ICHKI YONUV DVIGATELLARI NAZARASI

(Theory of Internal Combustion Engines)

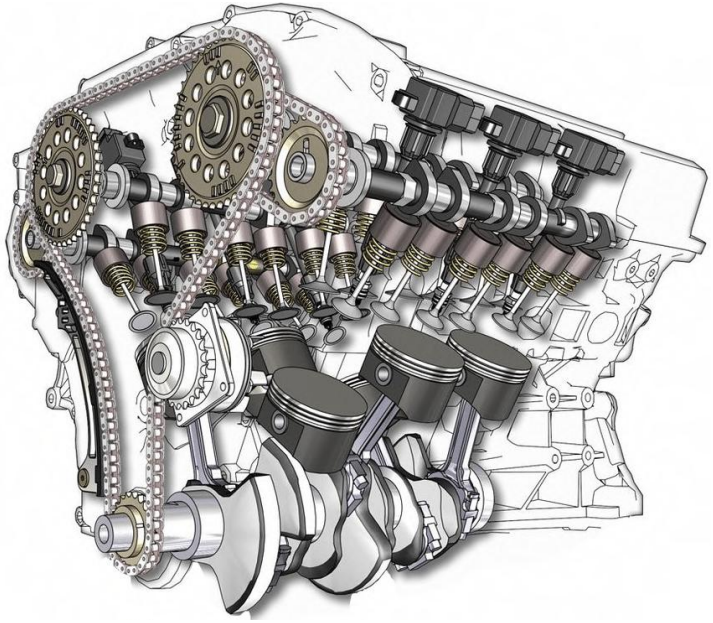

Photo source: https://www.researchgate.net/figure/Illustration-of-a-V6-internal-combustion-engine_fig1_339612888

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6-Mavzu: Siqish jarayoni.
(Topic 6: Compression event).

Reja:

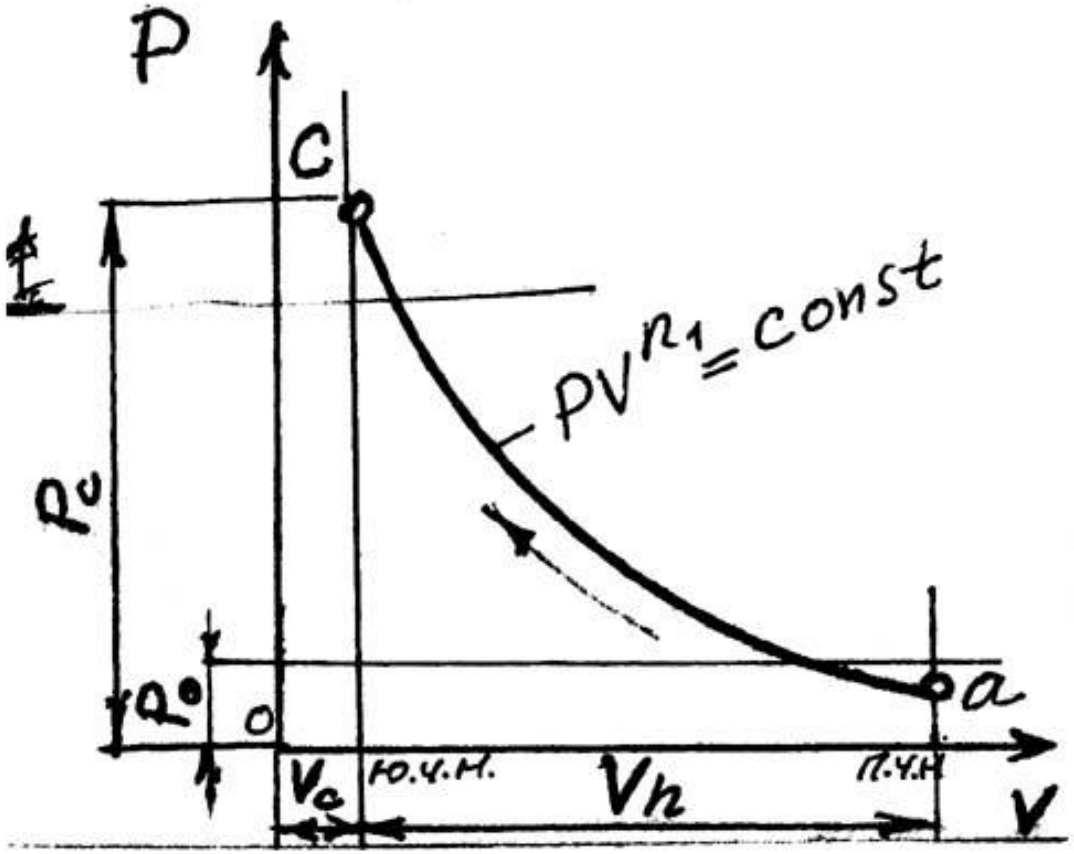
1. Siqish jarayonining vazifasi, bajarilish mohiyati va ko`rsatkichlari;
2. Siqish jarayoni oxiridagi ishchi jismning bosimi va haroratini aniqlash;
3. Siqish jarayonining politropik ko`rsatkichi;

