The Study of Turbine Characteristic for the Sodium-Cooled Fast Reactor

Tae Geun Yoo [a*], Min Ki Kim[a], Eui Kwang Kim [b]
[a]*FNC Tech., SNU 135-308, San 56-1, Shinrim 9-Dong, Kwanak-Gu, Seoul, 151-742, S. Korea*
[b]*KAERI, 1045 Daedeok-ro, Yuseong-gu, Daejeon, 305-353, S. Korea*
[*]*Corresponding author: keven@fnctech.com*

1. Introduction

A sodium cooled reactor(hereinafter "SFR"), which is one of Gen IV nuclear reactor power plant, has been known as the most promising next generation nuclear power plant. The development of the SFR that had been in a recession was resumed since 2000 and has been actively developed with not only a conceptual design but also its test facility to prove the actual size plant [2]. Nowadays, it is emphasizing the necessity of the evaluation for NSSS design as a part of the verification for SFR design validity. In other words, it means that should be preceded the turbine design of the SFR.

In this study, we intend to deduce the turbine cycle configuration based on the superheated steam cycle for the SFR as well as the analysis of the turbine characteristic. The ultimate goal of the study is to develop the turbine characteristic of the SFR.

2. Method and Results

2.1 Turbine cycle configuration for the SFR

The turbine is of tandem compound design separate high pressure (HP), intermediate (IP) and low pressure (LP) cylinders. The LP turbine is of a tandem compound 4 flow type while HP and IP turbines are of single flow type(See fig. 1). It was refer to the SAMCHEON-PO fossil plants which have similar steam condition. In case of reheater, the boundary condition was composed to refer the PFBR of the india.

The design of the reactor gets considerably simplified with steam to steam reheat cycle. Hence, all the designers of SFRs are preferred steam to steam reheat cycle. The live steam reheater has high pressure live steam on the tube side. The steam to be reheated is on the shell side. The capacity of the reheater is sized such that no excessive pressure drop occurs on the reheated steam.

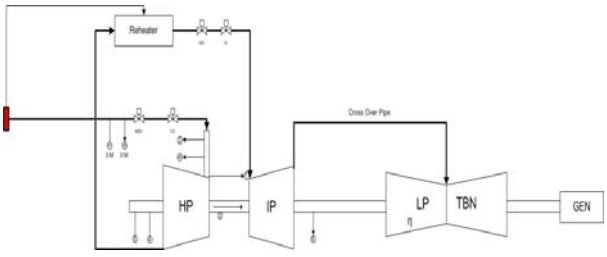

Fig. 1 SFR BOP Turbine Cycle [1]

2.2 Setup of the turbine characteristic

In the performance analysis for the preliminary heat balance of the BOP, it was demonstrated that turbine characteristic are similar to reference plant, such as the SAMCHEON-PO fossil plant (See fig. 2). Especially, the IP turbine internal efficiency was lower than the HP turbine. Considering the turbine configuration such as a reheater composition, the characteristic of IP turbine may differ.

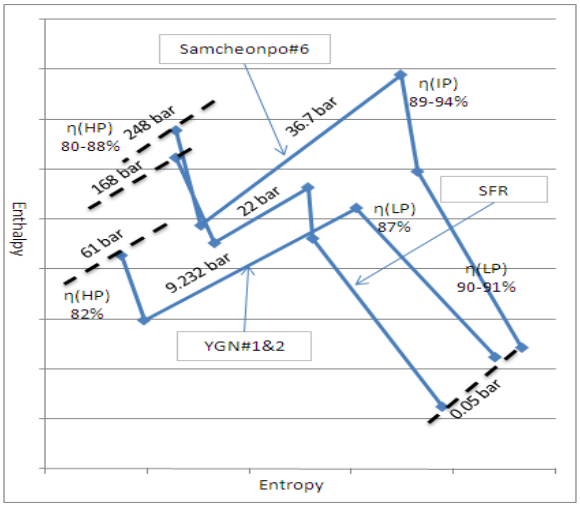

Fig. 2 Turbine Characteristic for the SFR

2.3 Analysis of the turbine characteristic

In case of the reheater of fossil power plant, it was generally designated that reheater is located inside boiler. So, this design is caused in the rise of IP turbine inlet steam enthalpy and the IP turbine internal efficiency.

In case of the nuclear power plant, reheater was generally designated that it is located outside steam generator. and it also has steam to steam reheat cycle. But, the HP turbine outlet pressure is lower than that other type plant. So, this design is caused in the rise of LP turbine inlet steam enthalpy and the LP turbine internal efficiency.

However, In case of the PFBR which has similar with the SFR design concept, reheater was designated that it is located outside steam generator. And also the steam condition and HP outlet steam pressure was similar. In the performance analysis for the turbine internal efficiency of the IP turbine, it was demonstrated the IP turbine characteristics are similar

to the PFBR. IP turbine inlet steam enthalpy of the PFBR is lower than the HP turbine inlet (See fig. 3). In other word, it means that the IP turbine characteristic depend on the reheater composition and HP turbine pressure drop.

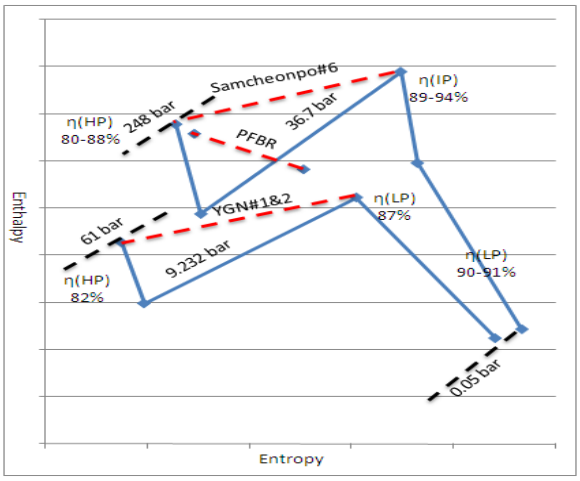

Fig. 3 Turbine characteristic for the PFBR

3. Conclusions

In this study, the characteristic analysis for the turbine cycle of SFR was carried out by using the heat balance. From the analysis results, it was found that the turbine characteristic setup could sufficiently appropriate design. From this study, it was found that the main considerations need to setup the reheater design and HP turbine pressure drop. The results of this study will be helpful to develop the turbine design technologies.

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