The Effects of the Heat Transfer between the Components of Ultra Micro Gas Turbine on its Performance

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1. Introduction

When downsizing a gas turbine, heat transfer between the components would be significant due to cube-square law. This paper has focused on these characteristic effects on UMGT's performance, which are mostly ignored in conventional gas turbines, using the unique gas turbine cycle that contains the heat transfer from the combustion chamber to the compressor and turbine.

2. Model cycle

The T-S diagram of this gas turbine cycle with heat transfer is illustrated in Fig.1. Heat lost from a combustion chamber corresponds to the temperature drop from T_3 to T'_3, hatched area. This conducts only to the compressor and turbine through chamber wall and shaft. Due to this heat transfer, temperatures at both the exit of the compressor and turbine increase compared with these where no heat transfer occurs.

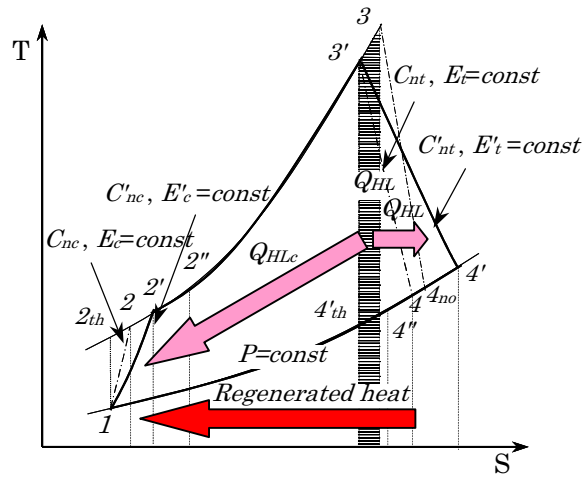

Fig. 1 T-S diagram of a model cycle of UMGT

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3. Results and discussions

Figure 2 shows that larger heat transfer ratio $HT=\{(T_3-T'_3)/T_3\}$ results in lower thermal efficiency E_{th} of the gas turbine for both simple and regenerative cycles. Moreover, larger heat loss distribution to compressor rather than turbine show lower thermal efficiency at a certain HT, which would be due that compressor efficiency is more sensitive to heat transfer than that of turbine. When heat transfer only inputs to either high- or low-pressure region of both components, heat transfer to the low-pressure region result in worse thermal efficiency. The reason of these results is discussed thermodynamically in the paper.

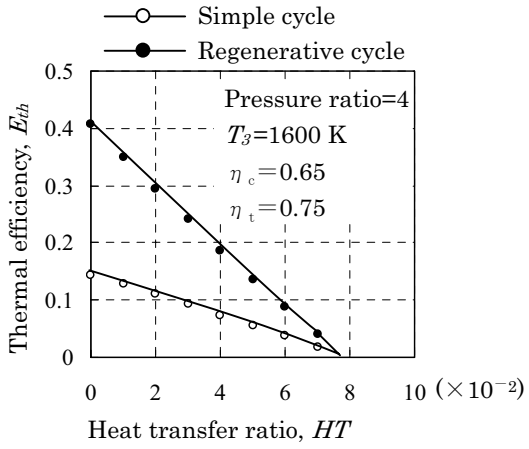

Fig. 2 Heat transfer ratio and thermal efficiency

4. Conclusions

Internal heat transfer within a gas turbine reduces its performance, and self-sustained operation would be impossible even at HT=0.075 for UMGT. In order to obtain high E_{th} with these heat transfer, compressor rather than turbine, and low-pressure region should be protected from inflow of these heat transfer.