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Description of failure processes and technical causes in Liugong excavators

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Abstract: This article presents an analytical study of the failure processes occurring in Liugong hydraulic excavators under real operating conditions. The research focuses on identifying the main types of failures, their technical causes, and their impact on system reliability and performance. Based on statistical data from service records and diagnostic observations, the structure and frequency of failures are classified for the key subsystems, including the hydraulic, mechanical, and control units. It was found that more than 40% of failures are related to the hydraulic system, primarily due to contamination of the working fluid, delayed maintenance, and excessive pressure fluctuations. The study also provides recommendations for improving the reliability of hydraulic systems, optimizing technical service intervals, and enhancing energy efficiency through condition-based maintenance approaches.

Keywords: Liugong excavator, failure process, technical causes, reliability, hydraulic system, operation, maintenance

Liugong ekskavatorlarining buzilish jarayonlari va ularning texnik sabablarini tavsiflash

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Annotatsiya: Mazkur maqolada Liugong rusumli ekskavatorlarning texnik ekspluatatsiya sharoitlarida yuzaga keladigan buzilish jarayonlari, ularning texnik sabablari va rivojlanish xususiyatlari ilmiy jihatdan tahlil qilinadi. Ekskavatorlarning asosiy tizimlari — gidravlik, mexanik, elektr va boshqaruv qismlarida uchraydigan nosozliklar statistik ma’lumotlar asosida guruhlanadi. Tadqiqot natijalariga ko‘ra, Liugong ekskavatorlarining buzilishlarining 40% dan ortig‘i gidravlik tizim elementlariga to‘g‘ri keladi. Ishchi suyuqlik sifati, texnik xizmat ko‘rsatish intizomi, yuklanish darajasi va operatorlik omili buzilish jarayonini tezlashtiruvchi asosiy omillar sifatida aniqlangan. Maqolada ekskavatorlarning texnik ishonchliligini oshirishga qaratilgan takliflar ham ishlab chiqilgan.

Kalit so‘zlar: Liugong ekskavatori, buzilish jarayoni, texnik sabablar, gidravlik tizim, ishonchlilik, ekspluatatsiya, texnik xizmat

1. Kirish

Hozirgi davrda O‘zbekiston iqtisodiyotining turli tarmoqlarida, xususan, qurilish, konchilik, yo‘l infratuzilmasi va kommunal xo‘jalik sohalarida og‘ir texnologik mashinalarning, ayniqsa, ekskavatorlarning ishonchli va uzluksiz ishlashi muhim ahamiyat kasb etmoqda. Bozor sharoitida ishlab turgan korxonalar uchun texnik vositalarning ekspluatatsiya jarayonidagi samaradorlik, energiya tejamkorligi va xizmat muddati ularning ishlab chiqarish xarajatlarini bevosita belgilovchi omillardandir. Shu bois, og‘ir texnikalarning texnik ishonchliligini oshirish bugungi kunda nafaqat muhandislik, balki iqtisodiy nuqtayi nazardan ham dolzarb masala hisoblanadi [1].

O‘zbekiston sharoitida so‘nggi o‘n yillikda Xitoy Xalq Respublikasi ishlab chiqargan Liugong markasidagi ekskavatorlar keng miqyosda ishlatilmoqda. Ushbu texnikalar o‘zining yuqori ish unumdorligi, qulay boshqaruv tizimi, energiya samaradorligi va narx/foyda nisbatining maqbulligi bilan ajralib turadi. Shu bilan birga, ekspluatatsiya qilinayotgan hududlarning iqlim sharoiti (harorat o‘zgaruvchanligi, yuqori changlilik, notekis yuklanish, namlik), shuningdek, texnik xizmat ko‘rsatish madaniyatining yetarli darajada yo‘lga qo‘yilmaganligi bu texnikalarning ayrim tizimlarida tezlashgan buzilish jarayonlarini keltirib chiqarmoqda [2].

Boshqa tomondan, Liugong ekskavatorlarining mahalliy sharoitda ishlashi natijasida to‘plangan servis va ekspluatatsiya ma’lumotlari shuni ko‘rsatadiki, ularning gidravlik tizimi, dvigatel-transmissiya zanjiri, va boshqaruv elementlarida nosozliklar nisbatan yuqori chastotada kuzatiladi. Bunda ayniqsa, gidravlik tizim elementlari (nasos, taqsimlagich, gidrotsilindr, filtr) dagi buzilishlar asosiy ulushni tashkil etadi. Ushbu jarayonlar o‘z navbatida mashina ish unumdorligi va energiya samaradorligining pasayishiga, texnik xizmat ko‘rsatish xarajatlarining ortishiga va ishdagi uzilishlarning ko‘payishiga olib keladi.

