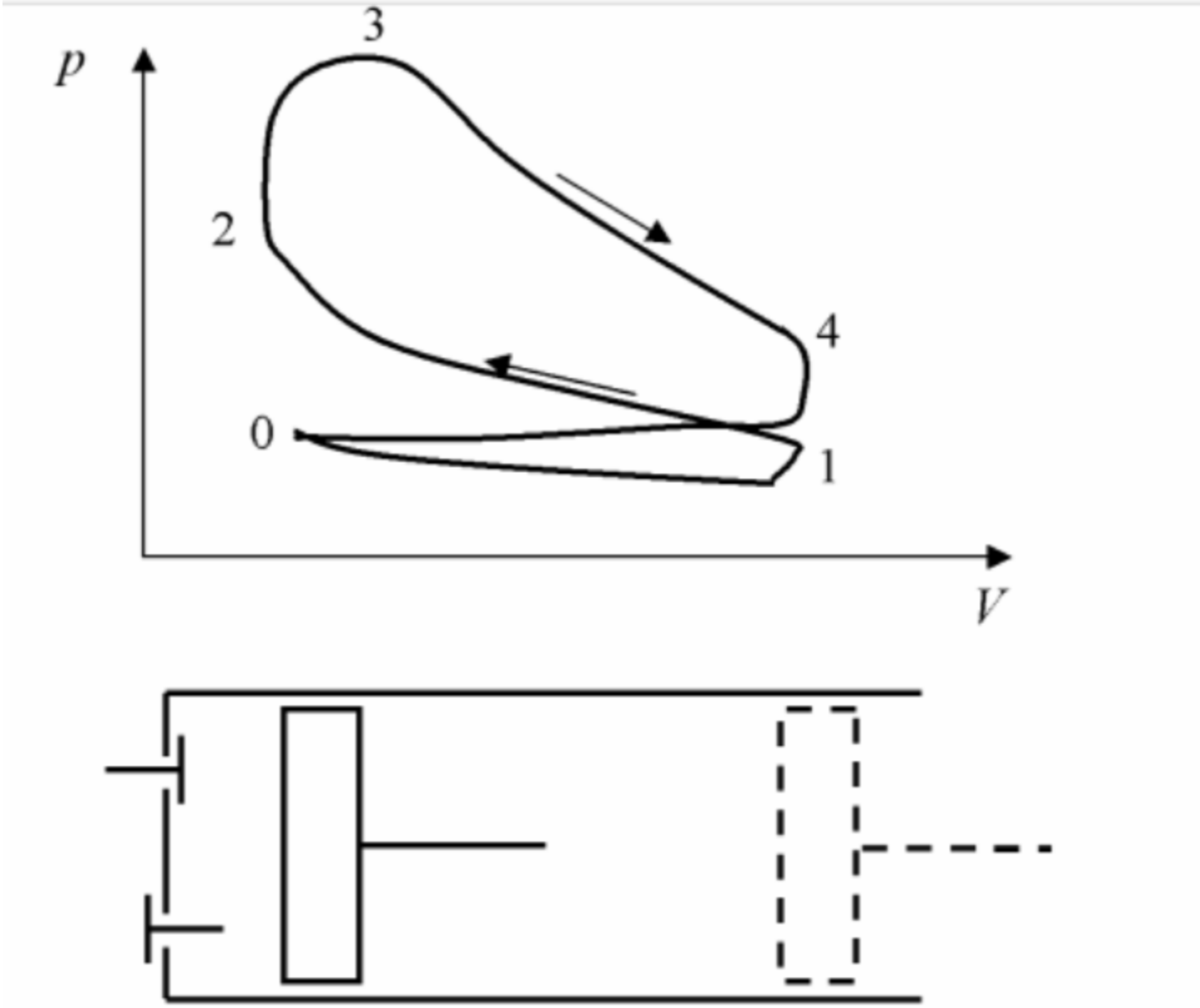
