

A Study on the Cause of Failure in Refrigeration System in WTRF

Hojun Lee, Yeonduck Han, Inhoon Lee, Kyumin Song

Korea Hydro & Nuclear Power Co., LTD(KHNP)

Hojun.lee@khnp.co.kr

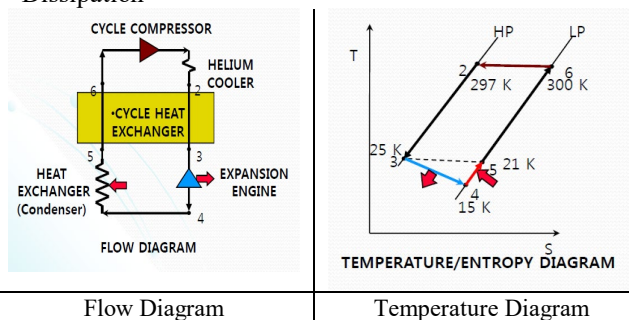
1. Introduction

Wolsong TRF(Tritium Removal Facility) operated by Korea Hydro & Nuclear Power Co., LTD(KHNP) has been in operation for about 18 years since it started operation in 2007. As the second facility worldwide, there were many equipment failures and shutdowns during initial operations due to reliability and lack of experience. As accumulated of operating and maintenance experience, it is now being stable operation. It is contributed to Korea's KHNP winning the contract for constructing Cernavoda TRF(CTRF) in Romania.

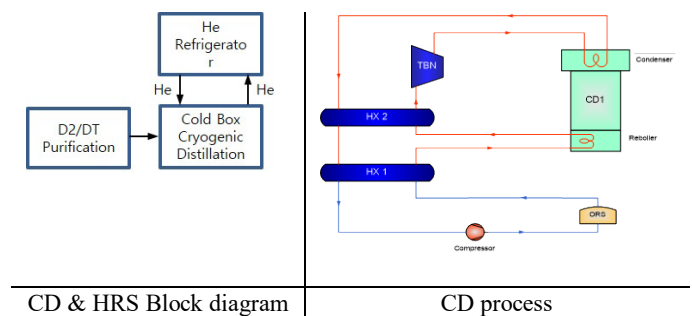
It have identified major operations and failures experiences of Wolsong TRF for 18 years, and found that there were many failures in Helium Refrigeration System (HRS).

2. Cryogenic Distillation(CD) and Helium Refrigeration System(HRS)

- Cryogenic Distillation process has started after extraction process
- The hydrogen isotope mixtures (H₂, D₂, T₂. etc) are separated using differences in boiling point under ultra-low temperatures (below 25K)
- HRS provides stable cryogenic conditions, and its reliability is critical for overall process performance.
- The entire system depends on HRS, which requires extremely stable operating conditions, including precise control of equipment operation, flow rate, pressure, and heat exchange efficiency.
- Refrigeration Principle: Brayton Cycle
Compression → Heating → Expansion → Heat Dissipation



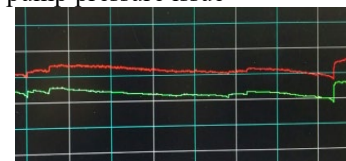
< Fig 1. Refrigeration principle >



< Fig 2. Overview of CD and HRS >

3. Failure experiences and Cause and lesson learned

- HRS Cold pump pressure issue



< Fig 3. Trend of pressure >

- Case: Frequently pressure up and down in the cold box
- Cause: Corrosion pinhole, leakage pinhole
- HRS Compressor oil hose maintenance



< Fig 4. Oil hose in compressor >

- Case: Pressure hose damaged and leakage
- Cause: High vibration and aging
- Improvement: All pressure hose replaced metal type during overhaul season. There have been no more issue after changing type.
- Factors contributing of malfunction
- Compressor or pumps trip, turbine shutdown, sensor drift, mechanical wear/damage, leakage of tube, relay malfunction.

4. Conclusion

It provides an overview of the HRS and their role in various applications and discuss common failure causes for this system.

WTRF life time is 40 years and it has been operated for about 20 years. As the WTRF facility ages, failure tends to increase. It can be improved WTRF as Enhancing the competency of operator and engineer through training and Securing reliable materials spare parts.

REFERENCES

- [1] Korea hydro & nuclear plant, Introduction to Wolsong Tritium Removal Facility, 2007
- [2] Open Gas-Turbine Cycle Working principal Brayton Cycle, M. Bahrami ENSC 461(S11), Simon Fraser University, 2011