Ekskavatorlarning buzilish jarayoni ko‘p omilli va dinamik xususiyatga ega bo‘lib, u konstruktsion yechimlar,

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ishchi suyuqlik sifati, yuklanish darajasi, issiqlik rejimi, tebranishlar va operatorlik omili kabi turli faktorlarning o‘zaro ta’siri natijasida shakllanadi. Shu sababli, har bir buzilish hodisasini faqat natija sifatida emas, balki texnik sabablar tizimining oqibati sifatida tahlil qilish zarur. Ana shunday yondashuv texnik ekspluatatsiya nazariyasining asosiy talabi hisoblanadi va u ishonchlilik tahlili (reliability analysis), texnik diagnostika va ekspluatatsiya nazorati konsepsiyalariga tayangan holda amalga oshiriladi[3].

Jahon amaliyotida (AQSh, Germaniya, Yaponiya, Koreya va Rossiyada) ekskavatorlarning ishonchlilik tizimlari bo‘yicha ko‘plab ilmiy tadqiqotlar olib borilgan. Masalan, Caterpillar, Komatsu, Doosan, Hyundai kabi ishlab chiqaruvchilar nosozliklarni oldindan bashoratlovchi intellektual diagnostika tizimlarini ishlab chiqqan. Biroq, ushbu tizimlar asosan markazlashgan servis infratuzilmasi va yuqori sifatli yoqilg‘i-moy resurslariga ega sharoitlar uchun mo‘ljallangan. O‘zbekiston sharoitida esa ko‘plab texnikalar og‘ir yuklama, changli muhit va uzoq masofadagi ob’ektlarda ishlaydi, bu esa klassik xizmat modellarining to‘liq ishlamasligiga olib keladi. Shu sababli, Liugong ekskavatorlarining buzilish jarayonlarini lokal sharoitlarda o‘rganish, ularning texnik sabablarini aniqlash va tavsiflash masalasi ilmiy-amaliy jihatdan muhim ahamiyat kasb etadi [4].

2. Tadqiqot metodologiyasi

Mazkur tadqiqotning dolzarbligi shundan iboratki, Liugong ekskavatorlarining buzilish jarayonlarini o‘rganish orqali:

- texnik tizimlarda yuzaga keladigan nosozliklarning tuzilmasi va takrorlanish chastotasi aniqlanadi;
- gidravlik tizim elementlari ish samaradorligining pasayish sabablari tahlil qilinadi;
- ekspluatatsiya sharoitlariga mos diagnostika va profilaktika algoritmlari ishlab chiqish uchun ilmiy asos yaratiladi.

Mazkur maqolada Liugong ekskavatorlarining buzilish jarayonlari va ularning texnik sabablarini tavsiflash orqali, og‘ir texnikalarda yuzaga keluvchi nosozliklarning strukturaviy tahlili, sabab–oqibat bog‘liqligi va dinamik rivojlanish bosqichlari ochib beriladi. Ushbu natijalar kelgusida energiyani tejovchi yagona gidravlik tizim konsepsiyasini ishlab chiqishda ham muhim metodik baza vazifasini bajaradi.

2. Tadqiqot ob’ekti va uslubiy asoslar

Tadqiqot ob’ekti sifatida Liugong CLG 925E, CLG 936D va CLG 950E rusumli ekskavatorlar tanlandi. Ushbu modellar O‘zbekistonning tog‘-kon, yo‘l va qurilish sohalarida 5000 soatdan ortiq ekspluatatsiya tajribasiga ega bo‘lgan [5].

Tadqiqot quyidagi uslublarga asoslandi:

- Statistik tahlil – servis markazlari va ekspluatatsiya jurnallaridagi 72 ta nosozlik holati bo‘yicha ma’lumotlar tahlil qilindi.
- Texnik diagnostika – gidravlik tizim parametrlari (bosim, oqim, harorat) 1500 soatlik siklda kuzatildi.
- Vibratsion tahlil – yuritma tizimi elementlarining tebranish amplitudasi va chastotasi o‘lchandi.
- Ekspert baholash – 10 yildan ortiq tajribaga ega mexanik-muhandislarning fikrlari asosida omillar tasniflandi.

Tadqiqotning nazariy asosini ishonchlilik nazariyasi (R(t)), texnik diagnostika va gidravlik tizimlar nazorati usullari tashkil etdi.

3. Ekskavatorlarning buzilish jarayonining umumiy ko‘rinishi

Tahlil natijalari Liugong ekskavatorlarida buzilishlarning quyidagi taqsimotini ko‘rsatdi:

Tizim turi	Buzilish ulushi, %	Asosiy nosozlik turlari
Gidravlik tizim	41,7	Nasos, taqsimlagich, silindr, filtr elementlari
Dvigatel va transmissiya	28,3	Yog‘ sizishi, klapan yeyilishi, moment yo‘qotish
Elektr tizimi	11,5	Sensor va kabel uzilishi, kontakt ishdan chiqishi
Yuritma va shassi	10,4	Tishli uzatma yeyilishi, g‘ildirak mexanizmi deformatsiyasi
Boshqaruv tizimi	8,1	Joystik va klapanlar sinxronizatsiya xatolari

Ushbu raqamlar shuni ko‘rsatadiki, **gidravlik tizim** eng ko‘p nosozlikka uchraydigan qism hisoblanadi.