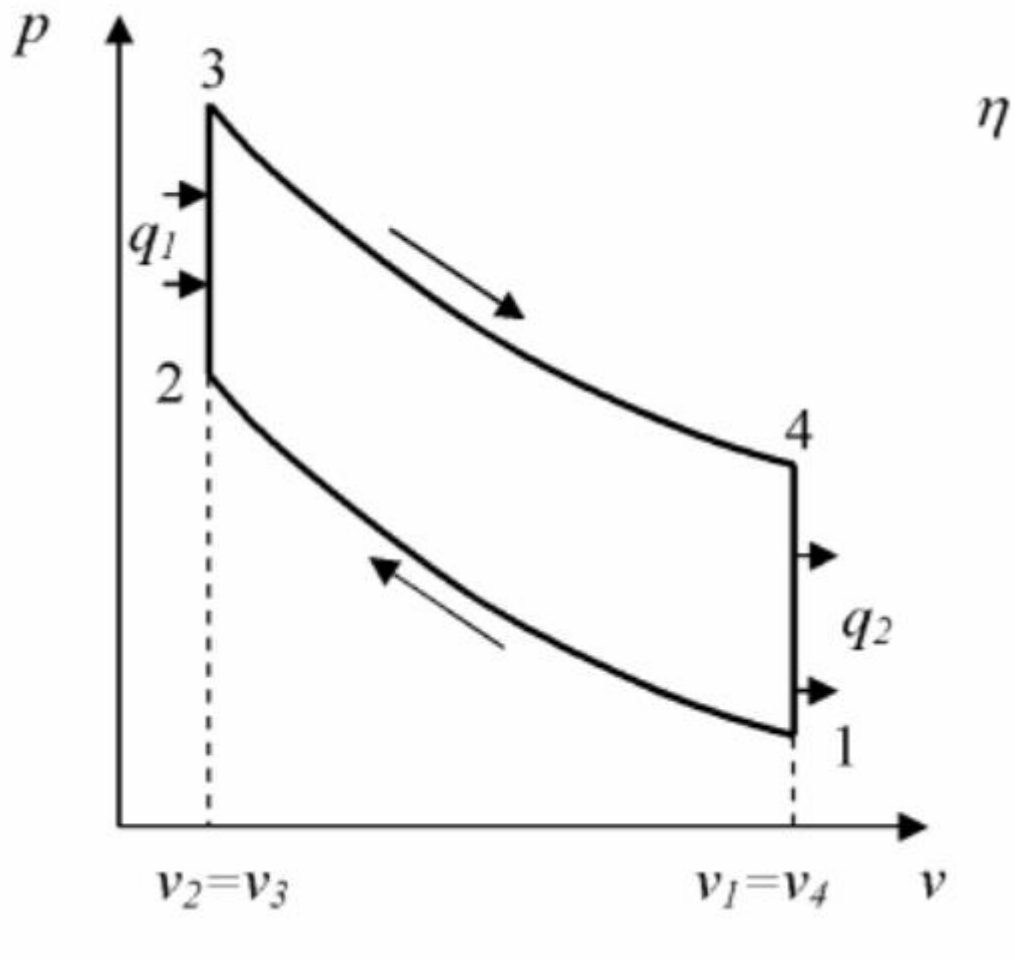
# Техникалық термодинамика

