

TOSHKENT SHAHRIDAGI TURIN POLITEXNIKA UNIVERSITETI
HUZURIDAGI ILMIY DARAJALAR BERUVCHI
PhD.22/01.02.2022 T.144.01 RAQAMLI ILMIY KENGASH

TOSHKENT SHAHRIDAGI TURIN POLITEXNIKA UNIVERSITETI

SHARIPOV ALISHER KALBAYEVICH

VODOROD-BENZIN YONILG'ISIDA ISHLAYDIGAN AVTOMOBILLAR
MOTOR MOYINING CHEGARAVIY ISH MUDDATINI ASOSLASH

TEXNIKA FANLARI BO'YICHA FALSAFA DOKTORI (PhD)
DISSERTATSIYASI AVTOREFERATI

Toshkent – 2024

**Texnika fanlari bo‘yicha falsafa doktori (PhD) dissertatsiyasi avtoreferati
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**Contents of dissertation abstract of Doctor of Philosophy (PhD) in technical
science**

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Falsafa doktori (PhD) dissertatsiyasi mavzusi O‘zbekiston Respublikasi Oliy ta‘lim, fan va innovatsiyalar vazirligi huzuridagi Oliy attestatsiya kamissiyasida B2023.4.PhD/T3763 raqam bilan ro‘yxatga olingan.

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KIRISH (falsafa doktori (PhD) dissertatsiyasi annotatsiyasi)

Dissertatsiya mavzusining dolzarbligi va zarurati. Jahonda avtomobillar uchun yonilg‘i manbai bo‘lgan neft mahsulotlariga yani benzin va dizelga talab juda oshib avtomobillardan chiquvchi zaharli gazlar miqdori 3.1% va 1% ga oshgan.¹ Avtomobillar ekspluatatsion ko‘rsatkichlarini oshirish va yonilg‘iga bo‘lgan tendensiyalarini tahlil qilish an-anaviy yonilg‘i turlari kamaytirish va qo‘shimcha sifatida alternativ yonilg‘i turlaridan jumladan ekologik toza, xavfsiz va arzon energiya manbai vodorod gazidan bosqichma-bosqich foydalanishni taqoza etmoqda. Alternativ vodorod gazi hozirda global energetika sektorida turli rivojlangan davlatlar tomonidan katta qiziqishni uyg‘otmoqda bu esa o‘z-o‘zidan kelajakda ommaviy alternativ yonilg‘i turidan foydalanib kengaytirib mavjud muommalarini hal etishga alohida e‘tibor qaratilmoqda.

Jahonda, benzin bazali avtomobillarda qo‘shimcha sifatida vodorod yonilg‘isi qo‘llagan holda, motor moyi chegaraviy ish muddatini aniqlash uchun resurs tejamkor texnologiyalar va texnika vositalarining yangi ilmiy texnikaviy yechimlari ishlab chiqishga yo‘naltirilgan ilmiy tadqiqot ishlari olib borilmoqda. Bu borada, motor moylarining parametrlarini chuqur statik tahlil qilish orqali dvigatelidan ishonchlilik ko‘rsatkichlarini sezilarli oshirishga xizmat qilmoqda. Vodorod yonilg‘isi o‘zining gidroskopik, fizik hamda kimyoviy xususiyatlari bilan avtomobil motor moylarining ishlash davomiyligini yaxshilashga qaratilgan texnologiya va usullarining ilmiy texnikaviy asosini yaratish va ilmiy asoslash dolzarb vazifalaridan hisoblanmoqda.

Respublikamizda so‘ngi yillarda g‘ildirakli avtomobillarda ishlatiladigan motor moylarining ishlash samaradorligini yaxshilashga hamda xizmat muddatini oshirishga qaratilgan texnologiyalarni integratsiya qilishga va avtomobil ekspluatatsiya davrida moylovchi materiallar sifatini yaxshilashga alohida e‘tibor qaratib kelinmoqda. O‘zbekiston Respublikasi Prezidentining 23.02.2024 yildagi PQ-82-sonli “Respublikamizda zamonaviy texnologiyalar asosida yashil vodorod ishlab chiqarishni tashkil qilish va iqtisodiyot tarmoqlarining ushbu mahsulotga bo‘lgan talabini qondirish” to‘g‘risidagi qaroriga muvofiq shu sohada ilmiy va amaliy izlanishlarning natijadorligini oshirish, innovatsion texnologiyalarni ishlab chiqishga keng joriy etish² hamda 18.03.2024 yildagi PQ-132-sonli O‘zbekiston Respublikasi Prezidentining “O‘zbekiston Respublikasida gibrid avtomobillarni ishlab chiqishni tashkil etish”³ nomli qarorlarida, jumladan qayta tiklanuvchi va vodorod energetikasini avtomobil sohasida keng rivojlantirish, mavjud muommalarga ma‘qbul yechim topish hamda avtomobil ishonchlilik xususiyatlarini oshirish yo‘lida motor moyining chegaraviy ish muddatini asoslash bo‘yicha muhim vazifalar belgilab berilgan. Mazkur vazifalarni amalga oshirishda, jumladan vodorod-benzin yonilg‘isida ishlaydigan avtomobillar motor moyining chegaraviy ish muddatini asoslash, vodorod-benzin aralashmasida ishlovchi dvigatel moyining eskirishiga olib keluvchi asosiy omillarni tanlash usuli ishlab chiqish muhim masalalardan biri hisoblanadi.

Ushbu ilmiy tadqiqot ishi O‘zbekiston Respublikasi Prezidentining 09.04.2021

¹ The Energy statistical review of world energy, 2023, 72th ed. KPMG.

² O‘zbekiston Respublikasi Prezidentining 23.04.2024 yildagi PQ-82-sonli qarori, <https://lex.uz/ru/docs/-6813831>

³ O‘zbekiston Respublikasi Prezidentining 18.03.2024 yildagi PQ-132-sonli qarori, <https://lex.uz/docs/6842792>

yildagi PQ-5063-sonli “O‘zbekiston Respublikasi qayta tiklanuvchi va vodorod energetikasini rivojlantirish chora-tadbirlari” tog‘risidagi qarorida qayta tiklanuvchi energiya manbalari va vodorodni ishlab chiqaruvchi, ulardan foydalanuvchi hamda ushbu turdagi energiya bilan ishlovchi uskuna, qurilma va texnologiyalarni sinovdan o‘tkazish, hamda O‘zbekiston Respublikasi Prezidentining 18.01.2022 yildagi PF-60-sonli farmonida 2022-2026 yillarga mo‘ljallangan yangi O‘zbekistonning taraqqiyot strategiyasi to‘g‘risidagi farmonidagi avtomobil ishlab chiqarish sohasiga ta’siri bo‘yicha ilmiy tadqiqotlar olib borish va mavjud muommalarni hal etishga yo‘naltirilgan meyoriy huquqiy hujjatlarda belgilangan vazifalarni amalga oshirishga ushbu dissertatsiya tadqiqoti muayyan darajada xizmat qiladi.

Tadqiqotning Respublika fan va texnologiyalari rivojlanishining ustuvor yo‘nalishlariga mosligi. Mazkur tadqiqot respublika fan va texnologiyalar rivojlanishining: II. “Energetika, energiya va resurs tejamkorlik, ustuvor yo‘nalishi doirasida bajarilgan. Fanlar akademiyasi, Energetika vazirligi, Innovatsion rivojlanish vazirligi, O‘zstandart agentliglarining 22.08.2019 yildagi PQ-4422-sonli O‘zbekiston Respublikasi Qarorining yo‘l xaritasidagi chora tadbirlariga hamda O‘zbekiston Respublikasi Prezidentining 09.04.2021 yildagi PQ-5063-sonli “O‘zbekiston Respublikasida qayta tiklanuvchi va vodorod energetikasini rivojlantirish chora-tadbirlari”ga mos keladi.

Muammoning o‘rganilganlik darajasi. Dunyo tajribasida avtomobil ekspluatatsiya davridagi sifatini yaxshilash maqsadida motor moylarining foydalanish xususiyatlari va chegaraviy ish muddatlarini tadqiq qilish masalasi bo‘yicha bir qator xorijlik olimlari ilmiy ishlar olib borishgan, jumladan, Marshall H.T., Oliver S.R. (AQSh), Williams K., Dyson A.(Buyuk Britaniya), Masahiko N., Takada M. (Yaponiya) va boshqalar. Yuqorida ko‘rsatib o‘tilgan olimlar ishlarini e’tirof etgan holda, aytish mumkinki, ularning ishlarida qo‘yilgan savol ya’ni, vodorod-benzin yonilg‘isida ishlaydigan avtomobillar motor moyining chegaraviy ish muddatini asoslash tadqiq qilinmagan.

O‘zbekiston Respublikasida qayta tiklanuvchi energetikasini rivojlantirish ishlab chiqarish jarayonlarini takomillashtirish uchun qurilmalar yaratish, texnologik jarayonlarni parametrlarini asoslash va takomillashtirish masalalari bo‘yicha tadqiqotlar Vereshagin V.I., Kovalskiy B.I., Runda M.M., Yanovich V.S., Bezborodov Yu.N., Ganja V.A., Morozov A.G., Grigorev M.A., Salimov A.U., Qadirov S.M., Lebedov O.V., Sharipov Q.A., Bazarov B.I., Musurmonov R.K. Musurmanov R.Q. va boshqa olimlar tomonidan moylovchi materiallar ishlash texnologik jarayonlarini modellashtirish, optimallashtirish va avtomatlashtirilgan boshqaruv tizimini takomillashtirish usul va algoritmlarini ishlab chiqish bo‘yicha salmoqli natijalarga erishganlar. Shu bilan birga, vodorod-benzin yonilg‘isida ishlaydigan avtomobillar motor moyining chegaraviy ish muddatini asoslash masalalari yetarli darajada o‘rganilmagan.

Dissertatsiya tadqiqotining dissertatsiya bajarilgan oliy ta’lim muassasasining ilmiy-tadqiqot ishlari rejalari bilan bog‘liqligi. Dissertatsiya tadqiqoti Toshkent shahridagi Turin Politehnika Universiteti hamda O‘zbekiston Respublikasi Innovatsion rivojlanish vazirligi hamkorligi asosida amaliy loyiha hamda “UzAutoMotors” AJ va Toshkent shahridagi Turin Politehnika Universiteti

hamkorligidagi ilmiy kengashning 2017 yil 21 sentyabrdagi 09/17-sonli majlis tadqiqot dasturi bilan bog‘liq.

Tadqiqotning maqsadi vodorod-benzin yonilg‘isida ishlaydigan avtomobillar motor moyining chegaraviy ish muddatini asoslashdan iborat.

Tadqiqotning vazifalari:

Avtomobil yonilg‘i ta‘minlash tizimida vodorod gazini qo‘shimcha sifatida o‘zaro uyg‘unlashuv usullari va zamonaviy holatini tahlil qilish hamda eksperimental tadqiqotlar o‘tqazish orqali yonilg‘i tejamkorligi va ekologik ko‘rsatkichlarini asoslash uslubini ishlab chiqish;

Vodorod-benzin yonilg‘i ta‘minlash tizimida avtomobil motor moyining maqbul eskirish matematik modelini nazariy tajribalar orqali asoslash;

Vodorod-benzin ta‘minotli avtomobilda motor moyining asosiy ekspluatatsion ko‘rsatkichlarini laboratoriya sharoitida sinash uslubini ishlab chiqish;

Tadqiqot natijalarini qo‘llash bo‘yicha tavsiyalar ishlab chiqish va joriy etishning iqtisodiy samaradorligini aniqlash;

Tadqiqotning obyekti sifatida vodorod-benzin dvigatelli avtomobil motor moyi olingan.

Tadqiqotning predmetini vodorod-benzin dvigatelli avtomobilning asosiy ekspluatatsion ko‘rsatkichlarining eskirishga bog‘liqlari tashkil qiladi.

Tadqiqotning usullari. Tadqiqot jarayonida klassik mexanika, matematik tahlil va matematik statistika usullari, nazariy mexanika, pog‘onali tajriba jarayonlarini kompyuterlashtirish (imitatsion va simulyatsiya) tizimlari orqali tahlil qilish usullari, avtomobil nazariyasi, sintez usullaridan foydalanilgan.

Tadqiqotning ilmiy yangiligi quyidagilardan iborat:

Frolov-Rodziller tenglamasini qo‘llash orqali qo‘shimcha vodorod gazi benzinli dvigatellarda optimal yonilg‘i proporsiyasini barqaror ishlash shartlari va turg‘unlik rejimlari asosida matematik model yaratilgan;

Regression-korrelyatsion tahlili asosida vodorod-benzinli dvigatel moylarining asosiy fizik-kimyoviy xossalarini ekspluatatsiya sharoitlarida chegaraviy shartlari aniqlangan;

Nyuton interpolatsion qonuniyati orqali vodorod-benzinli ichki yonuv dvigatel moyining chegaraviy ish muddati asosida matematik modeli optimallashtirilgan;

Motor moyiga vodorod-benzinli yonilg‘i ta‘sir mexanizmini hisobga olingan holda almashtirish muddatlari uchun tavsiyalar ishlab chiqilgan.

Tadqiqotning amaliy natijalari quyidagilardan iborat:

Benzin-vodorod-havo aralashmali yengil avtomobillar ekspluatatsion, texnik-iqtisodiy va ekologik ko‘rsatkichlarini yaxshilashga imkon beradigan aniq tarkibiy qismi takomillashtirilgan;

Avtomobil vodorod-benzin yonilg‘i taminlash tizimi ilmiy nazariy va tajriba sinovlariga asoslangan matematik modeli yaratilgan;

Vodorod-benzin bazali avtomobillar yonilg‘i moylash tizimida motor moyining asoslangan chegaraviy ish muddati ishlab chiqilgan;

Tadqiqot natijalarining ishonchliligi. Zamonaviy tadqiqot natijalarining ishonchliligi zamonaviy usul va vositalar yordamida amalga oshiriladi. Yonilg‘i ta‘minlash tizimi parametrlari va ish rejimlarining nazariy asoslanishi nazariy

mexanika va oliy matematika tamoyillariga asoslanadi, tajribalar natijalari matematik statistik usullar bilan qayta ishlanadi, nazariy va amaliy bilimlarning o‘zaro muvofiqligi tadqiqot natijalarini ishlab chiqarish jarayoniga kiritilganligi bilan izohlanadi.

Tadqiqot natijalarining ilmiy va amaliy ahamiyati. Tadqiqot natijalarining ilmiy ahamiyatiga ko‘ra avtomobil yonilg‘i ta‘minlash tizimi modellashtirish tili orqali matematik model integratsiya qilish usuli va analitik bog‘lanishlar o‘rtasida vazifalarini texnik, miqdor, qiymat indekslariga asoslangan chegaraviy ish muddati ishlab chiqildi;

Tadqiqot natijalarining amaliy ahamiyatiga ko‘ra mahalliy sharoitda avtomobil moylash tizimiga berilgan taklif va xulosalar, qo‘shimchalar asosida motor moyini eskirish belgilab berildi, hamda chegaraviy ish muddati asoslandi;

Tadqiqot natijalarini joriy qilinishi. Vodorod-benzin yonilg‘isida ishlaydigan avtomobillar motor moyining chegaraviy ish muddatini asoslashda:

“UzAvtosanoat” AJ – 2017 yil Qozoqistonning Astana shahrida o‘tkazilgan kelajak energiyasi mavzusidagi Astana-2017 xalqaro ixtisoslashtirilgan ko‘rgazmasida vodorod-benzin yonilg‘isi bilan ishlaydigan “Matiz” avtomobilini namoyish qilish vazifasi Turin politexnika universiteti jamoasiga yuklangan edi. (“UzAvtoMotors” AJ korxonasi 8-oktyabr 2021-yil ma‘lumotnomasi). Natijada Mazkur ko‘rgazmada universitet tadqiqotchi olimlari “Matiz” rusumli avtomobilning yonilg‘i ta‘minlash tizimini takomillashtirib, muaffaqiyatli qatnashildi;

Izlanishlar natijasida 2017-2021 yillar davomida alternativ yonilg‘i foydalanish ustida bir qancha nazariy va amaliy sinov ishlari olib borildi. Frolov-Rodziller tenglamasini qo‘llash orqali qo‘shimcha vodorod gazi benzinli dvigatellarda optimal yonilg‘i proporsiyasini barqaror ishlash shartlari va turg‘unlik rejimlari “Matiz” rusumli avtomobilning yonilg‘i ta‘minlash tizimiga joriy qilindi. (“UzAutoMotors” AJ korxonasi 8-oktyabr 2021-yil ma‘lumotnomasi). Natijada ichki yonuv dvigatel foydali ish koeffitsienti 5 % ga oshirish imkoni bergan;

Regression-korrelyatsion tahlili asosida vodorod-benzinli dvigatel moylarining asosiy fizik-kimyoviy xossalarni ekspluatatsiya sharoitlarida chegaraviy shartlari va ish muddatining eskirish tizimini eng maqbul algoritmi yaratildi va aniqlangan. Natijada dvigatel motor moyining fizik kimyoviy xususiyatlari nazariy va amaliy matematik statik tahlil asosida asosiy 4/10 tasi olindi, bunda eng e‘tiborli ko‘rsatkichi 6000-7000 km/soat bosib o‘tgan dvigatel motor moyi qovushqoqlik deb nomlash imkonini bergan;

Nyuton interpolyatsion qonuniyati orqali vodorod-benzinli ichki yonuv dvigatel moyining bosib o‘tgan km/soati ga qarab moylash materiallari eskirishining maqbul matematik modeli chegaraviy ish muddati optimallashtirilgan. (“UzAutoMotors” AJ korxonasi 8-oktyabr 2021-yil ma‘lumotnomasi); Natijada Chevrolet Genra G200 ichki yonuv dvigatelini standard va vodorod qo‘llagan holda 10 000 km masofa birlikda qancha sarf bo‘lishi nazariy va amaliy hisob kitob qilindi. Shahar sharoitida vodorod-benzin avtomobil 100 km masofani bosib o‘tganida 24 % yonilg‘i tejallishi imkonini yaratgan.

