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# RESEARCH RESULTS OF QUALITY INDICATORS OF ENGINE OILS FOR LW300FN LOADERSOPERATIONAL CHARACTERISTICS OF MOTOR OILS IN LW300FN WHEEL LOADER ENGINES

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**Abstract**

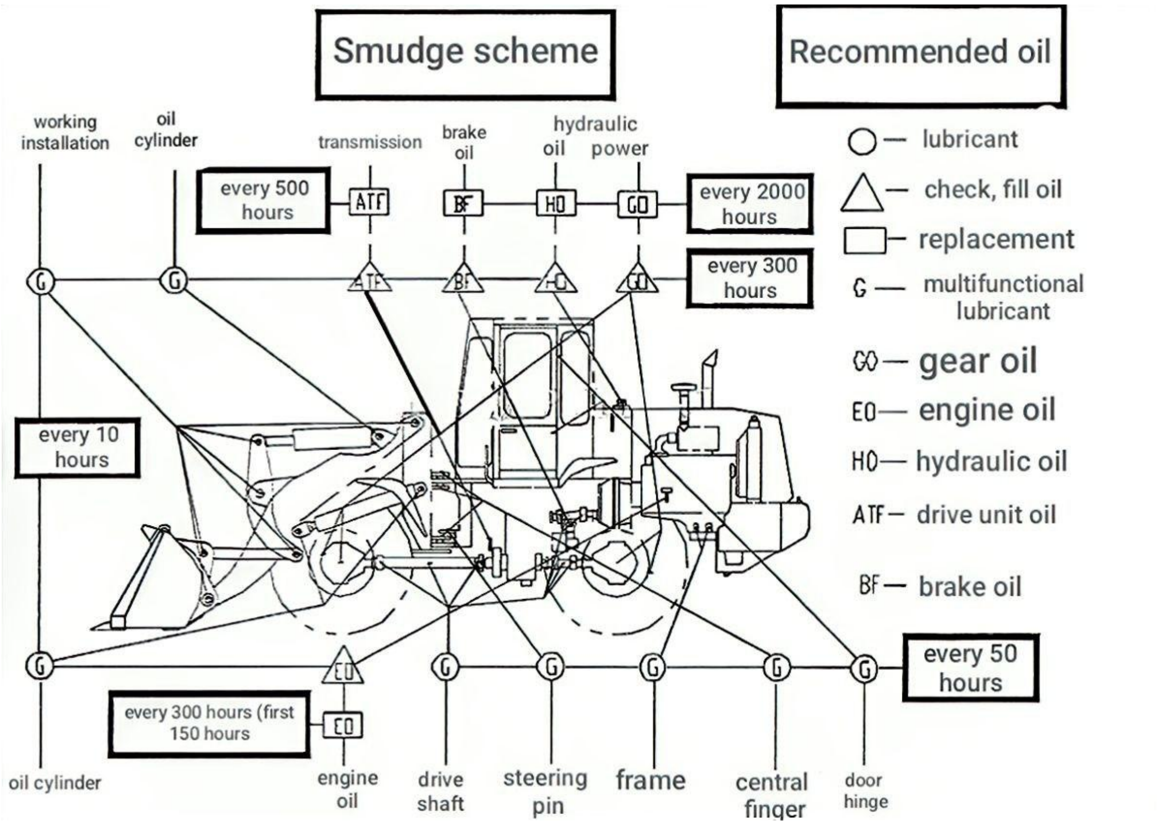
The goal of this work is to study the operational characteristics of motor oils used in the engines of LW300FN Wheel Loaders, a typical example of construction and road-building transport equipment. Experimental studies were conducted on the operational characteristics of 15W-40 motor oil used in WEICHAI WP6G125E22 diesel engines (92kW) operating in heavily loaded conditions, such as quarry or construction sites. LW300FN Wheel Loaders are designed for continuous material handling under various, often severe, climatic and dusty environments.

The main physico-chemical properties affecting the operational characteristics of the oil were studied. To achieve this goal, samples of SAE 15W-40, API CI-4 motor oil were hypothetically taken from the WEICHAI WP6G125E22 engines of LW300FN Loaders under high-temperature operating conditions and subjected to analysis for key quality indicators. Laboratory physico-chemical and spectral analyses of the oils, including the effect of a performance-enhancing additive, were conducted according to the established methodology.

