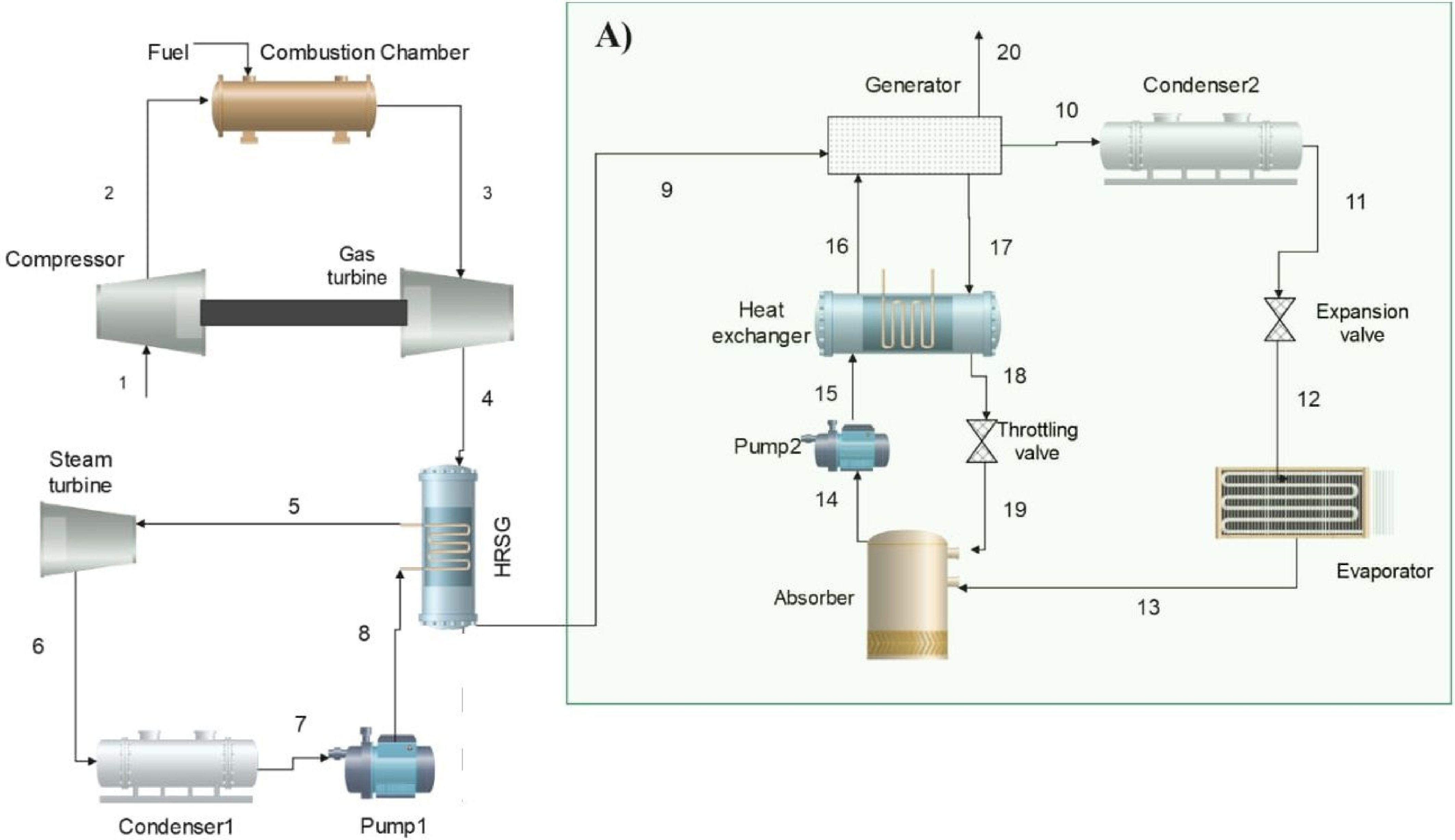
System Description

Consider a combined-cycle power plant with two possible waste heat recovery systems as shown in Figure 1.

