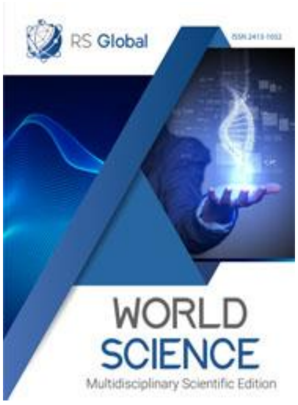

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POSSIBILITIES FOR REDUCING ENGINE OIL CONTAMINATION

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ABSTRACT

The technical condition, service life, and operational reliability of tractor and combine harvester engines are significantly influenced by their operating environment, including climatic conditions, load modes, speed and thermal regimes, external factors, and contamination generated by internal mechanisms. Among these variables, the climatic conditions of Mongolia have been shown by many researchers to exert a particularly strong influence. Due to the continental climate with extreme temperature fluctuations, low annual precipitation, and especially the dry and dusty environment in spring and autumn, airborne soil particles increase sharply, leading to intensified engine contamination for agricultural machinery operating in open fields. Dust particles, abrasive wear debris, and contaminants generated during engine operation are the primary contributors to engine contamination. This study examined the pathways through which dust enters engine oil, and introduced a non-destructive diagnostic method using an ultrasonic leak detector to identify micro-leaks invisible to the human eye in the engine air-intake system. Experimental results revealed micro-cracks in the intake system, which were repaired, leading to a 17.3-fold reduction in engine oil contamination. This indicates that dust entering through microscopic gaps undetectable by visual inspection can directly affect engine wear and performance.

KEYWORDS

Engine Oil, Air Filter, Contamination, Air-Intake System, Leakage

CITATION

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Introduction: The durability and reliability of diesel engines used in agriculture depend greatly on their operating environment, climatic conditions, load cycles, speed and temperature modes, and contamination caused by external and internal factors. Among these, airborne dust arising from fields and unpaved surfaces passes through the air filtration system into the engine cylinders, causing mechanical abrasion and accelerating wear of engine components. Dust particles also contaminate the air and fuel filtration elements.

Dust entering the combustion chamber through intake airflow and fuel supply causes wear in the upper cylinder region, piston ring zone, and ring grooves. Abrasive particles entering the engine oil accelerate wear on crankshaft journals, bearings, cylinder mid-sections, piston oil-control ring grooves, wrist pins, and camshaft lobes. When air filters are serviced properly, they allow 1–2% dust penetration, whereas neglected filters may allow up to 15–20%. Despite regular maintenance and timely filter replacement, dust contamination is frequently observed due to leaks in the air-intake system (loosened hose connections, cracked welds, holes, etc.). Therefore, in addition to scheduled maintenance, ensuring the air tightness of the engine air-intake system is essential.

The experiment, research application and methods: Five tractors were selected through random sampling. Engine oil samples were taken at specified intervals and analyzed in the accredited laboratory of Tekenomics Mongolia LLC. All tractors had timely oil and air-filter maintenance. For JD1204, oil contamination levels were found to be abnormally high, indicating a loss of air tightness in the air-intake system. Micro-leaks were diagnosed using an ultrasonic leak detector following these steps:

1. Stop the engine and remove the air filter /Shown in figure.1/.
2. Place the ultrasonic transmitter inside the air-intake duct.
3. Move the ultrasonic receiver along the intake system, including hose connections.
4. Observe changes on the detector display.
5. Constant readings indicate no leakage.
6. Increased ultrasonic intensity indicates a leak.