Siqish jarayoni

Siqish jarayoni - yonuvchi aralashmasining hajmini kamaytirish natijasida uning ichki energiyasini ko`paytirib, uni yonishga tayyorlaydi. Porshen p.ch.n. dan yu.ch.n. tomon siljiganda aralashma siqiladi. Bu vaqtda kiritish va chiqarish klapanlari yopiq bo`ladi.

Photo source:
https://www.mechanicalbooster.com/2014/02/how-does-four-stroke-petrol-engine-works.html/intake-stroke-copy-1

Siqish jarayoni PV diagrammasi



To’rt taktli dvigatelning siqish jarayoni diagrammasi [1]

Siqish jarayoni boshlanishida ishchi jism harorati, silindr-porshen guruhi qismlarining o`rtacha haroratidan past bo`ladi, shuning uchun bu paytda silindr devorlaridan ishchi jismga issiqlik beriladi. Siqish jarayoni yana davom etganda ishchi jismning harorati va bosimi ko`tariladi. Natijada,silindrdagi ishchi jism harorati silindr-porshen guruhi qismlarining o`rtacha haroratidan yuqori bo`ladi. SHuning uchun siqish jarayonini **o`zgaruvchan politropli ko`rsatkich**da bajargan ishi **o`zgarmas politropli ko`rsatkich**da bajargan ishiga teng deb qabul qilinadi [1]

O`zgarmas ko`rsatkichli politropli siqish jarayoning tenglamasi quyidagi kurinishga ega bo`ladi:

$$PV^{n_1} = const$$

bu yerda k_1-siqish jarayoning politropli ko`rsatkichi

$PV^{k_I} = const$ ifodadan foydalanib, siqish jarayonni boshlanish p.ch.n. nuqta (a) va jarayoni tugash yu.ch.n. nuqta (s) uchun politropli tenglamalarni yozamiz:

$$P_a V_a^{n_I} = const \qquad P_c V_c^{n_I} = const$$

bu tenglamalardan quyidagi tenglikni keltirib chqaramiz:

$$P_a V_a^{n_I} = P_c V_c^{n_I}$$

bu tenglamadan foydalanib siqish jarayoni oxiridagi (Pc) bosimni aniqlaymiz:

$$P_c = P_a \left(\frac{V_a}{V_c} \right)^{n_I},$$ bunda $$\frac{V_a}{V_c} = \varepsilon$$ bo`lgani uchun, $$P_c = P_a \varepsilon^{n_I}, MPa$$

Siqish jarayoni oxiridagi bosim

Zamonaviy avtomobil va traktor dvigatellarida siqish oxiridagi bosim quyidagi oraliqlarda bo’ladi:

Elektron purkaladigan dvigatellarda:	P_a = 1.0 ..... 2.5 MPa
Korbyuratorli dvigatellarda:	P_a = 1.0 ..... 2.5 MPa
Nadduvsiz tezyurar dizellarda:	P_a = 3.5 ..... 5.5 MPa
Nadduvli va porsheni sovutiladigan dizellarda	P_a = 5.5 ..... 9.0 MPa (va undan yuqori) [6].