Ilmiy ish natija va algoritmlari vodorod-benzin yonilg‘isida ishlab chiqarish jarayoniga keng joriy qilish imkonini berdi (“UzAutoMotors” AJ korxonasi 8-oktabr

2021-yil ma'lumotnomasi). Natijada vodorod-benzin dvigatel bilan jihozlangan mahalliy sharoitdagi avtomobillarda motor moyi chegaraviy ish muddatini asoslash misolida dvigatelning ishchi hajmi 1.5l bo'lgan avtomobillarda olinadigan yillik iqtisodiy samaradorlik (bitta avtomobil misolida) 2736000 so'mni tashkil etishi imkonini yaratgan.

Tadqiqot natijalarining aprobatsiyasi. Tadqiqotning asosiy natijalari 2 ta xalqaro va 2 ta respublika ilmiy-amaliy anjumanlarida ma'ruza qilindi va muhokama qilindi.

Tadqiqot natijalarining e'lon qilinganligi. Dissertatsiya mavzusi bo'yicha umumiy 21 ta ilmiy ish chop etilgan, shulardan, O'zbekiston Respublikasi Oliy attestatsiya komissiyasining falsafa doktori (PhD) dissertatsiyalari asosiy ilmiy natijalarini chop etish tavsiya etilgan ilmiy nashrlarda 10 ta maqola, jumladan, 7 ta respublika va 2 ta chet el ilmiy jurnallarida nashr etilgan. Shulardan 1 ta maqola yuqori impakt faktorli jurnallarda nashr etilgan.

Dissertatsiya tuzilishi va hajmi. Dissertatsiya kirish, to'rtta bob, xulosa, foydalanilgan adabiyotlar ro'yxati va ilovalardan iborat. Dissertatsiya hajmi 120 betni tashkil etadi.

DISSERTATSIYANING ASOSIY MAZMUNI

Kirish qismida vodorod gazini avtomobillarda qo'llangan holda motor moyiga bo'lgan ta'siri dolzarbligi va zarurlik darajasi ilmiy asoslangan. Ishning asosiy maqsad va vazifalari, tadqiqot obyekti va predmeti, uning O'zbekiston Respublikasi fan va texnologiyalari rivojlanishining ustuvor yo'nalishlariga mosligi ko'rsatilgan. Ishning ilmiy yangiligi vodorod-benzin yonilg'isida ishlaydigan avtomobillar motor moyining chegaraviy ish muddatini asoslash asosiy natijalari, ularning ilmiy va amaliy ahamiyati asoslangan. Shuningdek dissertatsiya ishi natijalarining amaliyotga tadbiqu, mavzu bo'yicha nashr etilgan ishlar va uning tarkibiy tuzilishi bo'yicha umumiy ma'lumotlar yoritilgan.

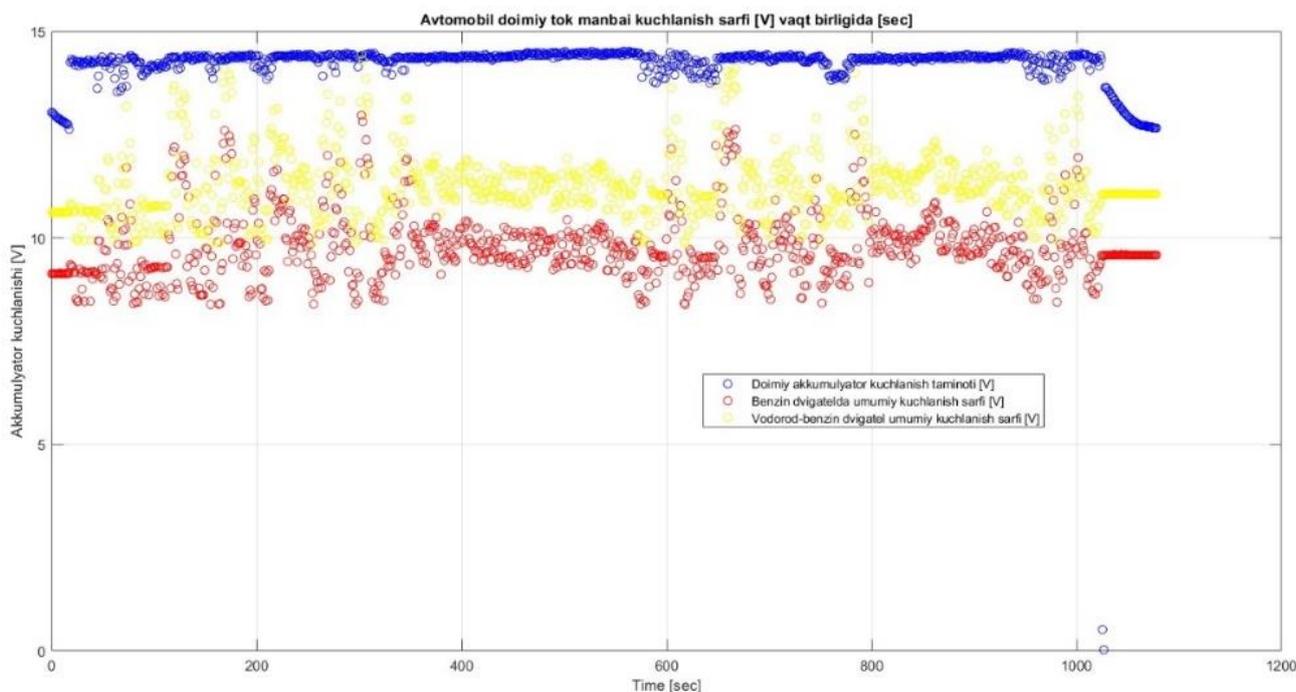
Dissertatsiya ishining «**Vodorod-benzin yonilg'isida ishlaydigan avtomobillar motor moyining mavjud holati**» nomli birinchi bobida mavjud vodorod-benzin yonilg'isida ishlaydigan avtomobillar tahlili, avtomobillarni gibrid vodorod gazi bilan birga ishlatishni ekologik asoslari va gibrid vodorod-benzin avtomobillarining dunyo bozoridagi ulushi hamda ularning energetik tahlili o'rganilgan. Shundan kelib chiqib, vodorod-benzin yonilg'isida ishlaydigan avtomobillarning energetik tahlili bo'yicha mavjud metodlar va muammo yechimi bo'yicha texnika-texnologiyalarning zamonaviy yutuqlari ko'rib chiqilgan. Neft mahsulotlarining 25% avtomobillar yonilg'i hom-ashyosiga to'g'ri keladi. Bulardan chiquvchi zaharli gazlarning 17% ekologiyani zararlantiruvchisidir.⁴ Vodorod ekologik toza, xavfsiz va arzon potentsiallariga ega yonilg'i gaz turi hisoblanadi. Alternativ vodorod gazini boshqa tur yonilg'ilar bilan solishtirib ko'radigan bo'lsak, benzin-450 °C, Propan-914 °C, metan-1003 °C, Vodorod-1085 °C ga to'g'ri keladi, vodorodning yonuvchanligi bir muncha yuqori qolgan tur yonilg'ilarga qaraganda, bu esa bevosita detonatsiya xavfini

⁴ Reitz RD, Ogawa H, Payri R, et al. IJER editorial: the future of the internal combustion engine. Int J Engine Res 2020.

kamaytiradi.⁵ Yonuvchanlik diapozoni solishtirish shuni ko‘rsatdiki: benzin-7.6:1.4, propan-10.1:2.1, metan-15:5, vodorod-75:4 nisbatlariga to‘g‘ri keladi, vodorod uchun optimal yonish sharoiti 29:1 hisoblanadi.⁶

Tadqiqotning **“Vodorod-benzin avtomobil motor moylarining chegaraviy ish muddatini asoslash bo‘yicha nazariy asoslar tadqiqot asoslari”** deb nomlangan ikkinchi bobida vodorod-benzin ichki yonuv dvigatellarida tadqiqot uchun motor moyini qo‘llash nazariy asoslari haqida yoritib o‘tilgan.

Vodorod gazi qo‘shimcha sifatida ichki yonuv dvigatellarida qo‘llashning fanga ma‘lum 3 ta turi bor. Bular, 1- ichki yonuv dvigateliga vodorod gazini to‘g‘ridan to‘g‘ri jo‘natish, keyingi ilmiy usulda ichki yonuv dvigateli slindr tashqarisida gazlar aralashmasini yonish kamerasiga jo‘natiladi. 3- usulda vodorod gazi qo‘shimcha sifati qo‘llash uchun maxsus injektorlardan foydalaniladi. Ilmiy ishda 2–usuldan foydalanildi. Vodorod boshqa tur qo‘shimcha gazlariga qaraganda deyarli har qanday haroratda yonuvchan, sababi 4 % havo aralashmasi ham yetarli hisoblanadi. Yonish jarayoni uchun 0.02 mJ (n.sh.) energiya talab etiladi, solishtirib ko‘rsatilsa benzin yonish uchun 240 mJ talab etiladi.



1-rasm. Avtomobil doimiy tok manbai sarfining qiyosiy tahlili.

Vodorod olishning xavfsiz va eng arzon usullaridan bo‘lgan elektrolizning LTE - (>200 °C) past haroratli – (low temperature electroliz), AE - (60-98 °C) alkani electrolysis (ishqorli), PEM – (50-80 °C) Proton exchange membrane (proton almashinish membranali), AEM – (40-80 °C) Anion exchange membrane (anion almashinish membranali), HTE – (700-100 °C) high temperature electroliz (yuqori temperaturadagi elektroliz) olish usullari malum bo‘lib. Tadqiqotda asosan energiya

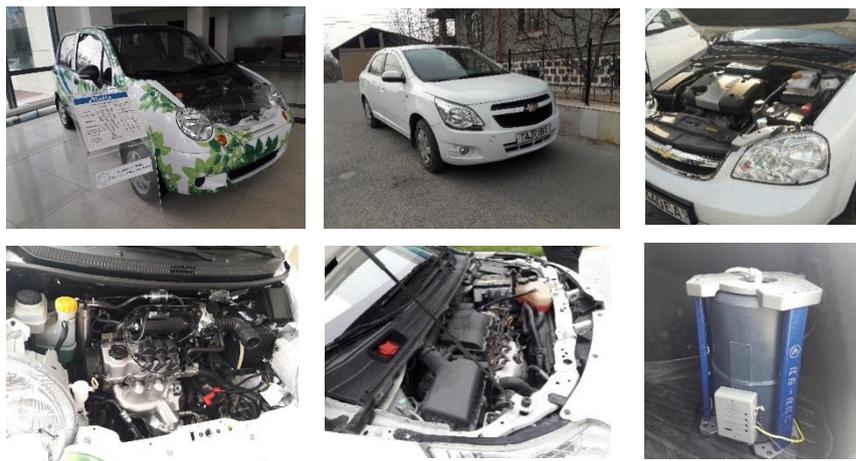
⁵ White C.M., Steeper R.R., Lutz A.E. The hydrogen-fueled internal combustion engine: a technical review. I.J. Hydrogen Energy 2006; 31(10):1292–305.

⁶ B. Lewis and G. von Elbe, Combustion, Flames and Explosions of Gases, 3rd ed., Academic Press, Orlando, 1987.

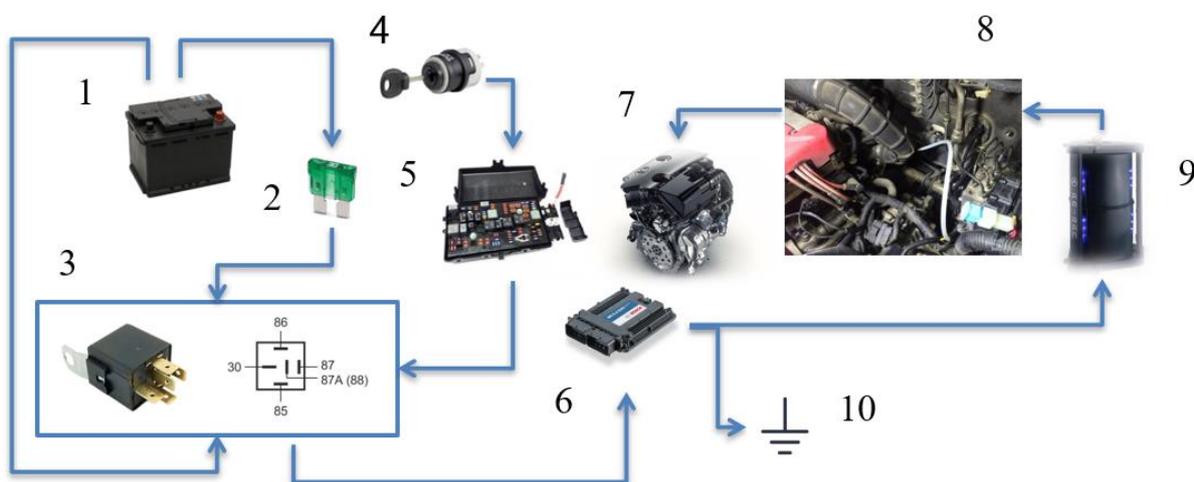
qiymatining foydali ish koeffitsienti 60-80 % lar atrofidagi AE – ishqorli vodorod olish usulidan foydalanildi. Nazariy asoslar tahliliga ko‘ra doimiy akkumulyotir tok manbaining 1 % sarfi bilan vodorod gazi qo‘shimcha olishga erishiladi.

Vodorod gazini qo‘llash usuli.

Amaliy tajribalar 2017-2020 yillar davomida yengil avtomobillarda olib borildi, bunda 30 ta yengil turdagi amaliy tajriba avtomobillaridan Chevrolet Cobalt, Chevrolet Matix, Chevrolet Lacetti 3 ta turkumidagi yengil tur avtomobillar tanlab olindi. Amaliy ish natijalari sarhisobi 2017–yil Qozoqiston Ostona shahridagi EXPO-2017 ko‘rgazmasida o‘z samarasini ko‘rsatdi.



2-rasm. Amaliy tajriba yengil turdagi avtomashinalar. Yengil turdagi avtomobillarda vodorod generatorini o‘rnatish amaliy test jarayonlari.



3-rasm. Vodorod-benzin yonilg‘i taminlash tizimi.

1-akkumulyotir, 2-peredoxranitil, 3-rele, 4-kalit, 5-rele panel, 6-RAM, 7-IYoD, 8-gazlar kirish kollektori, 9-generator.

Ikkinchi xavfsiz usul sifatida, amiran generatori avtomobillarda qo‘llanildi, bu yonilg‘i sarfini 38 % ga kamaytirishga erishildi. Bunda har 1000 km masofadan keyin texnik servis xizmat ko‘rik talab etiladi.

