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Analysis of Source of Oil Flooding

A. Laushkin, A. Khaziev (The Moscow State Automobile and Road Construction University (MADI))

Abstract. The article discusses the causes of flooding of engine oil from vehicles and provides quantitative estimates of transferring of water into oil.

Keywords: motor oil, humidity, water in oil.

Introduction

Recently in the Russian Federation, there are many cases of motor failure in warranty cars, caused by the loss of efficiency of motor oils. While testing of individual samples of lubricants conducted in the laboratory of MADI-CHEM Moscow State Automobile and Road Technical University (MADI), along with a significant deterioration of the physical and chemical properties of engine oils, a huge amount of water was found in them: up to 1 ... 2% with an acceptable water content in used oil 0.5%.

The water in the engine oil is most common in the operation of vehicles in winter and this fact shows:

• rejecting the thermal regime of the engine from the norm;

• a constant "feeding" of motor oil by water, because during the normal operation of the power plant water from the engine oil should evaporate.

The most common version of flooding of oil is condensation of water from the air entering the cylinders of the engine [1].

Water as a product of condensation of atmospheric air

Let’s calculate the mass of water flowing into the engine oil from the air. The relative humidity of the ambient air, in most regions of Russia generally varies from 60 to 85%. Changes in the relative humidity of the ambient air in the city of Moscow are shown in Figure 1.

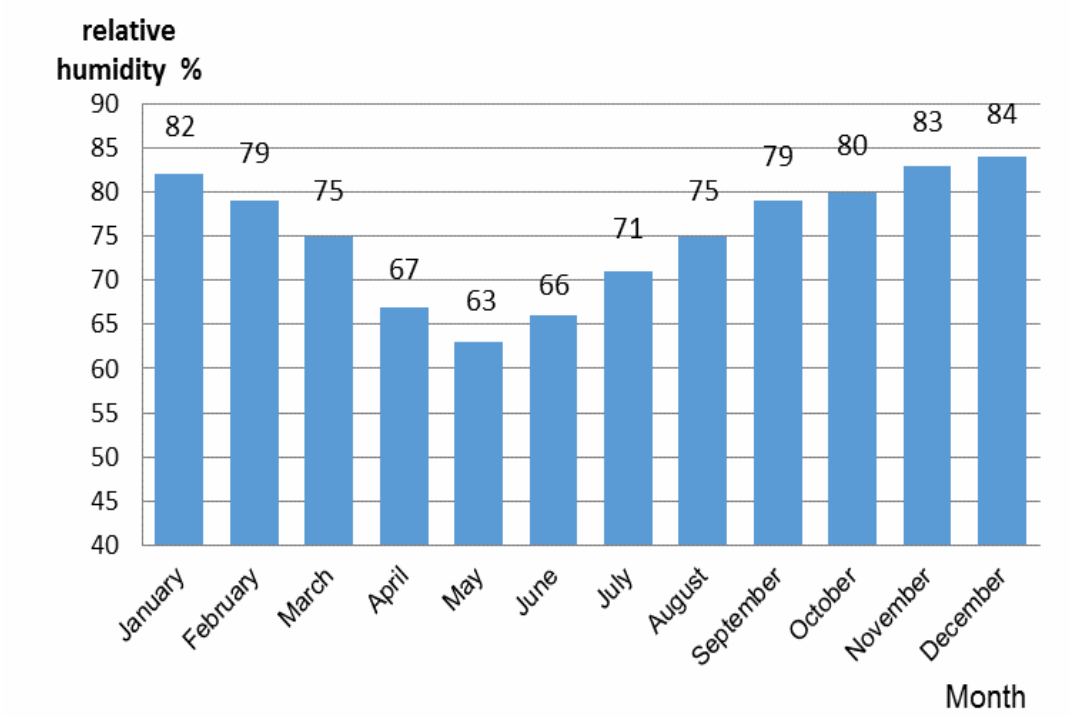

Fig. 1. Changes in the relative humidity of the ambient air in Moscow, %

Relative humidity of air is the ratio partiall pressure of water vapor to the equilibrium vapor pressure:

$RH = (p / p^*) \cdot 100\%$

where RH - relative humidity

p - partial water vapor pressure Pa;

p * - the equilibrium vapor pressure, Pa.

As to weight units, relative humidity - the ratio of the mass fraction of moisture in the air to its maximum possible value within the given temperature:

$RH = (f / f_{max}) \cdot 100\%$

where f - the mass fraction of moisture in the air, g / m^3;

f_{max} - maximum possible water content in the air, g / m^3.

Table 1 shows the maximum absolute humidity at different temperature conditions in ambient air [3].

We will calculate how much water gets into the working mixture from the air.

Stoichiometric combustion on the oxidation of 1 kg of fuel requires 14.7 kg of air.

Table 1 - Maximum absolute humidity in different temperatures:

Temperature of ambient air, t °C	−20	−10	0	10	20	30
Maximum possible contains of water in air(f_{max}, (g / m^3))	0,81	2,1	4,8	9,4	17,3	30,4

To convert from mass to volume units, we have use the air density (Table. 2) [4], and calculate the amount of water to 1 kg of air:

$k_{max} = f_{max} / \rho$, (g / kg)

where k_{max} - the weight content of water in the air, g / kg.

Now, multiplying k_{max} at the stoichiometric ratio, you know how much water gets into the engine during the combustion of 1 kg of fuel. The calculation results are in Table. 2 and Fig. 2.

