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Study on the efficiency of the particle filter in engines with compression ignition

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ABSTRACT: The paper presents a study of pollutant emissions from compression ignition engines. Pollutant emissions from motor vehicles have a profound impact on human health. Air pollution levels pose a significant problem, and people continue to be exposed to pollutants in the atmosphere, which can hurt their health and well-being. Euro standards contribute to a noble goal, reducing pollution and improving air quality. The shift to electrification encourages the transition to electrified models, which can reduce emissions by up to 50% over their lifetime.

KEYWORDS - Compression ignition engine, fuel, particle emissions, regeneration, the particulate filter.

I. INTRODUCTION

Black smoke from vehicles affects the human body by polluting the air with soot particles, heavy metals, and carcinogenic substances. It is the cause of many respiratory problems, irritation of the eyes and mucous membranes, and even contributes to the development of some tumors. The diesel particulate filter (DPF) is one of the innovations that has marked the evolution of automobiles and is becoming an essential part in the context of the strict emission regulations imposed globally. The functioning of the filter is not only a legal requirement but also a guarantee of engine performance and longevity. Starting with the Euro 4 car pollution standard, nitrogen oxides (NOx) contribute decisively to increasing the risk of cancer, especially in urban areas. To ensure optimal functioning of the DPF and prevent clogging, it is very important to follow the manufacturer's recommended maintenance intervals. Quality fuels must be used, and periodic checks must be carried out. It is recommended to drive the vehicle regularly at speeds that favor regeneration and to avoid stopping the engine during the regeneration process. By increasing fuel consumption, the pollution problem has been accentuated due to the harmful emissions of internal combustion engines used for propulsion [1]. The purpose of the paper is to emphasize the need to use the particulate filter because it plays an important role in reducing emissions. Reducing pollutant emissions from transport is important for achieving the EU's climate neutrality objective for 2050. The EU-wide target requires a 15% reduction in emissions from new cars and vans by 2025. This objective becomes stricter for 2030 to reduce emissions from new passenger cars by 55% and emissions from new vans by 50% [2]. In many regions, air pollution levels still exceed set limits. The Union's air quality standards continue to fall short of the targets set by the World Health Organization [3].

II. REDUCING POLLUANT EMISSIONS

Turbo diesel engines are equipped with a common rail injection system. The engines are characterized by high performance and reliability. The engines produce low noise during operation, are easy to maintain, and contribute to reducing fuel consumption. There are several methods for reducing CO2 emissions. These methods are related to limiting actual fuel consumption. Euro standards contribute to a noble goal, reducing pollution and improving air quality. The Euro 5 standard makes the DPF filter mandatory for all diesel cars. The Euro 6 standard drastically reduces the limits for NOx and PM, putting pressure on the efficiency of filter regeneration. The Euro 6d standard introduces real driving tests and forces manufacturers to optimize filter operation even in urban traffic [4]. In Euro 6, the limit for microparticles resulting from the combustion of diesel fuel dropped from 140 g/km in Euro 1 to 5 g/km [5]. The Euro 7 standard aims to facilitate the transition to electric cars. Cars produced by 2035 should be as low-polluting as possible [6].Diesel engines emit: Nitrogen oxides (NOx), Fine particles (PM), Carbon monoxide (CO), Unburned hydrocarbons (HC). Diesel engines are preferred over gasoline engines for their performance and economy (lower fuel consumption) [7].The focus is on reducing fuel consumption and emissions of pollutants. Reducing fuel consumption leads to lower greenhouse gas and carbon dioxide emissions. Studies conducted by the European Environment Agency show that particle filters contribute to a 90% reduction in solid particles, improving air quality in cities.

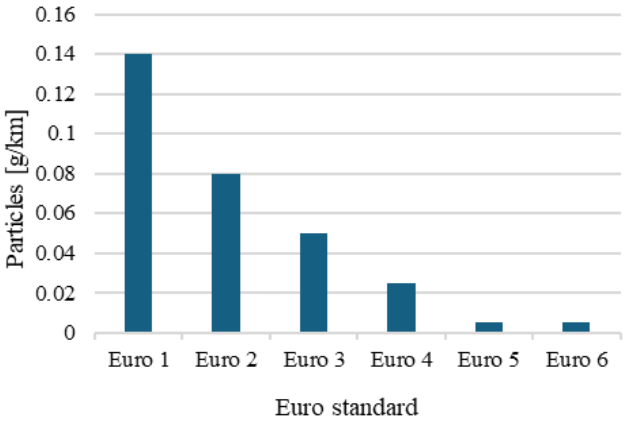

Fig.1. Emissions of particles

III. THE ROLE OF THE PARTICULATE FILTER IN REDUCING EMISSIONS

The particulate filter captures the soot that results from the combustion of diesel fuel, burning it through regeneration. It reduces PM particle emissions, which are very harmful to human health.In the event of faults, engine performance will decrease. Using the car becomes unsafe, it consumes more fuel, and it emits more smoke. It is important to perform a correct diagnosis. The warning light can come on when there are problems with the EGR, malfunctions related to the particulate filter, the lambda probe, or the failure of some sensors in the system.

