STUDIES ON REDUCING ENVIRONMENTAL POLLUTION PRODUCED BY AGRICULTURAL TRACTORS

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Abstract
The purpose of studies on reducing pollution produced by agricultural tractors is to identify, analyze and develop solutions to minimize the negative impact that these machines have on the environment.
The main objectives of such studies include: identifying pollution sources; developing cleaner technologies; optimizing agricultural practices; complying with European standards; analyzing the economic impact.
Energy consumption is a major source of air pollution, contributing to over 90% of sulphur dioxide emissions in the EU. Pollution from internal combustion engines in tractors takes two forms: chemical pollution and dust pollution. Chemical pollution, in turn, is carried out through pollutant emissions, soil pollution and toxicity.
Along with the evolution of technology, pollution regulations have also evolved, becoming increasingly restrictive. Reducing emissions produced by internal combustion engines in vehicles is the most important goal of manufacturers at the moment. The increase in the number of vehicles has led to the need to improve the environmental performance of the engines that equip them, in order not to increase air pollution substantially.

Introduction

Interest in environmental pollution has grown in recent times from a small number of people who dealt with pollution sporadically and randomly to the entire population of the globe and the most diverse institutions and organizations. [1], [3]
Of course, pollution deserves interest, primarily for its current aspects, because it still creates inconveniences and damages that affect health, sometimes involving large masses of people.[2], [4].
This requires its knowledge to be as thorough, urgent and extensive as possible.
The impact of polluting emissions on the environment consists of:
- formation of tropospheric ozone, which is very toxic to organisms;
- damage to flora, especially conifer species and fruit trees. [5], [7].

Effects on the health of the population produced by polluting emissions are:
- respiratory and cardiac diseases due to CO;
- irritation of the respiratory tract due to NOx;
- eye irritation and carcinogenic effects caused by hydrocarbons;
- anemia, diseases of the nervous system due to lead compounds;
- nervous depression due to benzene compounds.

Diesel engine emissions, due to the nature of combustion, consist of a series of pollutants, the most dangerous of which are nitrogen oxides and particulate matter. [6], [9].The Euro VI emissions regulation, which will apply to all new commercial vehicles and buses produced after 1 January 2014, introduces significant reductions in the levels permitted at the tailpipe. [8].
Thus, nitrogen oxide emissions must be at least 80% lower and particulate emissions reduced by 66% compared to the Euro V standard. Euro VI also introduces a limit on ammonia emissions for the first time [11], [15].
Currently, in diesel engines, injection systems and injection pressure are improved to achieve high pressures when spraying the fuel. This also improves the efficiency of the diesel engine. The combustion process is a very complex one both from a thermodynamic point of view and in terms of heat transfer. [13].
In recent years, internal combustion engines have had and continue to have a spectacular evolution. In addition to mechanical components, electronic control systems have appeared that can implement complex laws to ensure optimal engine operation, achieving a compromise between performance, low emissions and reliability. [10], [14].
The internal combustion engine is also a source of chemical and noise pollution that harms humans and the environment. Chemical pollution is due to the chemical substances and compounds found in the exhaust gases of vehicles. [12].
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Experimental

Pollution source analysis focuses on identifying how various activities and processes release harmful substances into the environment. The main types of pollutant emissions are exhaust gases and fine particles, which have a significant impact on air quality and human health.
The harmful substances present in the atmosphere fall into two groups, depending on the nature of their origin. Thus, there are primary substances, in gaseous or solid state, which are found directly in the exhaust gases of a vehicle (HC, CO, NOx and PM) and secondary substances which are represented by photochemical smog and wet smog.

Hydrocarbons (HC)

They are pollutants present in automobile emissions characterized by variable toxicity depending on the chemical composition. The main hydrocarbons in automobile exhaust gases are benzene, toluene and xylenes.

Carbon monoxide (CO)

It is a chemical substance in a gaseous state, colorless and odorless, which is formed due to the incomplete combustion of carbon-rich substances (fuels). Being an asphyxiating gas, it has a toxic effect on the body. The toxic asphyxiating effect of carbon monoxide is due to its combination with hemoglobin**.**

Nitrogen monoxide (NO)

It is a colorless, toxic gas, with an irritating effect on the respiratory mucosa. Long-term exposure has a carcinogenic effect on the human body. The toxic effect is due to the formation of methemoglobin (a product similar to carbaminohemoglobin), by combination with hemoglobin, which prevents the exchange of oxygen between tissues and respiratory organs.

Nitrogen dioxide (NO2)

It is a reddish-brown, toxic gas with a pungent odor. It has a harmful effect on the respiratory tract, causing irritation. By combining with water it forms nitric acid (acid rain) which has a devastating effect on the environment.

Particulate matter (PM)

They are made up of carbon molecules that combine with other chemical compounds (hydrocarbons, sulfites, nitrates, metals) and depending on their size form black smoke or soot.

Photochemical smog

It is a smoke-like fog characteristic of cities with heavy traffic and favorable formation conditions. The conditions underlying the formation of photochemical smog are: low humidity, temperature higher than 20oC and sunlight. For the formation of photochemical smog, 13 chain chemical reactions are required, initiated by nitrogen monoxide and dioxide, then ozone (O3) and hydrocarbons. The effects of photochemical smog on the human body are harmful because it causes irritation of the respiratory tract and eyes.

Wet smog

Unlike photochemical smog, wet smog forms in the atmosphere with high humidity, at relatively low temperatures (4ºC). It is formed due to chemical reactions between particles, carbon oxides and sulfur oxides. It has a suffocating effect on the human body.

