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Premixed Swirl Flame in a Reformer of Fuel Cell System

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Fuel cell system needs the reformer which produces directly the hydrogen from conventional hydrocarbon fuels available anywhere. Reforming methods can be generally classified into steam reforming, partial oxidation and auto-thermal reforming process. Steam reforming is an endothermic reaction that combines a hydrocarbon fuel with steam over a catalyst at high temperature, which typically has highest hydrogen yield on dry basis. Partial oxidation reforming is an exothermic reaction that combines a hydrocarbon fuel with some oxygen to oxidize the fuel partially into a mixture of carbon monoxide and hydrogen called as syngas. Autothermal reforming consists of the steam reforming, partial oxidation reforming and water gas shift reaction in a single process [1-3]. Since especially steam reforming reactions is endothermic and needs the environment of high temperature range of 600~1000□ depending on type of reactions and hydrogen yield[1], burner system should be installed inside of a reformer.

In general, the reformer burner uses the natural gas only at the start of the fuel cell system and after the fuel cell system reaches the steady operation condition, it uses the anode-off gas generated from the anode reaction of the fuel cell or the mixture of anode-off gas and natural gas for a required heating value of mixture. Anode-off gas is generally composed of hydrogen, carbon dioxide, methane and nitrogen. The burning velocity and adiabatic flame temperature of the mixture are very different depending on the composition of anode off gas and LNG. Therefore it is very important to make stable combustion condition using mixtures with very different flame speed at burner of a reformer.

In this paper, we focused on the combustion and stability characteristics of premixed swirl flame because swirl flow makes the range of combustion stability more wider from very lean to very rich mixture conditions.