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AUTHOR(S)	Erdenesaikhan Oyunsurtal, Ulziibaatar Tserendorj
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ENGINEERING SCIENCES

DIESEL ENGINE FUEL AND OIL CONTAMINATION IN THE AGRICULTURE SECTOR OF MONGOLIA

Erdenesaikhan Oyunsurtal, *Lecturer, School of engineering technology, Mongolian University of Life Sciences, Ulaanbaatar, Mongolia, ORCID ID: https://orcid.org/0000-0002-7913-7557*
Ulziibaatar Tserendorj, *Ph.D., Associate Professor, School of engineering technology, Mongolian University of Life Science, Ulaanbaatar, Mongolia*

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Diesel engine, fuel, oil, contamination.

ABSTRACT

The study was conducted to determine the amount of contamination such as soot and silicon iron of engine oil and fuel contamination of tractors of Mongolia's agricultural sector. According this research, tractors were randomly selected for field testing during spring's sowing and summer and autumn harrowing time, and fuel and oil samples were taken from them with a special vacuum suction according relevant instructions and the amount of contamination was determined in accredited laboratory of Tecenomics Mongolia LLC. According to the test results, fuel contamination increases exponentially and oil contamination increases polynomial, those results depending on the type of agricultural works, and period of the work in the field of the tractors.

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Introduction. When performing field, dust in the air mainly reaches the contact surface of the parts through the engine air filter and fuel and oil, moreover it can intensify their friction and wear. Researchers who studied about tribological indicators of engine oil contamination, they have found that soot, silicon, and iron increase the wear rate of engine parts [1, 2, 3]. The one of the main method which to protect the engine from contamination is that to optimize the frequency of maintenance of air, fuel and oil filters and to perform the services in accordance with the technology at all times. According to a study by scientists on fuel contamination, Dr. B. Purevdorj has studied how engine fuel contamination in Mongolia affects the wear and tear of feed system components, especially fuel pump plunger pairs. According to a study by scientists on fuel contamination, Dr. B. Purevdorj has studied how engine fuel contamination in Mongolia affects the wear and tear of feed system components, especially fuel pump plunger pairs and he took the and dust sample from fuel tanks and he determined fuel contamination levels [4]. According to the research of foreign researchers V.S. Loskutov and L.A. Emelyanov, the amount of contamination in the fuel tank of a tractor depends on the type of the performed work and the seasons, moreover, it has been found that the amount of contamination in the tractor tank increases by 2...3 times when transporting diesel fuel and refueling in dusty conditions [5, 6]. In addition, engine contamination are depreciating engine parts, reducing the operational resources, moreover it affects the normal operation of fuel, oil and air filters, thereby increasing fuel consumption and it reduces some technical parameters such as engine power and efficiency.

Testing methodology and instruments. Totally, 12 tractors were randomly selected and tested in the field and their fuel and oil samples were taken and analyzed in a laboratory of Tecenomics Mongol LLC. The analysis determined the amount of soot, silicon, and iron in the engine

oil, as well as the fuel contamination of each of the tractor's fuel tanks, fuel tank truck, and company fuel storage tanks.

Conditions and requirements for field testing of tractors and the methodology of oil sampling from the engine:

1. Tractors have to stop, and turn off the engine, open the tank lid within 20 minutes after the dust has been down, insert a special vacuum suction tube and take a sample of 200 ml from medium level of the fuel tank.
2. Taken same sized samples from the fuel tank truck and the company fuel tank.
3. Sampling of engine oil should be carried out under normal thermal regime (80…90°C) and 20 minutes after turn off the heated engine. Take a 200 ml sample from the middle oil level by inserting a special vacuum suction tube through the hole in the oil level check valve.
4. For each test, we noted the year of manufacture of the tractor, the type of performed work, and total worked hours.

Results. According to the methodology, fuel samples were taken from each of the 12 brands of tractors such as T-150-3, JD1204-4, Challenger, JD804, Б-1221, JD6920, T-150-4, JD1204-3, T-150-Д, JD1204-3, JD804-3, and JD6930 tractors with 4 repetitions during spring sowing, summer and autumn harrowing time, and defined the average amount of fuel contamination in the fuel bank. Accumulated contaminants in the warehouse and during fuel transportation were sampled three times at a time. Table 1 show the results which determined of the contamination that can occur during refueling in the field.

