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The Rotapower® rotary engine will economically combust sour gas to produce electricity

In the US, there are over 3,000 active landfills and many more that have matured and produce large quantities of sour gas (corrosive mixture including methane gas). Worldwide, 40% of all natural gas is sour gas and requires expensive treatment before it can be used. In many cases, the gases are flared for lack of an economical treatment or way to burn them effectively in a piston or turbine engine to produce electricity. A few landfill sites produce significant enough quantities of sour gas that a special very large engine developed by Caterpillar is used at a cost in excess of two million dollars and yearly maintenance exceeding $500,000. The requirements of a powerplant that can burn sour gas efficiently are very demanding. Sour gas is very corrosive and often contains less than 50% methane where combustion in a piston engine becomes unsteady. Microturbines can work down to 35% methane which more than doubles the usable gas available, but a micro turbine engine can cost up to $5,000 per kilowatt.

A charge-cooled rotor rotary engine uniquely creates a set of pre-combustion conditions that allow it to combust low methane content sour gas that would not be possible using an oil cooled rotor like the Mazda rotary engine or a piston engine.

Combustion of sour gas

Oil is used to cool the piston in a piston engine or the rotor in most rotary engines. This limits the temperature of these components in order not to break down the oil. Consequently, the surface temperature of the rotor or piston cannot exceed 400°F. By contrast, the Rotapower® rotary engine cools its rotor with the incoming air or fuel air mix and consequently, the rotor can reach a surface temperature of 900°F. The lower surface temperature with oil cooling leads to quenching of the already delicate combustion process of burning sour gas.

A further benefit of using a charge-cooled rotor is that the incoming sour gas air mixture is heated to 250°F before it enters the intake stroke where the temperature can rise to 450°F before it is ignited. This aids greatly in stabilizing the combustion process in marginal combustion conditions. The rotary engine has a very important additional characteristic that is fundamental to its ability to burn sour gas. In a piston engine, the intake stroke is separate from the power stroke which means that the intake charge which has a temperature well below that during the power stroke cools the combustion surfaces of the piston combustion chamber prior to ignition which contributes to quenching the combustion process. In the rotary engine, the combustion chamber is separate from the intake chamber. Maintaining a high combustion chamber temperature and pressure are critical to igniting and maintaining consistent combustion when the methane content falls below 50%. Due to this favorable combustion environment, it has been possible to ignite and burn a mixture like a 50/50 methanol/water. This mixture will not ignite outside the Rotapower® engine.

Corrosion issues with Sour gas

In a piston engine, there are a number of parts exposed to the corrosive effects of sour gas. This problem is particularly acute in a piston engine because the sour gas contaminates the lubricating oil making it highly acidic which then circulates throughout the piston engine with its high part count subject to this corrosive oil. The Rotapower® engine injects very small quantities of oil that move in then out of the engine before becoming acidic.

Other Factors

The standard rotary engine cannot have a compression ratio above 9 to 1 because of the geometry of the engine combustion chamber. The methane in sour gas would combust best at the highest effective compression ratio possible (~15 to 1). Compounding the Rotapower® engine by using two rotors in series allows compression ratios up to 18 to 1. The first rotor acts as a compressor/expander to and from a second rotor acting as the power rotor. One of the consequences of this series arrangement is that noise is reduced by 95% prior to muffling, the exhaust temperature is reduced by 50%, and the thermal efficiency is increased by 15% to 20%. The way this is accomplished is one of Freedom Motors' key patentable technologies.

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