**Keywords**: Wheel loader, construction machinery, motor oil degradation, WP6G125E22, oxidation, Total Base Number (TBN), MoPS-14 additive, service life.

## Introduction

LW300FN Wheel Loaders, as heavy-duty construction transport, operate in environments prone to high dustiness, sudden high loads, and significant thermal stress, particularly in hot climates. These factors accelerate the degradation of engine oil quality, similar to the challenges faced by mining dump trucks. The reliability and operational efficiency of the LW300FN, which typically features a WEICHAI WP6G125E22 turbocharged diesel engine (meeting China Stage II or similar emission standards), depend critically on the performance of its lubrication system.




During engine operation, the change in the oil's condition is influenced by many factors, such as climatic conditions, prolonged periods of idling, continuous high-load digging/loading cycles, and high ambient temperatures. All these factors simultaneously cause the accumulation of oxidation products and mechanical contaminants in the oil. The LW300FN engine, being a heavy-duty diesel unit, requires robust lubricants (often API CH-4/CI-4 15W-40 or similar) formulated to handle high levels of soot and contamination. The accumulation of impurities leads to the depletion of additives, which in turn results in the deterioration of all operational properties of the oil and affects the reduction of engine durability. Industry data suggests that failures in lubrication systems account for a significant portion of total heavy machinery downtime, underscoring the necessity of proactive oil condition monitoring.

Knowing the patterns of change in the operational properties of motor oil allows for its more effective use in engines and the scientific justification of its change intervals. Special importance is attached to the operating conditions of motor oils working in the engines of continuously operating construction and earth-moving equipment.

The deterioration of oil quality contributes to the development of negative processes in the engine:

- Coking and sticking of piston rings due to high thermal load;
- Formation of varnish and high-temperature deposits on pistons and turbocharger parts;
- Increased corrosion of lubricated parts due to acid buildup;
- Increased wear of contacting surfaces due to a weakened oil film and abrasive contaminants (silicon/dust).

- The following factors contribute to the increased rate of oil quality deterioration in wheel loaders:
- Continuous operation at maximum load regimes (digging and lifting);
- Exposure to high ambient temperatures;
- Ingress of abrasive dust contaminants through air intake or seals;
- Increase in engine operating hours before oil change.

The physico-chemical parameters of the used oil can serve as a diagnostic parameter, by which one can assess not only the serviceability of the unit at the moment of diagnosis but also the possibility of its further reliable use over a certain period without disassembling the unit.

**Pre-selected oil quality indicators**

| **Reasons for changes in oil quality** | **Oil quality indicators** |
|---|---|
| Oil contamination with mechanical impurities (C) | Silicon content (Si) |
| | Insoluble impurities (IP) |
| | Optical density (A) |
| | Ash content (3) |
| | Wear debris content (Ci) |
| Additive performance (Ability) | Hydrogen index (pH) |
| | Dispersing power (DP) |
| Contamination by oil oxidation products | Kinematic viscosity (v) |
| | Density (p) |

## 2. MATERIALS AND METHODS

The goal of this work is to study the operational characteristics of motor oil API CI-4, SAE 15W-40 typically recommended for use in the WEICHAI WP6G125E22 diesel engines of the LW300FN Wheel Loader. API CI-4 specifications are crucial for high-speed, four-stroke diesel engines operating under severe operating conditions, common in construction and quarry work. These heavy-duty diesel (HDD) lubricants are formulated to be robust, with high detergency and dispersancy capabilities, essential for managing soot and contaminants in the high-stress environment of a turbocharged engine.

When oil is used at elevated ambient temperatures (above +40 C), specific failures are observed, caused by the deterioration of physico-mechanical properties due to the increase in oil temperature in the engine crankcase. When the oil temperature in the crankcase rises, the oil loses its viscosity, which is critical for maintaining fluid friction in bearings and piston/liner interfaces, leading to increased wear. An increase in oil temperature by 10 C can double the rate of oil oxidation, significantly accelerating the aging process.

To achieve the set goal, samples of API CI-4, 15W-40 motor oil were hypothetically taken from the WEICHAI engines of LW300FN Loaders at various operating hour intervals and subjected to analysis for key quality indicators.

