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IMPACT ANALYSIS OF AIR HUMIDITY ON OPERATING PARAMETERS OF DIESEL ENGINE

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Abstract

A major problem in the combustion diesel engines is the different distribution of the mixture of air and fuel and also temperatures inside the combustion chamber. It helps the formation of points of the high and low oxygen concentration in the combustion chamber of the engine. In areas with a high concentration of oxygen, the combustion process produces very harmful NO_x, and in places with low oxygen concentration, as a result of incomplete fuel combustion particles are created in the form of soot. This not regular distribution of the mixture of air and fuel and temperatures in the combustion chamber affect the limited maximum engine power and efficiency at his every operating cycle. One method for improving the combustion process is feeding into the engine air with high relative humidity. The study was conducted on a chassis dynamometer at the Department of Vehicles Engineering Wroclaw University of Technology. For the purposes of the study determined the external characteristics, including maximum engine power and maximum engine torque at different air relative humidity and quite similar air temperature. Analysis of the results of research shows that high air relative humidity has a positive effect on the work parameters of the diesel engine.

Keywords: *humidity, diesel engine, efficiency, engine power, engine torque*

1. Introduction

The rapid development of communication is clearly felt by the environment and by the people. The impact of motoring on the environment is very diverse. You can divide it into beneficial effects, mainly sociological and civilization and unfavourable, e.g. Air pollution, causing vibration and noise, leaks [4]. The main factors that have environmental impacts are mainly: motor vehicles (cars, trucks, buses, etc.), Car production (factories), factories supplies (mining and refining), transport infrastructure (roads, gas stations, parking garages, the maintenance base). Road transport is a huge amount of goods transported over various distances, is a way to move people in urban areas and also beyond, is often a source of jobs and a base on which developed a tourism [2].

The biggest impact of motoring on the environment degradation is found in large urban areas. This is due to the fact that there were large traffic flows, stop-and-go vehicles, and low speed. In the urban area, there are worse conditions than the exhaust scattering on highways. It is estimated that more than 90% CO, 76% hydrocarbons, 38% NO_x, 70% of dust and nearly 100% of lead from the automotive industry [1].

One way to reduce fuel consumption by internal combustion engines and thereby reducing the emission of harmful substances into the atmosphere is to increase the efficiency of internal combustion engines. This can be achieved with use the air of high humidity put into intake manifold. The water in the air has a positive effect on engine operating parameters through a better distribution of oxygen inside the combustion chamber. The steam acts as a carrier of oxygen during the combustion process and at the same time speeds up this process. It means that each drop of water transfers an oxygen, which results in faster its mixing with the fuel. The result is a higher concentration and a more uniform dispersion of oxygen, which results in faster and more efficient and complete combustion. Eventually, this action reveals a greater engine efficiency, which gives increased power with less fuel.

2. Relative humidity of air

The relative humidity is the ratio of the partial pressure of water vapour in humid air in some temperature *T* to the vapour pressure of water at the same temperature. Relative humidity is expressed in percent. A relative humidity of 0% is dry air, and equals 100% of the air is fully saturated with water. At the relative humidity of one cooling air, gives rise to water condensation. The amount of superheated steam and saturated with air is limited. Hereby, steam in the air starts to condense when the air temperature is reduced to the saturation temperature of steam to the pressure in the air-component. This temperature is called the dew point temperature. Humidity air is a homogeneous mixture of dry air and the water contained therein, which may be in gaseous, liquid or solid.

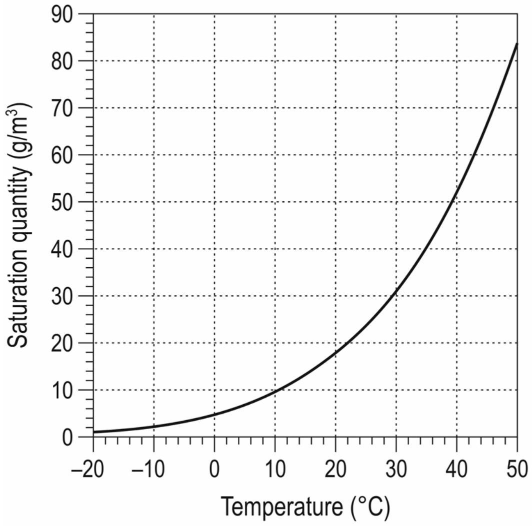

Fig. 1. The maximum water content depending on the temperature

The maximum vapour pressure is the highest pressure of water vapour at a given temperature. The value of this pressure increases with increasing temperature at very low ambient temperatures have the minimum amount of water vapour the air is saturated at high temperatures to air saturation need a lot of steam.