Table 1. Tractor fuel contamination

Fuel samples point taken	Tractor fuel contamination, %		
	In the spring sowing time (till 80 moto.hour) Between May 5 and May 28	**In the Summer harrowing time** (till 80…160 moto.hour) Between June 20 and July 5	**In the autumn harrowing time** (till 160…240 moto.hour) Between July 25 and August 6
Fuel contamination in tractor tanks /increased contamination in warehouses and fuel tank trucks /	0.236458	0.427292	0.621875
Fuel contamination in warehouse	0.06	0.07	0.08
Contamination of fuel tank truck	0.07	0.08	0.09
Contamination during refueling a tractor in the field	0.156458	0.190833	0.351042

The results of the fuel analysis (Table 1) show that the amount of contaminants in the fuel tank increases as the tractor's operating time increases. The reason for this contamination is the dust that enters the tank from the ambient air along with the fuel while refueling the tractor 1…2 times a day. For example, according the research, during the 240-hour operation of a tractor field, when refueling it is contaminate by 0.156% in spring sowing, 0.191% in summer and 0.351% in autumn. Figure 1 shows how the increase in fuel contamination in the tank depends on the number of hours worked by the tractor for each type of work performed. Figure 1 shows how the increase in fuel contamination in the tank depends on the number of hours worked by the tractor for each type of work performed.

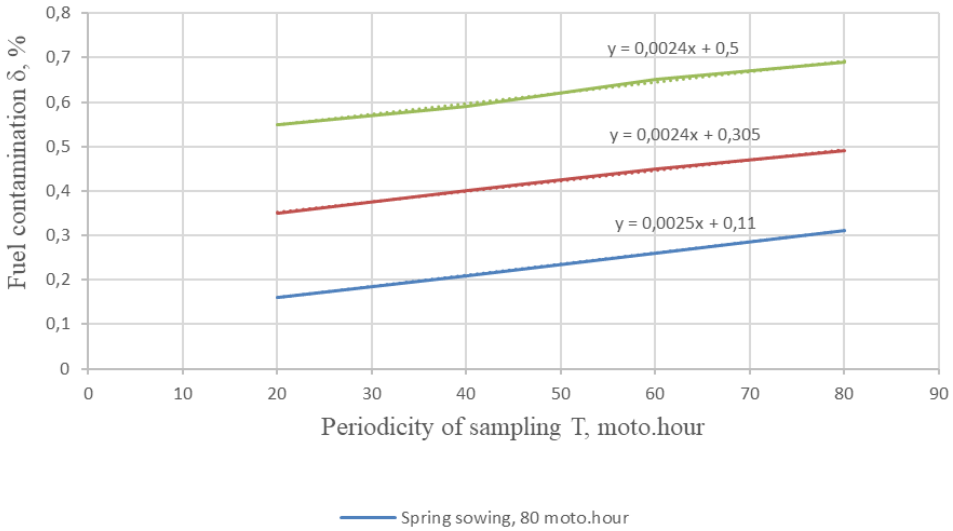

Fig. 1. The amount of fuel contamination depends on the type of performed work and the number of worked hours

For each type of tillage, the contamination of the tractor tank was y=0.0025x+0.11 in spring sowing, in summer was y=0.0024x+0.305 and in autumn was y=0.0024x+0.5, and according this equations it is increasing linearly. Figure 2 shows the geometric size of the mechanical mixture of low, medium, and highly contaminated fuels taken from a tractor bank, fuel tank truck, and farm warehouse using a microscope (Lab-Kits MB-YYS-300) 140 times more.

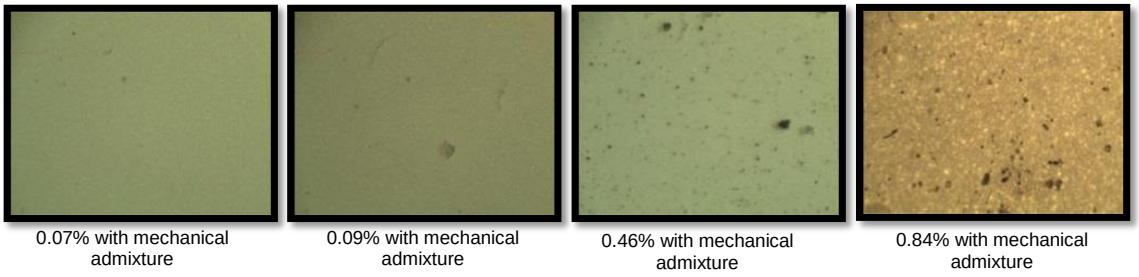

Fig. 2. Geometric dimensions of fuel contamination

When the mechanical mixture in the fuel is magnified 140 times more, the geometry dimention of the mixture increases as the contamination increases. This can contaminate the fuel filter and reduce its permeability, which moreover it adversely affects in the basic engine parameters. Figure 3 shows the regularity of fuel contamination in the tractor tank.

