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Technical Comments on the Alpine Project

Design of the Bovoni and Anguilla Projects

A review of the design and the technologies employed at the Bovoni and Anguilla Projects and a discussion of the process that will be required to obtain the air permits should refute the suggestions by some critics that the Projects will harm the environment and the health of the residents of the USVI.

Fluidized Bed Combustion Technology –Inherently Low Emissions

Fluidized bed combustion ("FBC") technology was selected for the Projects because of its superior environmental performance and fuel flexibility. It is one of numerous successful applications of fluidized bed technology.

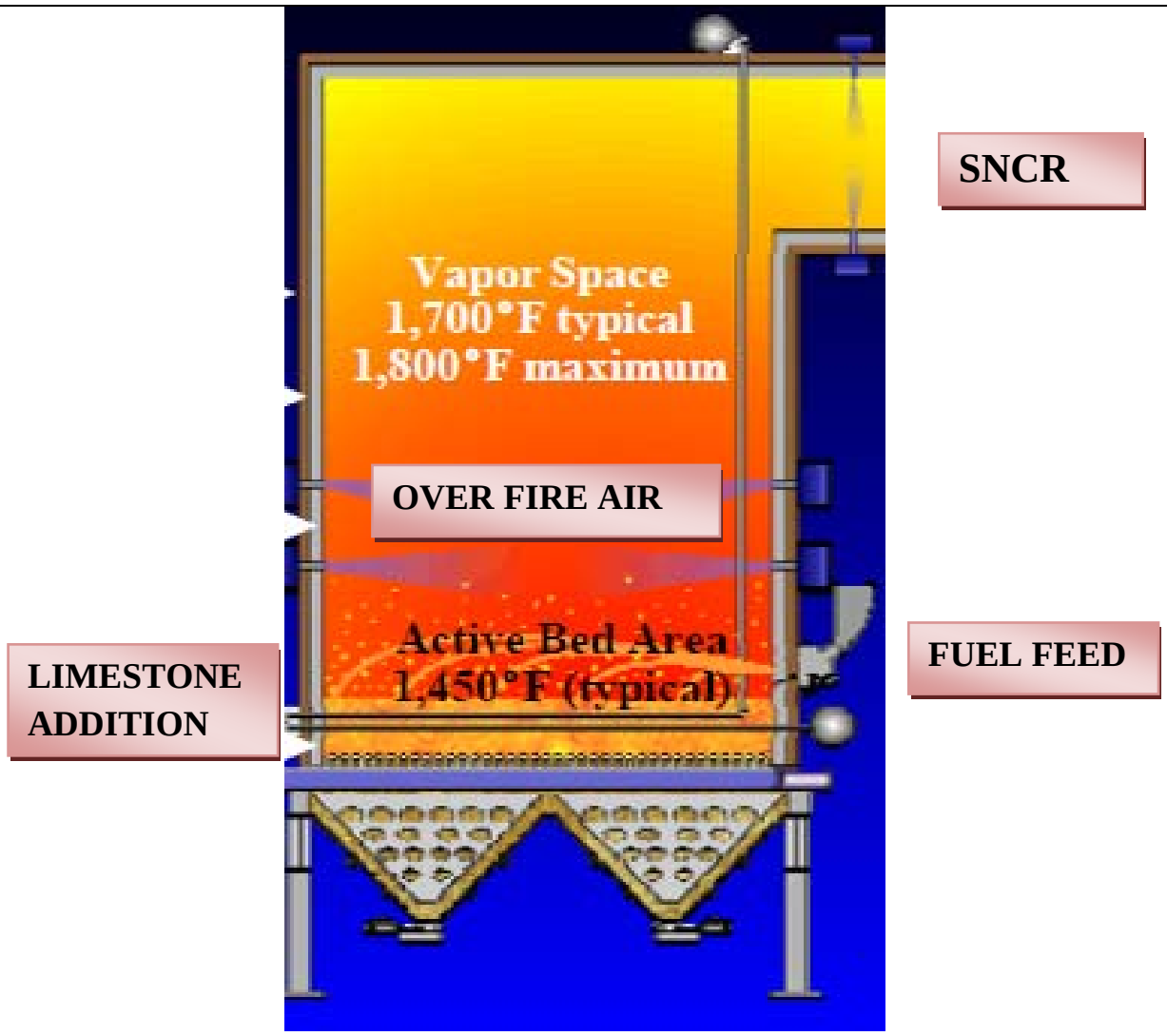
Fluid bed technology has been successfully applied to numerous processes in many different industries, since it was first used in Germany in 1926, for the gasification of powdered coal. Its initial application in the U.S. was during World War II in the fluid catalytic cracking process for the production of high-octane aviation fuel. Fluidized bed technology was applied to the combustion process for the first time in Great Britain in the late 1950's, as a way to burn its low-grade coal reserves. Interest in FBC began in the U.S. in the late 1970's, following the 1973 Arab Oil Embargo, as part of the "Clean Coal" program, primarily because of its ability to control sulfur dioxide ("SO_2") and nitric oxide ("NOx") emissions without the need for downstream pollution control equipment. Fluid bed technology has unique process characteristics that make it an excellent method in which to carry out chemical reactions, like combustion, involving gases and solids. These characteristics include high gas/solids mixing; excellent heat transfer between bed particles and the fluidizing gas and between the bed and heat transfer surfaces; near isothermal (constant temperature) conditions even when reactions are strongly exothermic (or endothermic) and stable, consistent process control.

