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A Case Study on Integrating Absorption Cooling into an ACC-Based Geothermal ORC System

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INTRODUCTION

Organic Rankine Cycle (ORC) power plants using Air-Cooled Condensers (ACC) face a significant efficiency problem, especially at high ambient temperatures. Increased ambient temperature raises condenser pressure, leading to capacity losses of up to 55% in the plant's power generation. This study presents an innovative waste heat recovery and hybrid cooling system developed to address this critical inefficiency within the scope of nGEL Project funded by Horizon Europe Programme.

METHODS

The developed hybrid system is controlled by an Energy Management System (EMS), which manages the distribution of heat that will be obtained from the existing HP separator's new outlet.

Cooling Integration:

- Under high ambient temperatures, the existing Air-Cooled Condenser (ACC) system is supported by additional cooling from absorption chiller, or cold thermal energy storage. This additional cooling reduces the condenser load, ensuring better efficiency than the business as usual case during summer months.

Trigeneration Flexibility:

- The system concept also allows for trigeneration operation (power, heating, and cooling), where the EMS dynamically directs heat based on demand. In cooling case, heat is directly utilized by the absorption chiller. If there is excess cold, it is stored in Cold TES for later use.

Internal Recovery:

- A recuperator integrated into the ORC cycle enhances overall system efficiency by transferring turbine outlet heat to the evaporator inlet, targeting an efficiency gain equivalent to 1 MWth per 1 MWe.

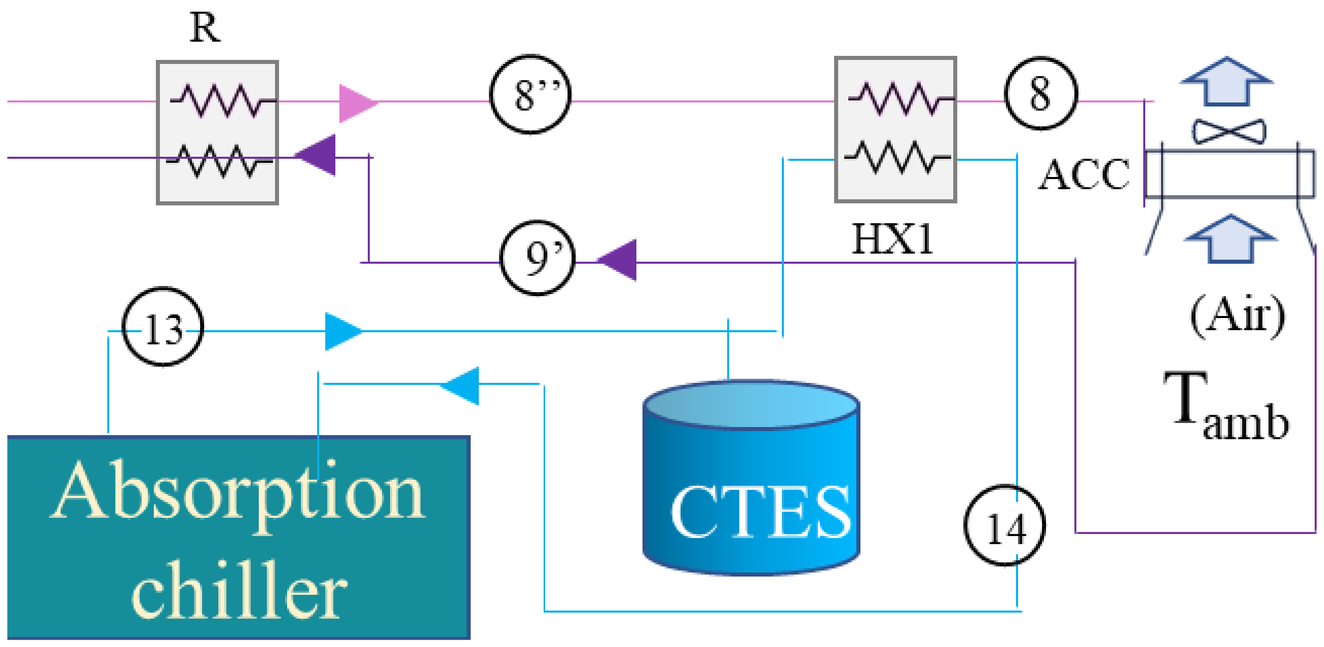


Figure 1. Additional cooling to share condenser load for ACC,

EXPECTED RESULTS

- With the developed hybrid cooling and regenerator strategy, a 5-10% increase in ORC net power generation is expected at high ambient temperatures (during the period when the 55% loss occurred).
- By utilizing waste heat in the trigeneration structure, the power plant's revenue model has been diversified; it has become not only an electricity source but also a valuable heating and cooling source.
- The system is designed to be tested in a manner that will not disrupt existing plant operations and will meet the highest safety standards (non-disruptive & safe).