In the Brayton cycle, air enters the compressor at the surrounding temperature and pressure and leaves it after compression. The compressed air enters the combustion chamber and reacts with natural gas. After that, the resultant combustion gas enters the gas turbine and produces power. By using HRSG. the flue gas of the Brayton cycle produces the energy input for the Rankine cycle.

In the Rankine cycle, water is heated in the HRSG by the flue gas and then, enters the steam turbine to produce power. After the steam turbine, water enters the condenser and then, the pump is used to increase the pressure.

To enter an NH_3-water absorption chiller to produce a cooling load.


Fuel
Combustion Chamber
2
3
Compressor
Gas turbine
1
4
Steam turbine
5
HRSG
6
8
7
Condenser1
Pump1
A)
20
Generator
10
Condenser2
9
11
16
17
Heat exchanger
Expansion valve
15
18
12
Pump2
Throttling valve
14
19
Evaporator
Absorber
13

Modeling Information

b) Use ambient condition of $T_0 = 298.15$ K and $P_0 = 101.325$ kPa.

c) The inlet mass flow rate of air is 50 kg/s.

d) Other parameters must be set by a rational value.

e) Main results of the system are energy efficiency of the overall system, exergy efficiency of the overall system, exergy destruction of the overall system, total net power production, and based on your decision, cooling load or freshwater production rate.

f) The effective parameters must be defined by the students. However, just some examples for clarification: the isentropic efficiencies of the compressor, gas turbine and gas turbine, gas turbine inlet temperature (GTIT), HRSG pinch point, higher and lower pressures of the absorption chiller, or TTD_c of single-stage flash distillation.

Objectives of the Project

a) Modeling the system and finding the main results of the system.

b) Report the mass flow rate, specific enthalpy, specific entropy, and specific exergy (physical and chemical) values of each point (see Figure 2).

c) Find the exergy destruction rate and exergy efficiency of each component.

d) Find the effects of important parameters on the main outputs of the system.

Report Tips

a) If the report is in English, use Times New Roman with a font size of 12, and if in Persian, use B-Nazanin with a font size of 14. The figures and tables font is recommended to be one order smaller than the size of the body of the report.

b) Each figure and table must have captions and be mentioned in the report.

c) The report must consist of an introduction, system description, modeling, results and discussion, conclusion, and reference.

d) In the introduction section: a brief description of electricity production, cooling production, and freshwater production. If applicable, a brief literature review. At the end of the introduction section, the objectives of the project must be included.

e) In the system description section: similar to what has been done on the first page of the project. It is recommended to draw the system figure again.

f) In the modeling section: The complete modeling includes equations and adjusted values for each parameter (see Figure 3).

g) In the results and discussion section: is the most important part. The main results and objectives of the project must be discussed. The results of any figure that is used must be discussed with reasons.

h) In the conclusion section: A brief description of what has been done, and mention the main outcomes of the project. If it is possible, give some opinions for future works.

i) In the reference section: Include references that are used in the report.

Supplementary Figures

state	P (kPa)	T(°C)	h (kJ/kg)	s (kJ/kg.K)	$\dot{m}$(kg/s)	ex (kJ/kg)	Working fluid
1	101.3	25	298.4	6.86	30.11	0	Air
2	1267	374.5	658	6.929	30.11	339	Air
3	1267	945.1	1301	7.637	30.11	770.9	Air
4	101.3	412.6	698.6	7.716	30.11	144.9	Air
5	101.3	262.6	540.5	7.456	30.11	64.3	Air
6	1000	93.57	392.7	1.233	1.722	29.61	Water
7	1000	350	3157	7.301	1.722	985.2	Water

Figure 2. *Sample table for reporting each state.*

System components	Exergy balances equations
Compressor	$\dot{m}_1 ex_1 + \dot{W}_{com} = \dot{m}_2 ex_2 + \dot{E}x_{D,com}$
Solar receiver	$\dot{m}_2 ex_2 + \dot{Q}_{rec}\left(1-\frac{T_0}{T_{rec}}\right) = \dot{m}_3 ex_3 + \dot{E}x_{D,rec}$
Turbine-I	$\dot{m}_3 ex_3 = \dot{m}_4 ex_4 + \dot{W}_{T-I} + \dot{E}x_{D,T-I}$

Figure 3. *Sample modeling table that can be used for equations.*