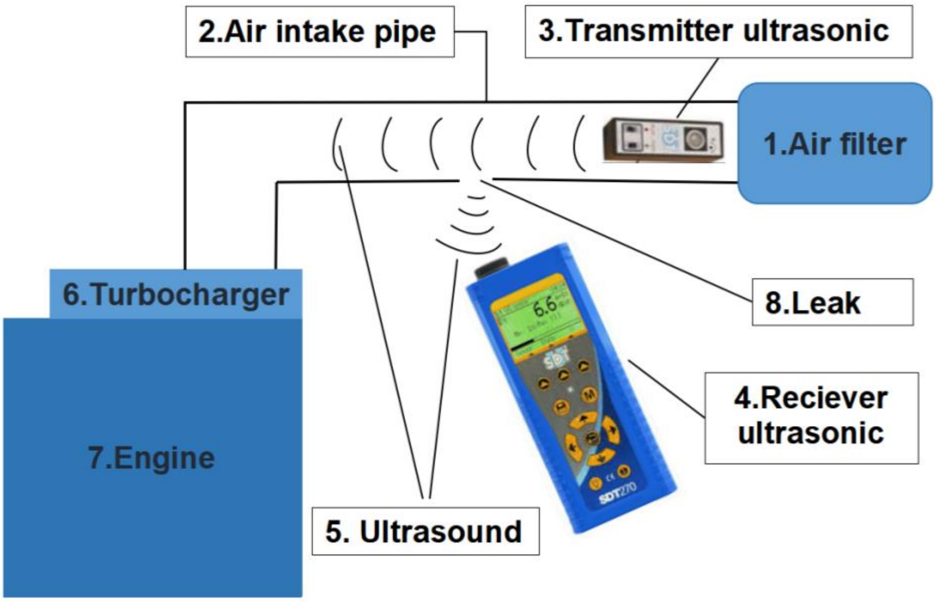
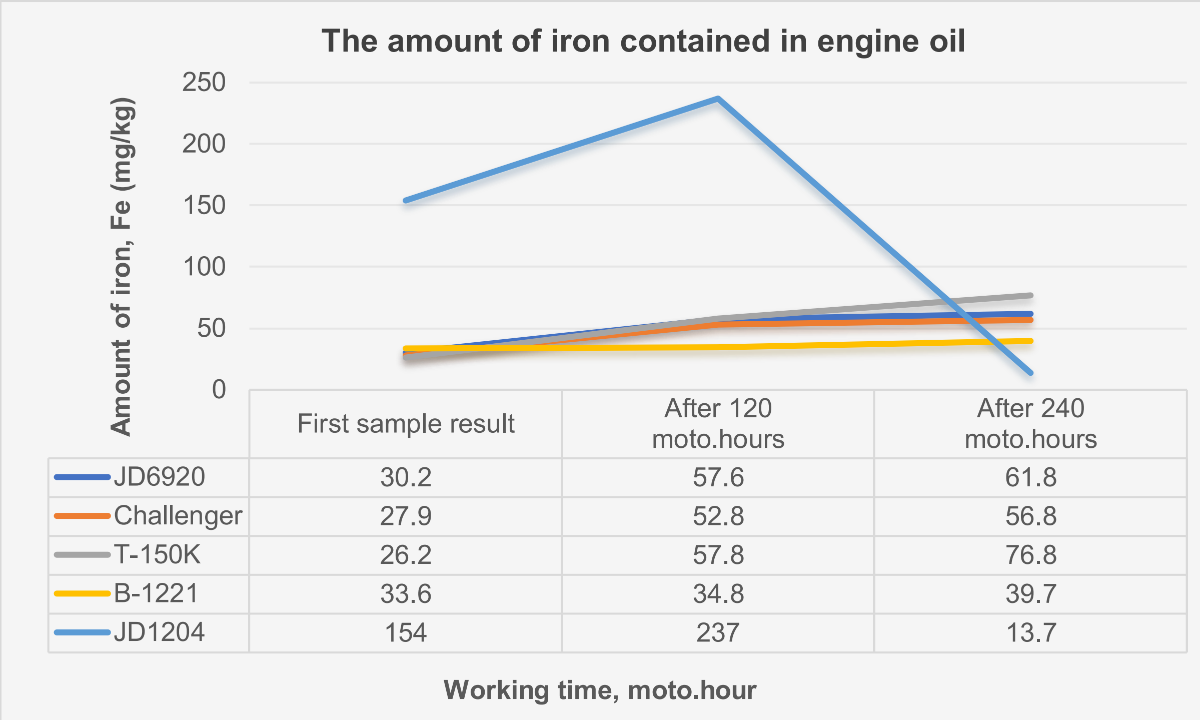


Fig. 1. *Schematic for checking vacuum using an ultrasonic level meter*

Research results and proceedings: Inspection revealed a loosened joint between intake pipes and a vibration-induced crack in the welded section of the JD1204 tractor. As a result, iron contamination in engine oil reached 154 mg/kg and 237 mg/kg in the first and second samples, respectively, exceeding the allowable limit of 57 mg/kg by 2.7 and 4.15 times. Based on the results of the tests and analyses, the normal operation of the engine depends on the operator's skill and the condition of technical maintenance.

A. Crack in the welded section B. The iron and rubber hose connection has come loose

Fig. 2. *Damage to the tractor engine's air intake pipe*



	First sample result	After 120 moto.hours	After 240 moto.hours
JD6920	30.2	57.6	61.8
Challenger	27.9	52.8	56.8
T-150K	26.2	57.8	76.8
B-1221	33.6	34.8	39.7
JD1204	154	237	13.7

Fig. 3. *Contamination of tractor oil (Fe, ppm) changes depending on operating time (T, moto.hours)*

After repairing the leak and replacing the engine oil, a third sample taken after 120 operating hours showed iron content reduced to 13.7 mg/kg, indicating normal contamination levels. Comparative analysis among other tractors (T-150K-09, JD6920, Challenger, B-1221) showed consistent wear rates, while JD1204 displayed abnormally high values before repair. A leaky turbocharger-to-intake duct reduces cylinder filling efficiency, enriches the mixture, and decreases engine power output.

Discussion: Foreign researchers James A.Addison and William M.Needelman state that the minimum lubricating oil film thickness between contacting diesel engine components must be maintained at 20 µm, and abrasive particles of similar size can easily disrupt this film. The degree of wear caused by dust depends heavily on the pathway through which contaminants enter the engine. Dust entering the oil pan resembles the size distribution of airborne dust and can enter during engine disassembly or oil changes. Research clearly shows that the larger the particle size entering engine oil, the more severe the wear.However, earlier studies mostly assume normal air-intake system conditions and do not consider micro-leaks as a primary source of oil contamination. In reality, intake system leaks are common and cannot be detected visually. Therefore, diagnosing and repairing them using ultrasonic methods is essential for maintaining normal engine operation.

Conclusions

1. Laboratory oil analysis revealed that engine oil contamination can increase independently of scheduled air filter service.
2. Ultrasonic leak detectors allow detection of micro-level air tightness losses in the air-intake system without disassembly.
3. Periodic inspection of the air-intake system using this method increases engine longevity; in this study, iron contamination was reduced by 17.3 times.

Air-intake system defects are a major cause of oil contamination, reducing filtration efficiency and negatively affecting engine performance and durability.

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