Update on Generation Efficiency and Criteria Air Pollutant Emissions of Integrated Coal Gasification Combined Cycle Power Plant

Hao Cai, Jarod Kelly, Michael Wang

This memo documents updates for the generation efficiency and criteria air pollutant (CAP) emission factors of integrated coal gasification combined cycle (IGCC) power plant used in the Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET®) model. The data source for this update is "Cost and Performance Baseline for Fossil Energy Plants Volume 1b: Bituminous Coal (IGCC) to Electricity Revision 2b – Year Dollar Update", published by National Energy Technology Laboratory (NETL) and Energy Sector Planning and Analysis (ESPA) in 2015 (Fout et al., 2015). The thermal and emission performances of three IGCC technologies. Specifically,the Shell gasifier, the E-Gas™ full-slurry quench gasifier, and the General Electric Energy (GEE) gasifier were each characterized on the basis of IGCC unit process engineering modeling (Fout et al., 2015). The thermal efficiency range is 39.0-42.1% for IGCC without carbon capture and sequestration (CCS) and 29.7-31.2% for IGCC with CCS. The thermal efficiency, CAP emission performances, and water consumption of the GEE gasifier without CCS, as shown in Table 1, which has been used by the Polk IGCC plant (without CCS) in Tampa, Florida, are chosen to represent the thermal and CAP emission performance of current IGCC gasifier technology adopted in the U.S., and are used in the 2017 version of GREET, replacing the old thermal efficiency and CAP emission factors therein, as shown in Table 1.

We assume that these thermal and emission performances, as well as the water consumption factor of the IGCC, as shown in Table 1, represent the 2010-2020 performances. We will update these assumptions when performance data that reflect future improvement of IGCC technologies become available.

Table 1. Thermal efficiency, CAP emission factors, and water consumption of the GEE gasifier (Fout et al., 2015)

	IGCC without CCS for GREET 2017, representing 2010-2020 performances	**Old parametric assumptions in previous GREET (Cai et al., 2013)**
Thermal efficiency, higher heating value (HHV)	39.0%	38.3%
Thermal efficiency, lower heating value (LHV)	40.7%*	40%
Process water consumption, gal/kWh	0.364	0.55
SO_2 emission factor, g/kWh	0.00491	0.04
PM_{10} emission factor, g/kWh	0.0284#	2.469

	IGCC without CCS for GREET 2017, representing 2010-2020 performances	Old parametric assumptions in previous GREET (Cai et al., 2013)
$PM_{2.5}$ emission factor, g/kWh	0.00827[&]	0.720
NO_x emission factor, g/kWh	0.235	0.117
CO emission factor, g/kWh	0.022[$]	0.022
VOC emission factor, g/kWh	0.001[$]	0.001

* Converted based on the HHV-based thermal efficiency (39.0%) and a LHV/HHV ratio of 95.8% for bituminous coal in GREET;

[#] Assuming that the total PM emissions (Fout et al., 2015) represent PM_{10} emissions;

[&] This is estimated based on the total PM emissions (Fout et al., 2015) and a $PM_{2.5}/PM_{10}$ emission ratio of 29.1% in GREET;

[$] Assuming they are the same as previously estimated in GREET.

Acknowledgement:
We thank Timothy Skone and Gregory Cooney from NETL for their assistance with this effort.

Reference

Cai, H., Wang, M., Elgowainy, A., and Han, J. 2013. Updated Greenhouse Gas and Criteria Air Pollutant Emission Factors of the U.S. Electric Generating Units in 2010. Technical Memorandum, Argonne National Laboratory, https://greet.es.anl.gov/publication-electricity-13.

Fout, T., Zoelle, A., Keairns, D., Turner, M., Woods, M., Kuehn, N., Shah, V., Chou, V., and Pinkerton, L. 2015. Cost and Performance Baseline for Fossil Energy Plants Volume 1b: Bituminous Coal (IGCC) to Electricity Revision 2b – Year Dollar Update. Technical Report, DOE/NETL-2015/1727. https://www.netl.doe.gov/File%20Library/Research/Energy%20Analysis/Publications/Rev-2b-Vol-1b-IGCC_final.pdf