Clean Fuels Free Fall Liquid Injection Technology

for coking and fouling liquid fuels, such as pyrolysis oil

Clean Fuels developed a new technology for feeding high-temperature processes with pyrolysis oil (liquefied biomass) and other coking and fouling fuels. Processes in which Free Fall Liquid Injection Technology (FFLIT) can be applied include combustion for furnaces and steam boilers, gasification, stationary engines and gas turbines. Pyrolysis oil made from biomass is a liquid fuel that is known for its coking character, which leads to strongly reduced plant availability. Clean Fuels's FFLIT technology effectively solves the issue.

Coking and fouling of liquid fuels is a result of the fuel's tendency at elevated temperatures to form deposits on fuel lines, valves, injectors, and reaction chamber surfaces. Particularly fuel injectors are vulnerable to deposition of solid matter caused by auto-oxidation (fouling) or cracking (coking).

Standard solutions to this problem include nozzle cooling and flushing and usually only postpone the occurrence of unacceptable levels of coking and fouling. Clean Fuels's FFLIT technology addresses the matter from a couple of new angles: radiative heat transfer to injector nozzles is minimised to maintain nozzle temperature below coking and fouling point, the liquid enters the reactor in free fall without touching any hot surface area, the fuel is evaporated rather than atomised and any coke formation upon evaporation is converted with separately applied reactants. To some extent, the technology shows similarities with the well known Swedish Primus Stove, with its liquid fuel vaporizer, known since 1892.

Clean Fuels engaged in the development of FFLIT technology because reliable technology for the combustion of biomass pyrolysis oil at small scales in the range of 10-500 kW is not really available at affordable costs.

Clean Fuels developed, built and tested an 80 kW burner for fuelling with pure plant oil (PPO) and pure biomass pyrolysis oil. Extended combustion tests showed that the emissions to air are well within limits allowable to the industry. The biomass pyrolysis oil used by Clean Fuels was produced by Clean Fuels in its charcoal production demonstration plant in Oldenzaal with a production capacity of 1.75 tonne charcoal per day.

FFLIT technology is also used by the same charcoal production facility. Other uses that are technically feasible without substantial further development include heating applications of 50-500 kW.

Patents to Clean Fuels's FFLIT technology are pending.

Oldenzaal, 26 March 2014

Clean Fuels' FFLIT test rig was materially supported by Unifrax Ltd.

T: +31 (0)53 4892909 F: +31 (0)53 434257 Siemons@CleanFuels.nl www.cleanfuels.nl

Visiting address Marconistraat 33A 7575 AR Oldenzaal The Netherlands

Clean Fuels b.v. c/o University of Twente PO Box 217 7500 AE Enschede The Netherlands

a sustainable energy economy

Ъ

EAN FUELS