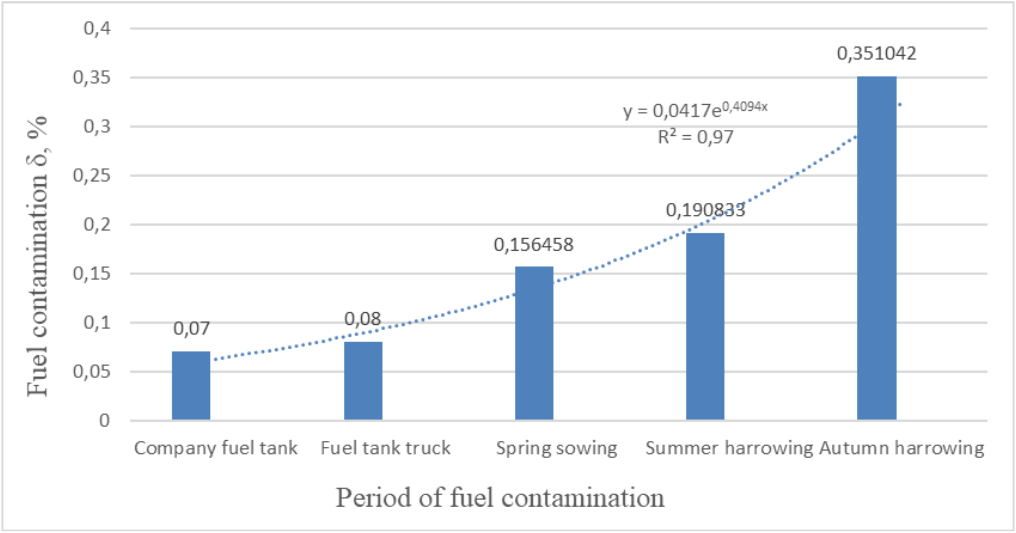

Fig.3. The relationship between annual amount of tractor fuel contamination and the type of the work

The average level of fuel contamination in the tractor bank is close to that of spring sowing and summer fallow, but it has increased sharply in autumn fallow time (Fig. 3). It is releted the land is moist during spring sowing and during the summer season, there is have a rain and less dust, however, during the autumn processing period, the land is arid because of the rainfall is less and high in plant dust.

Samples of engine oil of 12 tractors selected according to the research methodology were included in the laboratory analysis. The contaminant elements in engine oil are shown in Table 2.

Table 2. Contamination of tractor engine oil

№	Тракторын марк	Manufactured date	Moto. hour	Contamination		
				Soot (Soot) 35Abs/cm	Silicon (Si) 24mg/kg	Iron (Fe) 57 mg/kg
1	T-150-3	2008	2781	9	33.5	27
2	JD1204-4	2008	2975	13.8	40.8	35.8
3	Challenger	2011	794	8.1	14	35.7
4	JD804	2010	575	6.8	10.9	32.8
5	B-1221	2009	2903	10.2	38.6	33.6
6	JD6920	2009	5873	35.8	50.7	101.8
7	T-150-4	2007	2523	8.93	31.7	30.8
8	JD1204	2010	1084	8.57	21.5	38.6
9	T-150-D	2008	3512	18.6	46.1	51.3
10	JD1204-3	2008	1735	8.86	26.4	34.2
11	JD804-3	2008	1246	8.78	24.3	36.5
12	JD6930	2007	6995	57.81	84.2	201

According to laboratory tests, the amount of soot and silicon in tractor engine oil tends to increase as the engine life increases. The results table shows that the silicon contamination exceeds the standard limits, which confirms that the tractor engine operates in relatively dusty conditions.

Figure 4 shows how the amount of oil contaminant elements in a tractor engine depends on the service life.

