Fuel Flexible CFB Technology in Large Scale Power Generation

The use of Sumitomo SHI FW (SFW) circulating fluidized bed (CFB) combustion technology has grown from small-scale applications to large ultra-supercritical power plants in less than 20 years. The CFB is rapidly becoming the technology of choice for solid fuel-fired power generation applications, particularly for locations with lower quality and biomass fuel supplies. The fuel flexible and innately lower carbon emissions of CFB technology also addresses the need for sustainable use of domestic fuels in many countries, writes Asif Hussain, SVP of Strategic Business Development, Sumitomo SHI FW.

Asif Hussain

The World Bank reports that almost 600 million people remain without electricity in Africa. The challenge for electricity producers is to meet growing consumption by existing customers while also electrifying rural regions that represent 60% of the continent's population. Significant investment in new, environmentally acceptable, and reliable power generation facilities are required to meet the UN's Sustainable Development Goal of electrifying the African continent by 2030.

In sub-Saharan Africa, approximately 80% of new power plant investment goes to the construction of fossil fuel-fired facilities. Coal will continue to be an important fuel for power generation in the future so low-carbon electrification becomes the priority. However, conventional pulverized coal boiler technologies are limited in their ability to reduce emissions without augmentation of expensive post-combustion treatment technologies such as Flue Gas Desulfurization (FGD) and Selective Catalytic Reduction (SCR) that are unnecessary with SFW's circulating fluidized bed (CFB) technology. Over the past decade, the CFB has consistently demonstrated that CFB combustion technology inherently produces lower air and significantly less CO2 emissions than an equivalent-sized conventional power plant.

Selecting the Right Technology

Many power companies have embraced SFW's CFB technology because of its ability to efficiently burn many forms of fuels. The fuel-flexible SFW CFB power plant is capable of consuming agricultural biomass and other unwanted by-products (e.g., waste bark, wood, plastic, cardboard, and paper), low quality fuels (e.g., brown coals, lignites, and waste coals), as well as, high-energy, hard-to-burn fuels (e.g., anthracite and petcoke). Conventional boilers typically require fuel with a heating value above 5,500 kcal/kg, ash and moisture levels below 35%, and volatility above 20%. The SFW CFB, however, is capable of burning both the worst and best coals, lignites, biomasses and waste fuels with heating values ranging from 1,000 to 8,500 kcal/kg, ash and moisture levels as high as 60%, and volatilities down to 5%. Unlike a conventional boiler, the CFB is also capable of burning combinations of solid fuel and biomass-related fuels.

The fuel flexibility of the SFW CFB can also provide an economical and low-risk approach to carbon reduction. Biomass and waste fuels are considered carbon-neutral. By co-firing in a CFB, carbon emissions can be greatly reduced. A coal-fired CFB power plant co-firing 20% biomass can reduce its carbon emission to below the 750 g/kwh level set by the OECD standard for export credit financing new power plants. Further, by combining more efficient ultra-supercritical steam conditions with increasing shares of biomass, carbon emissions for a coal power plant can be reduced by over 50%.

The SFW CFB offers power generators the flexibility to find the right balance between power reliability, affordability and carbon emissions. The beauty of the CFB solution is that this balance can be continually adjusted over the life of the CFB plant taking advantage of volatile coal prices and protection against declining coal quality and any future CAPEX from tightening emissions. Since fuel makes up 75%-85% of the operating cost of a large power plant, the economic benefits of using locally-available low-quality fuels are difficult to ignore. Co-firing coal with biomass, waste products, or other indigenous fuels allows the plant to be built to produce power at a much lower price point.

The 2,200 MWe Advanced Green Power CFB Plant in Samcheok, South Korea

Use of low rank coal, lignite, and petcoke for power production are growing in India, China, Indonesia, Philippines, Australia, and South Africa is driven by better economics, lower fuel price volatility, and greater fuel supply security. Further, the use of biomass for power production is growing in many countries to reduce net carbon emissions and meet future CO2 reduction targets. These expanding low-quality solid-fuel markets across the globe have dramatically increased the value of fuel flexibility for large scale power plants and have been the primary driver behind the large CFB power plants coming on-line over the last 10 years.

