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	Final Project		Issue Date:	Khordad 13, 1404
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“Heat Recovery Process Optimization” Competition

Introduction

Heat recovery is of paramount importance in various industries and sectors due to its numerous benefits. The process of capturing and utilizing waste heat not only minimizes energy wastage but also reduces greenhouse gas emissions, thereby offering an environmentally friendly solution. By implementing heat recovery systems, organizations can significantly enhance their energy efficiency and lower operational costs. The recovered heat can be redirected to power generation, heating applications, or even utilized for process requirements, thereby reducing the reliance on conventional energy sources. Moreover, heat recovery promotes sustainability and resource conservation, contributing to a greener and more sustainable future.

Several heat recovery methods can be employed to capture and utilize waste heat effectively. Organic Rankine Cycle (ORC) is a heat recovery solution that utilizes organic fluids to convert waste heat into usable energy. It is particularly effective in situations where the waste heat source has a low or medium temperature range.

The ORC process (Figure 1) involves a closed-loop system where an organic fluid, with a lower boiling point than water, is used as the working fluid. The waste heat is transferred to the organic fluid in a heat exchanger, causing it to vaporize and expand. The expanding vapor drives a turbine, which is connected to a generator, producing electricity. After passing through the turbine, the vapor is condensed back into liquid form using a cooling system, and then it is pumped back into the heat exchanger to repeat the cycle.

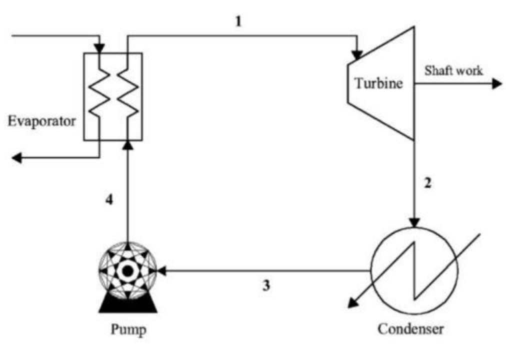

Figure 1: A typical simple ORC unit (Configuration A) [1]

In order to improve the process efficiency, several ORC configurations have been proposed such as the configuration shown in Figure 2).

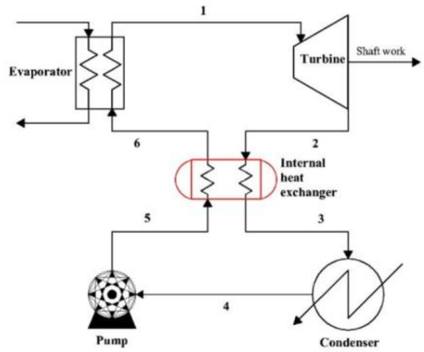

Figure 2: The ORC unit with recuperator (Configuration B) [1]

Problem Statement

Consider a hot water stream with the specifications shown in Table 1.

Table 1: waste hot water stream specifications

Parameter	Value
Pressure	10 bara
Temperature	170 °C
Flowrate	100 kg/s
Composition	Pure water

In this study, you are asked to optimize the ORC unit (Configuration A) to maximize the power output of the cycle. Assume that an air-cooled condenser is employed in the ORC unit. The input parameters and calculation conditions are listed in Table 2.

Table 2: Process design parameters

Parameter	Value
Hot water discharged temperature	70 °C
Cooling air inlet temperature	25 °C
Pressure drop (all heat exchangers)	0 bar
Pump isentropic efficiency	75%
Turbine isentropic efficiency	80%
Generator efficiency	95%
Approach temperature (all heat exchangers)	5 °C

Competition assignments

The class students are asked to be separated into five groups (Table 3).

Each group must simulate and optimize Configuration A using an equation-oriented approach in GAMS. Pure working fluid must be used in the cycles.

Table 3: Working groups

#	Name	#	Name	#	Name	#	Name	#	Name
1	سجاد امین تبار	2	رامین زرگران	3	محمدحسین وطن دوست	4	محمود ملارستمی	5	میثم امیری نژاد
	پارمیس اسحقی		محمدمهدی جعفری		امیررضا خیاط		سینا اقایان حسینی		سیدامیر حسینی
	ابوالفضل اخلاقی		امیرحسین هوازاده		سیدمتین لشگری		زینب عربی نژادمزلقانی		ابوالفضل معتمدی پور
	منا محمدی		سعید رضوانی نژاد		مرتضی رزم جوی آرین		حمیدرضا حسینی		یاسمن نوربخش

Each group should incorporate the working fluid selection into the optimization problem. In other words, there is no limitation on the working fluid and the optimal working fluid must be selected in the process optimization problem. At least five working fluids must be considered in the basis set from which the optimal one is selected by the optimizer.

Each group may gain 30% more score by simulating and optimizing Configuration B likewise.

The process optimization model must be correct in terms of both process design concepts and formulation. The convergence time will be also considered as the measurement of the successful formulation.

The group with the process which yields the highest power output wins the competition (20% more score)

Competition Rules

1- The optimization problem must be formulated in GAMS as an equation-oriented problem

2- Write a scientific essay in English having the structure below:

- Abstract (max 200 words)
- Introduction (max 1500 words)
- Problem statement (max 1000 words)
- Problem formulation (max 1000 words)
- Results and discussions (max 1000 words)
- Conclusions (max 500 words)
- References (min 10 references published from 2010 to date)

3- Use Peng-Robinson EOS and Kamath algorithm for the property estimation and phase calculations

4- Prepare a RAR package including:

- Simulation files (GAMS and Aspen Hysys)
- Essay (in both MS Word and PDF formats)
- References
- Others

5- Use the list attached (Attachment 1) as the database of working fluids and their properties

6- The attached references (Attachment 2) may be used as the starting point of literature survey

References

[1] Palma-Flores, O., Flores-Tlacuahuac, A., & Canseco-Melchor, G. (2015). Optimal molecular design of working fluids for sustainable low-temperature energy recovery. Computers & Chemical Engineering, 72, 334-349.