

# THEORY OF INTERNAL COMBUSTION ENGINES

## Topic 8: Power event.

### 8-Mavzu: Kengayish jarayoni.

#### Reja:

1. Haqiqiy sikldagi kengayish jarayonining o`ziga xosligi.
2. Issiqlikning devorlarga uzatilishi va yonilg`ining yonib tugashi.
3. Kengayish jarayonining poltropik ko`rsatkichi
4. Kengayish oxiridagi gazning termodinamik ko`rsatkichlari
5. Kengayish jarayoni kursatkichlarining amaldagi qiymatlari

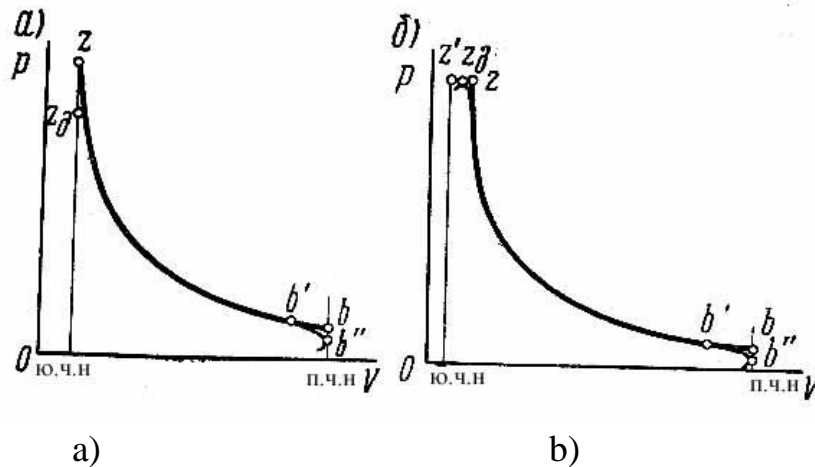
**Tayanch so`z va iboralar:** *kengayish jarayoni, kengayish jarayoni oxiridagi gaz bosimi, kengayish jarayonidagi gaz harorati, indikator diagramma, siklning indikator ishi, o`rtacha nazariy indikator bosim, xaqiqiy indikator bosim, indikator quvvat, indikator yonilg`i sarfi va foydali ish koeffitsienti.*

#### 1.1. Haqiqiy sikldagi kengayish jarayonining o`ziga xosligi. Issiqlikning devorlarga uzatilishi va yonilg`ining yonib tugashi.

Kengayish jarayoni yonilg`ining yonishidan hosil bo`lgan issiqlikni mexanik energiyaga aylantirish uchun xizmat qiladi. Dvigatel ishchi siklining qolgan kiritish, qisish va chiqarish tashkil etuvchi jarayonlari porshienning ishchi yo`lini tayyorlovchi jarayonlar hisoblanadi.

Kengayish jarayonida issiqlikning bir qismi silindrlar, blok qopqog`i, porsheng`, klapan va boshqa qismlarga uzatiladi, bir qismi mexanik energiyaga aylanadi, bir qismi mexanik isroflarga, sovitish va moylash tizimlariga uzatiladi. SHu sababli kengayish jarayoni davomida silindr ichidagi gazning bosimi va harorati porshen P.CH.N. ga yetgunga qadar kamayib boradi [1].

Kengayish jarayonida silindr ichidagi bosimning pasayishi 8.1-rasmdagi chizma shakllardan ko`rish mumkin.



8.1-rasm. Kengayish jarayonida silindr ichidagi bosimning o'zgarish shakli: a-karbyuratorli dvigatelda, b-dizel dvigatelda [1].

Kengayish jarayoni boshlanganda klapanlar yopiq bo'ladi. Porshen Yu.CH.N. ga yaqinlashganda chiqarish klapani (B') nuqtada ochiladi va P.CH.N. oxiri V nuqttagacha silindr ichidagi gazning bosimi kamayib boradi. Silindr ichidagi gazning (B) nuqtadagi ( $P_b$ ) bosimi, atmosfera ya'ni tashki havo bosimi  $P_0$  dan bir oz yuqori bo'ladi.