Siqish oxiridagi (Ts) harorat, **gaz holatining xarakteristik tenglmmasi**dan foydalanib aniqlanadi.

Gaz holatining xarakteristik tenglamasi quyidagi ifoda bilan yoziladi:

$$PV = 8314\ MT$$

bu yerda: M, T -gazning massasi va harorati.

Bu tenglamadan foydalanib ishchi jismning siqish boshlanishi p.ch.n. nuqta (a) va siqishni tugashi yu.ch.n. nuqta (s) uchun gaz holatining xarakteristik tenglamalarini yozamiz:

$$P_a V_a = 8314\ M_a T_a \qquad P_c V_c = 8314\ M_c T_c$$

Siqish davomida silindrdagi ishchi jism massasini o`zgarmas $(M_c \cong M_a)$ deb qabul qilgan holda, birincha tenglamani ikkinchisiga bo`lib, hamda $\frac{V_a}{V_c} = \varepsilon$ va $P_c = P_a \varepsilon^{n_I}$ ekanligini e'tiborga olib, silindr ichidagi ishchi jismning **siqish jarayoni oxiridagi haroratini** quyidagicha aniqlanadi:

$$T_c = T_a \frac{P_c V_c}{P_a V_a} = T_a \frac{P_a \varepsilon^{n_I}}{P_a \frac{V_a}{V_c}} = T_a \frac{\varepsilon^{n_I}}{\varepsilon} = T_a \varepsilon^{n_I - 1}, K$$

$$T_c = T_a \varepsilon^{n_I - 1}, k$$

Politropli ko`rsatkichning o`rtacha qiymati adiabata va izoterma ko`rsatkichlari qiymatlarining oralig`ida bo`ladi. Aylanishlar chastotasi 3000…3200 ayl/min gacha bo`lgan dvigatellarni hisoblashda va ularni loyihalashda nI ni taxminiy qiymatini aniqlash uchun professor V.I.Petrovning empirik ifodasidan fodalanish mumkin [1]:

karbyuratorli dvigatellar uchun: $$n_I = 1.41 - \frac{100}{n}$$

dizellar uchun: $$n_I = 1.41 - \frac{100}{n} - (0.01...0.02)$$

Politropli ko`rsatkichning **aniq qiymatini** topish uchun esa, dvigatelning tajriba yo'li bilan olingan indikator diagrammadagi ko'rsatkichlardan foydalaniladi: [2]

$$n_1 = \lg \frac{P_2}{P_1} \Big/ \lg \frac{V_2}{V_1}$$

bu yerda P1, P2, va V1, V2 lar kiritish klapanining yopilishi va ko'rinib yonishni boshlanish paytiga mos tushadigan va indikator diagrammadan o'lchab olinadigan bosimlar va hajmlar.

Politropli ko`rsatkichning o`rtacha qiymatlari:

karbyuratorli dvigatellar uchun: 1,34…1,39;

dizel dvigatellar uchun: 1,28…1,42 ga teng bo`ladi [1].

Siqish jarayoni oxirdagi ishchi jismning o`rtacha molyar issiqlik sig'imi barcha turdagi dvigatelolar uchun quyidagi ifoda bilan aniqlanadi:

$$\overline{\mu C_{vc}} = 20{,}16 + 1{,}74 \cdot 10^{-3} T_c$$ kj/kmol.grad [1].

Qoldiq gazlarning mollar soni ushbu ifoda bilan aniqlanadi [1]:

$$M_r = \alpha \gamma_r L_н, кмол$$

Siqish jarayoni oxiridagi, yonish oldida bo`lgan ishchi jismning mollar soni quyidagicha aniklanadi:

$$M_c = M_1 + M_r, кмол$$

bu yerda M1-silindrga yangi kirgan ishchi jismning miqdori.

