Clean Energy - What can be done about it?

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To fuel the current growth in the economy, energy production needs to be augmented in the years to come. However, it should be done in an efficient, reliable, and environmentally benign manner. To facilitate this, a number of collaborative projects are being conducted at NETL, Morgantown. This talk will focus on the significance and key outcomes of some of the ongoing projects.

Coal-fed Integrated Gasification Combined Cycle (IGCC) plants with carbon capture and storage (CCS) are the most efficient processes among all the commercially available technologies. To accelerate the deployment of IGCC with CCS, a number of studies are being conducted at the Collaboratory for Process & Dynamic Systems Research, Morgantown with a goal to develop an optimized configuration of the future IGCC plants that are capable of load-following response. A steady state plant-wide model has been developed that can be used for simultaneous optimization of the plant configuration and the operating conditions with the objective of maximizing the plant efficiency without violating the environmental limits. The plant also considers a radiant syngas cooler (RSC), a two-stage water gas shift (WGS) conversion process, and two advanced “F” class gas turbines (GT) partially integrated with an elevated-pressure air separation unit (EP ASU). A subcritical steam cycle is considered for heat recovery steam generation. Syngas is selectively cleaned by a two-stage SELEXOL acid gas removal (AGR) process. Sulfur is recovered using a two-train Claus unit with tail gas recycle to the AGR process. A multistage intercooled compressor is used for compressing CO_2 to the pressure required for sequestration. Detailed kinetic models of the sour-shift reactions and the Claus process have been incorporated in the simulation. Detailed model of an entrained, downflow, General Electric Energy (GEE) gasifier is under development. A plant-wide dynamic model has been developed that can be used for transient studies of the plant, operability studies, stability analysis, and to formulate control strategies.

A number of multi-objective optimization studies have been performed to reduce parasitic losses, augment power generation, and decrease hardware cost. The optimally designed plant in Aspen Plus is converted to a plant-wide pressure-driven Aspen Plus Dynamics model. Sizing information and details required for all the equipment have been incorporated in the simulation. All the basic controllers required for a stable dynamic run of the plant have been implemented. A combination of heuristic-based approach and Relative Gain Array (RGA) analysis has been applied for control loop pairing.

To promote the IGCC technology with CCS further and to facilitate the training of the operating personnel, a Dynamic Simulator Research & Training Center (DSR&T) is being established simultaneously at NETL, Morgantown and WVU’s National Research Center for Coal & Energy (NRCCE). High-fidelity real-time dynamic models of the entire plant will further research and provide path for derivative work. The Operator Training Simulator (OTS), for the first time in the world, will have a 3D immersive, interactive virtual environment for training operating personnel.