Benefits of Using LPP for Combustion of Natural Gas Condensates

LPP Combustion, LLC ("LPP") has developed a patented technology solution to produce clean energy from conventional, renewable, and alternative liquid fuels[1]. The LPP solution enables #2 fuel oil, diesel (D2), biodiesel, ethanol, coal liquids, and other opportunity liquid fuels to be burned using conventional natural gas-fired combustion turbines ("gas turbines") with the same low emissions as natural gas combustion. All competing technologies have focused on modifying the combustion hardware to solve liquid fuel combustion problems, such as auto-ignition, flashback, and high emissions levels. The LPP solution successfully solves these problems by changing the nature of liquid fuels to create a substitute natural gas, which can be burned, without water addition or modification to the gas turbine, to provide clean, environmentally friendly electric power. The LPP System works by vaporizing the liquid fuel into nitrogen (taken from the air) on a separate fuel skid, then introducing this conditioned fuel gas stream, which has similar combustion properties to that of natural gas, to the combustion device. The LPP hardware skid consists of conventional compressors, heat exchangers, piping, valves, control hardware, and passive air separation membranes.

LPP Combustion has developed and demonstrated the LPP technology over a range of combustion systems and burners including operation on a Solar Turbines SoLoNOx™ combustor at full operating pressure and temperature conditions on a gas turbine combustor test stand at Solar Turbines, and in a 30 KW gas turbine operating in Columbia, MD. The LPP System offers operators substantial, material benefits in the course of normal operations. This technology has been proven to produce the lowest emissions on liquid fuels, with NOx, CO, SOx, and particulates (soot) comparable to levels associated with lean, premixed natural gas fueled operation using Dry, Low Emissions (DLE) technology. Put another way, LPP Technology results in more than a 79% reduction in NOx emissions from liquid fuel turbine operation (e.g. 9 or less ppmvd NOx with LPP versus 42 ppmvd NOx for traditional liquid fuel operating on #2 diesel with water addition). Furthermore, the LPP Technology affords the cleanest use of renewable fuels by producing "green" power from gas turbine operation on biodiesel or ethanol with no "net" greenhouse gas (CO2) emissions. Another significant benefit of the LPP System is fuel utilization flexibility, since operators using the LPP System will realize significant arbitrage opportunities as natural gas and liquid fuel prices fluctuate.

An excellent opportunity fuel for use with the LPP technology is natural gas condensates. Natural gas condensates are a low-density mixture of hydrocarbon liquids that are present in the unprocessed natural gas produced from many gas fields, and in many locations, natural gas condensates are flared or treated as a stream that requires disposal. However, this unprocessed stream, either as a

[1] Gokulakrishnan, P., Ramotowski, M. J., Gaines, G., Fuller, C., Joklik, R., Eskin, L. D., Klassen, M. S. and Roby, R. J. (2008), "A Novel Low NOx Lean, Premixed, and Prevaporized Combustion System for Liquid Fuels", Journal of Engineering for Gas Turbines and Power, Vol. 130.

LPP Combustion, LLC

pure liquid or as multiphase mixture of gas and liquid, in combination with the LPP technology, provides a great opportunity to generate electricity, process steam, or both. Each wet natural gas field has its own unique gas condensate composition. However, in general, gas condensate has a specific gravity ranging from 0.5 to 0.8 and may contain a variety of compounds such as: hydrogen sulfide (H2S), chain alkanes having from 2 to 12 carbon atoms (denoted as C2 to C12), cyclohexane and perhaps other naphthenes, aromatics (benzene, toluene, xylenes and ethylbenzene) and various other compounds like CO2. The condensates are readily vaporized by the LPP system, allowing them to be used in combustion devices designed for natural gas. Hence, LPP allows the natural gas condensate stream that had been treated as waste, to instead be used to fuel combined heat and power systems for plant operations.

LPP Combustion has successfully demonstrated the use of simulated natural gas condensates in a Capstone C30 (30 kW) gas turbine, operating in either diffusion or premixed (low emissions) mode. Gas turbine operation and pollutant emissions from the C30, when using the natural gas condensates, were the same as measured when operating on natural gas. No instances of flashback in the combustor or degraded operation of the gas turbine have been observed when using the substitute natural gas derived from the condensates.