лектор: физ.мат.ғ.к. Мукамеденкызы В.

# Іштен жану поршенді двигателі циклы. Жылу шығарудың изохорлы циклы (Отто циклы). Жылу шығарудың изобарлы циклы (Дизел циклы). Жылу шығарудың аралас циклы


p
3
2
4
0
1
V

# ОТТО циклы




$$\eta = 1 - \frac{q_2}{q_1} = 1 - \frac{c_v(T_4 - T_1)}{c_v(T_3 - T_2)} = 1 - \frac{T_4 - T_1}{T_3 - T_2} = 1 - \frac{T_4/T_1 - 1}{T_3/T_2 - 1} \cdot \frac{T_1}{T_2} .$$

$$\frac{T_1}{T_2} = \left(\frac{v_2}{v_1}\right)^{k-1} = \left(\frac{1}{\varepsilon}\right)^{k-1} .$$

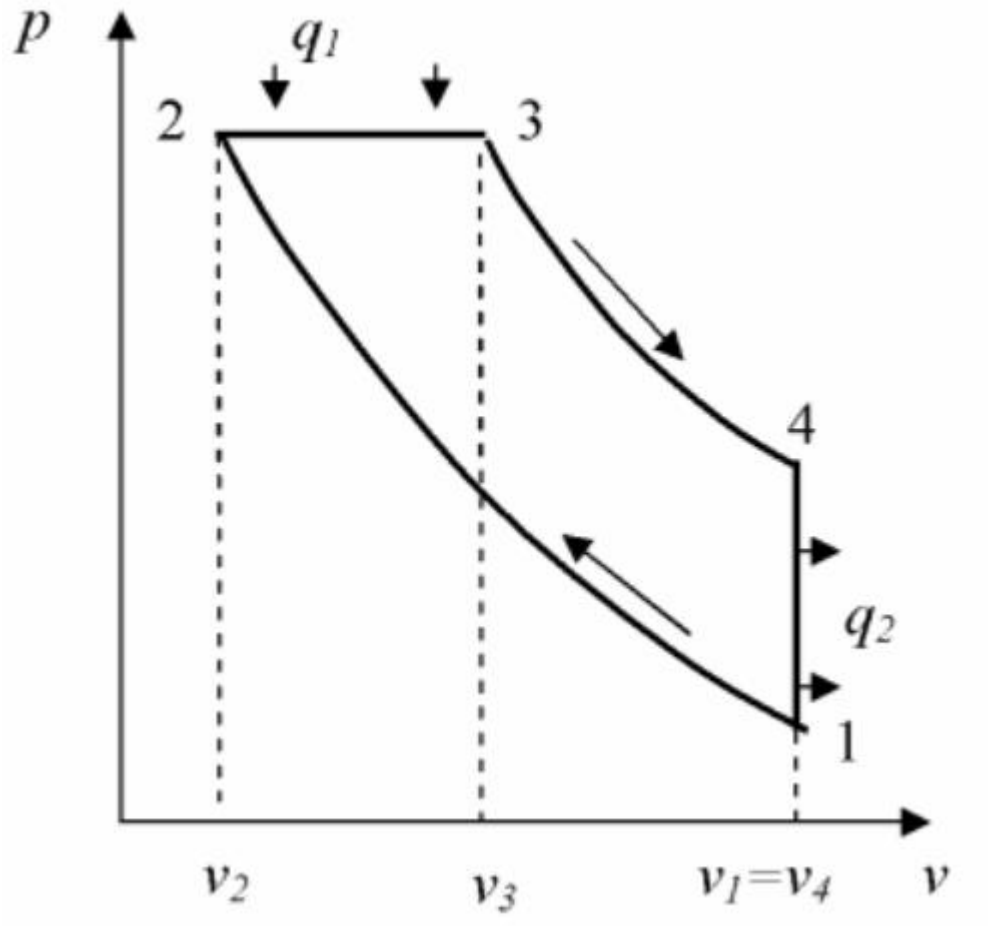
$$T_4 v_4^{k-1} = T_3 v_3^{k-1},$$
$$T_1 v_1^{k-1} = T_2 v_2^{k-1},$$
$$v_1 = v_4, \quad v_3 = v_2,$$

$$\boxed{\eta = 1 - \frac{1}{\varepsilon^{k-1}} .}$$

$$l = l_{расш} - l_{сж} = \frac{1}{k-1}\left[(p_3 v_3 - p_4 v_4) - (p_2 v_2 - p_1 v_1)\right],$$

$$l = q_1 \cdot \eta = c_v (T_3 - T_2)\left(1 - \frac{1}{\varepsilon^{k-1}}\right).$$

# ДИЗЕЛЬ циклы




$$\eta = 1 - \frac{q_2}{q_1} = 1 - \frac{c_v(T_4 - T_1)}{c_p(T_3 - T_2)} = 1 - \frac{1}{k} \cdot \frac{T_4/T_1 - 1}{T_3/T_2 - 1} \cdot \frac{T_1}{T_2} .$$

$$p_1 v_1^k = p_2 v_2^k,$$
$$p_4 v_4^k = p_3 v_3^k.$$

$v_4 = v_1$ и $p_2 = p_3$,

$$\frac{p_4}{p_1} = \left(\frac{v_3}{v_2}\right)^k .$$

$$\frac{p_4}{p_1} = \frac{T_4}{T_1} = \left(\frac{v_3}{v_2}\right)^k = \rho^k .$$

$$\boxed{\eta = 1 - \frac{1}{k} \cdot \frac{\rho^k - 1}{\rho - 1} \cdot \frac{1}{\varepsilon^{k-1}} .}$$

$$l = l_{расш} - l_{сж} = p_2(v_3 - v_2) + \frac{1}{k-1}\left[(p_3 v_3 - p_4 v_4) - (p_2 v_2 - p_1 v_1)\right],$$

