Gas Turbine Cycle with Reheat

A common method of increasing the mean temperature of heat reception is to reheat the gas after it has expanded in a part of the gas turbine. By doing so the mean temperature of heat rejection is also increased, resulting in a decrease in the thermal efficiency of the plant. However , the specific output of the plant increases due to reheat. A reheat cycle gas turbine plant is shown in Figure 5.1

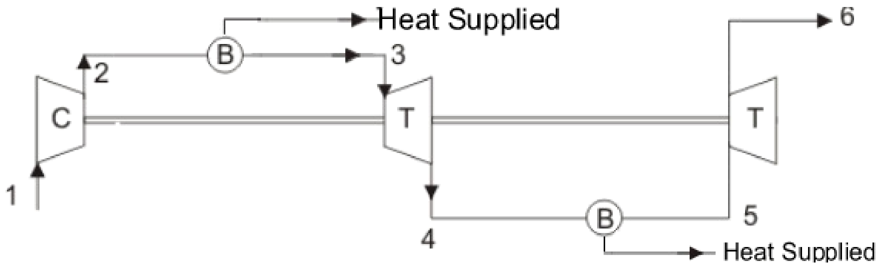


Figure 5.1 Reheat cycle gas turbine plant

The specific work output is given by,

$$= C_p(T_3 - T_4) + C_p(T_5 - T_6) - C_p(T_2 - T_1)$$

The heat supplied to the cycle is

$$= C_p(T_3 - T_2) + C_p(T_5 - T_4)$$

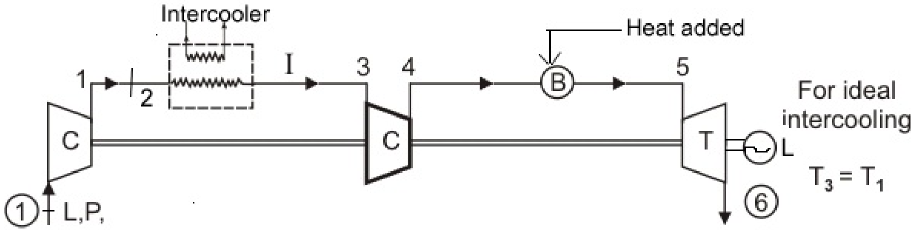
Thus, the cycle efficiency,

$$\eta = \frac{(T_3 - T_4) + (T_5 - T_6) - (T_2 - T_1)}{(T_3 - T_2) + (T_5 - T_4)}$$

Therefore, a reheat cycle is used to increase the work output while a regenerative cycle is used to enhance the efficiency.

Gas Turbine Cycle with Inter-cooling

The cooling of air between two stages of compression is known as intercooling. This reduces the work of compression and increases the specific output of the plant with a decrease in the thermal efficiency. The loss in efficiency due to intercooling can be remedied by employing exhaust heat exchange as in the reheat cycle.



Specific work output $= C_p(T_5 - T_6) - C_p(T_2 - T_1) - C_p(T_4 - T_3)$

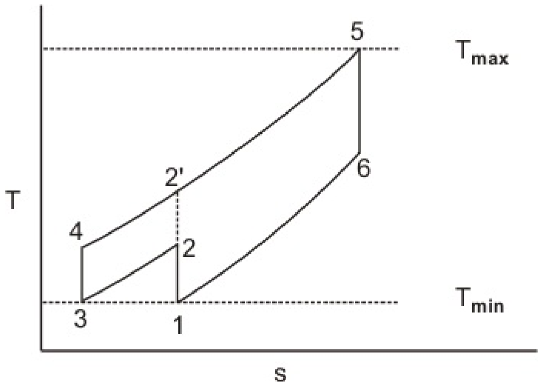


Figure 5.2 Cycle with intercooling

Heat supplied = $C_p(T_5 - T_4)$

If C_p is constant and not dependent on temperature, we can write:

$$\eta = \frac{(T_5 - T_6) - (T_2 - T_1) - (T_4 - T_3)}{(T_5 - T_4)}$$

Note $C_p(T_4 - T_3) < C_p(T_2' - T_2)$

Here heat supply and output both increases as compared to simple cycle. Because the increase in heat supply is proportionally more, η decreases.

With multiple inter-cooling and multiple reheat, the compression and expansion processes tend to be isothermal as shown in Figure 5.3