NGEL ORC SYSTEM

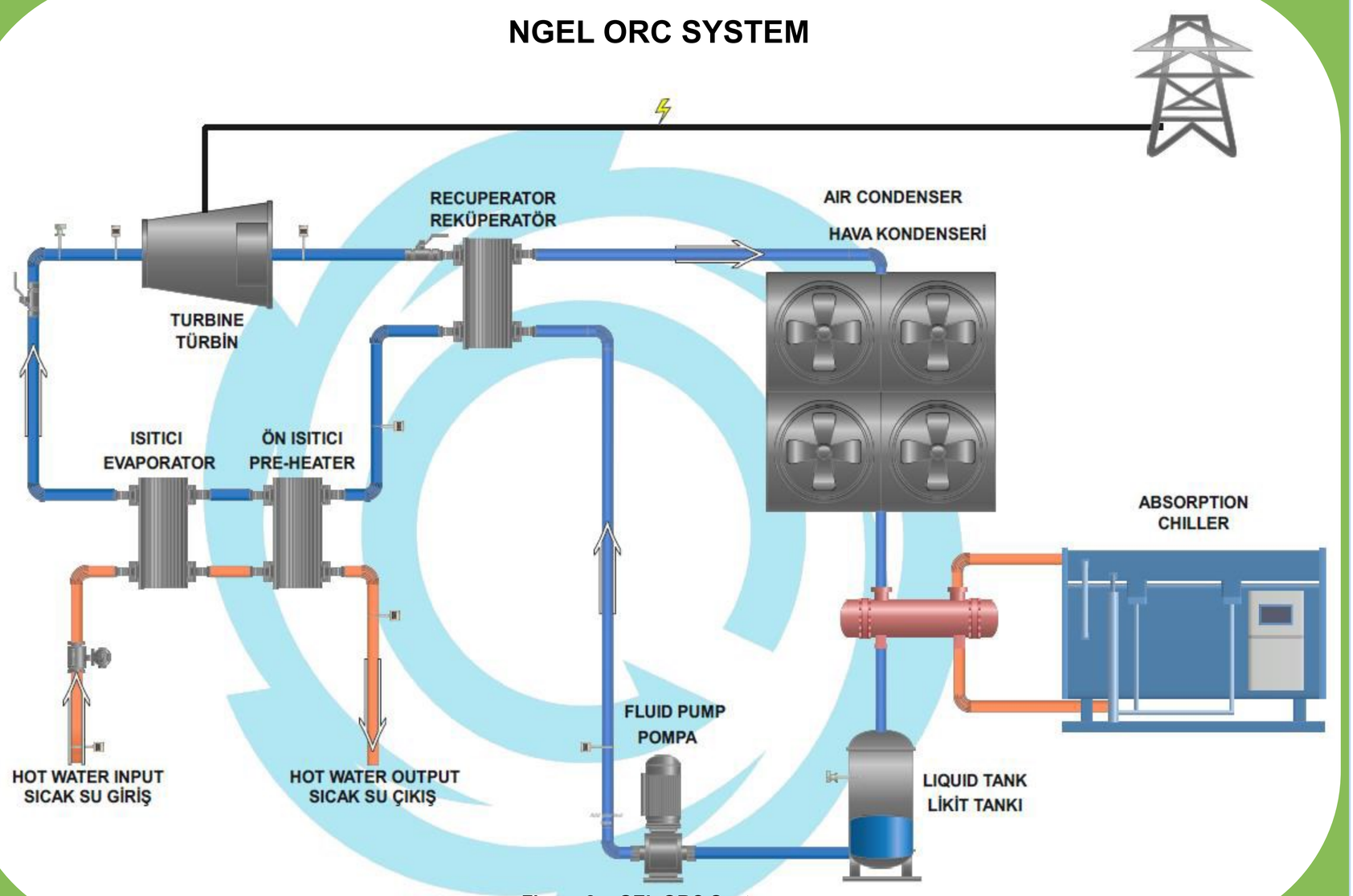


Figure 2. nGEL ORC System

DISCUSSION

- **Economic Impact:** The proposed hybrid system compensates for the significant power loss experienced by the plant, particularly during the summer months, maximizing the facility's revenue potential during periods of high electricity demand and prices.
- **Waste Heat Recovery:** The plant's waste heat (separator outlet) will be converted into a valuable cooling source, increasing the system's overall exergy efficiency.
- **Scalability:** This case study presents a repeatable and scalable modernization model for all ACC-based geothermal (or other waste heat) ORC power plants operating under similar climatic conditions.
- **Operational Flexibility:** The secondary ORC platform will provide safe testing and optimization capabilities without disrupting the operation of the main plant.

CONCLUSION

Geothermal-powered absorption cooling integration is a technically and economically promising, feasible strategy for eliminating seasonal power losses in ACC-based ORC plants.

This study successfully demonstrates a flexible trigeneration model (Power, Heating, Cooling) that increases the efficiency of geothermal resources.

The nGEL Project offers the industry a pioneering engineering model for multi-output and sustainable geothermal energy applications.

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