3. The test lab

An engine test stand is a measuring position used for data acquisition and determination of engine performance characteristics.
Whereas typical engine test benches obtain parameters in a direct way, chassis dynamometers measure performance of a vehicle tested. Based on the data collected, the evaluation of engine power and torque takes place [4]. In contrast to the engine dynamometer, a chassis dynamometer are simple and quick to use (no need to remove the motor), while their vehicle parameters; measurement precision is high, as repeatability of tests performed. When measuring power, braking gives accurate results measurement of engine power and torque. Chassis dynamometers do not directly measure the parameters of the engine, but its performance and only on the basis of the data obtained is determined by its power and torque. Calculating these measured values on normative values in accordance with inter-national standards is automatic. Chassis dynamometer allows accurate simulation of actual conditions prevailing when driving a vehicle on the road. Device capabilities are enormous. You can simulate depending on the needs of different load driving conditions: constant tractive effort, constant speed, constant speed driving or driving simulation. These options are particularly useful for so-called “Tune” the engine. We can also measure power in a continuous or discrete, and then convert it to the appropriate standards: DIN 70020, EEC 80/1269, ISO 1585, JIS D 1001, SAE J 1349. [5].

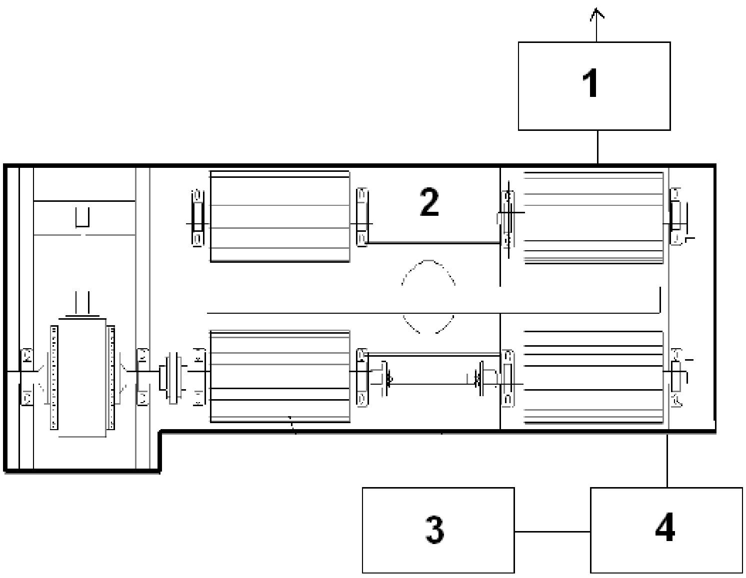

Fig. 2. Measuring station: 1 – extract fumes, 2 – rolls with brakes, 3 – cooling system, 4 – control system

The engine test stand Maha LPS 3000 (Fig. 2) consists of the following components:
- two rollers driven by the wheel of the test car (one for testing models with front-wheel drive, the other for vehicles with rear-wheel drive, both drives 4x4),
- two air-cooled brakes load simulating the test vehicle,
- hydraulic system for changing the wheelbase rolls,
- control unit,
- junction box to receive signals from external measurement devices (measurement of engine oil temperature, intake air temperature, engine speed),

– a system of pneumatic lifting and lowering the threshold of crossing between the rollers,
– fan, which cooling intake air,
– extract exhaust,
– complete vehicle safety belts from jumping out of the rollers,
– exhaust gas analyser.

4. Results

Tests were carried out on appropriate chassis dynamometer at the Department of Vehicle Engineering Wroclaw University of Technology using a vehicle equipped with an engine VW SDI 1.9.