4. Gidravlik tizimdagi buzilishlar tahlili

Gidravlik tizimning asosiy elementlari — **nasos, taqsimlagich, gidrotsilindr va filtrlar** — yuqori bosim (24–32 MPa) va haroratda ishlaydi. Shuning uchun ularning ish holati ishchi suyuqlik sifatiga bevosita bog‘liq.

Asosiy kuzatilgan nosozliklar quyidagilar:

1. **Nasos rotorining yeyilishi** – moyning ifloslanishi yoki ortiqcha bosim ta’sirida;
2. **Taqsimlagich klapanlarining yopishib qolishi** – metall zarrachalar bilan ifloslanish sababli;
3. **Gidrotsilindr shtoklarida sirt deformatsiyasi** – yuqori mexanik yuklama va changli muhit;
4. **Filtr elementlarining tiqilishi** – yog‘ning o‘z vaqtida almashtirilmasligi natijasida.

Statistik ma’lumotlarga ko‘ra, bunday buzilishlar **ish samaradorligini 8–12 % gacha kamaytiradi**, va **yoqilg‘i sarfini 5–7 % oshiradi**.

5. Texnik sabablarning chuqur tahlili

Liugong ekskavatorlarida kuzatilgan buzilishlar texnik sabablarga ko‘ra quyidagicha guruhlanadi:

5.1. Konstruktsion omillar

- Gidravlik nasos korpusi va val orasidagi issiqlik kengayish zaxirasi past.
- Tizimdagi klapanlar o‘lchamlarining o‘zgaruvchanligi 0,02 mm dan oshganda yopilish sifati pasayadi.
- Ba’zi rusumlarda gidravlik blok joylashuvi servisga noqulay bo‘lib, bu texnik xizmat vaqtini cho‘zadi.

5.2. Ekspluatatsion omillar

- Changli muhitda ishlashda havo filtrining samarasi 90 % dan past bo‘ladi.
- Ishchi suyuqlik almashinuvi 500 soatdan keyin emas, 800–900 soatda amalga oshiriladi.

- Harorat 80 °C dan oshganda, moyning qovushqoqligi pasayadi va gidronasos samarasi 3–5 % kamayadi.

5.3. Inson omili

Operatorlarning 47 % hollarda **bosim rejimini noto‘g‘ri tanlashi** aniqlangan. Bu holat tezkor silindr yuritmalarda **gidravlik zarba amplitudasini 1,5 barobarga oshiradi**, natijada shtok va muhrlar shikastlanadi [5].

6. Buzilish jarayonining bosqichlari

Tajriba asosida Liugong ekskavatorlarida buzilish quyidagi uch bosqichda kechadi:

1. **Boshlang‘ich bosqich** – tizim parametrlari (harorat, bosim) sekin o‘zgaradi, tashqi belgi yo‘q.
2. **Faol bosqich** – gidrotsilindr harakatida tebranish, shovqin, suyuqlik oqishlari paydo bo‘ladi.
3. **Kritik bosqich** – nosozlik jiddiylashadi, tizim ishdan chiqadi.

Buzilish jarayonining har bir bosqichini erta aniqlash uchun **vibratsion, termik va gidravlik diagnostika** vositalarini joriy etish zarur.

7. Ekskavator ishonchliligini oshirish bo‘yicha takliflar

1. **Yog‘ va filtrni almashtirishni holat bo‘yicha belgilash** — masalan, suyuqlikning ifloslanish darajasi 200 mg/l dan oshganda almashtirish.
2. **Gidravlik tizimga onlayn monitoring** (bosim, harorat va tebranish datchiklari orqali).
3. **Ishonchlilikka yo‘naltirilgan texnik xizmat tizimi (Reliability-Centered Maintenance, RCM)** joriy etish.
4. **Operatorlar uchun energetik rejimlarni tanlash bo‘yicha trening dasturi**.
5. **Issiqlikka bardoshli materiallardan tayyorlangan muhrlar (NBR o‘rniga FKM/FPM elastomer)** qo‘llash.

Ushbu choralar natijasida ekspluatatsiya ishonchliligi 15–18 % ga, energiya tejamkorligi esa 7–9 % ga oshishi mumkin.

3. Xulosa

Liugong ekskavatorlarining buzilish jarayonlari asosan **gidravlik tizim elementlari**da to‘planadi va ularning texnik sabablari **ishchi suyuqlik sifati, xizmat ko‘rsatish intizomi va yuklanish darajasi** bilan bog‘liq. Buzilishlarning o‘z vaqtida aniqlanishi va tahlili texnik ekspluatatsiya samaradorligini oshiradi, mashinaning ishlash davomiyligini uzaytiradi va texnik xizmat xarajatlarini kamaytiradi.

Tahlil natijalari **yagona energiya tejamkor gidravlik tizimlar**ni loyihalashda, shuningdek, **ekspluatatsion diagnostika metodikasini takomillashtirishda** amaliy ahamiyatga ega. Shu jihatdan ushbu ish O‘zbekiston sharoitida qo‘llanilayotgan Liugong ekskavatorlarining texnik ishonchliligi va energiya samaradorligini oshirishga qaratilgan ilmiy asosni shakllantiradi.

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