Near Zero Emissions Plant Using Oxy-Coal Combustion

Conventional combustion

In conventional coal combustion power plants, air and coal are supplied to the furnace. The oxygen in the combustion air burns the carbon (in coal), producing carbon dioxide (CO_2). The heat from combustion is transferred to make high temperature, high pressure steam. The steam energy spins the turbine of a turbine-generator set, producing electricity. Burning coal with air creates a combustion products flue gas stream in which the CO_2 is diluted to about 15 percent. The majority of the flue gas is nitrogen, the major constituent (78 percent) in the air provided to the furnace. The relatively inert nitrogen moderates the furnace temperatures and facilitates heat transfer for steam production. However, the dilution of the flue gas with nitrogen is also the primary technical impediment to capture of the CO_2. The CO_2 needs to be concentrated to be economically used for enhanced oil recovery (EOR), enhanced coal bed methane (ECBM) or stored in deep saline formations.

Oxy-coal combustion concept

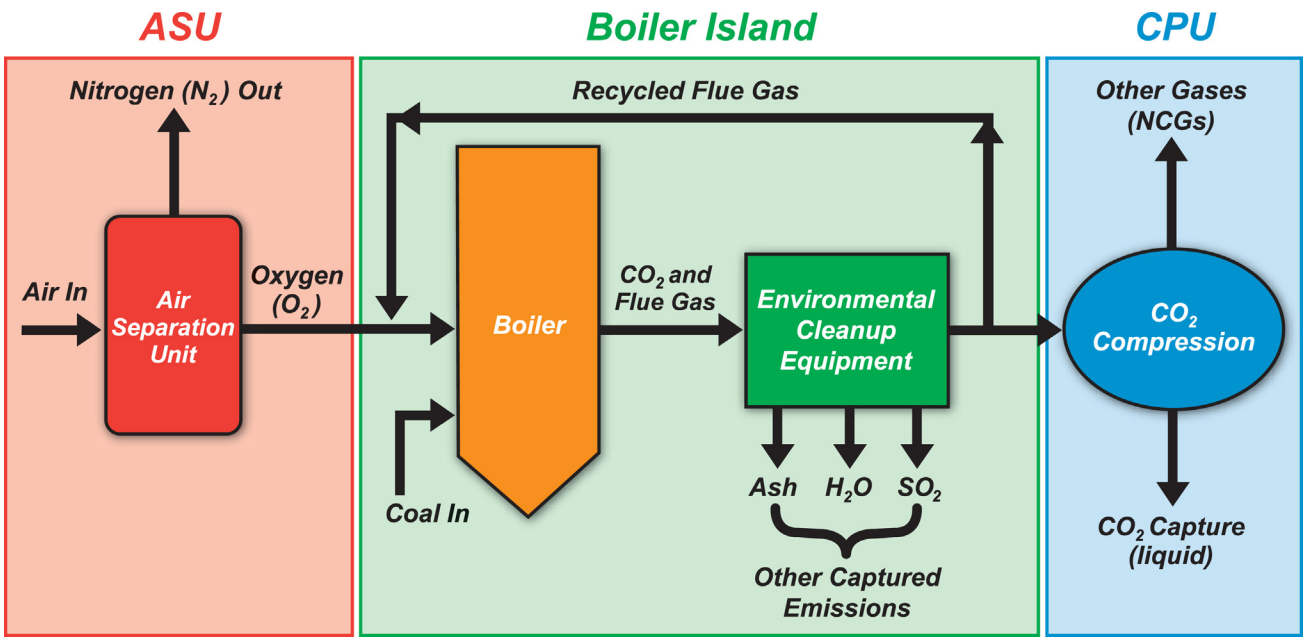
A variety of advanced combustion systems hold promise for producing concentrated streams of carbon dioxide from coal combustion systems. In the oxygen-fuel fired boiler concept, combustion air is replaced with oxygen. The oxygen is supplied by an on-site air separation unit (ASU). The nitrogen that would normally be conveyed with the air through conventional air-fuel firing is excluded. Instead, a portion of the CO_2-rich flue gas is returned back to the burners, essentially substituting CO_2 for the nitrogen in the furnace. The CO_2 in oxygen combustion influences furnace operation and heat transfer in ways similar to the nitrogen in the air-fired system. Oxygen combustion creates a flue gas that is primarily a concentrated stream of CO_2, rather than nitrogen, and other products of coal combustion. The fraction of the flue gas that is not recirculated to the burners leaves the plant, and would then be available for subsequent use or permanent storage.