## 1.2. Kengayish jarayonining politropik ko'rsatkichiga marom omillarining ta'siri.

Kengayish jarayoni chizigi (ZB) politropik chiziq bo'lib, uning qiymati dvigatel turlari bo'yicha quyidagicha aniqlanadi [2]:

Karbyuratorli dvigatel uchun

$$n_2 = 1.22 + 130/n ; \quad (1.23 \dots\dots 1.30)$$

Dizel dvigatel uchun:

$$n_2 = \lg \frac{P'_1}{P'_2} \bigg| \lg \frac{V'_2}{V'_1} ; \quad (1.18 \dots\dots 1.28)$$

bu yerda, n-dvigatel tirsakli valining aylanish chastotasi,  $P_1$ ,  $P_2$  va  $V_1$ ,  $V_2$  – ko'rinib yonishning oxiri, va chiqarish klapani ochilish paytiga mos tushadigan bosimlar va hajimlar [2].

## 1.3. Kengayish oxiridagi gazning termodinamik ko'rsatkichlari

Kengayish jarayoni oxiridagi gaz bosimining qiymatini gaz holatining politrop tenglamasidan foydalanib aniqlanadi [2]:

$$P \cdot V^{n_2} = const$$

Bu tenglamani kengayish boshlanishi (Z) va kengayish oxiri (V) nuqtalar uchun yozamiz;

$$P_z \cdot V_z^{n_2} = const \quad \text{va} \quad P_b \cdot V_b^{n_2} = const$$

Tenglamalarning o'ng tomonlarini tengligidan quyidagi ifodani yozamiz [3]:

$$P_z \cdot V_z^{n_2} = P_b \cdot V_b^{n_2}$$

Bu tenglamadan kengayish jarayoni oxiridagi bosimni aniqlaymiz:

$$P_b = \frac{P_z \cdot V_z^{n_2}}{V_b^{n_2}} = P_z \left( \frac{V_z}{V_b} \right)^{n_2}.$$

a) karbyuratorli dvigatel uchun  $V_z = V_c$  va  $V_v = V_a$  ekanligini ehtiborga olsak, ifodani o'rniga qo'yib quyidagini hosil qilamiz:

$$P_b = P_z \left( \frac{V_z}{V_b} \right)^{n_2} = P_z \left( \frac{V_c}{V_a} \right)^{n_2} = P_z \left( \frac{1}{\frac{V_a}{V_c}} \right)^{n_2} = P_z \left( \frac{1}{\varepsilon} \right)^{n_2} = \frac{P_z}{\varepsilon^{n_2}},$$

demak,  $P_b = P_z / \varepsilon^{n_2}$ , MPa

Xulosa: Kengayish oxiridagi gazning bosimi ( $P_b$ ) yonish jarayoni oxiridagi bosim ( $P_z$ ) ga to'g'ri, siqish darajasi ( $\varepsilon$ ) va politrop ko'rsatkichi ( $n_2$ ) ga teskari bog'langan ekan [3].

b) dizel dvigatel uchun  $V_z = \rho V_c$ ,  $V_v = V_a$  va  $\delta = \varepsilon / \rho$ , ekanligini ehtiborga olsak, ifodani o'rniga qo'yib quyidagini hosil qilamiz:

$$P_b = P_z \left( \frac{V_z}{V_b} \right)^{n_2} = P_z \left( \frac{\rho V_c}{V_a} \right)^{n_2} = P_z \left( \frac{\rho}{\frac{V_a}{V_c}} \right)^{n_2} = P_z \left( \frac{\rho}{\varepsilon} \right)^{n_2} = \frac{P_z}{\delta^{n_2}},$$

demak,  $P_B = \frac{P_z}{\delta^{n_2}}$ , MPa.

Xulosa: Dizel dvigatelda kengayish oxiridagi gazning bosimi ( $P_b$ ) gazning dastlabki kengayish darajasiga ( $b$ ) va politrop ko'rsatkichga ( $n_2$ ) teskari hamda yonish oxiridagi ( $P_z$ ) bosim bilan to'g'ri bog'langan ekan.

