EMISSIONS OF PARTICULATE MATTER FROM RAILWAYS-AN OVERVIEW

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REZUMAT. Recent, a fost acordată mai multă atenţie influenţei particulelor din mediu în suspensie asupra sănătăţii umane. Este recunoscut faptul ca în prezent sectorul transporturilor reprezintă o sursă majoră de particule în suspensie din aer. Pe lângă emisiile atmosferice provenite de la motoare, suprafețele supuse unei frecări de contact prin glisare sunt, de asemenea, o sursă semnificativă de particule în suspensie. Prin urmare, a fost efectuata o analiză a literaturii de specialitate pentru a concentra cunoştinţele actuale în ce priveşte concentraţia şi distribuţia de particule în suspensie din mediul înconjurător. Obiectivele acestei lucrări au fost de a colecta informaţii pentru a le oferi ulterior pentru alte articole, respectiv pentru a identifica segmentul pe care se concentrează activitatea proprie de cercetare.

Cuvinte cheie: particule in suspensie, cai ferate, uzura, emisii, mediu inconjurator.

ABSTRACT. Recently, much more attention has been given to the influence of particular matter into the environment on human health. It is currently acknowledged that the transport sector is a major source of airborne particulate matter. Besides atmospheric emissions from mobile engines, sliding contacts are also a significant source of airborne particulate matter. Therefore, a literature review was performed to summarize the current knowledge regarding the concentration and distribution of particulate matter in the environment. The objectives of this paper are to compile information, to provide information for other future articles and to identify where focus my research activity.

Keywords: particulate matter, railways, wear, emissions, environment.

1. INTRODUCTION

PhD student research field can be defined like Transport and Environment.

Transport presents real challenges as society tries to ensure a more environmentally sustainable future. Environment is derived from the French word "Environner", which means to encircle or surround. All the biological and non-biological entities surrounding us are included in environment. As per Environment (Protection) Act, 1986, environment includes all the physical and biological surroundings of an organism along with their interactions. Environment is thus defined as "the sum total of water, air and land and the inter-relationships that exist among them and with the human beings, other living organisms and materials"[2], schematically presented in Fig.1[2].

Reference [3] was the first article where substances released by railways to the environment were investigated for the first time.

Protection of soil, surface water and groundwater requires knowledge on the impact of pollutants emitted, for example by the transport sector in a diffuse pattern. In fact, transport sector can be considered as an important source of diffuse pollution to the environment. Until now, numerous studies focus on road traffic pollution, but little is known about railways. However, regular railway operation is also associated with the diffuse release of inorganic and organic substances in the environment (Fig. 2) [3].

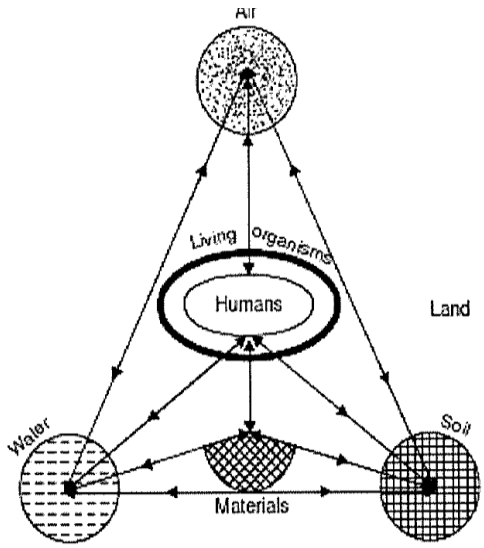

Figure 1 *Concept of Environment: air, water, land, living organisms and materials surrounding us and their interactions together constitute environment [2]*

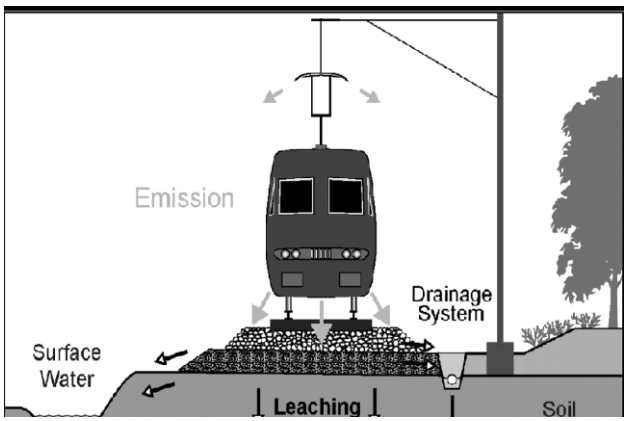

Figure 2. *Spatial distribution of substances emitted by regular railway operation and their influence to environment [3]*

From my knowledge, it was the first assessment in which all substances emitted by railways were quantified. Moreover, railway companies have problems to evaluate the efficiency of common drainage systems for substances mobilized from track profiles.

"Transport of goods and people with railways is generally considered as the most environmentally friendly means of transportation. The remaining environmental concerns usually focus on the emission of air pollutants and noise. The main emission source is considered to be exhaust emissions from diesel engines, mainly of NO_X, particulate matter and greenhouse gases. However, the emission performance for diesel locomotives is similar as for non-road machinery and usually better than for ship engines. With the use of electrically powered engines, these emissions are not present and the concern is transferred to wear particles and emissions during electricity production. The rate of emission from vehicles of particles stemming from wear of brakes and other materials, as well as from re-suspension from the ground, can be expected to depend on train properties such as weight and on driving parameters such as speed and acceleration. Wear of various track components, catenaries, engines, and wagons generally represent a large cost for train operators and railway authorities. Further, wear causes diffusion of valuable material in nature, in the form of polluted water or airborne particles, which may affect ecosystems and human health" [4].