Ushbu tadqiqotda motor moyining eskirish matematik modeli asoslashda quyidagi ko'rsatkichlar orqali ifodalanadi:

- Gigroskoplik omili - (γ)
- Taxminiy vodorod masofasi - (l)
- Aralashmaning gidravlik omillari ta'sirini hisobga oluvchi koeffitsiyent - (α)
- Vodorod-benzin yonilg'ilarining to'liq aralashish fazaga ko'ra - (Q/q_{cm})
- Vodorod-benzin aralashma maksimal normasi - (n_i)
- Vodorod-benzin aralashma minimal normasi - (n_k)
- Aralashma miqdori - (β)
- 0.9-2 qiymatlarni qabul qiluvchi o'zgarish proporsionallik koeffitsientini - (S)
- Vodorod aralashgan benzinning o'rtacha chuqurligi - (H)
- Vodorod benzinda batamom tarqalish uzunligi - (L)
- 1 ga teng qiymat - (A)
- Aralashma meyori - (n_p)
- Reynoldsning diffuziya soni - (Re)
- Diffuziya boshlanishidan benzinga aralashib ketguncha bo'lgan tarqalish koeffitsienti - (φ)
- Vodorodning benzin bilan batamom aralashish (x)
- Benzinning vodorod bilan aralashish kengligi (B)
- Aralashmasning o'rtacha tezligi (V)
- Vodorod oqimi tezligining benzin oqimi tezligiga nisbati bo'lib ($m = \vartheta_p/\vartheta_0$)
- Struyaning oqib chiquvchi teshikdan ixtiyoriy masofadagi diametrik (d)
- Benzinning kelib tushayotgan birlik struyasi diametri - (d)

Motor moyi gidroskoplik xususiyati uning xarorati ortib borgan sayin uziga vodorodni yutib olishi bilan tavsiflanadi. Buni, yonilg'i benzin-vodorod aralashma oqimining miqdori Rodziller bo'yicha γ koeffitsienti bilan ifodalanadi:

$$\gamma = \frac{1 - e^{-\alpha^3 \sqrt{l}}}{1 + e^{-\alpha^3 \sqrt{l}} \frac{Q}{q_{cm}}} \quad (1)$$

Vodorod benzin aralashmasining tarkibiy holati normasi hamda maksimal miqdordagi benzinga ko'p karrali vodorod aralashtirishlar soni quyidagi formula orqali ifodalanadi:

$$n_i = \frac{(q_{cm} + \gamma Q) \delta b}{q_{cm}} \quad (2)$$

Minimal miqdordagi benzinga ko'p hajm miqdordagi vodorod aralashtirishlar soni esa quyidagi formula orqali ifodalanadi:

$$n_k = \frac{(\beta q_{cm} + Q)}{\beta q_{cm}} \quad (3)$$

Vodorod gazi benzinga aralashishtirish mumkin bo'lgan qismini ko'rsatuvchi koeffitsient quyidagi formula orqali ifodalanadi:

$$\beta = \frac{1 - e^{-\alpha(\sqrt[3]{l} - \sqrt[3]{l_0})}}{1 + e^{-\alpha(\sqrt[3]{l} - \sqrt[3]{l_0})} \frac{Q}{q_{cm}}} \quad (4)$$

Benzin yonilg'isini vodorod gazi bilan aralashtirish meyorini quyidagi formula bilan ifodalanadi:

$$n_p = \frac{S\varphi H}{Ax(B-L)\lg \text{Re}_\delta} \quad (5)$$

Diffuzion aralashmalar Reynoldsning son qiymati quyidagi formulada ifodalanadi:

$$\text{Re}_\delta = \frac{gH}{D} \quad (6)$$

$$D = \frac{gH}{2mC} \quad (7)$$

$$2m = 0,7C + 6 \quad (8)$$

$$A = \frac{S_{\text{экс}}}{S_{\text{меор}}} \quad (9)$$

Diffuziya boshlanishidan benzingga aralashib ketguncha bo'lgan tarqalish koeffitsienti quyidagicha ifodalanadi:

$$\varphi = \frac{l_{\text{фарв}}}{l_{\text{прям}}} \quad (10)$$

O'qqa nisbatan simmetrik bo'lgan ixtiyoriy kesimdagi vodorod struyasining boshlang'ich aralashish darajasi uchun quyidagicha ifodalanadi:

$$n_H = \frac{0,258}{1-m} \left(\frac{d}{d_0} \right)^2 \left[\sqrt{m^2 + 8,1(1-m) \left(\frac{d_0}{d} \right)^2} - m \right] \quad (11)$$

Vodorod va benzinning boshlang'ich qo'shilishidagi limit qiymati qaralayotgan kesimning maksimal diametri benzinning chuqurligiga teng bo'lib, boshlang'ich aralashish darajasi uchun formulasi quyidagicha ifodalanadi:

$$n_{\delta_{\text{ен}}} = \frac{0,258}{1-m} \left(\frac{H}{d_0} \right)^2 \left[\sqrt{m^2 + 8,1(1-m) \left(\frac{d_0}{H} \right)^2} - m \right] \quad (12)$$

Demak, benzingga vodorod qo'shish formulasini quyidagicha yoziladi:

$$n_{\text{обц}} = \frac{(q_{\text{вodorod}} + Q)}{q_{\text{вodorod}} + Q e^{-\beta \left(\frac{l}{R} \right)^{\frac{1}{4}}} + Q_{\delta}} \quad (13)$$

Vodorod kam qo'shilgandagi aralashma ko'rsatgichi quyidagicha ifodalanadi:

$$n_{\text{обц}} = \frac{(q_{\text{вodorod}} + Q)}{(Q - Q_{\text{аралашма}} + q_{\text{вodorod}}) e^{-\beta \left(\frac{l}{R} \right)^{\frac{1}{4}}} + Q_{\text{аралашма}}} \quad (14)$$

Benzingga vodorod qo'shilgandagi umumiy aralashma miqdori quyidagicha ifodalanadi:

$$Q_H = n_H q \quad (15)$$

Yuqorida keltirilgan jadvaldagi qovushqoqlik koeffitsientining qiymatlari asosida 4.2.12-jadval tuzib, Leybnits interpolyatsion formulasini qo‘llab, vodorodning qo‘yilish meyoriga asoslangan grafiklarini quriladi.

O‘zgaruvchan parametrlarni 1- jadvaldan olinadi va bu qiymatlar asosida Nyuton interpolyatsion formulasi quyidagicha yoziladi:

$$L(x) = y_0 \frac{(x - x_1)(x - x_2)(x - x_3)}{(x_0 - x_1)(x_0 - x_2)(x_0 - x_3)} + y_1 \frac{(x - x_0)(x - x_2)(x - x_3)}{(x_1 - x_0)(x_1 - x_2)(x_1 - x_3)} + y_2 \frac{(x - x_0)(x - x_1)(x - x_3)}{(x_2 - x_0)(x_2 - x_1)(x_2 - x_3)} + y_3 \frac{(x - x_0)(x - x_1)(x - x_2)}{(x_3 - x_0)(x_3 - x_1)(x_3 - x_2)} \quad (16)$$

Tadqiqotning “**motor moyi asosiy operatsion xususiyatlari va chegaraviy ish muddatini o‘rganish metodikasi**” deb nomlangan **uchinchi bobida** benzin dvigateliga qo‘shimcha vodorod gazini xavfsiz integratsiya qilish metodikasiga bag‘ishlangan.



4-rasm. Eksploatatsion natijalarini aniqlash integrali.

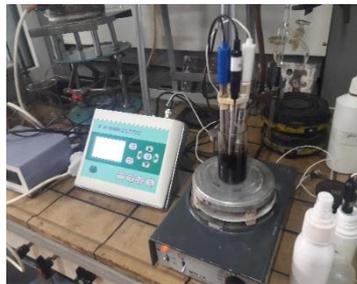
Motor moyi laboratoriya tajriba sinov ekpluatatsiya qilish metodikasida moyning chaqnash haroratini aniqlashda GOST 4333, ISO 2592 bo‘yicha TVO uskunasi foydalanildi. Chaqnash chegarasi 79-360 °C oraliqda tigelda moy namunadan gorilka orqali chaqnash hosil bo‘lishi bilan termometr harorat ko‘rsatkichi qayd qilib olinadi.



5-rasm. Laboratoriya chaqnash haroratini aniqlash jarayoni.

Moyning ishqor sonini aniqlashda laboratoriya sharoitida I-160-MI uskunasi yordamida pH faolligini aniqlanadi. Bunda 1 gr motor moy namuna HCl eritmasi bilan

birga aralastirilib elektrodlar yordamida sentrifuga qo‘yiladi. Uskunadagi table soni 4 ga tushguncha ushlab turiladi, olingan natija formulaga solinib ishqor soni aniqlanadi.



6-rasm. Motor moyi ishqor sonini aniqlash jarayoni.

Qovushqoqlik indeksini 25371-97 (ISO 2909-81) xalqaro standartlari orali B usuli yordamida 40 °C hamda 100 °C haroratlarda 15-20 minut davomida quyilib natijalar olinadi hamda ulardan olingan natijalar quyidagi tenglamalarda ifodalanadi:

$$VI = \left\{ \frac{[(\text{antilog } N) - 1]}{0.00715} \right\} + 100 \quad (17)$$

$$N = \frac{\log H - \log U}{\log Y} \quad (18)$$

Agarda 100 °C da 70 mm²/s dan yuqori bo‘lsa quyidagi formula orqali ifodalanadi:

$$H = 0.1684Y^2 + 11.85Y - 97 \quad (19)$$

Bunda:

- 40 °C va 100 °C lardagi kinematik qovushqoqligi - (U, Y)
- Maxsus jadval qiymati - (H)



7-rasm. 40 °C hamda 60 °C haroratlarda motor moyi qovushqoqlikni aniqlash jarayoni.

“Qo‘shimcha vodorod yonilg‘isining benzil dvigatel motor moylarining ekologik iqtisodiy karakteristikalariga tasirini eksperimental tadqiq qilish natijalari” deb nomlangan **to‘rtinchi bobida** ilmiy ish davomida olingan vodorod-benzin dvigatelli sinov test natijalari, motor moyining chegaraviy ish muddatini asoslash matematik model natijalari hamda IYoD motor moyi laboratoriya sinov test natijalari keltirib o‘tilgan.

IYoD tashqi tezlik xarakteristikalarini hisoblash va qurish loyihalashda nuqta koordinatalari prof. Leirdman usuli yordamida IYoD tezlik xususiyatlarini hisoblash usulidan foydalaniladi. Ushbu usul quyidagi ko‘rsatkichlar orqali ifodalanadi:

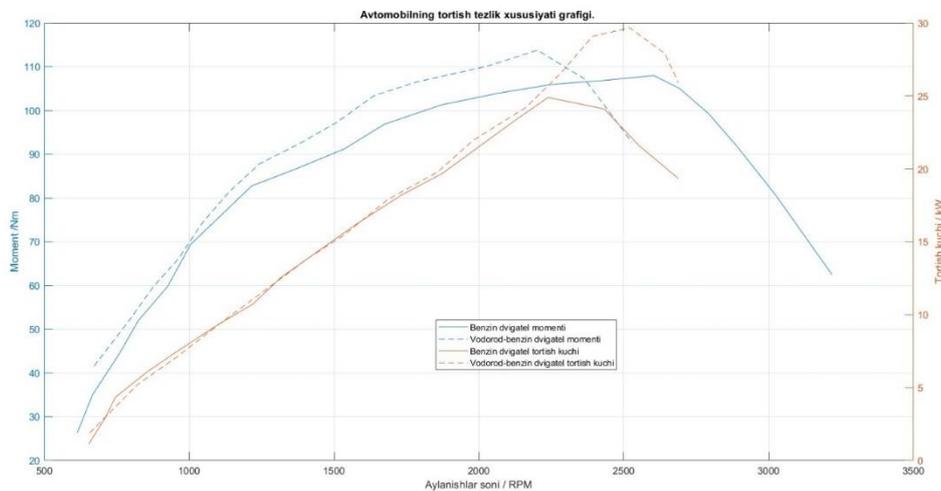
- IYoD ishchi quvvati - (N_e)
- IYoD maximum ishchi quvvati - (N_{max})
- IYoD tashqi tezlik xarakteristikalarini hisoblash va qurish loyihalashdagi koordinatalari (N_{emax}, n_N)
- Benzinli IYoD uchun ($a, b, c=1$)
- IYoD ishchi momentining o‘zgarish xarakteristikalarini (M_e)
- Uzatma valining aylanishlar soni (n_e)

IYoD ishchi quvvat xarakteristikasi nazariy hisob kitob formulasi quyidagicha ifodalanadi:

$$N_e = N_{emax} \left[a \frac{n_e}{n_N} + b \left(\frac{n_e}{n_N} \right)^2 - c \left(\frac{n_e}{n_N} \right)^3 \right] \quad (20)$$

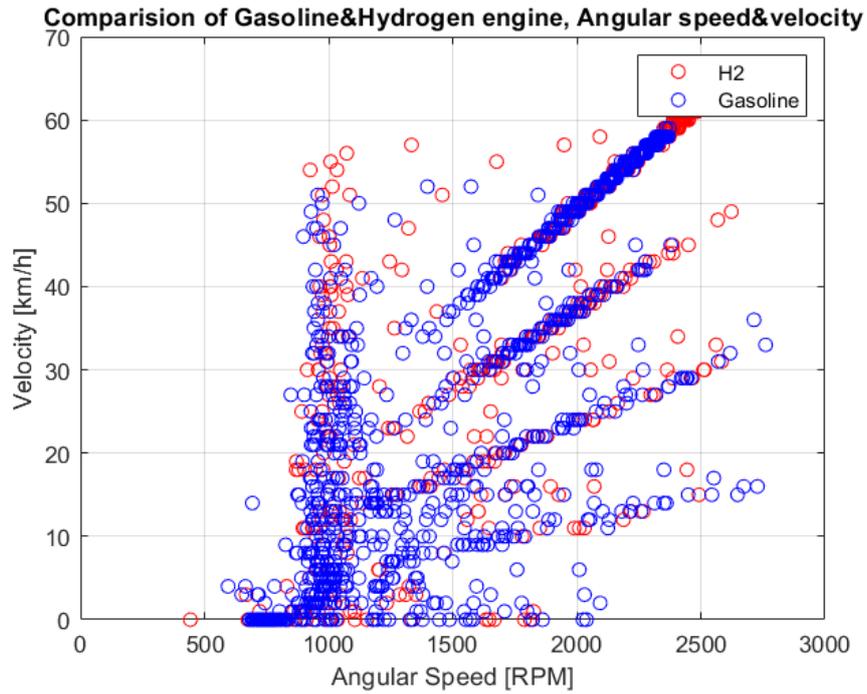
IYoD ishchi momentining o‘zgarish xarakteristikasini nazariy hisoblash quyidagi formula bo‘yicha ifodalanadi:

$$M_e = \frac{N_e}{n_e} * 716.2 \quad (21)$$



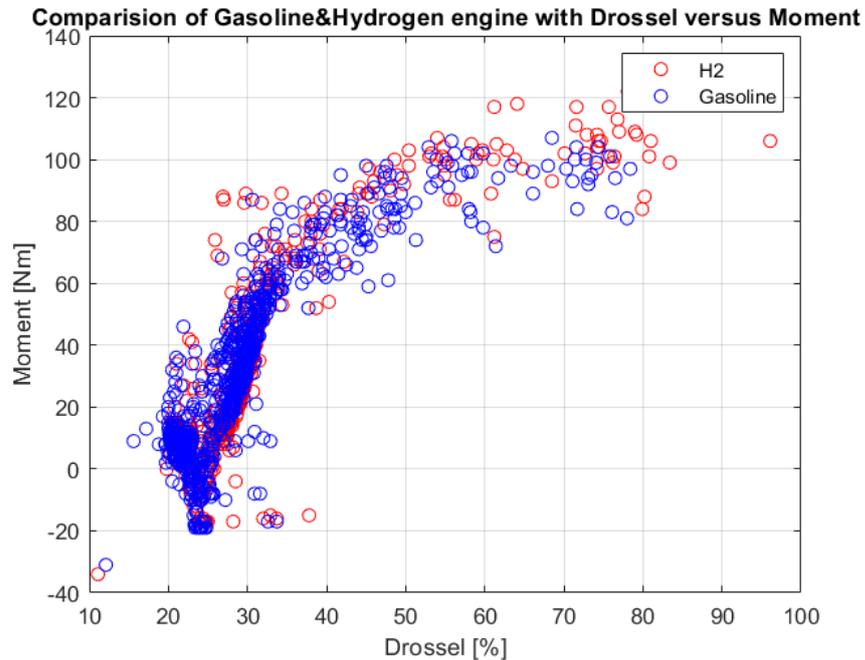
8-rasm. Avtomobil IYoD tortish tezlik xarakteristika grafigi.

