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A FEASIBILITY STUDY OF RECIPROCATING-FLOW SUPER-ADIABATIC COMBUSTION ENGINE

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ABSTRACT

Operation characteristics of an internal, super-adiabatic combustion engine have been investigated through a one-dimensional numerical simulation. The system consists of a displacer piston (D.P.), a power piston (P.P.) and a porous medium in a cylinder with a 6 cm bore, as shown in Fig.A-1. These create reciprocating motions with a 6 cm stroke and with a phase relation angle of 55 degree, similar to those of an ordinary Stirling engine. The porous medium consists of fine spheres with a 0.1 mm diameter and has a 98% porosity and a 15 mm thickness. The heat capacity is 350 times higher than that of air; that is, Γ = 350. Furthermore, an inverse crank-piston mechanism is used to realize constant volume heating and cooling processes, respectively, through heat storage and heat release by the porous medium. The stroke is 4 times longer than the thickness of the porous medium (L_s = 4.0).

Figure A-2 shows distributions of temperatures, the gas velocity, the pressure, the reaction rate and the product mole fraction at the D.P. side crank-angle of 150 degree. The mixture has a heating value (H_o = 2.1) equivalent to the concentration of 2.1vol.% methane in air. The exhaust gas is scavenged over the range of the crank angle from 327 to 33 degree.

The mixture compressed in the D.P. side cylinder is preheated by the porous medium and is ignited in the vicinity of its P.P. side end. The main reaction occurs in the gas phase, resulting in the increase in the gas temperature. The maximum temperature becomes higher than the theoretical (adiabatic) flame temperature because of heat recirculation through the porous medium. The thermal efficiency becomes higher as the reaction zone is stabilized closer to the porous medium; then, it reaches the maximum, i.e., 57.5%, under the operation conditions of the rotation speed N_E of 100rpm and the phase relation angle Ψ of 55 degree.

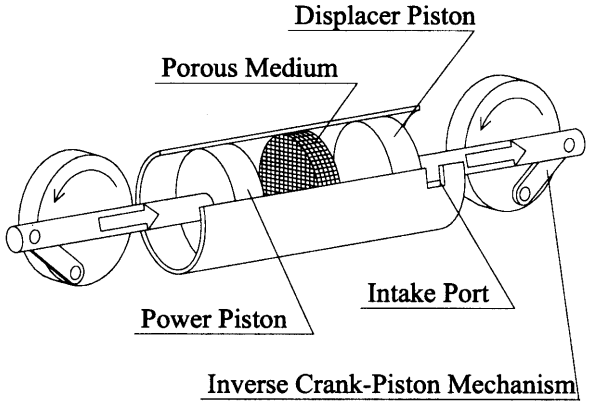

Figure A-1 Schematic Diagram of Super-Adiabatic Combustion Engine with an inverse Crank-Piston Mechanism

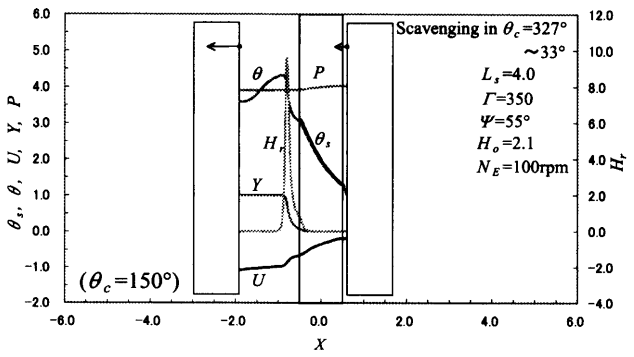

Figure A-2 Distributions of Dimensionless Temperatures θ, θ_s, Velocity U, Pressure P, Reaction Rate H_r and Product Mole Fraction Y at Crank Angle θ_c of 150 degree