When the "Check Engine" light comes on, the service station uses a tester and finds the real faults. The light should go off after troubleshooting and cleaning the EGR valve. The warning light on the dashboard should stop lighting up when the exhaust gas recirculation valve is replaced. After the faults have been rectified, the error can be cleared, and the warning light will return to normal. Reducing emissions from a vehicle can be done through a combination of technologies, driving behaviors, and maintenance. The awareness of the environmental impact of pollution has led to the development and implementation of advanced technologies in the automotive industry.

Acid rain or smog also occurs because of the action of particles that are emitted in large numbers by internal combustion engines. The diesel car studied has low emissions due to optimized consumption. Modern automatic transmissions can reduce fuel consumption and emissions in urban traffic. The Start-Stop system automatically stops the engine at a traffic light, reducing unnecessary emissions Low rolling resistance tires improve energy efficiency and reduce emissions. They are designed to minimize energy loss, which leads to lower fuel consumption and reduced CO2 emissions. Driving style reduces engine strain and consumption. Checking your engine, brakes, and tires maintains efficiency. Under-inflated tires increase fuel consumption and pollutant emissions. Vehicles consume less fuel and emit less CO_2 in fluid traffic. Driver behavior has the greatest impact on emissions in real driving conditions.

Strong acceleration, excessive speed, and fuel consumption lead to increased CO_2 emissions. The DPF filter has the role of retaining harmful particles from exhaust gases. The role of the particulate filter is to retain harmful particles from the exhaust gases. To function properly, the particulate filter must regenerate periodically, burning off soot accumulations. Passive regeneration occurs during normal driving at high temperatures (highway, constant speeds). Active regeneration is initiated by the ECU when the DPF is almost full. The engine injects additional fuel to increase the temperature in the DPF.

Forced regeneration is performed in service with a diagnostic tester if other methods fail.If regeneration is not done correctly; a warning light appears on the dashboard indicating increased fuel consumption and black smoke when accelerating. Proper maintenance (oil, air filter, extra-urban driving) can prolong efficient operation. Stopping the engine during regeneration should be avoided. For complete regeneration, it is ideal to drive the vehicle for 20–30 km. If the regeneration is not done correctly, the filter is charged above 80%.

We can avoid pollution by monitoring air quality and preventing exposure on days with high levels.Monitoring air quality and avoiding exposure on high-level days. Use of environmentally friendly means of transport. It will be necessary to increase the number of zero-emission vehicles. Vehicles that meet the requirements of the EURO 5 standard will be permitted to enter clean traffic zones by 2030.

Fig.2. Particulate filter - exhaust system

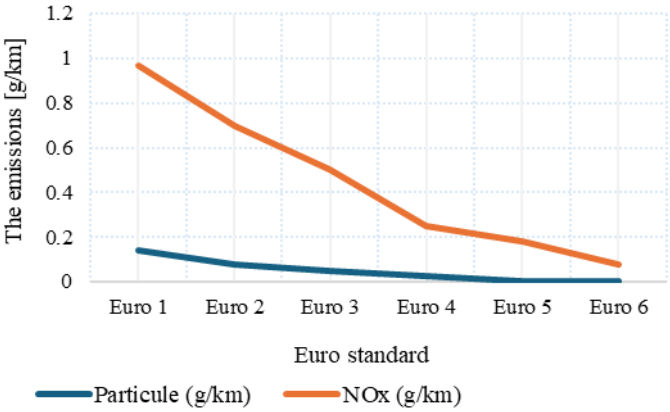

Fig. 3. Emissions from compression-ignition engines

The vehicle that is running with a clogged DPF filter will not function properly. The exhaust gases have nowhere to be eliminated through the exhaust system, being blocked by the clogged holes of the particulate filter. The computer limits the power developed, entering “safe mode” or “limp mode”.

IV. CONCLUSION

Black smoke from vehicles affects the human body by polluting the air with soot particles, heavy metals, and carcinogenic substances. It is the cause of many respiratory problems, irritation of the eyes and mucous membranes, and even contributes to the development of some tumors. The diesel particulate filter (DPF) is one of the innovations that has marked the evolution of automobiles and is becoming an essential part in the context of strict emission regulations imposed globally. The functioning of the filter is not only a legal requirement but also a guarantee of engine performance and longevity. A vehicle that is running with a clogged DPF filter will not function properly. The exhaust gases have nowhere to be eliminated through the exhaust system, being blocked by the clogged holes of the particulate filter. The computer limits the power developed, entering “safe mode” or “limp mode”. Starting with the Euro 4 car pollution standard, nitrogen oxides (NOx) contribute decisively to increasing the risk of cancer, especially in urban areas. To ensure optimal functioning of the DPF and prevent clogging, it is very important to follow the manufacturer's recommended maintenance intervals. Quality fuels must be used, and periodic checks must be carried out.It is recommended to drive the vehicle regularly at speeds that favor regeneration and to avoid stopping the engine during the regeneration process.

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