Eksperimental test natijalarining matematik statistik tahlil natijalari shahar sharoitida ikkinchi hamda to‘rtinchi uzatmalarda 2300 rpm dan 2500 rpm gacha aylanishlar soniga erishildi.



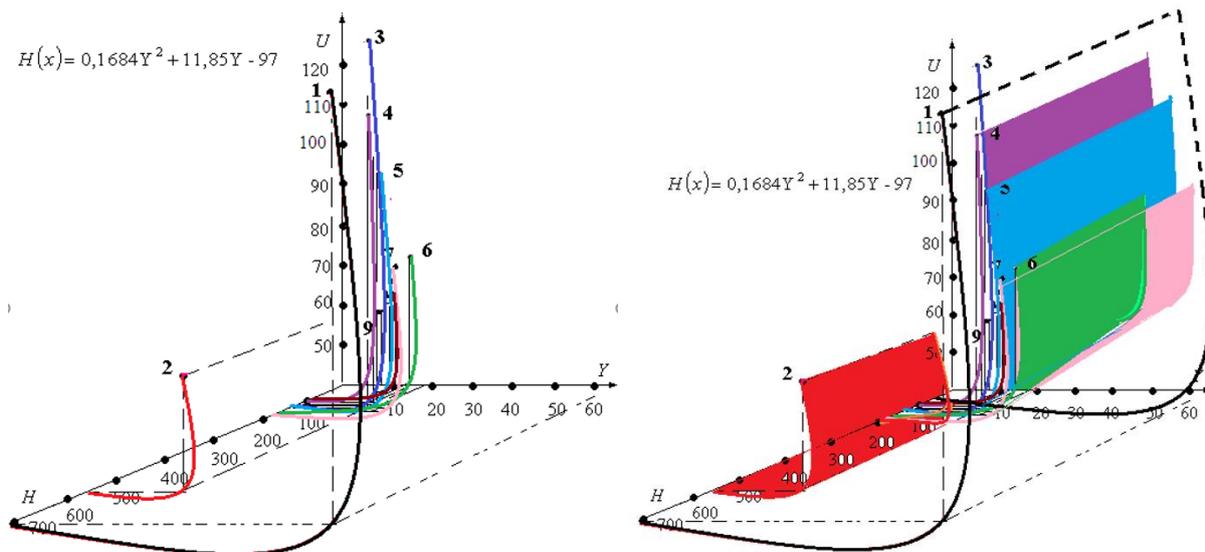
9-rasm. (ko'k) benzinli hamda (qizil) benzin-vodorod IYoD tezliklar kesimida aylanishlar sonini qiyoslash grafigi.

Grafikda drossel 25 % dan 35% gacha o'zgarganda quvvat benzin maksimal quvvati 60 Nm dan 80 Nm gacha oshishi ifodalangan.

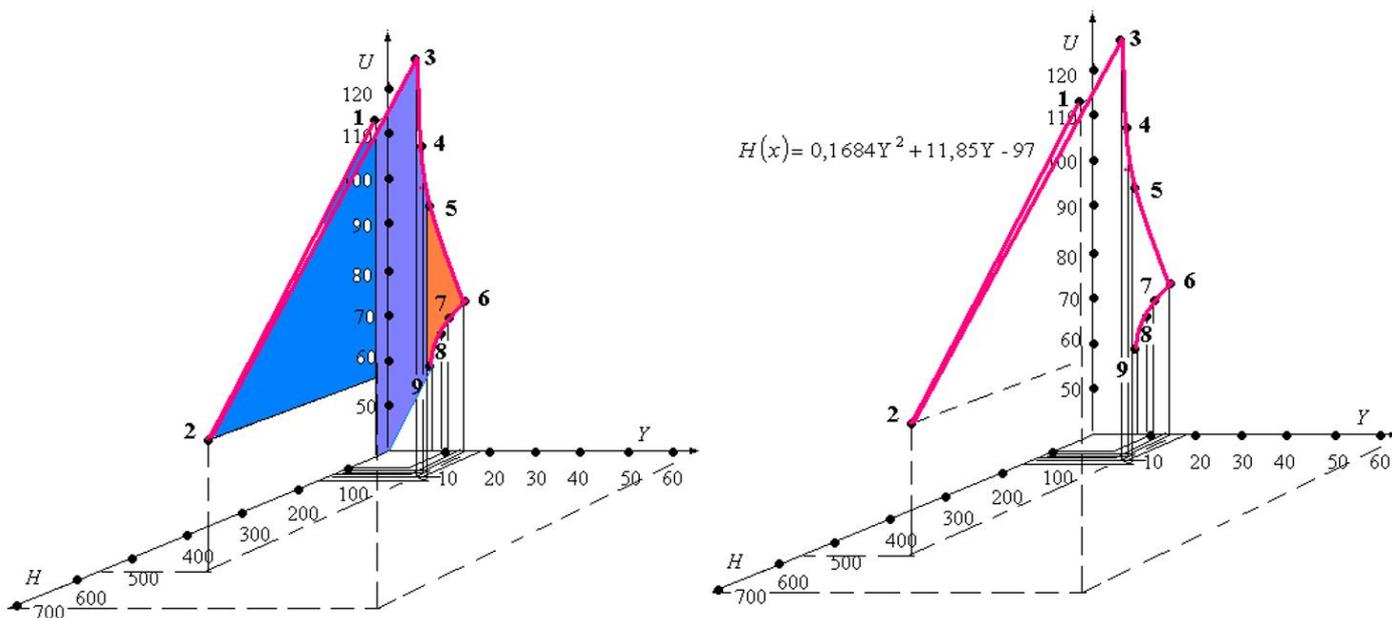


10-rasm. (ko'k) benzin IYoD hamda (qizil) benzin-vodorodli IYoD quvvatining drossel valining ochilish foizlarining qiyosiy grafigi.

Motor moyining chegaraviy ish muddatini asoslash matematik statistik tahlil usuli yordamida olib borildi. Bunda Matlab dasturidan foydalanildi hamda kvadrat tenglamaning fazodagi kesim ko‘rinishlari quyidagi grafidagi ifodalanadi.

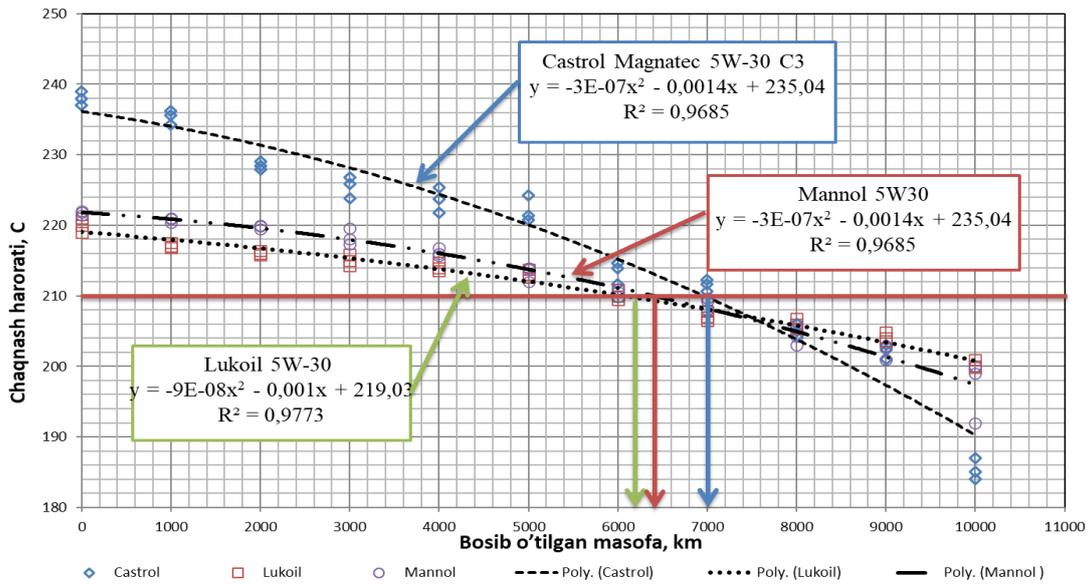


11-rasm. Vodorod gazining benzin tarkibiga absorbsiya jarayonining fazodagi ko‘rinishi.

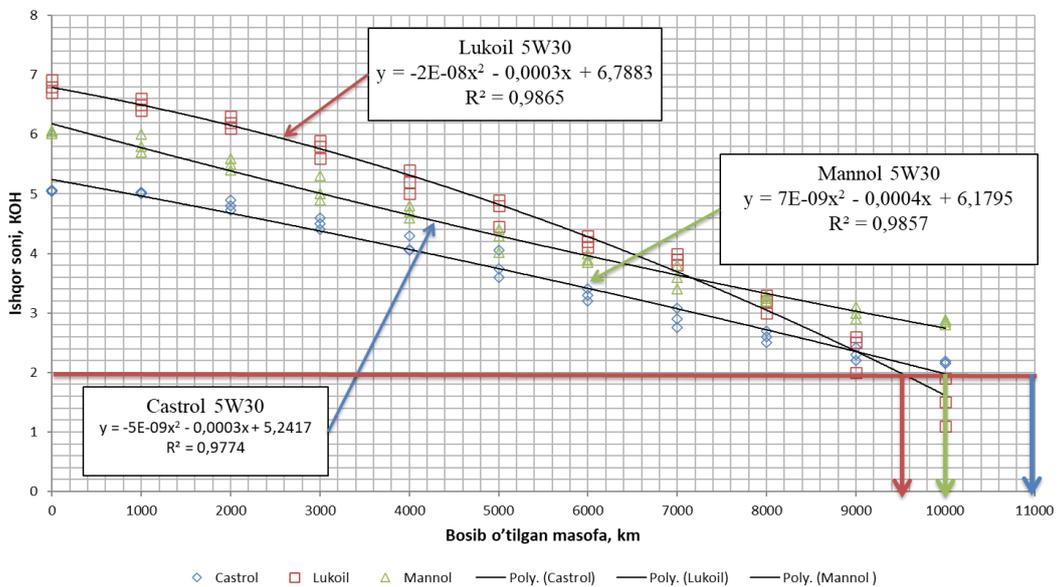


12-rasm. Motor moyi eskirish grafigi va uning chegaralarini aniqlashning fazodagi ko‘rinishi.

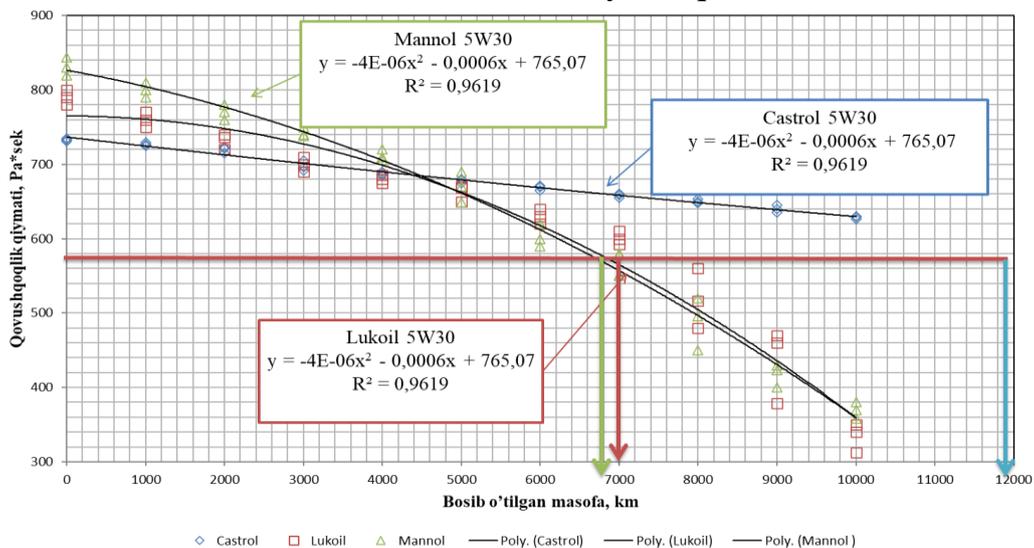
Motor moyini chaqnash harorati ochiq tigelli TVO apparatida GOST 4333 va ISO 2592 bo‘yicha sinaladi. (chaqnash harorati chegarasi 6 °C-400 °C gacha). 40 °C hamda 100 °C da standartlar bo‘yicha qovushqoqlik koefitsientini VI aniqlanadi. (TBN) Ishqor soni I-160-MI laborotoriya ionomeri apparatida standartlar bo‘yicha sinaladi.



13-rasm. Motor moyining chaqnash harorati.



14-rasm. Motor moyi ishqor soni.



15-rasm. 40 °C hamda 100 °C dagi qovushqoqlik qiymati.

UMUMIY XULOSALAR.

“Vodorod-benzin yonilg‘isida ishlaydigan avtomobillar motor moyining chegaraviy ish muddatini asoslash” mavzusini o‘rganish asosida quyidagi umumiy xulosalar qilindi:

1. Dunyoda alternativ vodorod gazini benzin dvigatelli avtomobillarda qo‘shimcha sifatida qo‘llagan holda motor moyiga sinergetika masalalari yetarlicha o‘rganilmagan. Shuningdek, bizning sharoitda ushbu texnologiyalarni tadbiq qilish darajasi yuqori emasligi, muammolarni hal etishda soxadagi zaxiralarning mavjud ekanligi aniqlandi va eksperimental tadqiqotlar asosida foydali ish koeffitsientini 5 % ga oshirgan holda yonilg‘i sarfini 24 % ga kamaytirildi, va ekologik tasir gazlar NO_x , CO, HC lar miqdori mos holda 15%, 18%, 14% gacha kamaytirildi.

2. Avtomobil vodorod-benzin yonilg‘i taminlash tizimida vodorod gidroskopik diffuziya yonilg‘i sinerjiyasi D.Rodziller formulasi bilan asoslandi hamda o‘qqa nisbatan simmetrik bo‘lgan ixtiyoriy kesimli vodorod konsentratsiyasining boshlang‘ich aralashish darajasi formulasi nazariy tajribalar asosida avtomobil motor moyining eskirish matematik modeli yaratildi.

3. Avtomobil vodorod-benzin ta‘minot tizimi tahlil qilish asosida mahalliy sharoitda alternativ yonilg‘i bilan motor moyi ta‘sirlashuvida moyning asosiy 3 ta parametrlari, yani chaqnash harorati, qovushqoqlik ko‘rsatkichi, ishqor soni hamda kislotalar sonlari misolida qo‘llab nazariy va amaliy jihatlari o‘rganildi. Matematik modeli asosida Nyuton interpolatsion formulasi yordamida eskirish algoritmidagi amaliy va nazariy tadqiqotlar 3% tafovutda erishildi. Shuningdek, ekspluatatsiya sharoitida avtomobil moylash tizimlaridan foydalanishning sinergetika konsepsiyasiga binoan tartib va moslashuvchanlik parameter tushunchalari asoslandi.

4. Vodorod-benzin avtomobil parametrlari tadqiqotlar o‘tkazilib, quyidagi natijalarga asoslandi:

- Chevrolet Genra G200 ichki yonuv dvigatelini standard va vodorod qo‘llagan holda 10 000 km masofa birlikda qancha sarf bo‘lishi nazariy va amaliy hisob kitob qilindi.

- O‘tkazilgan tajriba sharoitlarida standard va vodorod-benzinli avtomobil yonilg‘i ta‘minlash tizimlari uchun Nyuton interpolatsion tenglamalari usuli yordamida aniqlandi.

- Shahar sharoitida vodorod-benzin avtomobil 100 km masofani bosib o‘tganida 24 % yonilg‘i tejaldi. Bitta avtomobil bir yilda 30000 km masofani bosib o‘tadi deb oladigan bo‘lsak, o‘rta hisobda 648 litr yonilg‘i tejalganligi amaliy tahliliy usullar bilan aniqlanadi. Bunda vodorod benzin sinerjiyasi asosida avtomobil motor moyi har 10000 km masofa qaraganda 500-1000 km oldinroq almashtirish kerak.

5. Vodorod-benzin dvigatel mahalliy sharoitda motor moyi chegaraviy ish muddatini asoslash misolida dvigatelning ishchi hajmi 1.5l bo‘lgan avtomobillarda olinadigan yillik iqtisodiy samaradorlik (bitta avtomobil misolida) 149796000 so‘mni tashkil etadi.

