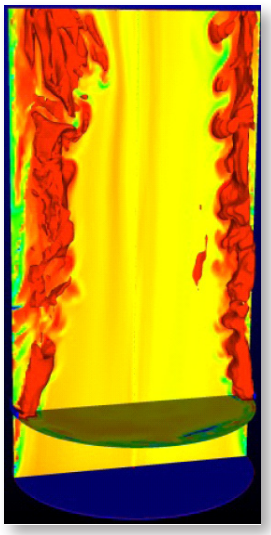
Advanced Gasification

Carbon feedstock gasification is a promising pathway for high-efficiency, low-pollutant power generation and industrial processes. However, our inability to meet a number of operational goals could create roadblocks to widespread acceptance and commercialization of advanced gasification technologies.

For example, we must achieve online gasifier availability of 85–95 percent in utility applications—and 95 percent for chemical production and other applications—so the service life of gasifiers can meet the performance needs of users. To do so, we need new technologies that address carbon conversion, slag viscosity, and downstream fouling. Technologies that reduce the cost of CO_2 separation and capture are also required.

NETL's Gasification Team and members of the NETL-Regional University Alliance (NETL-RUA) will take an integrated approach to developing physics-based methods, models, and tools that can support the development and deployment of advanced gasification devices and systems.



High resolution simulations of NCCC TRIG using NETL's MFIX and C3M models

Advanced Gasification Research at NETL

Refractory Improvement

Coal, a common carbon feedstock in slagging gasifiers, is typically high in mineral impurities, which significantly impact slag viscosity and refractory interactions. Research aimed at refractory improvement is focused on refractory development and the impact of additives on carbon feedstock ash behavior and refractory wear. Refractory service life improvement through material development or modeling and control of slag chemistry will be evaluated via laboratory testing at NETL and through the cooperation of industry gasifier operators.

The goal is to develop a slag model that allows operators to control slag viscosity, maximize refractory service life, and minimize downstream material issues like syngas fouling. It is expected this information will become part of an NETL developed database, allowing predictive modeling of coal and/or petcoke slags in gasifiers.

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Conversion and Fouling

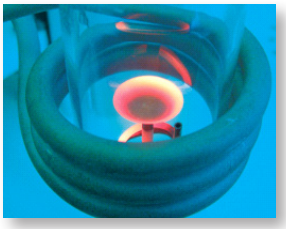
Accurate physical models are currently unavailable for predicting rates of slag buildup in a gasifier and ash deposition in a syngas convective cooler. Demonstration plants have experienced problems such as lower carbon conversion and plugging of syngas coolers with fly ash. These issues reduce plant heat rate, place additional strain on solids handling and grey water circuits, and reduce the overall reliability of the gasifier.

Convective syngas cooler fouling source – Global Energy, Inc

Research in this area will focus on establishing how iron and vanadium oxide content, as well as oxidation state, impact slag viscosity and is aimed at negating plugging and fouling throughout the syngas cooling system. It will lead to increased capabilities for predicting gasifier performance and further determine the impacts and limits of using various coal grades and petcoke in entrained gasifiers. In addition, development of computational simulation tools will reduce uncertainty associated with the use of low-rank coal and mixed feeds. Results of this work will aid in gasifier design and performance relative to the use of these fuels, allowing for fuel flexibility in current and future gasification facilities.

Low-Rank Coal Optimization

Research in this area will focus on the development of gasification performance prediction models to reduce uncertainties associated with the use of low-rank coals and co-feeds, including biomass. The development of a hierarchy of co-feed TRIG models with uncertainty quantification will provide a practical framework for quantifying various types of uncertainties and assessing the impact of their propagation through computer models of the physical system. Reducing the uncertainty of using these feeds will enable gasification designers and operators, leading to greater use of these resources.



Temperature inside the high speed HS-TGA

Warm Gas Cleanup

Palladium-based sorbents are among the most promising candidates for the high-temperature, one-step capture of trace elements from coal-derived fuel gases, which will reduce the footprint, cost, and complexity of pollution mitigation. NETL research on gas cleanup will focus on testing and developing palladium sorbents for the capture and removal of trace metals like mercury, arsenic, selenium, phosphorus, and cadmium (co-capture). Capacity for capture will be determined in simulated fuel gases through the use of laboratory-scale packed-bed reactors and at larger scales in slipstreams of real fuel gas at an actual gasification facility. Warm gas cleanup research promotes the utilization of abundant domestic coal in a clean and environmentally friendly manner. Technology developed under this project will allow gasification to meet stringent EPA regulations for trace metal emissions.

AVESTAR™ Center

Dynamic simulation at NETL's AVESTAR Center is one of the highly specialized and increasingly sophisticated computational tools that will be used by the Gasification Team to help achieve operation and control objectives for gasification and CO_2 capture technologies.

Transparent view of gasifier in AVESTAR's 3D virtual immersive training system for IGCC power plant with CO_2 capture

AVESTAR trainees use high-fidelity real-time dynamic simulator for IGCC power plant with CO_2 capture

Key technical challenges and gaps for developing plant-wide, pressure-driven dynamic models and corresponding control strategies for IGCC systems with CO_2 capture will be addressed. Research efforts will focus on developing a comprehensive portfolio of dynamic simulation research, development, and training activities, including optimizing the operation and control of advanced gasification-based energy plants with carbon capture. AVESTAR will be instrumental in preparing an industry workforce trained to safely and effectively operate, control, and manage commercial-scale IGCC systems with CO_2 capture.

www.netl.doe.gov/avestar