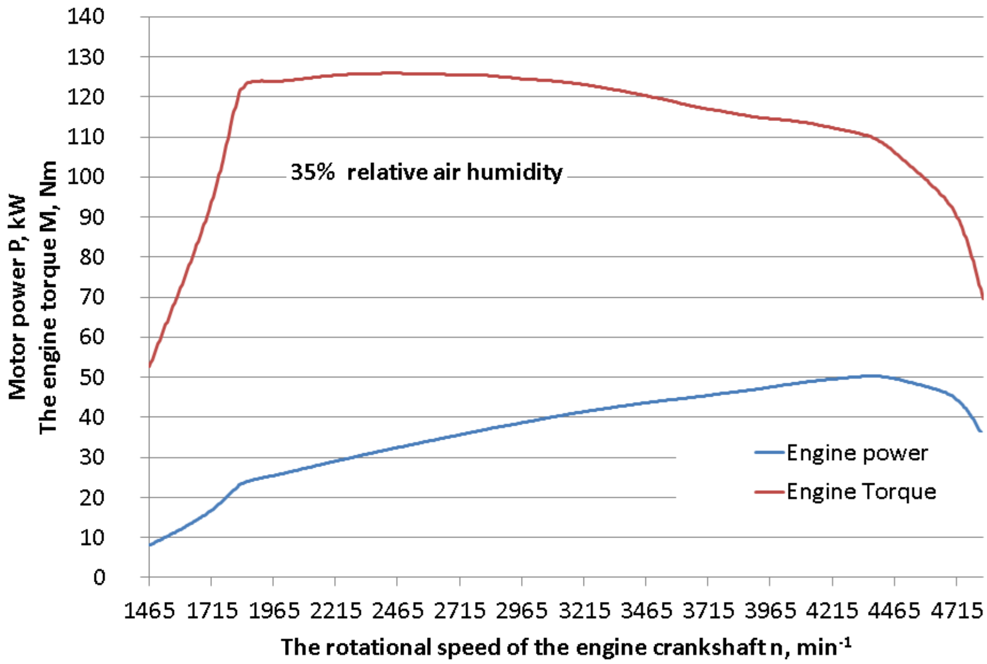

Fig. 3. Characteristics of the outer engine relative humidity of 35%

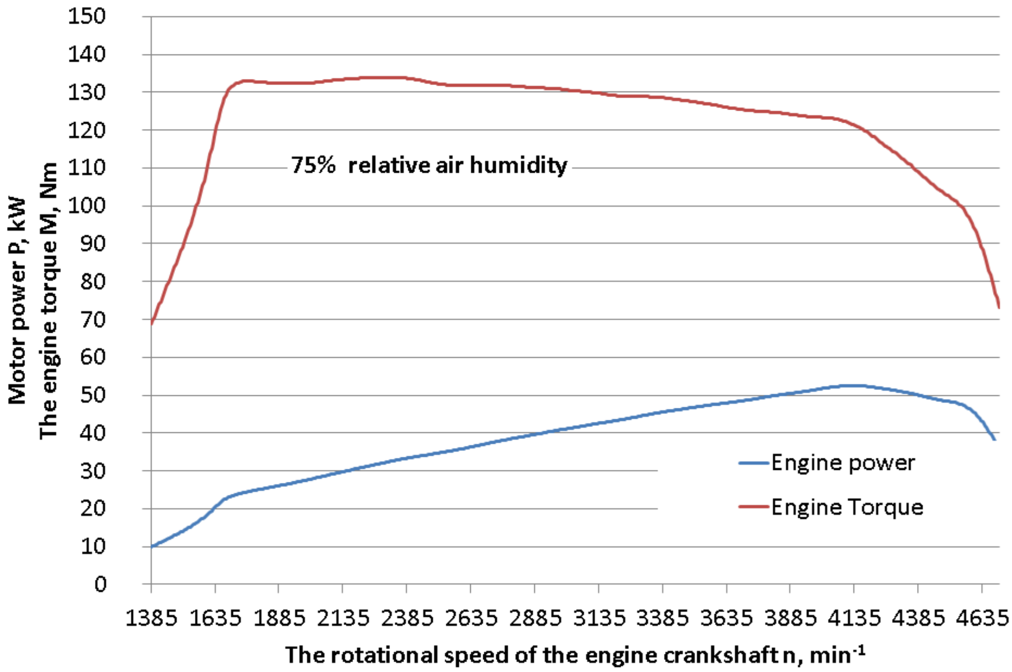

Fig. 4. Characteristics of the outer engine relative humidity of 75%

For the study has been done external characteristics of the engine, which reflect the main parameters of the engine. The study was conducted with a constant air temperature of approximately 20°C and at variable relative humidity of from 35% to 75%.

External characteristics are diagrams engine torque and engine power at full throttle (as a function of speed). External characteristics of the motor is a graph illustrating the engine power *P* and engine torque *M* of the rotational speed n while the motor is running at full throttle or the injection pump set for maximum efficiency. It illustrates the maximum torque and power of an engine, which has, and at what speed it does.

As a result of measurements of maximum engine, power supplied various fuels with the respective speeds of the crankshaft achieved external characteristics shown in Fig. 3 and 4.