Table 2 - Mass containing of water in the air and water mass, getting into the engine from the ambient air considering combustion of 1 kg. of fuel:

Temperature of ambient air, t °C	−20	-10	0	10	20	30
Density of ambient air ρ, kg/m^3	1,3943	1,3413	1,2920	1,2466	1,2041	1,1644
Mass containing of moisture in the air, g/kg	0.58	1.57	3.72	7.54	14.37	26.11
Water mass, getting into the engine from ambient air during combustion of 1 kg. of fuel	0.009	0.023	0.055	0.111	0.211	0.384

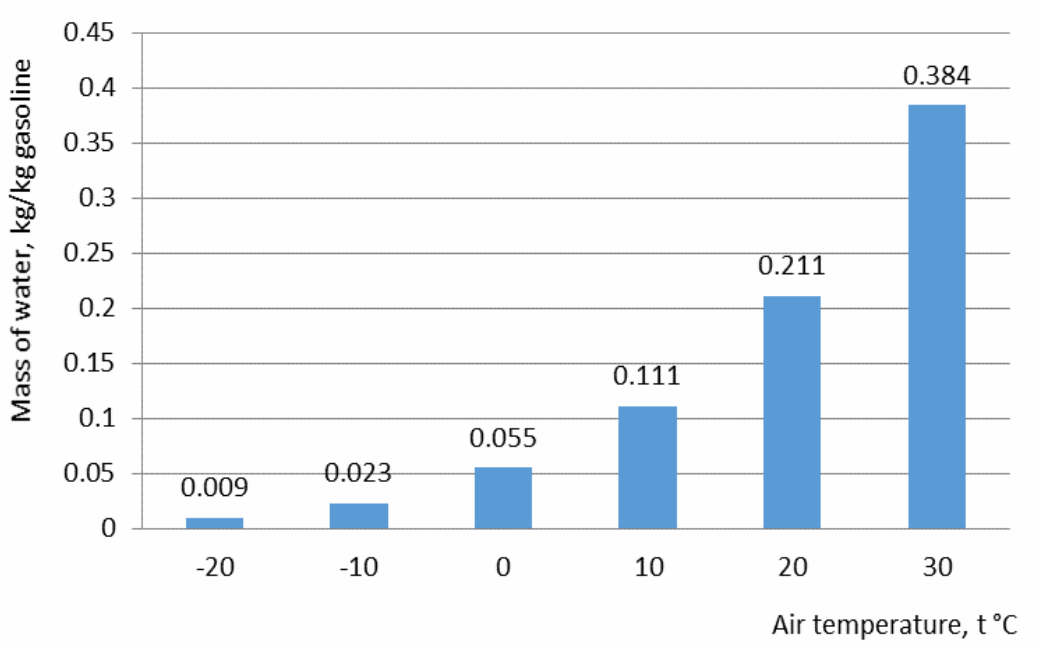

Fig. 2. The weight of the water flowing into the engine from the ambient air during combustion of 1 kg of gasoline, kg

Thus, depending on the temperature during combustion of 1 kg of gasoline into the engine from the ambient air enters from 0.009 to 0.384 kg of water.

In work practice of testing laboratory "MADI-CHEM" there are often cases when the engine oil collected from the engines of new cars, water could be found.

For example, at the end of winter specialists of dealer stations of Moscow there were prepared samples of engine oil from engines of three new, not sold cars. The cars were parked in the open parking in Moscow, "waiting for" their customers, and were periodically started for a short time to reshuffle, coming to the area of pre-selling preparation, to the area of additional equipment, cleaning, etc. According to the research samples, along with the deterioration of a number of indicators, in the engine oil there have been found 0.69 ... 0.85% of water. Considering the amount of engine oil (4 l), it turns out that the engine oil has collected 0,028 ... 0,034 kg of water.

Running of each of the vehicles did not exceed 50 km. Taking into account the ambient temperature (-20 ... -10 ° C), and fuel consumption: 5 l ≈ 3.75 kg of petrol by 50 kilometers, it is theoretically possible that the ingress of moisture from the ambient air will be 0,034 ... 0,086 kg.

This means that between 33 and 100% humidity, with air trapped in the cylinder chamber, then pass into the sump, which is impossible for a technically serviceable vehicle. Therefore, it is necessary to look for other ways of penetration of water into the oil.

Findings

The analysis of the reasons for the ingress of water into the engine oil during operation of the vehicle and quantitative assessment allowed to establish:

- according to the ambient temperature during combustion of 1 kg of gasoline into the engine air enters from 0.009 to 0.384 kg of water;
- accumulation of water occurs to a greater extent in the operation of a cold engine, the car travels a short distance and low ambient temperatures.
- given that the mass of the water enters the engine at low ambient-flowing air, has a minimum value, for example only 0.009 kg of water collect in cylinders at burning 1kg of

fuel at ambient air temperature -20°C, is necessary to look for other causes water to enter the engine oil.

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ВЫЯВЛЕНИЕ ПРИЧИН ОБВОДНЕНИЯ МОТОРНОГО МАСЛА

А.В. Лаушкин, А.А. Хазиев

Аннотация. *В статье рассмотрена проблема обводнения моторного масла при эксплуатации автомобилей и приведена количественная оценка попадания воды в масло из атмосферного воздуха.*

Ключевые слова: *моторное масло, влажность, температура воздуха*

1. Лаушкин Андрей Вячеславович, МАДИ, ведущий инженер испытательной лаборатории МАДИ-ХИМ, 125319, г.Москва, Ленинградский проспект, д.64, (499) 155-0749, E-mail: lav82@mail.ru.
2. Хазиев Анвар Асхатрович, МАДИ, доцент кафедры Эксплуатации автомобильного транспорта и автосервиса, кандидат технических наук, доцент, 125319, г.Москва, Ленинградский проспект, д.64, (495) 155-0749, E-mail madi-chim@mail.ru.