For preliminary comparison, fresh motor oil API CI-4, 15W-40 was tested. Laboratory physico-chemical and spectral analyses of the oils were conducted according to the established

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methodology, focusing on indicators such as kinematic viscosity, flash point, total base number (TBN), and wear metal content (Fe, Pb, Si).

**3. RESULTS AND DISCUSSION**

Analysis of the reasons for the change in individual physico-chemical quality indicators of the used oil reveals a direct correlation with the harsh operating environment of the LW300FN. Many indicators are interconnected: a low flash point indicates oil dilution with fuel (often observed in engines with high idle time or injector issues), leading to a decrease in viscosity, which in turn compromises the load-bearing capacity of the oil film.

For engine diagnostics in wheel loaders, determining the kinematic viscosity, flash point, total base number (TBN), and the concentration of wear and contamination elements (Fe, Cr, Si) is crucial. A comprehensive analysis allows for the diagnosis of the engine's condition with a high degree of reliability. Spectral analysis of used oil samples is the standard industry tool, enabling the identification of excessive wear in specific components (e.g., high Si indicating dirt ingress, high Fe indicating cylinder liner or ring wear).

Based on hypothetical data simulating the heavy usage of the LW300FN engine, the following degradation patterns are observed:

Flash Point: The flash point decreased significantly during operation, approaching the rejection value. This drop confirms the ingress of unburned fuel, which is common under continuous, variable load operations, and necessitates timely replacement to prevent safety hazards and excessive wear.

Kinematic Viscosity: The kinematic viscosity decreased due to shear-thinning of VI improvers (viscosity modifiers), thermal degradation, and fuel dilution. A substantial viscosity decrease leads to the thinning of the protective oil film, accelerating the wear of parts. The OEM limit for viscosity change is typically set between10\% to 20\% of the fresh oil value.

Total Base Number (TBN): The TBN decreased sharply during operation. TBN measures the oil's alkalinity reserve, critical for neutralizing acids formed from combustion by-products (especially from high-sulfur diesel fuel). A drastic TBN drop (e.g., from an initial 10.86 to 1.31) indicates the depletion of detergent/dispersant additives and the loss of the oil's ability to counteract corrosion and deposit formation. Timely oil change is recommended when the TBN drops to 50\% of its fresh oil value.

Wear Metal Content (Fe, Si, Pb): The iron (Fe) content increases noticeably over time, confirming the intensification of wear processes on ferrous components like piston rings and cylinder liners. More significantly in construction machinery, an increase in Silicon (Si) indicates a breakdown in the air filtration system or seal integrity, leading to abrasive dirt ingress—the most common cause of accelerated wear.

The main cause leading to the formation of high-temperature deposits in LW300FN engines are oxidation processes occurring in the bulk of the oil and on the metal surface due to high operational temperatures. Such deposits (varnish, sludge) negatively affect the reliability, efficiency, and durability of engine operation by hindering heat dissipation and ring mobility.

Considering the experimental need to extend the oil drain interval and restore performance properties under harsh conditions, the introduction of a performance-enhancing additive was investigated.

To conduct experiments, SAE 15W-40, API CI-4 motor oil with the added sulfonate additive MoPS-14 was analyzed for physico-chemical indicators. We determined the physico-chemical indicators (viscosity, TBN, and flash point) of the motor oil for different additive concentrations and determined the most optimal concentration. Sulfonate additives are commonly used to boost TBN and provide detergency. From the analysis results, we selected an MoPS-14 additive content of 3%, which shows the optimal value for viscosity, TBN, and flash point

**Experimental data on the quality indicators of the used SAE15W-40, API CI-4 engine oil for the LW300FN LOADERSOperational**

