NOISE AND VIBRATIONS PRODUCED BY TRACTORS AND SELF-PROPELLED AGRICULTURAL MACHINERY

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Abstract. *The fuel used for compression ignition engines is usually Diesel. The fuel mixture (air and Diesel) is formed in the combustion chamber in a very short time, while it takes the fuel injection. For this process to undergo normal conditions the spraying of fuel by the injector must be made as finely as possible. Taking into account that, at the time of injection of Diesel (end of compression), the air has a high pressure (25-35 dan/cm^2), the pressure with which the Diesel is injected is much higher (110-1500 dan/cm^2). As a fuel injection in the combustion chamber, it does not immediately ignite, but first occurs when fine Diesel droplets in the mixture are heated until they vaporise. Then follows auto-ignition, triggering a very high propagation speed. The time elapsed when the injection begins until the Diesel self-ignition is called a delay in self-ignition. It is desirable that the delay in self-ignition is as short as possible. It depends on several factors including the type of diesel, the type of combustion chamber, the injection advance, the compression ratio, and others. The ability of Diesel to have a certain delay in auto-ignition is expressed by the cetane figure or its cetane index. The cetane digit of the Diesel is the percentage of cetane in a standard mixture of two hydrocarbons: the cetane which has a cetane figure 100 and alpha-methylnaphthalene which has a cetane figure 0. The higher the cetane figure, the lower the delay in self-ignition is.*

Keywords*: tractors, agricultural machinery, vibrations, Diesel*

INTRODUCTION

Solving complex problems of modern agriculture are inconceivable without a complete mechanization of production processes. It is clear, therefore, that mechanization will play a key role in the effort to increase agricultural production and productivity. [NIȚĂ LUCIAN-DUMITRU, 2007] In addition to the advantages it has, the mechanization of agriculture also has a number of negative consequences, such as high fuel cost, environmental pollution, and increased risk of occupational diseases caused by the noise and vibrations of self-propelled agricultural tractors and machines. [K. I. LATO , M. POPA , A. LATO, M. CORCHES, I. RADULOV, A. BERBECEA , F. CRISTA, 2019, LAȚO KAREL IAROSLAV, GJONGECAJ BESNIK, GJOKAL FRAN, CRISTA FLORIN, NIȚĂ LUCIAN DUMITRU, 2019]

The issue of resources, with the global energy crisis, has become topical, saving fuel by reducing consumption in mechanized agricultural works representing a measure of first urgency. The use of agricultural tractors and self-propelled combines equipped with high performance engines that have a low fuel consumption on both the work performed and the power unit is one of the current fuel saving solutions. [MIHUȚ A., PAȘCALĂU C., CASIANA MIHUȚ, MIRCOV V.D, 2018, MIHUȚ C. 2014].

The main sources of pollution in agriculture include tractors and self-propelled agricultural machines equipped with thermal engines. The polluting action of the thermal engines is manifested by emissions of gas and particles. This is the reason why the effort to reduce the number of polluting emissions from thermal engines of tractors is of interest in all countries, particularly in those who have industries involved in the construction of engines and

tractors. [POPA D., ILEA R., BUNGESCU S., ALEXANDRA BECHERESCU, 2015, POPA D., ILEA R., BUNGESCU S., ALEXANDRA BECHERESCU, 2015].

The noise and vibrations produced by self-propelled tractors and agricultural machinery have adverse effects on humans during work because they actually contribute to the installation of fatigue, reducing the actual work capacity and increasing the risk of occupational diseases. Controlling noise and vibrations in agriculture has become an important issue in recent years caused, partially, by the considerable multiplication and the increase in power of noise and vibration sources and, on the other hand, due to medical research that has highlighted the harmful nature of noise and vibrations on the human body and the negative effects that affect labour productivity. [LUCIAN NITA, DORIN TARAU, SIMONA NITA, ALINA HEGHES, RADU BERTICI, DANIEL DICU, 2019, NITA L., ADIA GROZAV, GHEORGHE ROGOBETE, 2019].