**SCIENTIFIC COUNCIL AWARDING SCIENTIFIC DEGREES
PhD.22/01.02.2022.T.144.01 AT TURIN POLYTECHNIC UNIVERSITY IN
TASHKENT**

TURIN POLYTECHNICAL UNIVERSITY IN TASHKENT

SHARIPOV ALISHER KALBAYEVICH

**VALIDATION OF AUTOMOTIVE ENGINE OIL LIFE CYCLE IN A
HYDROGEN FUELLED ENGINES**

05.08.06 – Wheeled and tracked vehicles and their operation

**DISSERTATION ABSTRACT OF DOCTOR OF PHILOSOPHY (PhD)
ON TECHNICAL SCIENCES**

TASHKENT – 2024

The theme of doctor of philosophy (PhD) was registered at the Supreme Attestation Commission at the Cabinet of Ministers of the Republic of Uzbekistan under number №B2022.2.PhD/T2002

The dissertation has been prepared at Turin polytechnic university in Tashkent.

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Abstract of the dissertation sent out on “_____” _____ 2024 y.

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INTRODUCTION (annotation of Doctor of Philosophy (PhD) dissertation)

Relevance and necessity of the dissertation topic. The demand for petroleum products, i.e. gasoline and diesel, which are the source of fuel for cars in the world, has increased by 3.1% and 1%, respectively. Increasing the operating performance of vehicles and analyzing fuel trends requires the reduction of traditional fuel types and the gradual use of alternative fuel types, including environmentally friendly, safe and cheap energy source hydrogen gas. is doing. Alternative hydrogen gas is currently attracting great interest from various developed countries in the global energy sector, which in itself is paying special attention to solving existing problems by expanding the use of mass alternative fuel type in the future.

In the world, using hydrogen fuel as an additive in gasoline-based cars, scientific research activities are being conducted aimed at developing new scientific and technical solutions of resource-saving technologies and technical means to determine the limit working life of motor oil. In this regard, a deep static analysis of the parameters of motor oils serves to significantly increase the reliability indicators of the engine. Hydrogen fuel, with its hydrosopic, physical and chemical properties, is considered one of the urgent tasks of creating a scientific and technical basis of technologies and methods aimed at improving the service life of motor oils.

In recent years, in our republic, special attention has been paid to the integration of technologies aimed at improving the performance and service life of motor oils used in wheeled vehicles, and improving the quality of lubricants during vehicle operation. In accordance with the decision of the President of the Republic of Uzbekistan No. PQ-82 dated 23.02.2024 "Organizing the production of green hydrogen based on modern technologies in our Republic and meeting the demand of economic sectors for this product", the effectiveness of scientific and practical research in this field increase, wide introduction to the development of innovative technologies and the decisions of the President of the Republic of Uzbekistan No. PQ-132 of 18.03.2024 entitled "Organizing the development of hybrid cars in the Republic of Uzbekistan", including the wide development of renewable and hydrogen energy in the automotive sector, the important tasks of finding an acceptable solution to the existing problems and improving the reliability characteristics of the motor oil are determined. In the implementation of these tasks, one of the important issues is the justification of the limit service life of engine oil for cars running on hydrogen-gasoline fuel, the development of a method for selecting the main factors that lead to the wear of engine oil running on a hydrogen-gasoline mixture.

This scientific research work is based on the decision of the President of the Republic of Uzbekistan dated 09.04.2021 No. PQ-5063 "Measures for the development of renewable and hydrogen energy of the Republic of Uzbekistan", the producers of renewable energy sources and hydrogen, their users and this testing of energy-powered equipment, devices and technologies, as well as a vehicle in the decree of the President of the Republic of Uzbekistan dated 18.01.2022 No. PF-60 on the development strategy of new Uzbekistan for 2022-2026 This dissertation research serves to a certain extent to carry out scientific research on the impact on production areas and to implement the

tasks defined in the regulatory legal documents aimed at solving existing problems.

Compliance of the research with the priorities of the development of science and technology of the Republic. This research is about the development of republican science and technology: II. "Energy, energy and resource saving, was carried out within the priority direction. Actions in the roadmap of the Decision of the Republic of Uzbekistan No. PQ-4422 of 22.08.2019 of the Academy of Sciences, Ministry of Energy, Ministry of Innovative Development, Uzstandart agencies and Resolution of the President of the Republic of Uzbekistan No. PQ-5063 of 09.04.2021 "Development of renewable and hydrogen energy in the Republic of Uzbekistan measures".

Level of study of the problem. In the world experience, a number of foreign scientists have conducted scientific work on the issue of researching the characteristics of the use of motor oils and the limit work periods in order to improve the quality of the car during its operation, including Marshall H.T., Oliver S.R. (USA), Williams K., Dyson A. (Great Britain), Masahiko N., Takada M. (Japan) and others. Acknowledging the work of the above-mentioned scientists, it can be said that the question raised in their work, that is, the justification of the limit service life of motor oil for cars running on hydrogen-gasoline fuel, has not been researched.

Development of renewable energy in the Republic of Uzbekistan, research on the creation of devices for the improvement of production processes, justification and improvement of parameters of technological processes Vereshagin V.I., Kovalsky B.I., Runda M.M., Yanovich V.S., Bezborodov Yu.N., Ganja V.A. , Morozov A.G., Grigorev M.A., Salimov A.U., Kadyrov S.M., Lebedov O.V., Sharipov Q.A., Bazarov B.I., Musurmonov R.K. Musurmanov R.Q. and other scientists have achieved significant results in the development of methods and algorithms for modeling, optimization and improvement of the automated control system. At the same time, the issues of justifying the limit service life of engine oil for cars running on hydrogen-gasoline fuel have not been sufficiently studied.

The connection of the dissertation research with the research plans of the higher educational institution where the dissertation was completed. The dissertation research is related to a practical project based on the cooperation of the Turin Polytechnic University in Tashkent and the Ministry of Innovative Development of the Republic of Uzbekistan and the research program of the scientific council meeting No. 09/17 on September 21, 2017 in cooperation with UzAuto Motors JSC and Turin Polytechnic University in Tashkent.

The purpose of the study is to justify the limit of service life of engine oil for cars running on hydrogen-gasoline fuel.

Tasks of the research:

Analyzing the state-of-the-art compatibility methods of hydrogen gas as an additive in the vehicle fuel supply system, and developing a method for justifying fuel economy and environmental performance by conducting experimental research;

Basing the mathematical model of optimal wear of motor oil in the hydrogen-gasoline fuel supply system through theoretical experiments;

Development of a method of testing the main operating parameters of motor oil in a hydrogen-gasoline vehicle in laboratory conditions;

Development of recommendations for the application of research results and determination of economic efficiency of implementation;

As the object of the study, motor oil of a car with a hydrogen-gasoline engine was taken.

The subject of the study is the dependence of the main operational indicators of the car with a hydrogen-gasoline engine on wear and tear.

Research methods. Classical mechanics, mathematical analysis and mathematical statistical methods, theoretical mechanics, methods of analyzing step-by-step processes of experience through computerization (imitation and simulation) systems, automobile theory, and synthesis methods were used in the research process.

The scientific novelty of his research is as follows:

Using the Frolov-Rodziller equation, a mathematical model was created based on stable operating conditions and stagnation modes of the optimal fuel ratio in gasoline engines with additional hydrogen gas;

On the basis of the regression-correlation analysis, the basic physical and chemical properties of hydrogen-gasoline engine oils were determined in terms of operating conditions;

Based on the limit working life of hydrogen-gasoline internal combustion engine oil, the mathematical model is optimized through Newton's interpolation law;

Recommendations for replacement periods have been developed taking into account the mechanism of effect of hydrogen-gasoline fuel on engine oil.

The practical results of the research are as follows:

A specific component has been improved that allows to improve the operational, technical-economical and environmental indicators of cars with gasoline-hydrogen-air mixture;

A mathematical model of the vehicle hydrogen-gasoline fuel supply system based on scientific theoretical and experimental tests was created;

In the fuel lubrication system of hydrogen-gasoline-based cars, the limit service life of motor oil was developed;

Reliability of research results. The reliability of modern research results is carried out using modern methods and tools. The theoretical justification of fuel supply system parameters and operating modes is based on the principles of theoretical mechanics and higher mathematics, the results of experiments are processed by mathematical statistical methods, and the compatibility of theoretical and practical knowledge is explained by the fact that it is included in the process of producing research results.

Scientific and practical significance of research results. According to the scientific significance of the results of the research, a limit work period based on technical, quantity, and value indexes was developed between the method of integrating the mathematical model and the analytical connections through the Modeling Language of the vehicle fuel supply system;

According to the practical significance of the research results, motor oil wear was determined based on the recommendations and conclusions given to the car lubrication system in local conditions, and the limit working period was justified;

Implementation of research results. When justifying the limit service life of engine oil for cars running on hydrogen-gasoline fuel:

UzAvtosanoat joint-stock company - 2017 At the Astana-2017 international specialized exhibition on the theme of future energy held in Astana, Kazakhstan, the team of the Polytechnic University of Turin was assigned the task of demonstrating the car "Matiz" running on hydrogen-gasoline fuel. (Information of October 8, 2021 at UzAuto Motors JSC). As a result, university research scientists successfully participated in this exhibition by improving the fuel supply system of the "Matiz" car;

As a result of the research, a number of theoretical and practical tests were conducted on the use of alternative fuel during 2017-2021. (Information of October 8, 2021 at UzAuto Motors JSC). As a result, a method of safe integration of the vehicle fuel system in the conditions of Uzbekistan with hydrogen gas as an additional fuel was developed, the efficiency of the internal combustion engine was increased by 5%, and the fuel consumption per 100 km/h reduced by 24%;

The optimal algorithm was created in the wear system based on the limit service life of motor oil in an internal combustion engine. (Information of October 8, 2021 at JSC "UzAuto Motors") As a result, the physical and chemical properties of the engine motor oil were obtained based on the theoretical and practical mathematical static analysis of the main 4/10, in which the most significant indicator is 6000-7000 km /hour engine motor oil was found to be viscous;

Based on the optimal mathematical model of the wear of lubricants depending on the km/h traveled by the internal combustion engine. (Information of October 8, 2021 at UzAuto Motors JSC);

The results and algorithms of the scientific work made it possible to widely introduce them to the production process of hydrogen-gasoline fuel ("UzAuto Motors" JSC, October 8, 2021 reference). As a result, based on the results of the experiment, conclusions and suggestions were given for the lubrication system of the car engine.

Approval of research results. The main results of the research were presented and discussed at 2 international and 2 national scientific-practical conferences.

Publication of research results. A total of 21 scientific works were published on the subject of the dissertation, including 10 articles in scientific publications recommended for publication of the main scientific results of Doctor of Philosophy (PhD) dissertations of the Higher Attestation Commission of the Republic of Uzbekistan, including 7 republics and 2 foreign ones published in scientific journals. Among them, 1 article was published in high impact factor journals.

Dissertation structure and size. The dissertation consists of an introduction, four chapters, a conclusion, a list of references and appendices. The length of the dissertation is 120 pages.

THE MAIN CONTENT OF THE DISSERTATION

In the introduction, the relevance and necessity of hydrogen gas used in cars on engine oil is scientifically based. The main goals and tasks of the work, the object and subject of research, its compatibility with the priority directions of the development of science and technology of the Republic of Uzbekistan are indicated. The scientific

novelty of the work is based on the main results of substantiating the limit working life of motor oil for cars running on hydrogen-gasoline fuel, their scientific and practical significance. Also, general information on the practical application of the results of the dissertation, published works on the topic and its structural structure are highlighted.

The first chapter of the dissertation entitled **"The current state of motor oil for hydrogen-gasoline vehicles"** contains an analysis of hydrogen-gasoline vehicles, the environmental basis of using vehicles with hybrid hydrogen gas, and the share of hybrid hydrogen-gasoline vehicles in the world market and their energy analysis is studied. Based on this, the existing methods of energy analysis of cars running on hydrogen-gasoline fuel and the modern achievements of techniques and technologies for solving the problem were considered. 25% of oil products are fuel for automobiles. 17% of toxic gases released from them are harmful to the environment. Hydrogen is a type of fuel gas with environmentally friendly, safe and cheap potential. If we compare alternative gas with other types of fuels, Gasoline-450oF, Propane-914oC, Methane-1003oC, Hydrogen-1085oC, the flammability of hydrogen is slightly higher than other types of fuels. , which reduces the risk of direct detonation. Comparison of the flammability range showed that the ratio corresponds to: gasoline-7.6:1.4, propane-10.1:2.1, methane-15:5, hydrogen-75:4, the optimal combustion condition for hydrogen is 29:1.

The second chapter of the study, entitled **"Theoretical basis of the research basis for the justification of the limit working life of hydrogen-gasoline motor oils"** describes the theoretical basis of the use of motor oil for research in hydrogen-gasoline internal combustion engines.

There are 3 known types of use of hydrogen gas as an additive in internal combustion engines. These are, 1- direct delivery of hydrogen gas to the internal combustion engine, in the next scientific method, the mixture of gases is sent to the combustion chamber outside the cylinder of the internal combustion engine. In the 3rd

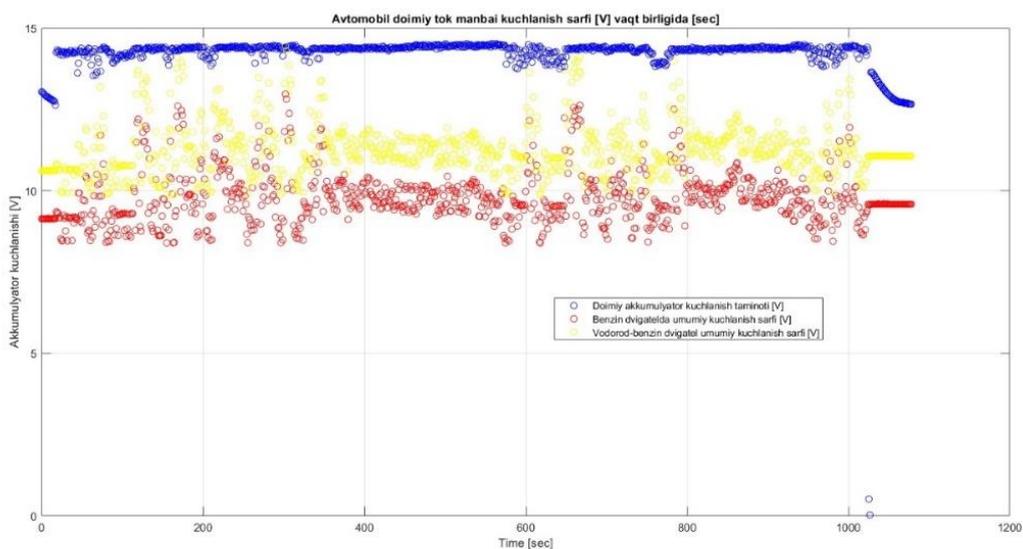


Figure 1. Comparative analysis of automotive DC power consumption. method, special injectors are used to apply hydrogen gas as an additional quality. 2 methods were used in the scientific work. Hydrogen is more flammable at almost any

temperature than other types of additional gases, because even a 4% air mixture is sufficient. The combustion process requires 0.02 mJ of energy, compared to 240 mJ for gasoline combustion.

One of the safest and cheapest methods of hydrogen production is LTE - (>200oC) low temperature electrolyze, AE - (60-98oC) alkane electrolyze (alkaline), PEM - (50-80oC) Proton exchange membrane (proton with an exchange membrane), AEM - (40-80C) Anion exchange membrane, HTE - (700-100oC) high temperature electrolysis (high temperature electrolysis). The research mainly used the AE - alkaline hydrogen production method, with a useful efficiency of 60-80% of the energy value. According to the analysis of the theoretical basis, additional hydrogen gas can be obtained with the consumption of 1% of the constant battery current source.

The method of using hydrogen gas.

Practical experiments were conducted on passenger cars during 2017-2020, in which 3 types of passenger cars Chevrolet Cobalt, Chevrolet Matix, Chevrolet Lacetti were selected from 30 types of practical test vehicles. Summary of the results of practical work in 2017 showed its effectiveness at the EXPO-2017 exhibition in Astana, Kazakhstan.