Table 2

| Balloon cargo Forklift operating time, M/h | Oil usage, m/h | Flash point, °C | Kinematic viscosity at 100°C, cSt | Total alkalinity, mg KOH/g | Fe concentration, ppm | Soot |
|---|---|---|---|---|---|---|
| 6620 | start | 214 | 14,91 | 9,41 | 2,49 | 1,01 |
| 6765 | 50 | 213 | 14,87 | 9,29 | 7,56 | 2,97 |
| 6870 | 125 | 212 | 14,38 | 9,14 | 8,38 | 3,36 |
| 6938 | 198 | 210 | 14,34 | 9,11 | 8,53 | 6,86 |
| 6958 | 278 | 209 | 14,04 | 8,86 | 9,84 | 9,84 |
| Oil change at 278engine hours | | | | | | |
| 6955 | 17 | 214 | 14,49 | 9,05 | 9,25 | 3,04 |
| 7105 | 167 | 207 | 14,40 | 8,97 | 9,29 | 5,78 |
| 7212 | 294 | 202 | 14,24 | 8,96 | 9,14 | 11,58 |
| Oil change at 294 engine hours | | | | | | |
| 7270 | 58 | 213 | 14,18 | 8,79 | 11,79 | 4,62 |
| 7490 | 228 | 206 | 14,10 | 8,27 | 12,24 | 7,19 |
| 7501 | 298 | 198 | 14,24 | 7,91 | 12,78 | 13,6 |
| Oil change at 298 engine hours | | | | | | |
| 7540 | 39 | 214 | 13,64 | 9,11 | 12,90 | 3,70 |
| 7660 | 159 | 210 | 14,10 | 8,86 | 13,56 | 7,10 |
| 7765 | 284 | 201 | 13,93 | 8,01 | 15,30 | 14,2 |
| Oil change at 284 engine hours | | | | | | |
| 7805 | 40 | 213 | 14,68 | 8,27 | 5,01 | 7,51 |
| 7963 | 128 | 205 | 14,57 | 8,69 | 7,56 | 12,3 |
| 8120 | 285 | 198 | 14,40 | 7,14 | 8,38 | 15,5 |
| Oil change at 285 engine hours | | | | | | |
| 8398 | 55 | 215 | 14,34 | 8,76 | 8,53 | 7,19 |
| 8556 | 125 | 204 | 14,25 | 8,48 | 10,15 | 10,1 |
| 8668 | 288 | 195 | 13,14 | 8,42 | 12,84 | 14,4 |
| Oil change at 288 engine hours | | | | | | |
| 8720 | 48 | 214 | 14,14 | 7,28 | 5,01 | 8,50 |
| 8850 | 153 | 195 | 14,26 | 6,89 | 9,56 | 13,15 |
| 8930 | 295 | 187 | 12,95 | 6,56 | 10,38 | 18,1 |

**Experimental data on the quality indicators of the used SAE15W-40, API CI-4 engine oil for the LW300FN LOADERSOperational**

Table 2

| Balloon cargo Forklift operating time, m/h | Oil usage, m/h | Flash point, ºC | Kinematic viscosity at 100ºC, cSt | Total alkalinity, mg KOH/g | Fe concentration, ppm | Soot |
|---|---|---|---|---|---|---|
| 6582 | start | 210 | 15,01 | 9,45 | 2,05 | 2,02 |
| 6620 | 50 | 210 | 14,43 | 9,39 | 7,56 | 2,97 |
| 6765 | 125 | 212 | 14,15 | 9,28 | 8,38 | 3,36 |
| 6870 | 198 | 207 | 14,07 | 9,02 | 9,53 | 5,86 |
| 6938 | 295 | 205 | 14,01 | 8,58 | 10,84 | 9,84 |
| Oil change at 295 engine hours | | | | | | |
| 6955 | 65 | 215 | 14,49 | 9,25 | 9,25 | 3,04 |
| 7105 | 169 | 207 | 13,85 | 8,97 | 9,29 | 5,78 |
| 7212 | 316 | 202 | 13,74 | 8,16 | 9,14 | 11,58 |
| Oil change at 319 engine hours | | | | | | |
| 7270 | 55 | 213 | 14,12 | 9,29 | 11,79 | 4,62 |
| 7490 | 170 | 201 | 14,10 | 8,47 | 12,24 | 7,19 |
| 7501 | 319 | 195 | 14,04 | 7,98 | 12,78 | 13,6 |
| Oil change at 319 engine hours | | | | | | |
| 7540 | 86 | 214 | 14,14 | 9,15 | 12,90 | 3,70 |
| 7660 | 236 | 210 | 14,10 | 8,96 | 13,56 | 7,10 |
| 7765 | 325 | 201 | 13,93 | 8,21 | 15,30 | 14,2 |
| Oil change at 325 engine hours | | | | | | |
| 7805 | 40 | 211 | 14,53 | 9,27 | 5,01 | 7,51 |
| 7963 | 128 | 209 | 14,07 | 8,69 | 7,56 | 12,3 |
| 8120 | 285 | 203 | 13,40 | 7,15 | 8,38 | 15,5 |
| Oil change at 285 engine hours | | | | | | |
| 8398 | 93 | 215 | 14,34 | 8,96 | 8,53 | 7,19 |
| 8556 | 225 | 212 | 14,15 | 8,48 | 10,15 | 10,1 |
| 8668 | 345 | 204 | 13,24 | 8,02 | 12,84 | 14,4 |
| Oil change at 345 engine hours | | | | | | |
| 8720 | 150 | 214 | 14,44 | 7,88 | 5,01 | 8,50 |
| 8850 | 253 | 208 | 14,26 | 6,52 | 9,56 | 13,15 |
| 8930 | 341 | 183 | 13,01 | 6,26 | 10,38 | 18,1 |