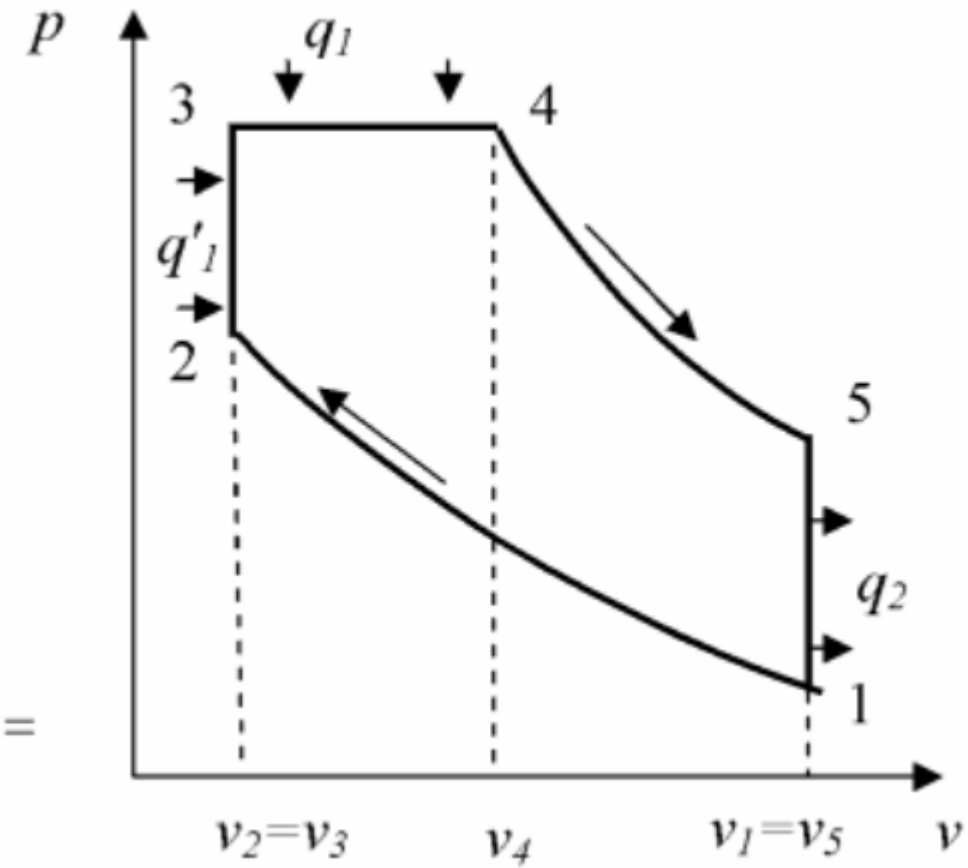
$$l = q_1 \cdot \eta = c_p(T_3 - T_2)\left(1 - \frac{\rho^k - 1}{k\varepsilon^{k-1}(\rho - 1)}\right).$$

$$\eta = 1 - \frac{q_2}{q_1} = 1 - \frac{q_2}{q_1' + q_1''} \ .$$

$$q_1' = c_v(T_3 - T_2) \ .$$

$$q_1'' = c_p(T_4 - T_3) \ .$$

$$q_2 = c_v(T_5 - T_1) \ .$$




$$\eta = 1 - \frac{c_v(T_5 - T_1)}{c_v(T_3 - T_2) + c_p(T_4 - T_3)} = 1 - \frac{T_5 - T_1}{(T_3 - T_2) + k(T_4 - T_3)} =$$

$$= 1 - \frac{T_5/T_1 - 1}{(T_3/T_2 - 1) + k(T_3/T_2)(T_4/T_3 - 1)} \cdot \frac{T_1}{T_2} \ .$$