One of the main directions of research and development in the agricultural industry is the creation of cleaner engines and propulsion systems. These efforts focus on reducing fuel consumption, pollutant emissions and environmental impact, with the ultimate goal of more sustainable agriculture.

To reduce diesel engine emissions, manufacturers are focusing on cleaner combustion and exhaust aftertreatment technologies.

Advanced injection systems, modern engines use high-pressure, electronically controlled injection systems that spray fuel into extremely fine droplets. This ensures more complete combustion and reduces emissions of fine particulate matter (PM) and nitrogen oxides (NOx).

Diesel Particulate Filters (DPF), these filters capture soot particles from the exhaust gases and periodically burn them, turning them into harmless ash.

Selective Catalytic Reduction (SCR), an SCR system injects a urea-based fluid, known as AdBlue, into the exhaust gas stream. This fluid reacts with nitrogen oxides and converts them into harmless nitrogen and water.

Another important direction is the transition from fossil fuels to cleaner energy sources.

Alternative propulsion systems

Electric propulsion, electric tractors completely eliminate polluting emissions and noise at the point of use. They are ideal for small-scale agricultural operations and offer high torque, essential for field work.

Hybrid systems, hybrid tractors combine an internal combustion engine with an electric motor. This configuration allows the electric motor to take on light loads, reducing fuel consumption and emissions.

Results and discussion

Studies are focusing on developing engines compatible with biofuels (biodiesel) or synthetic fuels, which can reduce the carbon footprint of agriculture.

The use of smart technologies and robotics also contributes to cleaner agriculture:

Autonomous tractors - these machines, guided by GPS and sensors, avoid overlapping work and minimize field passes, reducing fuel consumption and soil compaction.

Route optimization - navigation systems and automatic route planning ensure maximum efficiency in the execution of agricultural tasks, reducing operating time and, implicitly, emissions.

Optimization of agricultural practices is essential to reduce environmental impact and improve sustainability.

Another strategy is the use of machines that exert less pressure on the soil, thus reducing compaction.

Low-pressure tires: Specialized tires with a larger contact patch distribute the tractor's weight over a wider area. This reduces the specific pressure on the soil, protecting its structure and improving water infiltration and root growth.

Lighter equipment: Solutions are being sought to use smaller, lighter equipment for certain tasks, instead of heavy tractors. For example, autonomous agricultural robots can perform operations such as seeding or weeding, with minimal impact on the soil.

These approaches not only protect the environment, but also increase economic efficiency, by reducing fuel costs and improving crop productivity in the long term.

Studies and research are essential to comply with the strict regulations imposed by the European Union on pollutant emissions. These standards change periodically, and the agricultural industry must constantly adapt.

In addition to the environmental benefits, studies also assess the economic efficiency of new technologies. The aim is to provide viable solutions that do not significantly increase costs for farmers.

In short, studies in this field contribute to a more sustainable, more efficient and environmentally friendly agriculture, essential to ensure food security and protect ecosystems.

Conclusion

Internal combustion engines are a major source of atmospheric pollution with toxic emissions. These are the reasons why the effort to reduce the amount of polluting emissions from internal combustion engines is of interest to all countries, and even more so to those that have a vehicle and agricultural tractor manufacturing industry.

The major problem currently posed by the internal combustion engine is the pollution of the atmosphere by combustion gases, a fact that attracts the attention of specialists, especially in order to reduce harmful emissions. Any new type of internal combustion engine, in order to be accepted, must have a type approval certificate in which the measured emissions do not exceed the limits imposed by environmental protection legislation.

The sources of pollutant emissions from an internal combustion engine are caused by the combustion of fuel and the imperfect sealing of the engine cylinders, the fuel tank and the supply pipes. The pollutants generated by combustion are eliminated into the atmosphere through the exhaust gases and partly through the engine crankcase gases. The pollutants determined by the imperfect sealing are discharged directly into the atmosphere through the evaporation of the fuel from the engine fuel system and the fuel tank.

During the periodic technical inspection and traffic checks carried out by representatives of the traffic police and the Romanian Automobile Registry, the first operation consists of checking the tightness of the exhaust gas exhaust. The next operation consists of determining the CO concentration using a gas analyzer.

In Europe, legislation limits the emissions of various polluting gases produced by motor vehicles. All vehicles are built in accordance with this legislation and have an emission control system in their structure that eliminates or considerably reduces these emissions. The car subassemblies that filter exhaust fumes are the catalytic converters and the particulate filters, their action being also controlled by the ECU.

High exhaust emissions occur when the fuel is not burned completely, the engine is not properly adjusted, when starting or stopping the engine, when driving at low speed. Without a catalyst, when the engine is running at a standstill, the CO content in the exhaust gases should not exceed 5%.

Reducing environmental pollution from agricultural tractors is a crucial objective for a more sustainable future.
Air pollution caused by internal combustion engines is a complex problem, and solving it requires an approach that involves both individual-level measures, public policies and technological advances.
Car manufacturers are continuously working to develop more efficient engines that consume less fuel and emit fewer pollutants.
The transition to zero- or low-emission vehicles, such as electric cars (EVs) and hybrids, is seen as a key long-term solution. This transition is supported by innovations in battery technology and the development of charging infrastructure.
By combining these approaches, a significant reduction in air pollution from internal combustion engines can be achieved, contributing to a cleaner environment and better public health.
Research and development of biofuels, green hydrogen or other synthetic fuels, which generate much lower emissions, is another way to reduce pollution.

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