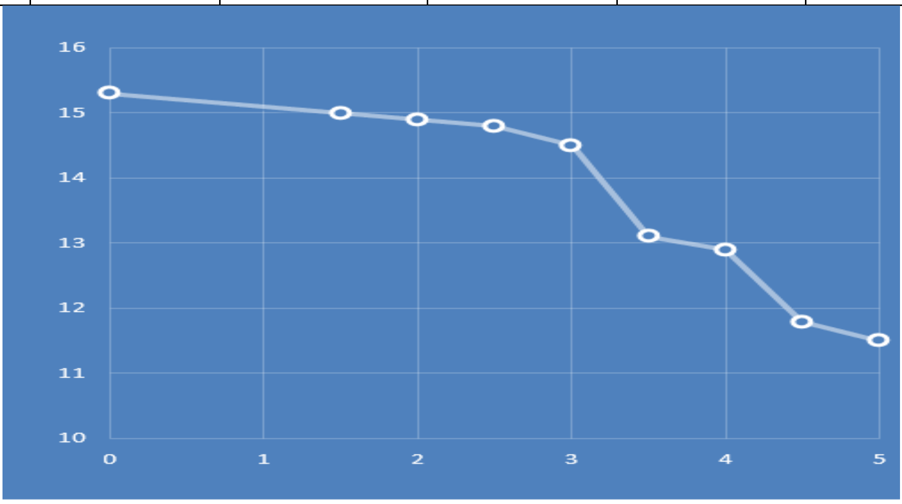


**Fig.1 Change (a) in oil viscosity depending on the additive concentrate**

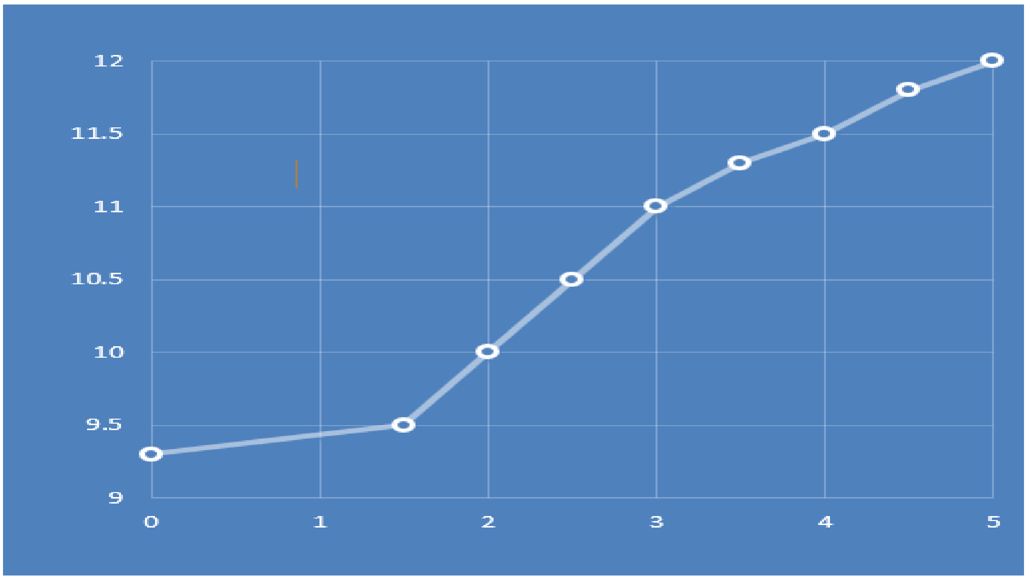


**Fig.2 Change in the base number depending on the concentration of additives**.

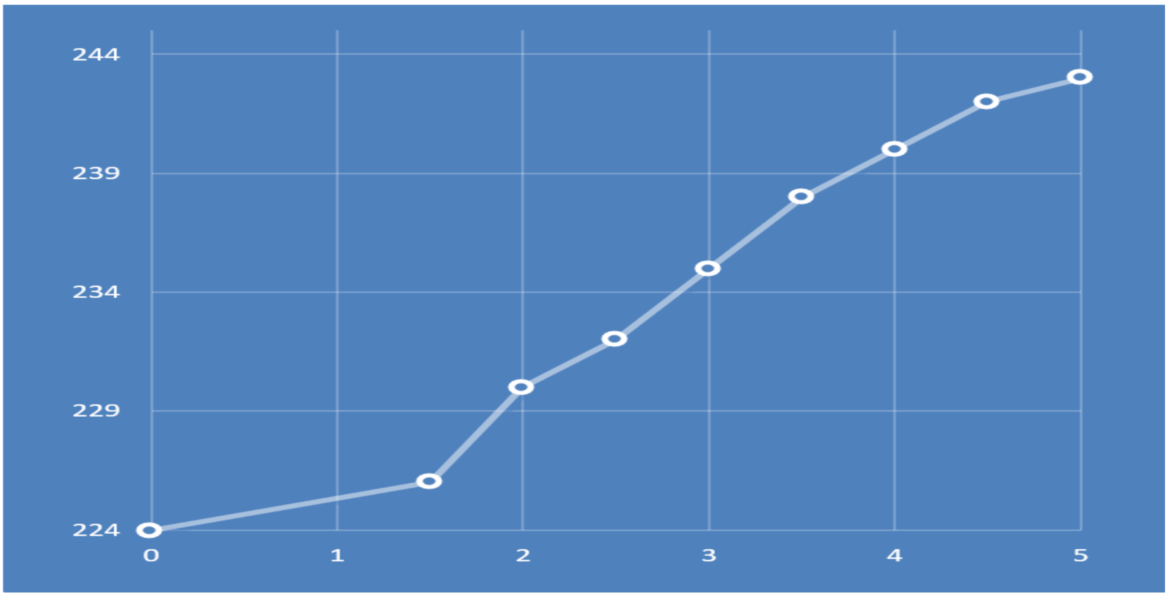


**Fig.3 Change in the flash point of the oil depending on the additive concentration**

## CONCLUSION

Based on the results of laboratory studies, the introduction of 3% of the MoPS-14 additive into SAE 15W-40, API CI-4 motor oil yielded positive results for physico-chemical indicators compared to the base SAE 15W-40, API CI-4 oils. The additive significantly mitigated the degradation effects inherent in the heavy-duty operation of the LW300FN.

The key improvements observed are:

The Total Base Number (TBN) increased from 9.3 to 12, demonstrating a crucial boost in the oil's acid-neutralizing capability, which extends its useful life in high-load, high-sulfur environments.

The flash point rose to 243 C, which suggests an improvement in the oil's thermal stability and safety margin against high operating temperatures.

It is noted that with a further increase in the additive concentration, the viscosity decreases to 11.5, which must be strictly controlled to prevent increased friction losses and premature component wear. The optimal use of such an additive at a 3% concentration will increase the service life of the motor oil and may lead to a reduction in piston ring wear by potentially forming a protective layer. This demonstrates the effectiveness of the possible application of the new sample we obtained for use in LW300FN Wheel Loaders and similar construction equipment. In the future, these additive-enhanced oils can be approved for the next stage—operational testing on specialized construction or road-building equipment.