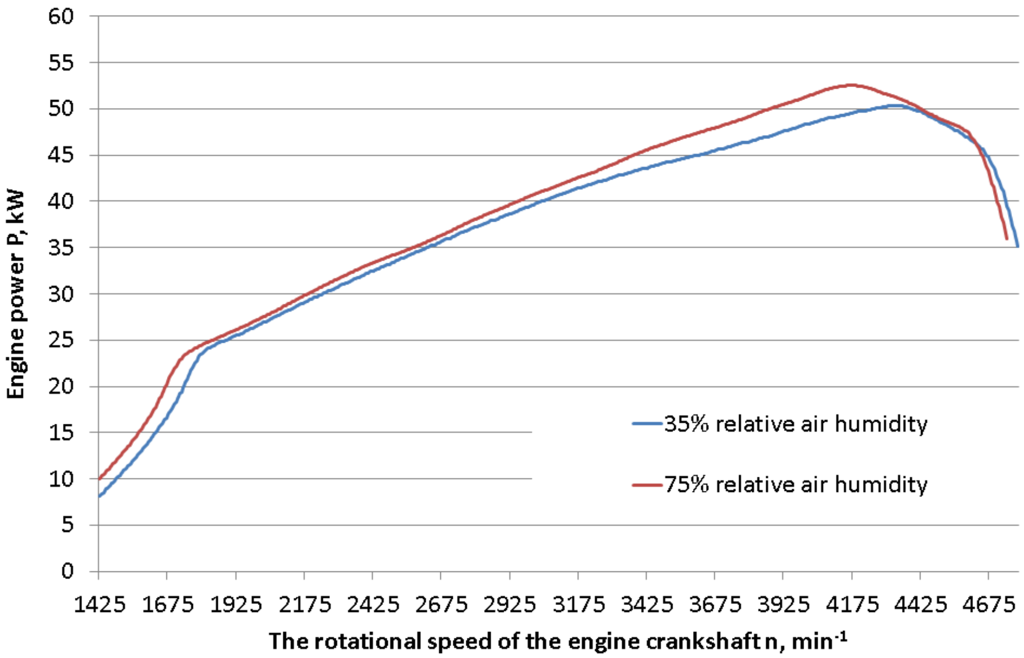

Fig. 5. Comparison of engine power characteristics at different relative humidity

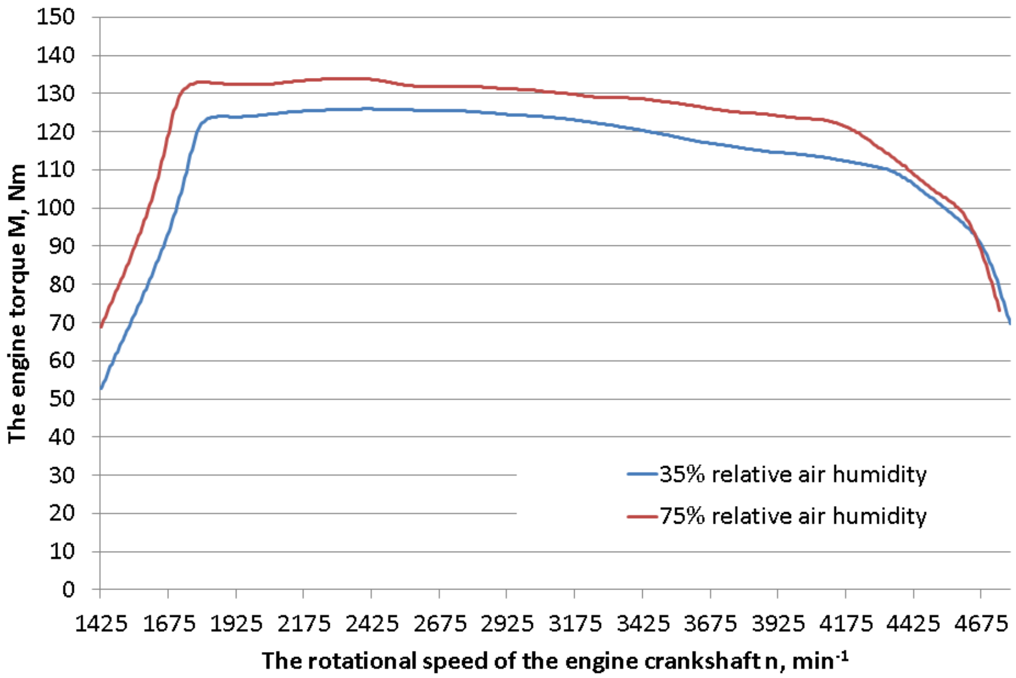

Fig. 6. Comparison of torque characteristics at different relative humidity

5. Conclusions

The presented data show that the performance of an engine running in different weather conditions do not differ significantly. It can be stated however that the motor fed with a mixture of diesel fuel and air with a relative humidity of 75% is obtained more power and a larger torque of the crankshaft than the relative humidity is up to only 35%.

Engine power working in a variety of weather conditions does not differ significantly. You can tell what is true that most of the water vapour content in the air results in an increased engine power, however, as stated these differences are insignificant.

Torque of the engine crankshaft running in different weather conditions does not differ significantly. However, you may find that engine in conditions of relative humidity greater increases torque of the engine crankshaft.

Operation parameters of the motor like engine power and torque of the engine increases when relative air humidity increases. The positive impact of increased air humidity on the work of combustion engine can be seen in the upper rotational speeds of the crankshaft. There, the differences reach up to 10%. In the remaining range of engine speed differences are minor and during normal vehicle operation cannot be felt by the driver at all.

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