In a FBC boiler, see Figure 1, fuel is burned in a turbulent bed of small particles (ash, limestone, calcium oxide ("CaO"), calcium sulfate ("$CaSO_4$"),unburned carbon, etc) which are kept in a state of agitation and fluidity by the upward flow of high velocity air and combustion gases. The turbulence in the combustor vapor space, combined with the thermal stability provided by the large mass of bed material provide for complete, controlled and uniform combustion. These factors are critical to maximizing thermal efficiency and controlling emissions.

In a FBC boiler, combustion occurs at a much lower temperature than in a conventional boiler. It operates in a temperature range of 1,400–1,700 ºF. This temperature range is critical to the control of both NO_X and SO_2 emissions, as well as, to the capture of heavy metals.

Figure 1

Fluidized Bed Combustor



NOx Emissions

At the low combustion temperatures in a FBC boiler the formation of NOx is limited to very low levels. This compares with conventional boiler technologies where combustion occurs at temperatures well above 2,500 ºF, which is sufficiently high to oxidize the nitrogen that comes in with the combustion air, greatly increasing NOx emissions. In most cases, a basic FBC system, without any additional controls, will produce NOx emissions that are less than half of what a conventional boiler would produce using low-NOx burner technology. On the latest generation of FBC boilers, like the design that will be used on the Bovoni and Anguilla Projects, NOx emissions are reduced even further by the injection of ammonia in

the upper combustor. This is known as Selective Non-Catalytic Reduction or "SNCR." This can be seen in Figure 1. The use of SNCR results in a further 50% to 60% reduction in NOx emissions from the already low NOx emissions from the FBC boiler.

SO_2 Emissions

The low combustion temperatures in an FBC boiler are also responsible for the process in which 90% to 95% of the SO_2 produced during combustion is captured before it even leaves the FBC boiler. At these temperatures, the limestone that is injected into the combustor is calcined to form CaO ($CaCO3 \rightarrow CaO + CO_2$) and then the CaO reacts with the SO_2 ($CaO + SO_2 + ½O_2 \rightarrow CaSO_4$) to produce gypsum, a byproduct that has many different uses. On the latest generation of FBC boilers, like the design that will be used on the Bovoni and Anguilla Projects, a dry lime scrubber/baghouse, sometimes called a "polishing scrubber," is placed downstream of the FBC boiler. The combination of the limestone injection into the FBC boiler and the lime injection into the dry scrubber results in an overall SO_2 capture of 98% or more.