**References**:

1. Smirnov A. V. Automotive maintenance materials. Textbook allowance / NovSU them. Yaroslav the Wise. - Veliky Novgorod, 2004 .- 176 p.

2. Jerichov, B. B. Automobile maintenance materials: textbook. allowance. state architect build un-t - SPb., 2009 .- 256 s.

3. Kirichenko N.B. Automobile maintenance materials: Textbook. – M.: Publishing Center "Academy" 2012.-208 pp.

4. Maharramov A.M., Akhmedova R.A., Akhmedova N.F. Petrochemicals and oil refining. Textbook for higher education. Baku: BakiUniversiteti Publishing House, 2009, 660 p.

5. Umirov, N., Abdurokhmonov, S., Ganiboyeva, E., Alimova, Z. Thermal equilibrium of the tractor and vehicle engines' cooling systems in agriculture technological processes. BIO Web of Conferences., 2024, 105, 05020.

6. Fozilov, G., Islam, R., Akhmedov, A., Alimova, Z., Yuldoshev, S. Results of theoretical and experimental researches about determination the corn seed separator sieve parameters of the corn-thresher machine. BIO Web of Conferences., 2024, 105, 04009.
7. Razzokov, T.X., Toshtemirov, S.J., Ergashov, G.K., ... Rashidov, N.S., Alimova, Z.X. Substantiation of the results of uneven leveling of heaps on the dryer conveyor. E3S Web of Conferences., 2024, 494, 04048.
8. Alimova, Z., Karimova, K., Tursunov, S. Research of the quality of motor oils of heavy dump trucks during operation under conditions of high temperatures. International Conference on Thermal Engineering, 2024, 1(1).
9. Ayrapetov, D. Technology development for producing plastic lubricant with secondary raw materials E3S Web of Conferences, 2024, 587, 01018.
10. Khakimov, B., Sharipov, Z., Alikulov, S., Alimova, Z., & Ganiboyeva, E. (2023, August). Tests on the tractor installed experimental device for heating the mixture of bioethanol in diesel fuel. In IOP Conference Series: Earth and Environmental Science (Vol. 1231, No. 1, p. 012017). IOP Publishing.
11. Shadimetov, Y., Ayrapetov, D. Impact of Transportation Pollutants on the Environment and Human Health E3S Web of Conferences, 2024, 563, 03096.
12. Makhamadjanov, A., Alimova, Z. (2024, June). Studying the dynamic characteristics of zeolites used in adsorption cycles for natural gas desulfuration In ICTEA: International Conference on Thermal Engineering (Vol. 1, No. 1).
13. Ismayilov, K., Alimova, Z., Asqarov, I., & Karimova, K. (2023, June). The research on road dust and particles caused by traffic (on the example Jizzakh city). In AIP Conference Proceedings (Vol. 2789, No. 1). AIP Publishing.
14. Makhamadjanov, M. I., Alimova, Z. K., Akhmatjanov, R. N., Magdiev, K. I., & Samataev, T. (2024, March). Recovery of zeolite waste for reuse during cleaning natural gases. In AIP Conference Proceedings (Vol. 3045, No. 1, p. 060032). AIP Publishing LLC.
15. Alimova, Z., Niyazova, G., & Sabirova, D. (2024). Specifications for applying high octane additives to the motor gasoline in hot climate. In E3S Web of Conferences (Vol. 508, p. 07010). EDP Sciences.
16. Ismayilov, K., Alimova, Z., Asqarov, I., & Karimova, K. (2023). The research on road dust and particles caused by traffic (on the example Jizzakh city). Problems in the textile and light industry in the context of integration of science and industry and ways to solve them:(PTLICISIWS-2022), 2789(1), 040082.
17. Dubov, G., Bogomolov, A., Grigorieva, E., Strelnikov, P., & Nokhrin, S. (2021). Study of corrosion characteristics of motor oils used in gas-diesel engines of BelAZ mining dump trucks. In E3S Web of Conferences (Vol. 315, p. 03010). EDP Sciences.
18. Al Saadi, D. A. Y., & Ostrikov, V. V. (2024). Assessment of Changes in The Characteristics of Motor Oils in Grain Harvest Engines. Babylonian Journal of Mechanical Engineering, 2024, 7-11.