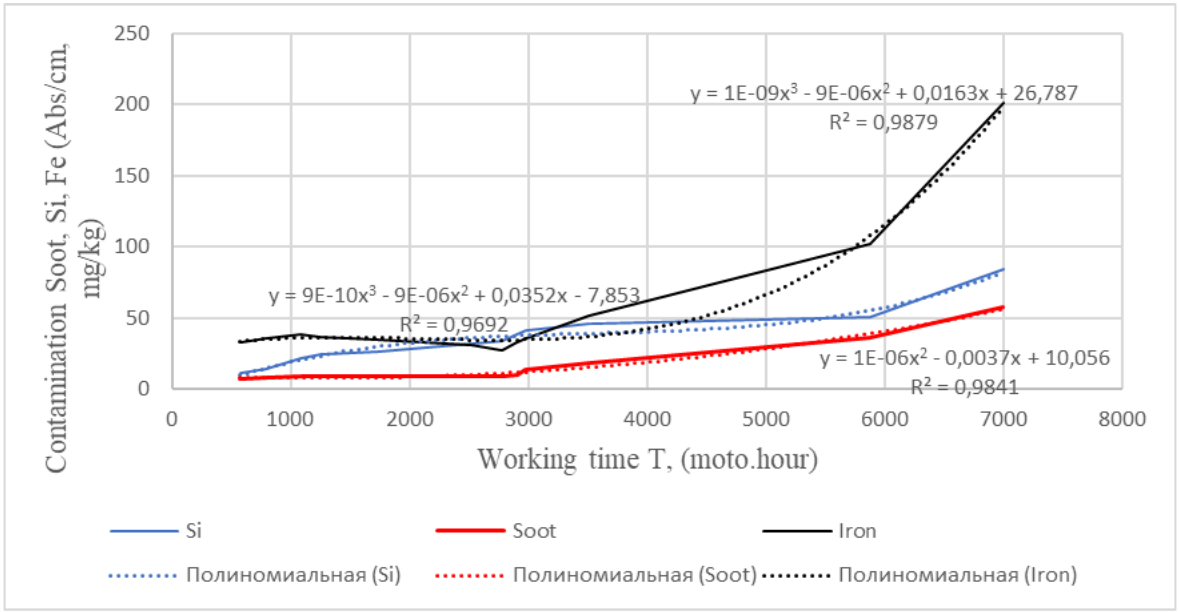

Fig.4. Correlation between tractor engine life and oil contamination

As the silicon content of the engine oil increases the content of metallic elements increases by the polymer correlation. It is due to the contamination of the engine oil with silicon dust, thus it is intensifying the wear of the main contact parts of the engine, and then it is become the one of the cause of the formation of metallurgy. Therefore, it is important to regularly clean the air filter element of the tractor engine and there have to improve the design of the air purification system.

Discussions. Researcher V.S. Bogdanov was found that added by water and mechanical impurities to engine oil, the friction force on lubricating parts of engine increased by 9...22%, its temperature by 9...11%, and wear by 33...50% [7]. James A. Addison and William M. Neidelman have identified the causes of diesel engine oil contamination and wear mode, and the types and causes of contamination. The minimum thickness of the oil layer to reduce the friction of the engine contact parts shall be up to 20 μm, but the size of small particles of the contamination the oil from the outside were the same sized with minimum thickness of the oil layer [8].

The research of scientists V.S. Loskutov and L.A. Emelyanov, contamination during refueling was determined in one working day in winter and summer time, but we studied fuel contamination in spring, summer and autumn every 20 motor hours and determined the annual growth trend [5, 6]. Scientist N.Zolboo (Ph.D) determined that the number of engine failures increases as fuel contamination increases [9]. V.S. Bogdanov, James A. Addison, and William M. Neidelman also found that the amount of mechanical impurities in the oil increased engine wear and tear, but we determined the relationship between the increase in silicon, metal, and soot in the engine oil as the tractor's operating time increased.

Conclusions.

1. Tractor fuel contamination was 1.8 times higher during summer tillage than during spring sowing, and 2.63 times higher during autumn fallow tillage processing.
2. When the sample is filtered in the laboratory and the contamination is magnified 140 times more by using microscope, the size was increasing depending on the type of field work. The amount of tractor fuel contamination was 0.08% in the spring sowing time, but the contamination was increased till 0.84% at the end of autumn.
3. In order to reduce fuel contamination, cleaning the tractor's fuel tank at the end of each field work phase is the basis for ensuring that the tractor runs smoothly, maintains the technical condition of the engine, and reduces operating costs.
4. In order to reduce fuel contamination, cleaning the tractor's fuel tank at the end of each field work is the basis for ensuring that the tractor runs smoothly, maintains the technical condition of the engine, and reduces operating costs.
5. Silica contamination in engine oil which to enter by airborne dust is highly dependent on the height of the air filter tube and the type of work to be performed. The main reason for the high content of silicon in the tractor engine through the air filter from the outside is due to the dusty environment and moreover the work which to disturb the soil.
6. In the case of Mongolia, we estimate that the annual level of fuel contamination is 40% higher than that determined by the Russian Scientist L.A. Emelyanov.
7. The research in this area will be required because of the fuel and oil contamination can affect their filter permeability, engine fuel shortages, increasing the mechanical resistance of fuel and oil pumps, decreasing basic engine parameters, and increasing fuel consumption.

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