**4.8. Atkinson Cycle:**

Atkinson cycle is an ideal cycle for Otto engine exhausting to a gas turbine. In this cycle the isentropic expansion (3-4) of an Otto cycle (1-2-3-4) is further allowed to proceed to the lowest cycle pressure so as to increase the work output. With this modification the cycle is known as Atkinson cycle. The cycle is shown on p-v and T-s diagrams in Fig.4.8. Processes involved are:

- **Process 1-2:** Reversible adiabatic compression ($v_1$ to $v_2$).
- **Process 2-3:** Constant volume heat addition.
- **Process 3-4:** Reversible adiabatic expansion ($v_3$ to $v_4$).
- **Process 4-1:** Constant pressure heat rejection.
**Thermal Efficiency:**

Heat supplied = $C_v (T_3 - T_2)$
Heat rejected = $C_p (T_4 - T_1)$
Net work done = $C_v (T_3 - T_2) - C_p (T_4 - T_1)$

\[
\eta_{th} = \frac{C_v (T_3 - T_2) - C_p (T_4 - T_1)}{C_v (T_3 - T_2)}
\]

\[
= 1 - \frac{\gamma (T_4 - T_1)}{(T_3 - T_2)}
\]

Let, $r = \frac{v_1}{v_2} = CR$

\[
T_2 = T_1 r^{\gamma - 1}
\]

\[
\frac{T_3}{T_2} = \frac{P_3}{P_2} = r_p = \text{Pressure ratio}
\]
\[ T_3 = T_2 r_p = T_1 r_p^{\gamma - 1} r_p \]

\[ \frac{T_3}{T_4} = \left( \frac{P_3}{P_4} \right)^{\gamma - 1} \gamma = \left( \frac{P_3}{P_1} \right)^{\gamma - 1} \gamma = \left( \frac{P_2}{P_1} \right)^{\gamma - 1} \gamma = \frac{r_p^{\gamma - 1}}{r_p^{\gamma - 1}} \right) r_p^{\gamma - 1} \]

since,

\[ \frac{P_2}{P_1} = \left( \frac{v_1}{v_2} \right)^{\gamma} = r_p^{\gamma} \]

and

\[ T_4 = \frac{T_3}{r_p^{\gamma - 1}} = \frac{T_1 r_p^{\gamma - 1}}{r_p^{\gamma - 1}} = T_1 \frac{1}{r_p^{\gamma}} \]

\[ \eta_{th} = 1 - \gamma \left[ \frac{\frac{1}{r_p^{\gamma}} - 1}{(r_p - 1)r_p^{\gamma - 1}} \right] \]