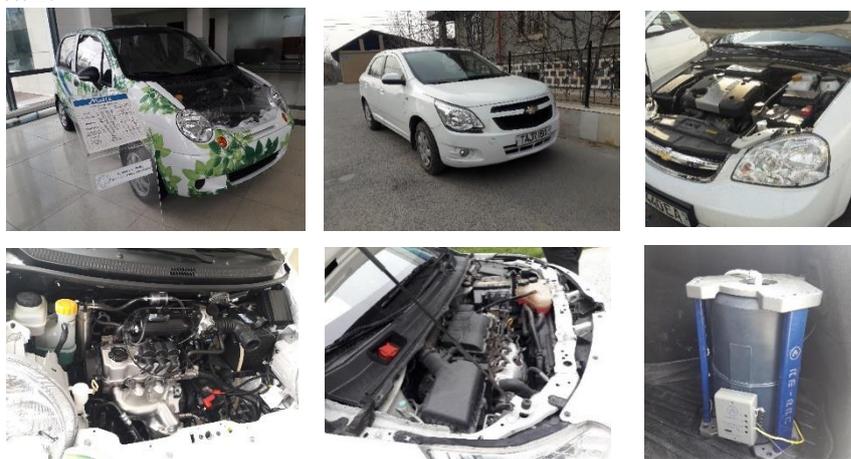


Figure 2. Practical experience of light vehicles.

Practical test procedures for installing a hydrogen generator in light vehicles.

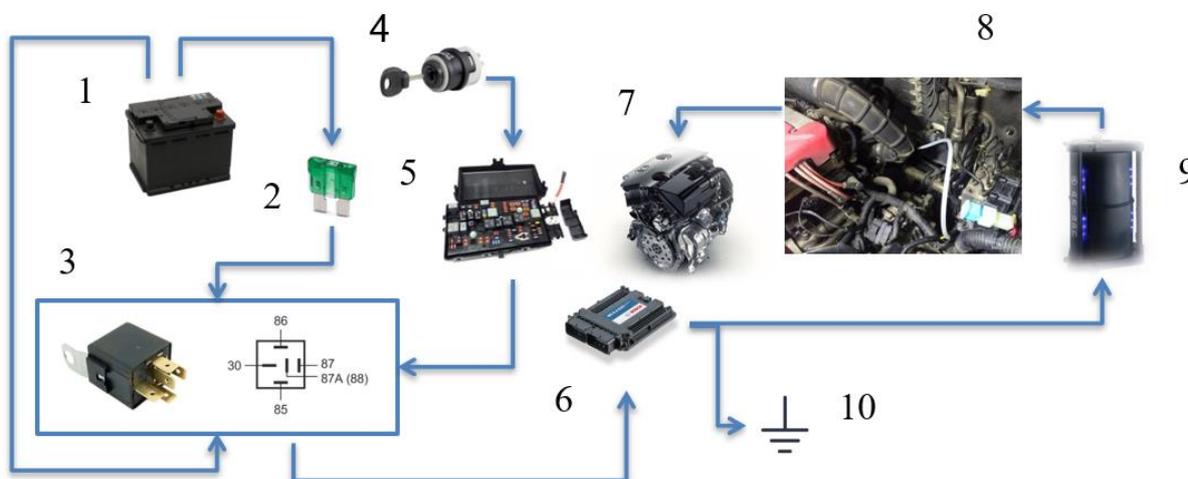


Figure 3. Hydrogen-gasoline fuel supply system.

1-accumulator, 2-peredochranitel, 3-relay, 4-switch, 5-relay panel, 6-RAM, 7-IYoD, 8-gas inlet collector, 9-generator.

As a second safe method, the amiran generator was used in cars, which achieved a 38% reduction in fuel consumption. it requires maintenance after every 1000 km.

In this study, the mathematical model of engine oil wear is represented by the following indicators:

- Hygroscopic factor (g)
- Approximate hydrogen distance (l)
- Coefficient taking into account the effect of hydraulic factors of the mixture (a)
- According to the phase of complete mixing of hydrogen-gasoline fuels (Q/q_{cm})
- Maximum rate of hydrogen-gasoline mixture (n_i)
- Minimum norm of hydrogen-gasoline mixture (n_k)
- Amount of mixture (b)
- the coefficient of proportionality of change, which takes the values of 0.9-2 (S)
- Average depth of gasoline mixed with hydrogen (H)
- Total diffusion length in hydrogen gasoline (L)
- a value equal to 1 (A)
- Mixture criterion (n_p)
- Reynolds diffusion number (R_e)
- Diffusion coefficient among beginning and mixing with gasoline (φ)
- Complete mixing of hydrogen with gasoline (x)
- Width of mixing of gasoline with hydrogen (B)
- Average speed of mixing (V)
- is the ratio of hydrogen flow rate to gasoline flow rate ($m=V_p/V_0$)
- diametric of the jet at an arbitrary distance from the exit (d)
- Gasoline incoming unit jet diameter (d)

The hygroscopic property of motor oil is characterized by the fact that it absorbs hydrogen as its temperature increases. This is expressed by the coefficient g according to Rodziller, the amount of fuel gasoline-hydrogen mixture flow:

$$\gamma = \frac{1 - e^{-\alpha^3 \sqrt{l}}}{1 + e^{-\alpha^3 \sqrt{l}} \frac{Q}{q_{cm}}} \quad (1)$$

The norm of the compositional state of the hydrogen gasoline mixture and the number of multiple hydrogen mixtures to the maximum amount of gasoline are expressed by the following formula:

$$n_i = \frac{(q_{cm} + \gamma Q) \partial b}{q_{cm}} \quad (2)$$

The number of hydrogen mixtures with a minimum amount of gasoline is expressed by the following formula:

$$n_k = \frac{(\beta q_{cm} + Q)}{\beta q_{cm}} \quad (3)$$

The coefficient indicating the proportion of hydrogen gas that can be mixed with gasoline is expressed by the following formula:

$$\beta = \frac{1 - e^{-\alpha(\sqrt[3]{l} - \sqrt[3]{l_0})}}{1 + e^{-\alpha(\sqrt[3]{l} - \sqrt[3]{l_0})} \frac{Q}{q_{cm}}} \quad (4)$$

The standard for mixing gasoline fuel with hydrogen gas is expressed by the following formula:

$$n_p = \frac{S\varphi H}{Ax(B-L)\lg \text{Re}_\delta} \quad (5)$$

The Reynolds number value of diffusion mixtures is expressed in the following formula:

$$\text{Re}_\delta = \frac{gH}{D} \quad (6)$$

$$D = \frac{gH}{2mC} \quad (7)$$

$$2m = 0,7C + 6 \quad (8)$$

$$A = \frac{S_{\text{экс}}}{S_{\text{меор}}} \quad (9)$$

The diffusion coefficient from the beginning of diffusion to mixing with gasoline is expressed as follows:

$$\varphi = \frac{l_{\text{фарв}}}{l_{\text{прям}}} \quad (10)$$

For the initial degree of mixing of a hydrogen jet of arbitrary cross-section, symmetrical about the axis, it is expressed as follows:

$$n_{\text{н}} = \frac{0,258}{1-m} \left(\frac{d}{d_0} \right)^2 \left[\sqrt{m^2 + 8,1(1-m) \left(\frac{d_0}{d} \right)^2} - m \right] \quad (11)$$

The limit value of the initial mixing of hydrogen and gasoline is the maximum diameter of the considered section equal to the depth of gasoline, and the formula for the initial mixing level is expressed as follows:

$$n_{\delta_{\text{ен}}} = \frac{0,258}{1-m} \left(\frac{H}{d_0} \right)^2 \left[\sqrt{m^2 + 8,1(1-m) \left(\frac{d_0}{H} \right)^2} - m \right] \quad (12)$$

So, the formula for adding hydrogen to gasoline is written as follows:

$$n_{\delta_{\text{иц}}} = \frac{(q_{\text{водород}} + Q)}{q_{\text{водород}} + Q e^{-\beta \left(\frac{l}{R} \right)^{\frac{1}{4}}} + Q_{\delta}} \quad (13)$$

The mixture index when little hydrogen is added is expressed as follows:

$$n_{\delta_{\text{иц}}} = \frac{(q_{\text{водород}} + Q)}{(Q - Q_{\text{аралашма}} + q_{\text{водород}}) e^{-\beta \left(\frac{l}{R} \right)^{\frac{1}{4}}} + Q_{\text{аралашма}}} \quad (14)$$

The total amount of mixture when hydrogen is added to gasoline is expressed as follows:

$$Q_{\text{н}} = n_{\text{н}} q \quad (15)$$

Table 4.2.12 is created based on the values of the viscosity coefficient in the above tables, using the Leibniz interpolation formula, graphs of hydrogen are constructed based on the deposition rate.

Variable parameters are taken from Table 1, and based on these values, Newton's interpolation formula is written as follows:

$$L(x) = y_0 \frac{(x - x_1)(x - x_2)(x - x_3)}{(x_0 - x_1)(x_0 - x_2)(x_0 - x_3)} + y_1 \frac{(x - x_0)(x - x_2)(x - x_3)}{(x_1 - x_0)(x_1 - x_2)(x_1 - x_3)} + y_2 \frac{(x - x_0)(x - x_1)(x - x_3)}{(x_2 - x_0)(x_2 - x_1)(x_2 - x_3)} + y_3 \frac{(x - x_0)(x - x_1)(x - x_2)}{(x_3 - x_0)(x_3 - x_1)(x_3 - x_2)} \quad (16)$$

The third chapter of the study, entitled "**Methodology for studying the main operating characteristics and limit of working life of motor oil**" is devoted to the methodology of safe integration of additional hydrogen gas into the gasoline engine.

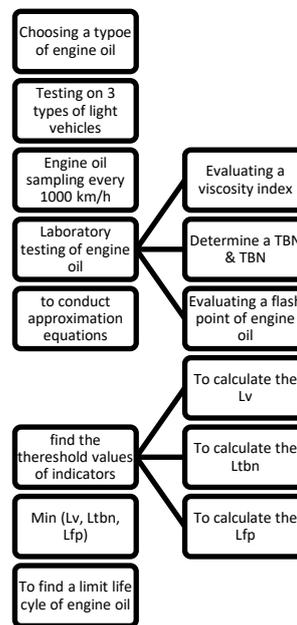


Figure 4. Integral for determining operational results.

The TVO equipment according to GOST 4333, ISO 2592 was used to determine the flash temperature of the oil in the method of laboratory experimental test operation of motor oil. The flash limit is 79-360oC, and the temperature indicator of the thermometer is recorded when a flash is formed from the oil sample in the crucible through the burner.



Figure 5. Laboratory flash temperature determination procedure.

When determining the alkali number of oil, pH activity is determined using I-160-MI equipment in laboratory conditions. In this case, 1 g of motor oil sample is mixed with HCl solution and centrifuged using electrodes. The number of tables in the equipment is kept until it drops to 4, the result obtained is entered into the formula and the number of alkali is determined.

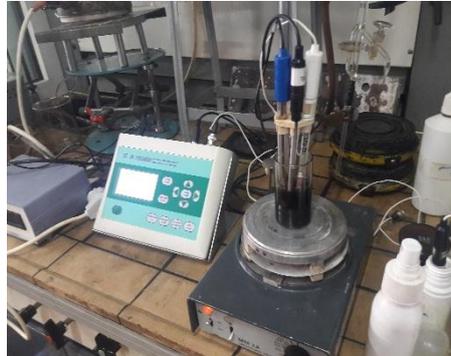


Figure 6. Motor oil alkali number determination process.

Viscosity index 25371-97 (ISO 2909-81) international standard B method is obtained by casting at temperatures of 40oC and 100oC for 15-20 minutes, and the results obtained from them are expressed in the following equations:

$$VI = \left\{ \frac{[(\text{antilog } N) - 1]}{0.00715} \right\} + 100 \quad (17)$$

$$N = \frac{\log H - \log U}{\log Y} \quad (18)$$

If it is higher than 70 mm²/s at 100°C, it is expressed by the following formula:

$$H = 0.1684Y^2 + 11.85Y - 97 \quad (19)$$

In this:

- kinematic viscosity at 40° and 100°C - (U, Y)
- Special table value - (H)



Figure 7. Motor oil at temperatures of 40oC and 60oC viscosity determination process.

In the fourth chapter, entitled "Results of experimental research on the effect of additional hydrogen fuel on the environmental and economic characteristics of gasoline

engine oils", the test results of the hydrogen-gasoline engine test obtained during the scientific work, the results of the mathematical model for the basis of the limit service life of the engine oil, and the IYoD engine oil The results of the laboratory test are cited.

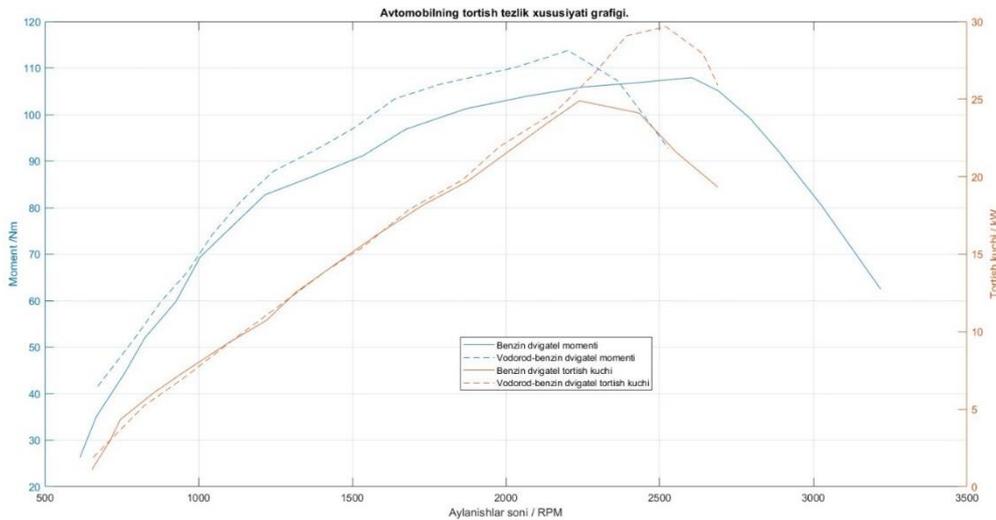
Calculation and construction of IYoD external speed characteristics point coordinates in the design prof. The method of calculating IYoD speed characteristics using the Leirdman method is used. This method is represented by the following indicators:

- ICE working capacity - (N_e)
- ICE maximum working power - (N_{max})
- Coordinates (N_{emax} , n_N) in the calculation and design of external speed characteristics of ICE
- For gasoline engine ($a, b, c=1$)
- ICE working torque change characteristics (M_e)
- Number of rotations of the extension shaft (n_e)

The formula of the theoretical account book of the characteristics of the labor force of ICE is expressed as follows:

$$N_e = N_{emax} \left[a \frac{n_e}{n_N} + b \left(\frac{n_e}{n_N} \right)^2 - c \left(\frac{n_e}{n_N} \right)^3 \right] \quad (20)$$

The theoretical calculation of the characteristic of the change of the operating moment of the ICE is expressed according to the following formula:



$$M_e = \frac{N_e}{n_e} * 716.2 \quad (21)$$

Figure 8. Car IYOD towing speed characteristic graph.

The results of mathematical statistical analysis of the results of the experimental test, the number of rotations from 2300 rpm to 2500 rpm in the second and fourth gears in urban conditions was achieved.

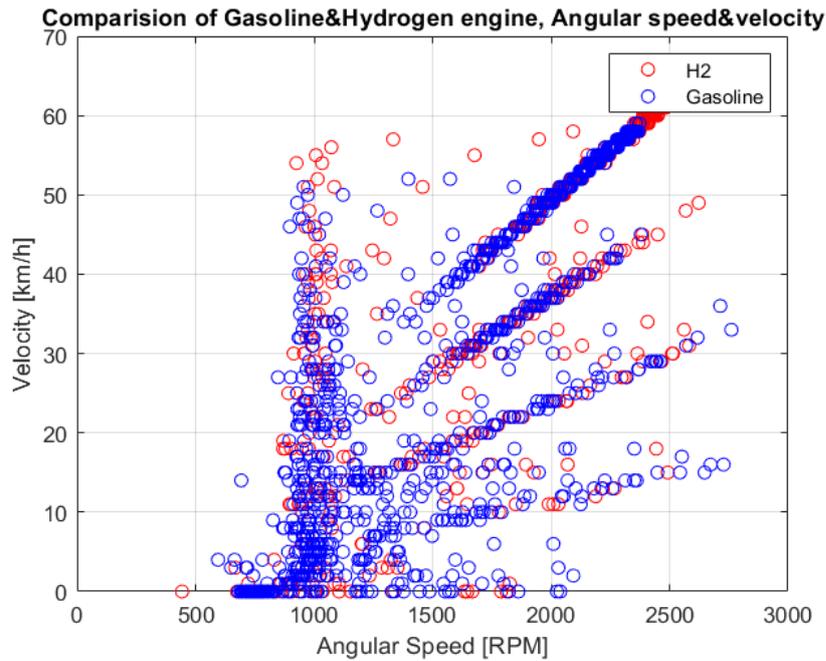


Figure 9. (blue) gasoline and (red) gasoline-hydrogen ICE speed section comparison graph.