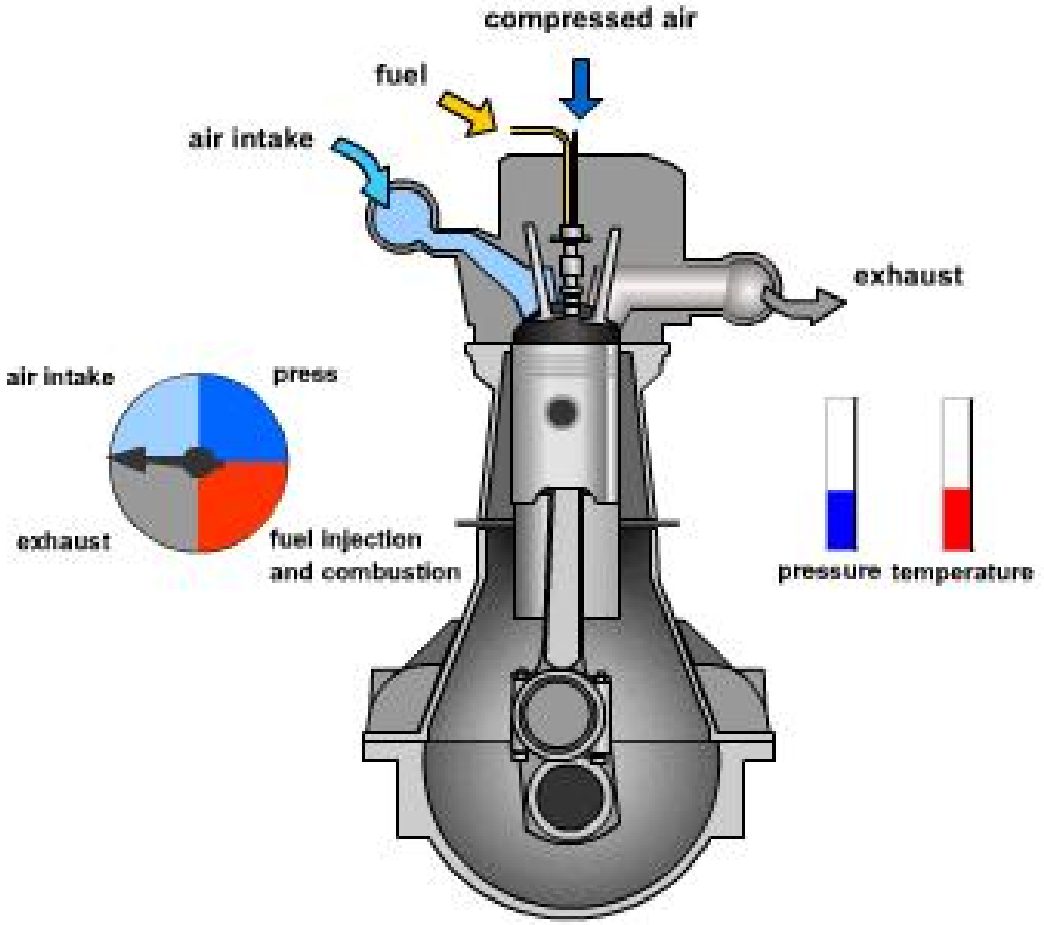
Silindrga yangi kirgan ishchi jismning miqdori

Silindrga yangi kirgan ishchi jismning miqdori quyidagicha aniklanadi:

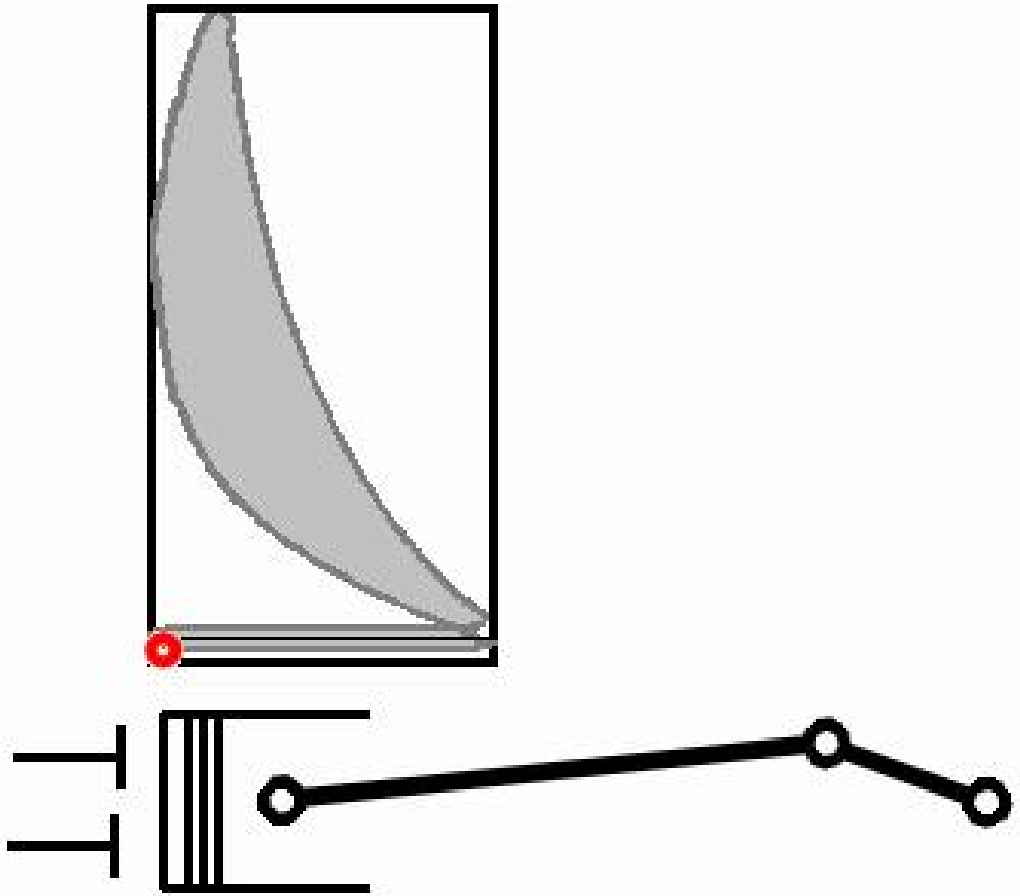
Karbyuratorli dvigatellar uchun $$M_1 = \alpha L_н + \frac{1}{\mu_ё}, кмол$$

Dizel dvigatel uchun $$M_1 = \alpha L_н, КМол$$

bu yerda $\mu_ё$ - yonilg`i massasi (benzin uchun $\mu_ё$ = 115kg/kmol ga teng)



Source: https://www.scienceabc.com/innovation/engine-knocking-octane-rating-fuel.html



Source: http://m5carblog.blogspot.com/2013/01/engine-thermodynamics.html

Nazorat savollari:

1. Siqish jarayoning vazifasi nimadan iborat?
2. Siqish jarayoning kanday ko`rsatkichlari bor?
3. Jarayonni sodir bo`lish mohiyatini tushuntiring.
4. Siqish jarayoni oxiridagi bosimni qaysi ifoda bilan aniqlanadi?
5. Siqish oxiridagi ishchi jismning haroratini qaysi ifoda bilan aniqlanadi?
6. Karbyuratorli dvigatel uchun o`rtacha politropli ko`rsatkich qanday aniqlanadi?
7. Dizel dvigatel uchun o`rtacha politropli ko`rsatkich qaysi ifoda bilan aniqlanadi?

Foydalanilgan adabiyotlar

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E’TIBORINGIZ UCHUN RAHMAT