$$T_5 / T_1 = p_5 / p_1 \ .$$

$$p_1 v_1^k = p_2 v_2^k \ , \quad p_4 v_4^k = p_5 v_5^k$$

$$\frac{p_5}{p_1} = \frac{p_4}{p_2}\left(\frac{v_4}{v_2}\right)^k = \frac{p_3}{p_2}\left(\frac{v_4}{v_3}\right)^k = \lambda\rho^k \ ,$$

$$T_5 / T_1 = \lambda\rho^k \ .$$

$$T_3 / T_2 = p_3 / p_2 = \lambda \ ,$$

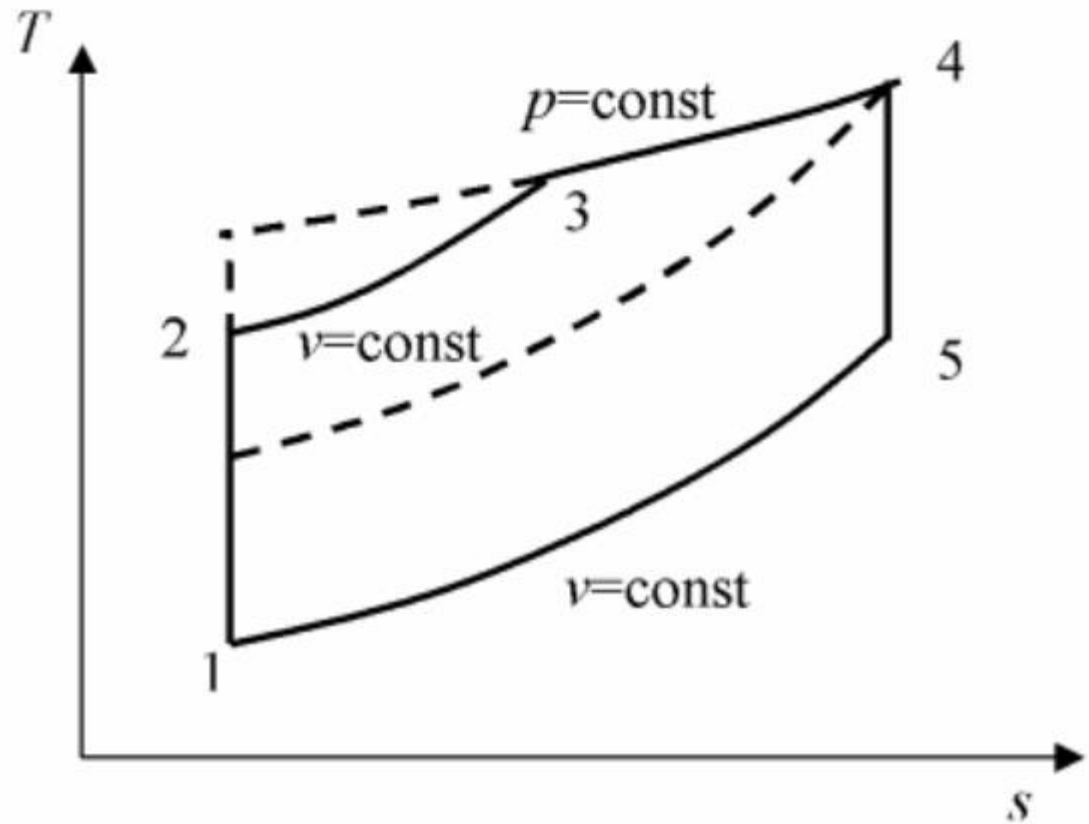
$$v_4 / v_3 = T_4 / T_3 = \rho \ ,$$

$$T_1 / T_2 = (v_2 / v_1)^{k-1} = (1/\varepsilon)^{k-1} = 1/\varepsilon^{k-1} \ .$$

$$\eta = 1 - \frac{\lambda\rho^k - 1}{(\lambda - 1) + k\lambda(\rho - 1)} \cdot \frac{1}{\varepsilon^{k-1}} \ .$$

$$\eta^p < \eta^{v+p} < \eta^v ,$$

$$\eta^p > \eta^{v+p} > \eta^v ,$$



$$l = l_{расш} - l_{сж} = p_4(v_5 - v_4) + \frac{1}{k-1}\left[(p_5 v_5 - p_3 v_3) - (p_2 v_2 - p_1 v_1)\right].$$