Beyond carbon management, an important secondary benefit of oxy-coal firing is the reduction of nitrogen oxides (NO_x) emissions. By using oxygen and replacing the nitrogen with the CO_2-rich recirculated flue gas, much less NO_x is produced since there is much less nitrogen available. Furthermore, some of the fuel NO_x (derived from nitrogen present in the coal) in the recycled flue gas will be reduced by reactions within the flame. With the additional removal performed in the CO_2 compression purification unit (CPU), the plant will essentially achieve *near zero emissions* of all regulated emittants.

Oxy-coal combustion testing and commercialization

Babcock & Wilcox Power Generation Group, Inc. (B&W PGG) has been actively engaged in oxy-coal combustion research and development since the late 1990s. We have demonstrated the technology at our Clean Environment Development Facility (CEDF), a 30 MW_{th} combustion test facility.

Oxy-Coal Combustion Plant Configuration



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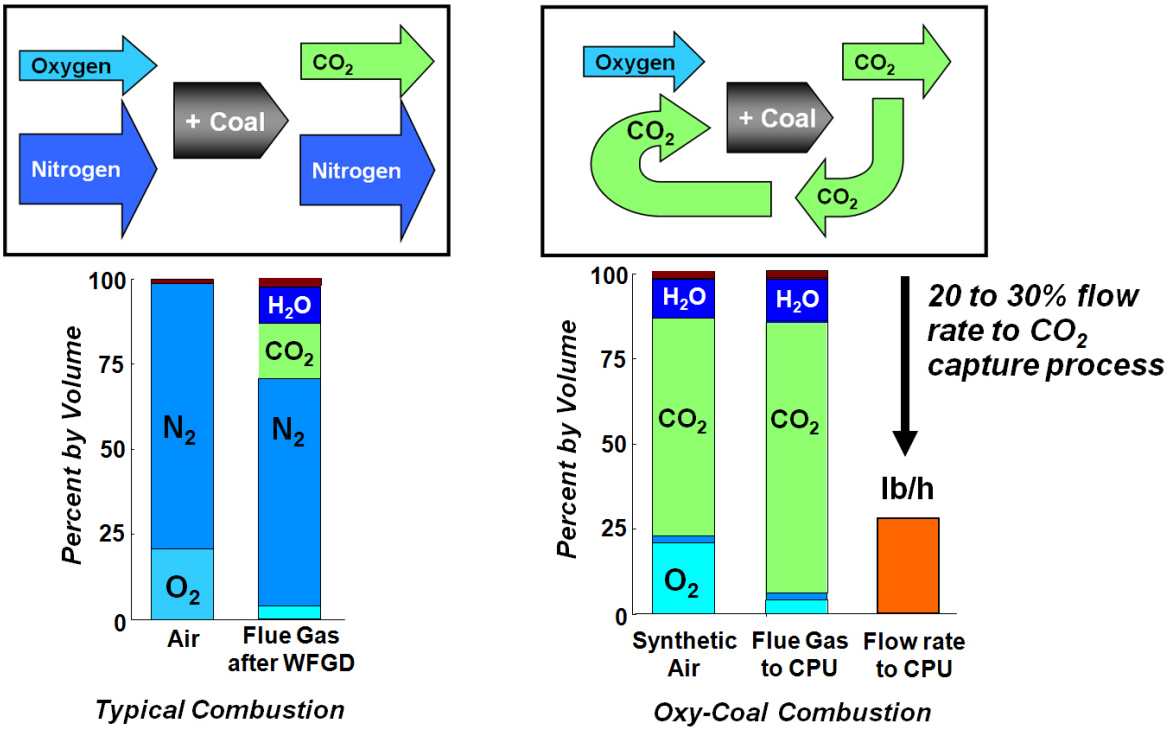
The CEDF operated in full oxy-coal combustion mode, marking a major milestone in B&W PGG's research efforts, and providing additional proof that oxy-coal combustion is a viable technology that can be used to capture carbon dioxide in coal-fired power plants. B&W PGG evaluated operation and emissions from several types of coal, including bituminous, lignite and subbituminous (Powder River Basin or PRB). Large-scale demonstration is the next step before moving to commercial scale deployment.

Experience gained has allowed for a commercial-scale 100 MW_e net plant to be designed and offered for demonstration. Extensive integration studies with the air separation unit and compression purification unit have led to advanced reference plant designs for 350 MW_e and 500 MW_e net capacity.

Oxy-fuel combustion potential:

- **near zero emissions power plant (NZEP)**
- **applicable for new power plants and select retrofits**
- **system that looks and operates substantially like a conventional power plant**
- **produces a flue gas stream that facilitates removal of CO_2**
- **plant efficiencies and costs of electricity are projected to be lower than those forecasted, but not yet attained, for gasification capture systems**

Oxy-Coal Combustion Principles



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