Steam Power Plant Using Feed Water Heating

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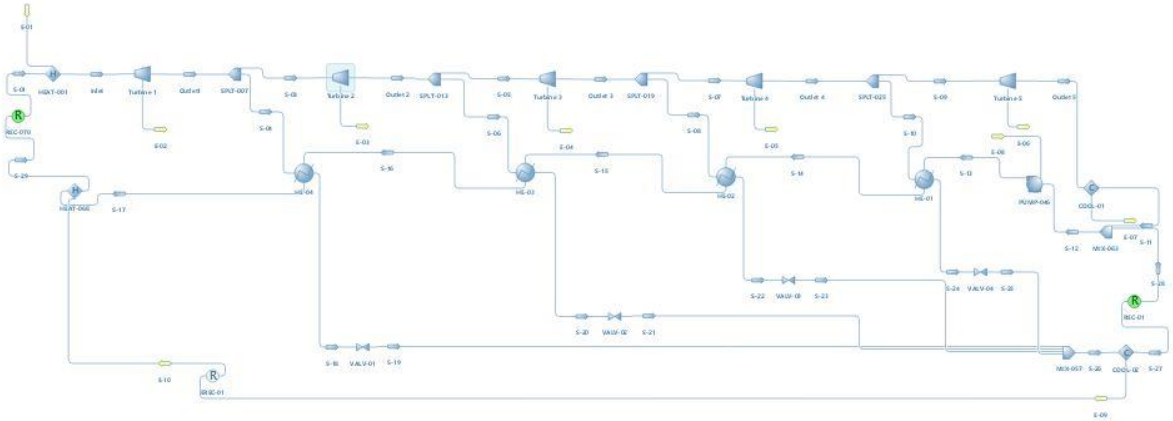
Background & Description:

The principle of regenerative cycle is to recover some exhaust heat and transfer it to the feed water. In steam power plant, water from the condenser is heated by the streams that are extracted from the turbine and then it is pumped to the boiler rather than directly feeding the water from condenser to the boiler. The purpose of using regenerative cycle is the raise the temperature of steam inlet to the boiler and to increase the thermal efficiency of the plant.

This process flow sheet shows the working of regenerative cycle with 4 feed water heaters. The steam conditions for inlet to the turbine is 8600 kPa and 500 ^{0}C. The exhaust Pressure from the fifth turbine is 10 kPa. The turbines and pump efficiencies are taken as 0.75. Property package used to solve the flowsheet is Steam Table (IAPWS-IF97).



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Results:

Inlet	Temperature	500	C
Inlet	Pressure	8600	kPa
Inlet	Mass Flow	36000	kg/h
Inlet	Mixture Specific Enthalpy	3392.16	kJ/kg
Inlet	Mixture Specific Entropy	6.68587	kJ/[kg.K]
Inlet	Vapor Phase Molar Fraction	1	
Inlet	Liquid Phase (2) Molar Fraction	0	

Table 1: Inlet steam Properties.

Object	Outlet 2	Outlet 3	Outlet 4	Outlet 5	Outlet1	
Temperature	267.363	169.864	95.9747	45.8075	352.26	C
Pressure	1150	375	87.69	10	2600	kPa
Mass Flow	32641.2	29798.2	27292.1	24999.6	36000	kg/h
Molar Flow	1811.86	1654.05	1514.94	1387.69	1998.3	kmol/h
Mixture Specific Enthalpy	2976.37	2798.48	2607.91	2371.75	3130.03	kJ/kg
Mixture Specific Entropy	6.92679	7.06492	7.23701	7.48381	6.82996	kJ/[kg.K]
Vapor Phase Molar Fraction	1	1	0.972976	0.911318	1	

Table 2: Properties of outlet Steam From Turbine

Object	Turbine 5	Turbine 4	Turbine 3	Turbine 2	Turbine 1	
Pressure Drop	0.7769	2.8731	7.75	14.5	60	bar
Power Generated	1639.96	1444.73	1472.46	1393.18	2621.32	kW
Pressure	10	87.69	375	1150	2600	kPa

PROPERTIES TABLE			
PUMP-01	Power Required	115.669	kW

Object	HEAT-001	
Heat Added	24192.2	kW

Table 3: Turbine, Pump and Boiler energy consumption/Generated

Conclusion:

Regenerative cycle give better thermal efficiency than normal cycle feed heater as thermal efficiency of this cycle was found to be nearly 0.33 which is better than Rankine cycle for same process conditions.

References:

1. Van Ness, H.C., Smith, J.M. and Abbott, M.M., 2012. Introduction to Thermodynamics of Chemical Engineering. (pg-296-302)