The graph shows that when the throttle changes from 25% to 35%, the maximum power of gasoline increases from 60 N*m to 80 N*m.

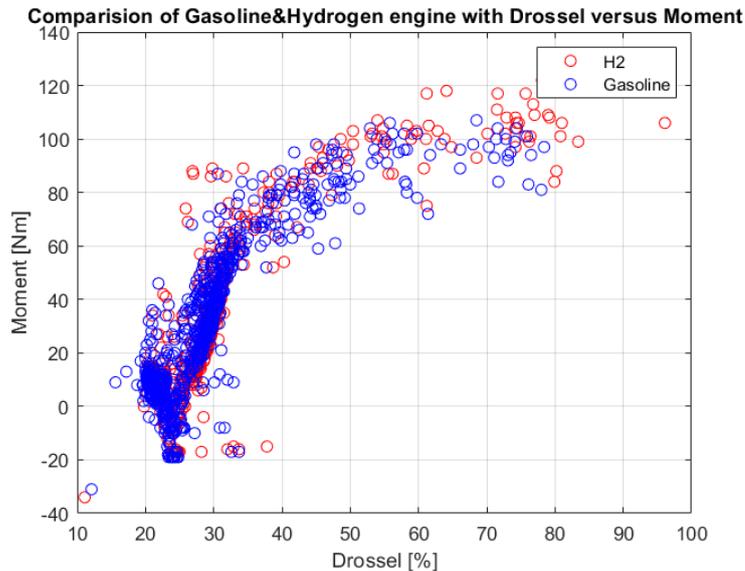


Figure 10. A comparative graph of throttle shaft opening percentages of (blue) gasoline IOD and (red) gasoline-hydrogen IOD.

The determination of the maximum service life of motor oil was carried out with the help of the mathematical statistical analysis method. The Matlab program was used for this, and the cross-sectional views of the quadratic equation in space are represented in the graph below

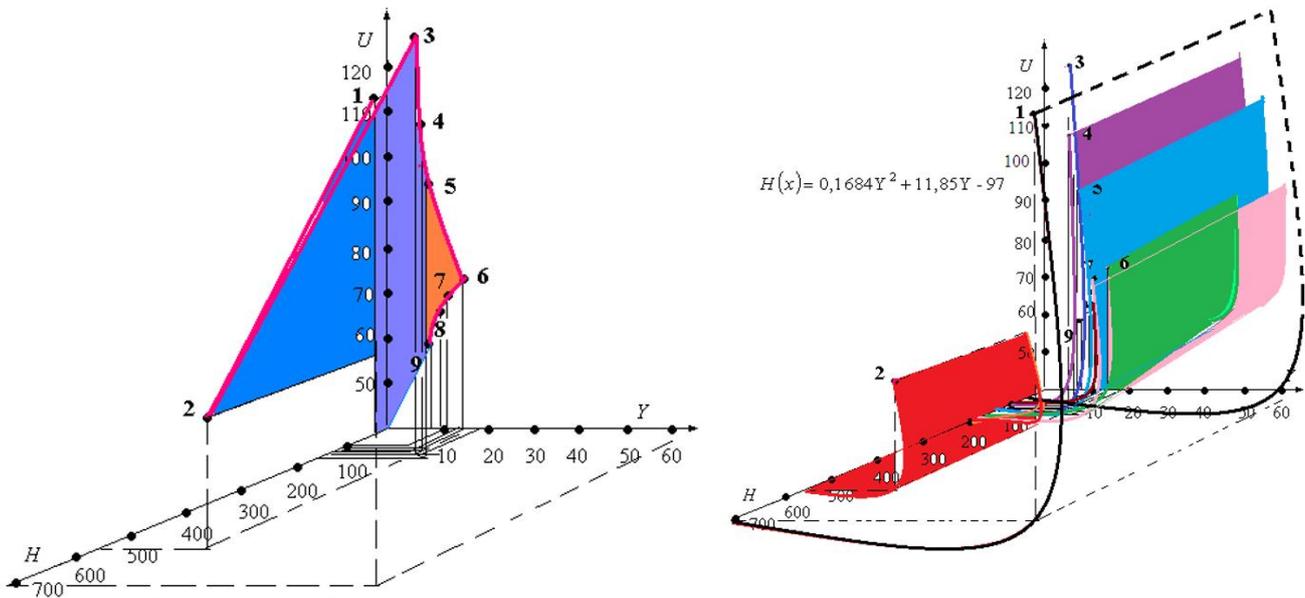


Figure 11. A view of the process of absorption of hydrogen gas into gasoline.

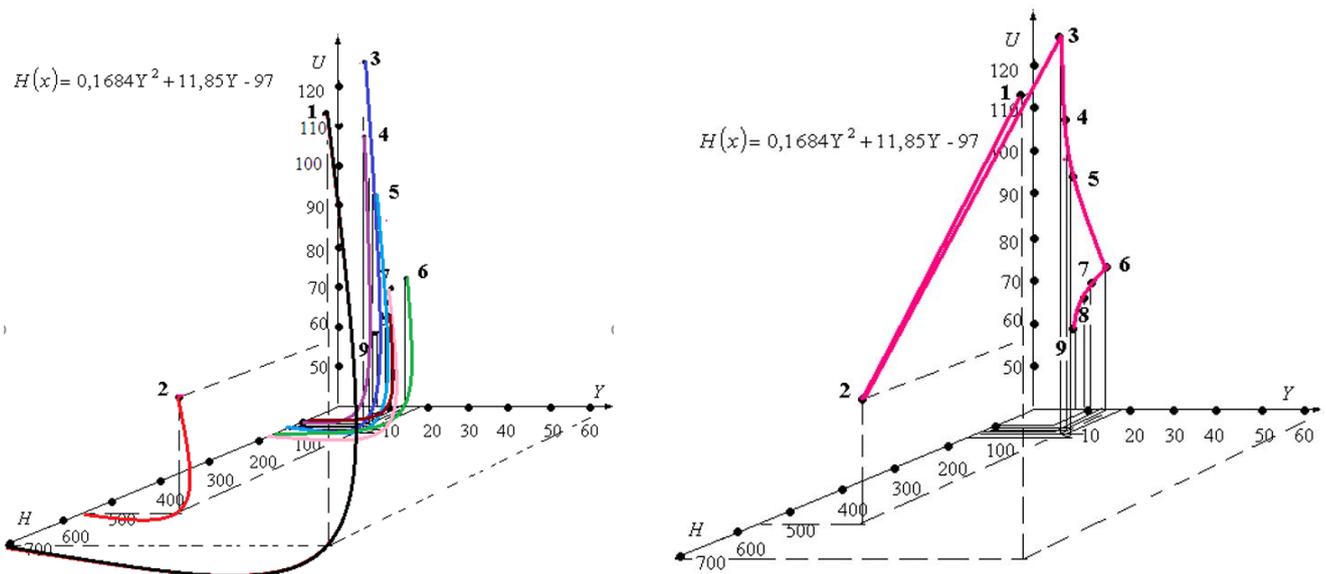


Figure 12. Spatial view of motor oil wear graph and determination of its limits.

The flash point of motor oil is tested according to GOST 4333 and ISO 2592 in an open crucible TVO apparatus. (flash temperature limit is 6°C-400°C). Viscosity coefficient VI is determined by standards at 40°C and 100°C. (TBN) Alkalinity is tested according to standards in the I-160-MI laboratory ionomer apparatus.

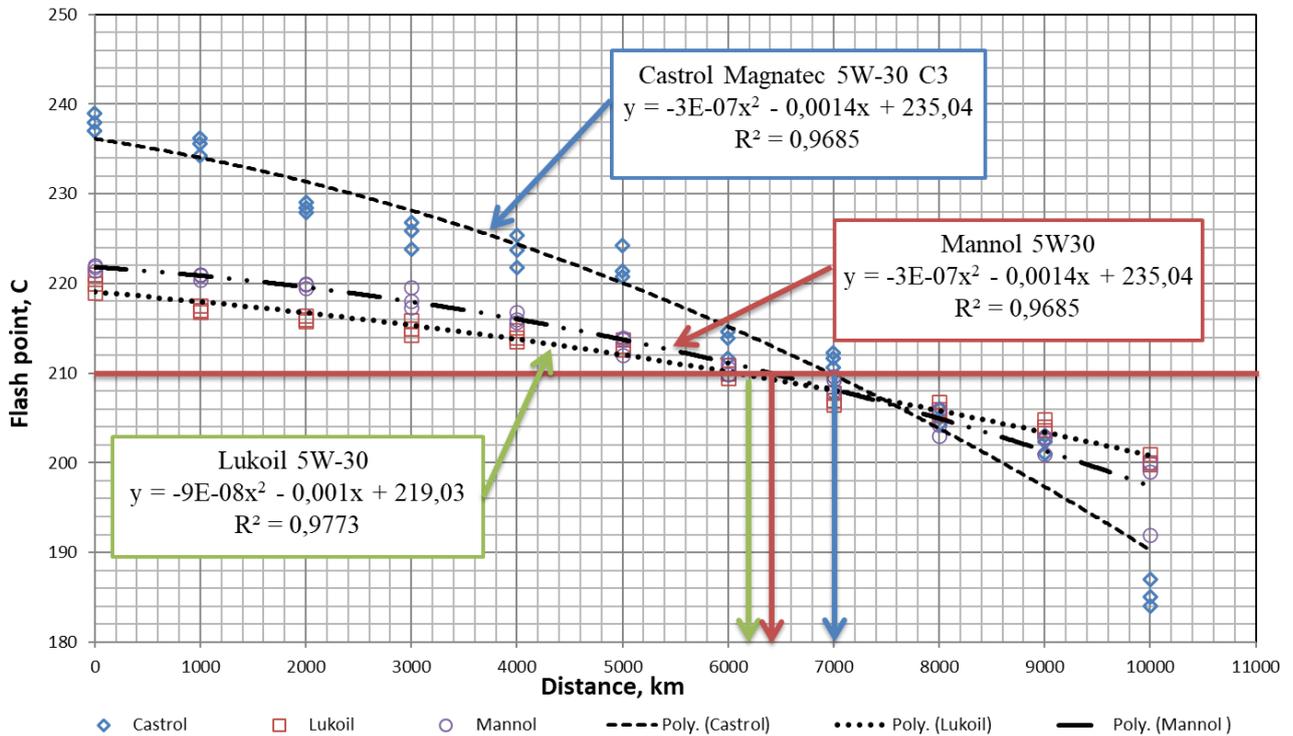


Figure 13. Evaluating of engine oil flash point.

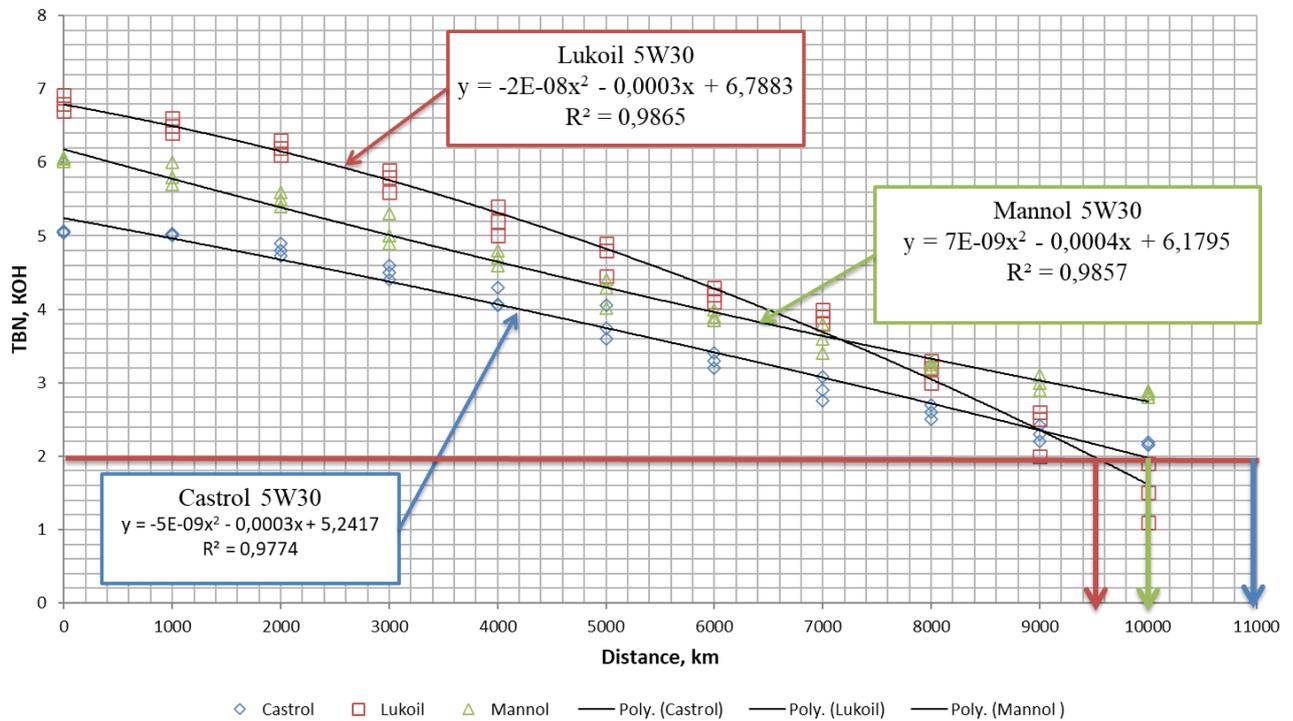


Figure 14. TAN and TBN numbers.

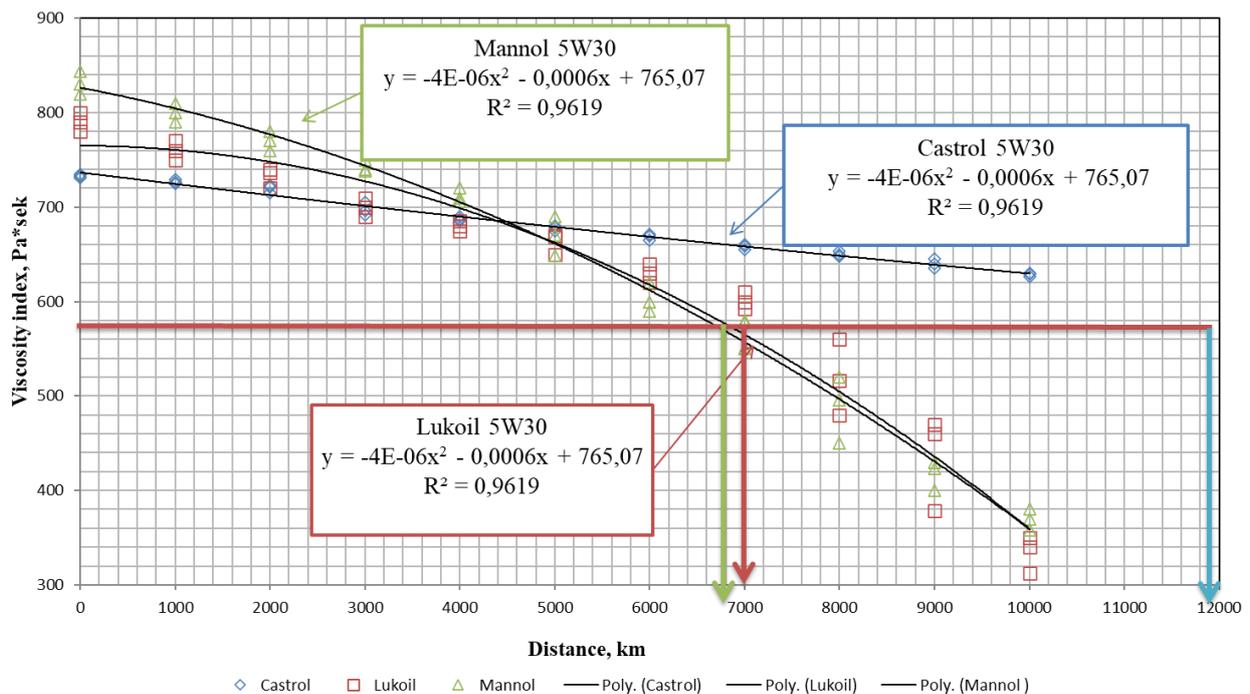


Figure 15. Engine oil viscosity at temperatures of 40 and 100 °C

GENERAL CONCLUSIONS.