Kengayish jarayoni oxiridagi gazning haroratini ( $T_b$ ) aniqlash uchun gaz holatining xarakteristik tenglamasidan foydalanib aniqlaymiz:

Gaz holatining xarakteristik tenglamasi quyidagicha bo'ladi:

$PV = 8314 T M$ . Bu tenglama (Z) va (V) nuqtalar uchun quyidagicha [1]:

$$P_z V_z = 8314 \cdot T_z M_z \quad \text{va} \quad P_b V_b = 8314 \cdot T_b M_b \quad \text{bo`ladi,}$$

bundan  $M_z \approx M_b$  bo`lgani uchun,  $\frac{P_z V_z}{T_z} = \frac{P_b V_b}{T_b}$  ni hosil qilamiz, bu tenglikdan

( $T_b$ ) ni qiymatini aniqlaymiz:

$$T_b = T_z \frac{P_b V_b}{P_z V_z}.$$

a) karbyuratorli dvigatel uchun:  $V_z = V_c$ ;  $V_b = V_a$  ekanligini ehtiborga olib quyidagini hosil kilamiz:

$$T_b = T_z \frac{P_b V_b}{P_z V_z} = T_z \cdot \left( \frac{P_z V_a}{\varepsilon^{n_2} \cdot P_z V_z} \right) = T_z \cdot \left( \frac{V_a}{V_c} \right) = T_z \cdot \left( \frac{\varepsilon}{\varepsilon^{n_2}} \right) = \frac{T_z}{\varepsilon^{n_2-1}},$$

$$\text{demak, } T_b = \frac{T_z}{\varepsilon^{n_2-1}}, \text{K} \quad (8.5)$$

Xulosa: Kengayish oxiridagi gazning harorati ( $T_b$ ) yonish oxiridagi haroratga ( $T_z$ ) to`g`ri va siqish darajasi ( $\varepsilon$ ) va politrop ko`rsatkichiga ( $n$ ) teskari bog`langan ekan [4];

b) dizel dvigateli uchun  $V_z = \rho V_c$  va  $V_b = V_a$  ekanligini ehtiborga olib, uni o`rniga quyib quyidagini hosil kilamiz:

$$T = T_z \cdot \frac{P_b V_b}{P_z V_z} = T_z \cdot \frac{P_z V_a}{\delta^{n_2} \cdot P_z \cdot \rho \cdot V_c} = T_z \cdot \frac{V_a / V_c}{\delta^{n_2} \cdot \rho} = T \cdot \frac{\varepsilon}{\delta^{n_2} \cdot \rho} = T_z \cdot \frac{\delta}{\delta^{n_2}} = \frac{T_z}{\delta^{n_2-1}},$$

$$\text{demak, } T_b = \frac{T_z}{\delta^{n_2-1}}, \text{K} \quad (8.6)$$

Xulosa: Kengayish oxiridagi haroratni ( $T_b$ ) yonish oxiridagi haroratga ( $T_z$ ) to`g`ri, kengayish darajasiga ( $b$ ) va politrop ko`rsatkichiga ( $n_2$ ) teskari bog`langan ekan [5].

Kengayish jarayoni kursatkichlarining amaldagi qiymatlari 8.1-jadvalda keltirilgan:

Kengayish jarayoni kursatkichlari

8.1-jadval

Dvigatel turi	$n_2$	$\epsilon_b$ , MPa	$T_b$ , K
Karbyuratorli	1,23-1,3	0,35-0,60	1400-1700
Dizel	1,18-1,28	0,20-0,50	1000-1400

Jadvaldan ma'lumki, karbyuratorli dvigatellarda kengayish ohirida gazning bosimi va harorati dizelga nisbatan yuqori bo`ladi [6].

### FOYDALANILGAN ADABIYOTLAR

1. B.A.Qayumov, J.Q.Mirzaxamdov. “Issiqlik texnikasi va ichki yonuv dvigatellari” fanidan o'quv uslubiy majmua. AndMI, 2022.
2. U.Karimov. “Traktor va avtomobil dvigatellari nazariyasi”. Toshkent, Mehnat, 1989.
3. Кодиров С.М. “Автотрактор двигателлари” - Тошкент, “Toshkent Tezkor bosmaxonasi”, 2010. — 572 б.
4. Lukanin V.N. va boshq. M.Fayziyev va boshq. Tarjimasi. “Ichki yonuv dvigatellari”.-T.: “Turon-Iqbol”, 2007- 608 b.
5. S.M. Kadirov, N.K. Paswan. “Internal combustion engines”. APH Publishing Corporation. New-Delhi-110002.2013.
6. To'layev B. “Ichki yonuv motorlari nazariyasi va dinamika asoslari”. T.: “Fan va texnologiya”, 2010. 294b.