By burning fossil fuels in engines, the following main substances result: water vapor (13%), carbon dioxide (13%), and nitrogen (74%). Depending on the mixture, carbon oxide (up to 10%) for rich mixtures (20% air) and oxygen (up to 7%) for very poor mixtures (50% excess air) are formed. By burning, nitrogen oxides, hydrocarbons, particles, and sulphur oxides are produced in low proportions. With the exception of water vapor (nitrogen and oxygen are the constituent elements of the atmosphere), all other substances are considered to be pollutant emissions and, in their vast majority, noxious emissions. [OKROS A., ADRIAN BORCEAN, MIRCOV VLAD DRAGOSLAV, MIHUȚ CASIANA, BOTOȘ FLORENTINA NICOLETA, 2018, OKROS A., POP GEORGETA, 2014]

Harmful substances in the atmosphere are classified in primary substances and secondary substances. Primary substances are directly produced by identifiable sources; secondary substances are produced in the air through the interaction of multiple primary substances or by air reaction of primary substances under the action of atmospheric factors (moisture, heat, solar rays). [MIHUȚ C., ANIȘOARA DUMA-COPCEA, 2018, MIHUȚ C., ADALBERT OKRÖS, OLIMPIA IORDĂNESCU, LUCIAN NIȚĂ, 2012]

Studies conducted by Diesel engine builders in order to reduce the sound level are considerable and their production started a long time ago.

The objectives pursued are: adjusting the injection advantage according to engine load, engine fanning, smoke, use of catalytic reactors, fuel additive, exhaust gas recirculation, and electronic injection.

MATERIAL AND METHODS

Medical aspects of noise and vibrations of tractors and self-propelled agricultural machines

Until recently, in the world, the main focus in the construction of tractors was on traction, operating safety, simplicity and ease of driving, simplicity and ease of technical service, simplicity of aggregation with the working machine, reduced gauge and, especially, optimum consumption of fuels and lubricants. Requirements in terms of comfort during work were still quite poorly taken into account when designing and constructing these types of agricultural machinery.

The notion of *traffic comfort* includes a number of phenomena such as:

- *Mechanical vibrations* that reach the driver's body in several ways, namely through the steering wheel, through the chair and control pedals: mechanical vibrations are generated, in particular, by the irregularities of the rolling path and, to a smaller extent, of the engine;

- *Noise* is particularly generated by the engine and mechanical transmissions, and its level in the head of the driver should be as small as possible;

- The *disposition of the service elements* that should be as favourable as possible in relation to the hands and legs of the driver;

- *Accident protection* should be resolved, especially as regards the overturning of the tractor;
- *Good visibility conditions*, both during the day and during the night;
- *Suitable microclimate* inside the tractor cabin, preventing high temperature variations, rain, dust, pesticides, or exhaust gas.
- *Efficient and safe braking installation*.

The analysis of the health status of tractor drivers, made by conjugated methods on a sample of tractor drivers, highlights the following:

- Part of the tractor drivers accuse gastro-duodenal disorders starting with a feeling of weight in the stomach, nausea, burns, some being diagnosed with gastritis or ulcer established by clinical examination; major causes: cold food, irregular meals and mechanical vibrations of the tractor;
- Other tractor drivers have cervical and dorsal-lumbar myalgia without connection with meteorological changes but related to intense work on the tractor and succumbing to rest; indicated causes: tractor vibrations transmitted by chair, forced labour positions in certain agricultural works;
- About one sixth in the surveyed lot accuses ears and hearing disorders: ears pain, whirlwinds, sinks, dizziness, clicks, and decrease of auditory acuity at the end of the work day persisting several hours after resting; indicated causes: *noise produced by the tractor*, the tractor being equipped with a cabin, air currents in the cabin in summer, etc.;
- Some claim they have a pain in the backbone, pains in the twist movements of the trunk or lens and lombo-sciatic, exacerbated at the end of the work; causes: *tractor mechanical vibrations*, trunk twist effort and prancing;
- Others claiming occipital headache appearing after a number of hours worked on the tractor, which disappears at rest; major causes claimed: *trepidations and oscillations of the tractor*, air currents in the cabin in summer;
- Very few complain of numbness and tingling sensations in fingers, redness with heating or bleaching and cooling fingers after a long effort to maintain the steering wheel; existing causes: *vibrations of the tractor and the steering wheel*.

