
    - ♦ $50/ston $CO_2$ sales, LCOE = $70.30.

| Case 1 $/MWh | Case 2 $/MWh |
|---|---|
| 83.4 | 103.6 |

| | | Case 1 $/MWh | Case 2 $/MWh |
|---|---|---|---|
| **$CO_2$ net back price (Base = $10/ST)** | | | |
| 1 | $8/ST | 85.0 | 105.3 |
| 2 | $13/ST | 81.0 | 101.1 |
| **Long term interest rate (Base = 7%pa)** | | | |
| 3 | 12%pa | 96.6 | 120.2 |
| **CAPEX change** | | | |
| 4 | + 25% | 102.0 | 127.0 |
| 5 | - 25% | 64.8 | 80.2 |
| **OPEX Change** | | | |
| 6 | +25% | 85.4 | 105.9 |
| 7 | - 25% | 81.4 | 101.4 |
| **Change of location basis** | | | |
| 8 | USGC | 63.5 | 76.5 |

# LARGE PILOT

# SITE AND SCOPE

- Team has chosen a 5-MW demonstration scale.
- Three locations currently being considered:
  - Great Plains Synfuels Plant, Dakota Gasification Company (DGC)
  - EERC
  - NETPower Allam Cycle demonstration site, La Porte, Texas

# POSSIBLE DGC LOCATIONS

# EERC OPTION

- A 5-MW system could be housed in the EERC's Fuels of the Future facility or TRDU tower.
- Team is currently evaluating high-level needs to determine how this could be implemented.


olutions.

# CURRENT NET POWER SITE

# LARGE PILOT – FUTURE WORK

- Work will continue on the development of a host site for a large pilot-scale demonstration:
  - Site selection by late fall 2018
  - Detailed cost estimate for selected site
  - Completion of Environmental Information Volume
  - Development of project team
- Phase II application to be submitted by March 31, 2019.

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