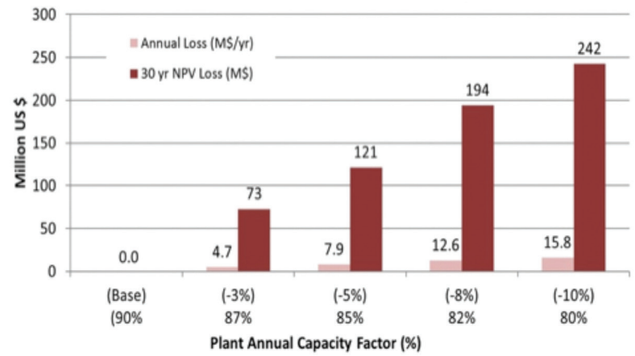
Optimizing Operating Economics

Fuel flexibility can add up to huge operating cost savings over the life of a power plant. In addition to fuel flexibility and fuel security, the CFB also provides emission flexibility. It can achieve low air emissions without post-combustion SCR NOx and FGD SOx control saving significant plant construction, operating, and maintenance cost over the life of the power plant. This flexibility is important since emission regulations are continually being tightened in nearly all countries, including Africa and protects against further capital investment. On the contrary, a pulverized fuel plant with a narrow fuel specification would be at a competitive disadvantage with a higher average fuel cost, limiting its dispatch, and financial return.

Increasing Plant Reliability

Plants with SFWCFBs have demonstrated plant availabilities well above conventional PC boilers over a wider fuel range.

Boiler Reliability Can Drive A Project's Financial Success



The economic value of the increased 3% - 5% availability of the SFW CFB plant over a conventional PC plant is demonstrated in the graph . This higher availability difference was maintained for even brown coals and lignites. The total economic value can translate to over a $100 million NPV gain in net income over the life of a 600 MWe power plant.

Plant Case Studies

Many recent projects illustrate the successful application of SFW CFB technology but two projects have particular application to Africa. First, the Lagisza CFB Power plant is the longest operating supercritical CFB power plant in the world today. Located at Tauron's Lagisza power plant in Bedzin, Poland, the plant has been in operation since 2009. At the heart of the plant is a 460 MWe supercritical SFW CFB featuring a very impressive net plant efficiency of 43.3% (LHV) on bituminous coal. Perhaps most importantly, the plant meets its permitted stack emissions without SCR or FGD equipment, thereby saving Tauron over US$45 million with its construction cost and millions more each year in avoided O&M costs.

Lagisza CFB Power Plant located in Bedzin, Poland

An even more impressive example of SFW CFB technology is the 2,200 MWe Green Power Plant operating since 2016 in Samcheok, South Korea. The Samcheok plant has four 550 MWe SFW CFBs utilizing ultra-supercritical steam conditions (257 barg, 603/603C). The Samcheok plant meets even tighter stack emissions without using FGD equipment, saving Korea's Southern Power Company over $100 million in construction cost. The plant is designed to burn a wide range of import coals including sub-bituminous high-moisture coals (20%-42%). The CFBs are also capable of co-firing indigenous bituminous coal and up to 5% biomass. The plant is designed to operate with a 42.4% net efficiency (LHV) and went into full commercial operation in December 2016, taking their place as the most advanced CFB units in the world.

The Value of CFB is Clear for Africa

CFB can bring high value to the African continent, that has large reserves of low-quality coals, lignites and waste coals from mining operations. Today, CFB technology has been proven at the large scale to economically, cleanly and reliably convert these low rank fuels into power and steam, lowering the continent's energy cost and improving its energy security. The CFB technology also keeps the door open for co-firing coals, petcokes and biomass from either import or domestic sources, when prices or regulations is right, so you don't have to lock yourself into one fuel source.

The fuel and emission flexibility offered by CFB translates into more value for a power project developer in terms of CAPEX and OPEX savings since no SCR or FGD is required, greater project return from higher plant reliability and less maintenance, fuel cost savings from market arbitrage and carbon emission reduction.