The simple enumeration of the results of the analysis highlights the fact that the phenomena included in the sphere of *traffic comfort* should not be neglected. The notion of comfort so defined exceeds the sphere of its meaning, reaching economic and social coordinates. Indeed, better *traffic comfort* ensures higher working capacity, an increase in labour productivity, and health protection for the tractor driver.

Returning to the previous medical analysis, it is noteworthy that, in six of the nine types of affections reported, the causes of these diseases include *noise* and *mechanical vibrations*. Taking these issues into account, this paper analyses how they are produced and especially how they are reduced.

RESULTS AND DISCUSSIONS

Studies on the effects of *sound aggression* have highlighted a number of mechanisms such as:

- Disturbing intellectual mechanisms, having implications on judgment and self-control, character and behavioural disorders;
- Difficulty of adapting to intellectual work, which leads to fatigue, to a certain degree of inconvenience to work;
- Emotional changes such as excitation, inhibition, or mixed, and disruptions in thymus activity;

- State of nervousness, hyperexcitability, sleep disorders, insomnia;
- Psycho-affective changes consisting of sudden passages from one affective state to another, anxiety, restlessness, mental confusion with auditory hallucinations especially in people who already have a trend towards paranoidal conditions.

In people exposed to high-level noise, there is a trend towards a state of mental irritability caused by physical fatigue and the need to speak aloud to understand and the difficulty of perceiving other people's verbal communications.

This state of irritability is manifested in the workplace and, particularly, in the family, favouring disturbances in inter-human relationships.

The noisy ambience negatively influences the achievement of work tasks.

Both in the case of a predominantly intellectual and motor activity, the emergence of an even short-term intense, unexpected noise leads to disturbance and temporary decrease in performance.

The negative influence of continuous noise on achieving tasks is seen especially when the work is complex, demanding immediate memory and making decisions. In a noisy ambience, solving technical problems and making mathematical calculations is much more difficult than in a silent ambience.

A factor that plays an essential role in determining harmful noise is the degree of complexity of the activity to be performed. The easier the activity is, with a repetitive character minimizing the individual's attention, the less the noise influences it, and its effort is harder to be highlighted.

Motor tasks that do not require great coordination or precision are not suffering from exposure to noise.

Obvious negative influences occur in the case of activities that include multiple and complex mental functions such as immediate memory, perception, and vigilance.

The temporal structure of a task plays an essential role in highlighting the negative influence of noise on it. Thus, temporal uncertainty, a certain density of the signals and indifferent stimuli, the irregularity of the interval between signals, all these variables hamper the optimal conditions of the task to be fulfilled and, thereby, increase its susceptibility to the harmful action of noise.

CONCLUSIONS

In order to control and reduce the pollutant emissions of internal combustion engines, as well as the sources of tractors' noise and vibrations, it is necessary to apply extensive regulations and programs of different measures, depending on the specific conditions of each country, through which to ensure an overall success. This concern has emerged and accentuates both at national and international level.

This study allows the following conclusions to be drawn:

- In recent years, the focus has been, worldwide, on the construction of low fuel Diesel engines as well as on reducing polluting emissions, noise and vibrations;
- Periodic technical checks and current maintenance of internal combustion engines lead to cost reduction and increased reliability;
- By using supercharged Diesel engines and electronic injection in tractors, pollutant emissions and fuel consumption are reduced and their efficiency is improved;
- Pollutants present in the exhaust gases of Diesel engines cannot be completely eliminated, but can be reduced to acceptable values by humans, plants and animals;
- Reducing the noise level within the tractor cabin involves closing and soundproofing it;

- Reducing vibrations within the tractor cabin involves ensuring cabin suspension in relation to the chassis and chair suspension in relation to the cabin.

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