Volatile Organic Hydrocarbons and Carbon Monoxide

Volatile Organic Hydrocarbons ("VOC") and Carbon Monoxide ("CO") emissions from the FBC are inherently very low because of the excellent combustion characteristics of an FBC boiler. The high degree of mixing and turbulence in the FBC boiler and the great thermal mass formed by the large amount of solids in the FBC boiler create the ideal environment for good combustion and inherently low VOC and CO emissions.

Heavy Metal Emissions

Petroleum coke is the final product of the refining process. It contains the heavy metals that were contained in the original petroleum feedstock in trace amounts. Vanadium, nickel, lead and other metals are contained in the petroleum coke in concentrations that depend on the original petroleum feedstock.

Because the FBC boiler operates at low combustion temperatures, most of these heavy metals do not volatilize; therefore they remain captured as part of the byproduct material that is produced in the FBC boiler. Most of the heavy metals combine with the calcium byproducts in the FBC boiler as a solid. Up to 99.9% or more of these heavy metals are removed in the multiclone and dry lime scrubber/baghouse from the flue gas prior to entering the environment. Some heavy metals, such as lead, may partially volatilize during the combustion process and condense in the convection pass. This lead will be removed in the dry scrubber/baghouse with efficiencies of up to 99.9%.

Mercury Emissions

Mercury emissions from the FBC are expected to be extremely low due to the low combustion temperatures and the interaction of the mercury with the large mass of calcium based byproducts within the FBC boiler. In addition, mercury will be captured in the dry lime scrubber/baghouse. To provide further mercury control a separate activated carbon injection system is included in the design of the Projects.

Acid Gases

Acid gases, hydrochloric acid ("HCl") and sulfuric acid ("H_2SO_4"), are removed with high efficiency by a combination of the calcium based byproducts present in the FBC boiler and by the dry lime scrubber/baghouse that is downstream of the FBC boiler.

Particulates

Particulates will be captured within the system by a Multiclone followed by the dry lime scrubber/baghouse. Up to 99.9% or more of the solids produced in the FBC boiler will be removed from the flue gases prior to entering the environment.

Fuel Diversification

VIWAPA currently uses expensive fuel oils to generate electric power in the territories. The extremely high cost of these fuels and the resulting high cost of electricity generated from these fuel places a tremendous burden on many ratepayers. In addition, the cost of disposing of the islands MSW is also a burden on the residents of the USVI. These costs and burdens will likely become much greater unless the problems are addressed in a rational way.

FBC technology is unique in its ability to burn fuels with very different combustion characteristics, whether alone or in combination. Many of these fuels are known as "Opportunity Fuels," because FBC technology provides the opportunity to use many different waste materials as a valuable fuel. Opportunity Fuels are low in cost because alternative uses are limited or non-existent and frequently the use of an Opportunity Fuel avoids a disposal cost.

Conclusion

Fluidized bed combustion is an advanced low emissions technology that is capable of controlling emissions to extremely low levels while burning a wide range of fuels. The FBC design being employed at the Bovoni and Anguilla Projects is the latest generation that includes multiple emission control strategies to address the complete spectrum of potential environmental emissions.

Best Available Control Technology – Ensures Low Emissions

A Prevention of Significant Deterioration ("PSD") Permit must be obtained from the EPA before construction of the Bovoni and Anguilla Projects can begin. Under PSD, the Projects must be designed using Best Available Control Technology ("BACT"). BACT is defined as follows:

"…best available control technology means an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant…"

The Projects will be designed to burn a blend of petroleum coke and pelletized RDF. Petroleum coke is a byproduct of refinery operations. Because it is essentially the bottom of the refining process, it must be disposed of at whatever price the disposal market will pay. Because of this fact, petroleum coke will always be much less expensive than the fuel oil currently used by VIWAPA. In addition to the Hovensa refinery on St. Croix, there are large supplies of petroleum coke in the Gulf region and other regions of the Americas. Prior to the development of FBC technology burning petroleum coke using conventional technology was difficult and resulted in significant environmental emissions.

The application of BACT ensures that the Bovoni and Anguilla Project MUST use technologies that produce the maximum degree of reduction for each pollutant, which will result in a safe and clean environment for all of the residents of the USVI.