The following general conclusions were made based on the study of the topic "Validation of engine oil life cycle in a hydrogen fuelled engines":

1. In the world, the synergistic issues of motor oil using alternative hydrogen gas as an additive in cars with gasoline engines have not been sufficiently studied. Also, it was found that the level of application of these technologies in our conditions is not high, there are reserves in the field in solving problems, and based on experiments, fuel consumption is reduced by 34% while increasing the useful work coefficient by 5%, and environmentally friendly gases NOx, CO, HCs the amount was reduced to 15%, 18%, 14%, respectively.

2. Hydrogen hygroscopic diffusion fuel synergy in the automotive hydrogen-gasoline fuel supply system was based on D. Rodziller's formula and the formula for the initial mixing level of hydrogen concentration with an arbitrary cross-section symmetrical about the axis is based on theoretical experiments and wear of automotive motor oil a mathematical model was created.

3. On the basis of the analysis of the automobile hydrogen-gasoline supply system, the main 3 parameters of the oil, i.e. flash temperature, viscosity index and alkali-acid numbers, in the interaction of motor oil with alternative fuel in local conditions, using theoretical and practical aspects were studied. Based on the information model, practical and theoretical studies on wear algorithm using Newton's interpolation formula achieved a 3% difference. Also, according to the synergetic concept of the use of car lubrication systems in operational conditions, the concepts of order and flexibility parameters were based.

4. Hydrogen-gasoline vehicle parameters were researched and based on the following results:

- A theoretical and practical calculation was made of the fuel consumption per 10,000 km of the Chevrolet Genra G200 internal combustion engine using standard and hydrogen.

- It was determined using the method of Newton's interpolation equations for standard and hydrogen-gasoline car fuel supply systems under the experimental conditions.

- 24% of fuel was saved when a hydrogen-gasoline car covered a distance of 100 km in urban conditions. If we consider that one car travels 30,000 km in a year, on average, 648 liters of fuel is saved by practical analytical methods. In this case, based on the synergy of hydrogen gasoline, the motor oil should be changed 500-1000 km earlier than every 10000 km.

5. In the example of determining the limit of working life of motor oil in local conditions of a hydrogen-gasoline engine, the annual economic efficiency (in the case of one car) of cars with an engine capacity of 1.5 l is 14,979,600 sums.

**НАУЧНЫЙ СОВЕТ PhD.22/01.02.2022. Т.144.01 ПО ПРИСУЖДЕНИЮ
УЧЕНЫХ СТЕПЕНЕЙ ПРИ ТУРИНСКОМ ПОЛИТЕХНИЧЕСКОМ
УНИВЕРСИТЕТЕ В ТАШКЕНТЕ**

**ТУРИНСКОМ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ В ГОРОДЕ
ТАШКЕНТ**

ШАРИПОВ АЛИШЕР КАЛБАЕВИЧ

**ОБОСНОВАНИЕ ПРЕДЕЛЬНОГО СРОКА СЛУЖБЫ
АВТОМОБИЛЬНОГО МОТОРНОГО МАСЛА, РАБОТАЮЩЕГО НА
ВОДОРОДНО-БЕНЗИНОВОМ ТОПЛИВЕ**

05.08.06 – Колесные и гусеничные машины и их эксплуатация

**АВТОРЕФЕРАТ ДИССЕРТАЦИИ ДОКТОРА ФИЛОСОФИИ (PhD)
ПО ТЕХНИЧЕСКИМ НАУКАМ**

Ташкент – 2024

Тема доктора философии (PhD) зарегистрирована в Высшей аттестационной комиссии при Кабинете Министров Республики Узбекистан под номером №B2019.4.PhD/T1476.

Диссертация была подготовлена в Туринском политехническом университете в Ташкенте.

Автореферат диссертации размещен на трех языках (узбекский, русский, английский (резюме)) на сайте www.polito.uz и на сайте информационно-образовательного портала «ZiyoNet» www.ziyo.net.uz.

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Защита диссертации состоится «__» _____ 2024 года в ____00 часов на заседании Научного совета PhD.22/01.02.2022.T.144.01 при Туринском политехническом университете в г.Ташкенте (Адрес: 100095, г. Ташкент, улица Кичик халка йули, 17. Тел./факс: (998-71)-246-50-92, e-mail: info@polito.uz)

С диссертацией можно ознакомиться в Информационно-ресурсном центре Туринском политехническом университете в г.Ташкенте (Адрес: 100095, г. Ташкент, улица Кичик халка йули, 17. Тел./факс: (998-71)-246-50-32, e-mail: irc@polito.uz)

Автореферат диссертации разослан «__» _____ 2024 года.
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ВВЕДЕНИЕ (аннотация докторской диссертации)

Актуальность и необходимость темы диссертации. Спрос на нефтепродукты – бензин и дизельное топливо, являющиеся источником топлива для автомобилей в мире, увеличился на 3,1% и 1% соответственно. Повышение эксплуатационных характеристик транспортных средств и анализ топливных тенденций требует сокращения традиционных видов топлива и постепенного использования альтернативных видов топлива, в том числе экологически чистого, безопасного и дешевого энергоносителя – газообразного водорода. Альтернативный водородный газ в настоящее время вызывает большой интерес со стороны различных развитых стран мировой энергетики, которые сами по себе уделяют особое внимание решению существующих проблем за счет расширения использования массового альтернативного вида топлива в будущем.

В мире при использовании водородного топлива в качестве присадки в бензиновые автомобили ведутся научные исследования, направленные на разработку новых научно-технических решений ресурсосберегающих технологий и технических средств для определения предельного срока службы моторных масел. В связи с этим глубокий статический анализ параметров моторных масел служит существенному повышению показателей надежности двигателя. Водородное топливо с его гигроскопическими, физико-химическими свойствами считается одной из актуальных задач создания научно-технической основы технологий и методов, направленных на повышение срока службы моторных масел.

В последние годы в нашей республике особое внимание уделяется внедрению технологий, направленных на повышение эксплуатационных характеристик и срока службы моторных масел, используемых в колесной технике, а также улучшение качества смазочных материалов при эксплуатации транспортных средств. В соответствии с постановлением Президента Республики Узбекистан № PQ-82 от 23.02.2024 г. «Организация производства зеленого водорода на основе современных технологий в нашей Республике и удовлетворение спроса отраслей экономики в этой продукции», эффективность увеличения научных и практических исследований в этой области, широкое внедрение в разработку инновационных технологий и решения Президента Республики Узбекистан № PQ-132 от 18.03.2024 года «Организация развития гибридных автомобилей в Республике Узбекистан». Узбекистан», в том числе широкое развитие возобновляемой и водородной энергетики в автомобильной сфере, определены важные задачи по поиску приемлемого решения существующих проблем и повышению характеристик надежности моторного масла. При реализации этих задач одним из важных вопросов является обоснование предельного срока службы моторного масла для автомобилей, работающих на водородо-бензиновом топливе, разработка метода выбора основных факторов, приводящих к износу моторного масла, работающий на водородо-бензиновой смеси.

Данная научно-исследовательская работа основана на решении Президента Республики Узбекистан от 04.09.2021 № PQ-5063 «Меры по

развитию возобновляемой и водородной энергетики Республики Узбекистан», производителей возобновляемых источников энергии и водорода, его пользователей и настоящих испытаний энергетического оборудования, приборов и технологий, а также транспортного средства в постановлении Президента Республики Узбекистан от 18.01.2022 № ПФ-60 «О стратегии развития нового Узбекистана для 2022-2026 гг. Данное диссертационное исследование служит в определенной степени для проведения научных исследований по воздействию на производственные территории и реализации задач, определенных в нормативных правовых документах, направленных на решение существующих проблем.

Соответствие исследований приоритетам развития науки и техники республики. Данное исследование посвящено развитию республиканской науки и техники: II. «Энергетика, энерго- и ресурсосбережение осуществлялось в рамках приоритетного направления. Действия в дорожной карте Постановления Республики Узбекистан № PQ-4422 от 22.08.2019 года Академии наук, Министерства энергетики, Министерства инновационного развития, ведомства «Узстандарт» и Постановления Президента Республики Узбекистан №. PQ-5063 от 04.09.2021 «Мероприятия по развитию возобновляемой и водородной энергетики в Республике Узбекистан».

Уровень изученности проблемы. В мировом опыте ряд зарубежных ученых вели научные работы по вопросу исследования особенностей использования моторных масел и предельных сроков работы с целью повышения качества автомобиля в процессе его эксплуатации, в том числе Маршалл Х.Т., Оливер С.Р. (США), Уильямс К., Дайсон А. (Великобритания), Масахико Н., Такада М. (Япония) и другие. Признавая работы вышеупомянутых ученых, можно сказать, что вопрос, поставленный в их работах, а именно обоснование предельного срока службы моторного масла для автомобилей, работающих на водородо-бензиновом топливе, не исследован.

Развитие возобновляемой энергетики в Республике Узбекистан, исследования по созданию устройств для улучшения производственных процессов, обоснование и улучшение параметров технологических процессов Верещагин В.И., Ковальский Б.И., Рунда М.М., Янович В.С., Безбородов Ю.Н., Гянджа В.А., Морозов А.Г., Григорьев М.А., Салимов А.Ю., Кадыров С.М., Лебедев О.В., Шарипов Г.А., Базаров Б.И., Мусурмонов Р.К. Мусурманов Р.К. и другие ученые достигли значительных результатов в разработке методов и алгоритмов моделирования, оптимизации и совершенствования автоматизированных систем управления. В то же время вопросы обоснования предельного срока службы моторного масла для автомобилей, работающих на водородо-бензиновом топливе, недостаточно изучены.

Связь диссертационного исследования с научными планами высшего учебного заведения, в котором выполнена диссертация. Диссертационное исследование связано с практическим проектом, основанным на сотрудничестве Туринского политехнического университета в г.Ташкент и Министерства инновационного развития Республики Узбекистан и научно-исследовательской программы заседания ученого совета № 09/17 от 21 сентября 2017 года.

совместно с АО «UzAuto Motors» и Туринским политехническим университетом в г. Ташкенте.

Цель исследования обосновать предел срока службы моторного масла для автомобилей, работающих на водородно-бензиновом топливе.

Задачи исследования:

Анализ современных методов совместимости газообразного водорода в качестве присадки в системе топливного питания автомобилей и разработка метода обоснования топливной экономичности и экологических показателей путем проведения экспериментальных исследований;

Обоснование математической модели оптимального износа моторного масла в водородно-бензиновой системе топливоснабжения путем теоретических экспериментов;

Разработка метода испытаний основных рабочих параметров моторного масла в водородно-бензиновом автомобиле в лабораторных условиях;

Разработка рекомендаций по применению результатов исследований и определению экономической эффективности внедрения;

В качестве **объекта исследования** было взято моторное масло автомобиля с водородно-бензиновым двигателем.

Предметом исследования является зависимость основных эксплуатационных показателей автомобиля с водородно-бензиновым двигателем от износа.

Методы исследования. В процессе исследования использовались классическая механика, математический анализ и методы математической статистики, теоретическая механика, методы анализа пошаговых процессов опыта посредством систем компьютеризации (имитации и моделирования), теория автомобилей, методы синтеза.

Научная новизна его исследований заключается в следующем:

Создана математическая модель, с помощью уравнения Фролова-Родзиллера, основанная на устойчивых режимах работы и режимах стагнации оптимальной топливной смеси в бензиновых двигателях с дополнительным газообразным водородом;

Определены основные граничные физико-химические свойства водородно-бензиновых моторных масел в условиях эксплуатации на основе регрессионно-корреляционного анализа;

Оптимизирована математическая модель с помощью закона интерполяции Ньютона, основываясь на предельном сроке службы водородно-бензинового моторного масла для двигателей внутреннего сгорания;

Разработаны, с учетом механизма воздействия водородно-бензинового топлива, рекомендации по срокам замены моторное масло.

Практические результаты исследования заключаются в следующем:

Усовершенствован конкретный компонент, позволяющий улучшить эксплуатационные, технико-экономические и экологические показатели автомобилей с бензино-водородно-воздушной смесью;

На основе научных теоретических и экспериментальных испытаний создана математическая модель водородно-бензиновой системы питания автомобиля;

В системе топливной смазки водородно-бензиновых автомобилей разработан предельный срок службы моторного масла;

Достоверность результатов исследования. Достоверность результатов современных исследований осуществляется с использованием современных методов и инструментов. Теоретическое обоснование параметров и режимов работы системы подачи топлива базируется на принципах теоретической механики и высшей математики, результаты экспериментов обрабатываются методами математической статистики, а совместимость теоретических и практических знаний объясняется тем, что включены в процесс получения результатов исследования.

Научная и практическая значимость результатов исследования. По научной значимости результатов исследования разработан предельный период работы на основе технических, количественных и стоимостных показателей между методом интеграции математической модели и аналитическими связями через язык моделирования топливной системы автомобиля;

По практической значимости результатов исследований определен износ моторного масла на основании рекомендаций и заключений, данных для системы смазки автомобиля в местных условиях, и обоснован предельный срок работы;

Внедрение результатов исследований. При обосновании предельного срока службы моторного масла для автомобилей, работающих на водородно-бензиновом топливе:

Акционерное общество «УзАвтосаноат» - 2017 На международной специализированной выставке «Астана-2017» на тему энергетики будущего, проходящей в городе Астана, Казахстан, перед командой Туринского политехнического университета была поставлена задача продемонстрировать автомобиль «Матиз», работающий на водороде. бензиновое топливо. (Информация от 8 октября 2021 года в АО «UzAuto Motors»). В результате ученые-исследователи университета успешно приняли участие в данной выставке, усовершенствовав систему подачи топлива автомобиля «Матиз»;

В результате исследований проведен ряд теоретических и практических испытаний по использованию альтернативного топлива в течение 2017-2021 годов. (Информация от 8 октября 2021 года в АО «UzAuto Motors»). В результате был разработан метод безопасной интеграции топливной системы автомобиля в условиях Узбекистана с газообразным водородом в качестве дополнительного топлива, КПД двигателя внутреннего сгорания увеличен на 5%, а расход топлива на 100 км/ч. снизился на 24%;

В системе износа создан оптимальный алгоритм, основанный на предельном сроке службы моторного масла в двигателе внутреннего сгорания. (Информация от 8 октября 2021 года в АО «УзАвто Моторс») В результате на основе теоретического и практического математического статического анализа основных 4/10, в которых наиболее значимый показатель – двигатель 6000-7000 км/час, моторное масло оказалось вязким;

На основе оптимальной математической модели износа смазочных материалов в зависимости от пробега двигателя внутреннего сгорания км/ч. (Информация от 8 октября 2021 года в АО «UzAuto Motors»);

Результаты и алгоритмы научной работы позволили широко внедрить их в процесс производства водородно-бензинового топлива (АО «УзАвто Моторс», справка от 8 октября 2021 года). В результате по результатам эксперимента были даны выводы и предложения по системе смазки двигателя автомобиля.

Утверждение результатов исследования. Основные результаты исследований были представлены и обсуждены на 2 международных и 2 национальных научно-практических конференциях.

Публикация результатов исследования. Всего по теме диссертации опубликована 21 научная работа, в том числе 10 статей в научных изданиях, рекомендованных к публикации по основным научным результатам диссертаций доктора философских наук (PhD) ВАК Республики Узбекистан, в том числе 7 республик и 2 зарубежных опубликованы в научных журналах. Из них 1 статья была опубликована в журналах с высоким импакт-фактором.

Структура и объем диссертации. Диссертация состоит из введения, четырех глав, заключения, списка использованной литературы и приложений. Объем диссертации составляет 120 страниц.

E'LON QILINGAN ISHLAR RO'YXATI
СПИСОК ОПУБЛИКОВАННЫХ РАБОТ
LIST OF PUBLISHED WORKS

1-bo'lim (Част I; Part I)

1. Шарипов А.К., Иноятходжаев Ж.Ш., // Автомобилларда алтернатив ёнилги турларини қўллаш ва уларни кўрсаткичлари. // “Вестник ТТПУ” (АСТА ТТРУ). №8 2017 г. 88-91ст.
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3. Sharipov A.K., Inoyatkhodjayev J.Sh., // Reducing air pollution hydrogen used as a fuel in the ICE in Uzbekistan. // “Acta of TPUT” Vol.9, Iss.4, Article 6, 12-1-2019, (<https://uzjournals.edu.uz/actattpu>)
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7. Sharipov A.K., // Using alternative fuels in Uzbekistan automotive industry. // “Иқтисодий тармоқлари ва ижтимоий соҳанинг энергия самарадорлигини оширишга қаратилган автоматлаштириш ва энергетика муаммоларни ечишда илғор инновацион технологиялар ва таълимни ўрни”
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