"There are comparatively few studies that address the emission of particles from railways, probably because the impact on air quality is expected to be small. Those that have been completed normally deal with emissions from diesel engines or the air quality in coaches, but with electrical trains, the particles mainly originate from wear of rails, brakes, wheels, and carbon contact strips. The friction between wheels and rail causes metal losses from the surfaces but it is an open question what fraction of these losses results in airborne particles. It is in this context of interest to study particle emissions from railways. A number of studies have reported high concentrations of particles in underground stations and subways. There are few studies reporting levels of particles in railway environments above ground and no studies reporting emission factors or the variability in emissions with driving pattern"[5].

PhD research theme is "Theoretical and experimental researches regarding the influence of the railway's track curvature on the particulate matter's concentration emitted in the environment".

Objectives to be achieved are:

- theoretical study of the process of emission of particulate matter in the environment;
- experimental study to determine the concentration of harmful particulate matter (PM_{10}) emitted by trains circulating on the section Timisoara Nord – Lugoj;
- numerical simulation of the process of emission of particulate matter (PM_{10}) in the environment using CFD software;
- comparison of results: theoretical–experimental – numerical
- finding viable solution to reduce harmful concentrations of particulate matter (PM_{10});

In our country have not done research in this direction and therefore I proposed a detailed study, both theoretically and experimentally, regarding particulate emissions generated by railway transport.

This paper presents the preliminary knowledge from the theoretical study of the process emission of particulate matter in the environment.

2. METHODS AND MATERIALS

U. Olofsson used a pin-on-disc material test stand with a clean air supply to measure the number and size of airborne wear particles online[1]. The test was performed using a pin-on-disc machine with a horizontal rotating disc and a deadweight-loaded pin (Fig. 3[1]).

The main particle measuring instrument was an optical particle counter at the outlet. The counter used was an Aerosol Spectrometer, which measures airborne particles from 0.25 µm to 32 µm in 31 size intervals and concentrations from 1particle/l to 2×106 particles/l with a sample flow rate of72l/h.The particle concentration was recorded every sixth second. A scanning mobility particle "sizer (SMPS) was also applied to the outlet air. The test specimens were water jet cut from real railway wheel and block brake samples. The brake block samples had A flat end and a diameter of 10mm and the brake block materials were from cast iron and composite pads respectively. The disc from railway wheel material has a diameter of 90mm and was from R7 wheels. Each test run was performed with a pair of new surfaces. The maximum contact pressure is roughly around 1MPa in a brake shoe to wheel contact when applying the maximum allowable braking force."[1]

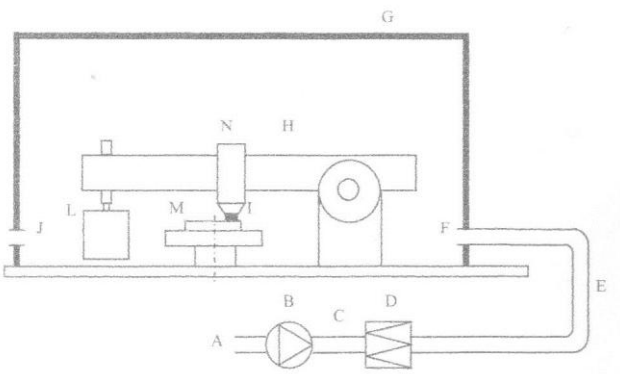

Figure 3. *Schematic of the test equipment A:Room air; B:fan; C:flow rate measurement; D:filter; E:flexible tube; F:inlet for clean air, measurement point; G:closed box(chamber); H:pin-on-disc machine; N:air inside box,well mixed; J:air outlet, measurement points; L:deadweight; M:rotating disc sample; I:pin sample [1]*

E. Fridell et al.[5] considered that is necessary to study the emissions of wear particles from trains conditioned by measure both particle concentration and airflow.

„A common method for doing this for road traffic is to use tunnels; tunnel naturally provides a given volume and cross section that facilitate air-flow estimations. The particle concentration is measured at the outlet of the tunnel with a sampling frequency of 1 Hz, together with measurements of the wind flow in two dimensions. Further, the speed and length of passing trains were monitored with the help of two pairs of diode-lasers/ photo detectors positioned at the side of the track. To evaluate emissions from individual trains, particles emitted in the tunnel needs be ventilated out between each train's passage. A tunnel on a track with a train frequency of only one to a few trains per hour was therefore chosen. The tunnel is ventilated by both the flow caused by the passing trains and the ambient wind (Fig.4[5]). A tunnel with a length of the same order as the train length was chosen to facilitate the ventilation caused by wind. A small cross section area facilitates the ventilation by the train, but probably constrains the wind ventilation. During measurements, the particle concentration and the wind flow could only be probed at one point, and thus a track centered in the tunnel is preferred and a tunnel with a single track was thus chosen. Particles were counted with a Portable Aerosol Spectrometer Grimm, Model 1.108. This counts the number of particles in the diameter interval 0.3–20 µm. The principle parameter measured is therefore the particle number concentration as a function of the particle size"[5].

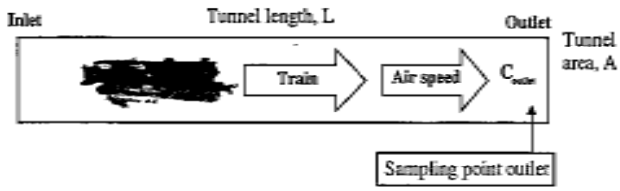

***Figure 4**. Tunnel measurements of particles emissions [5]*

Personally, for the beginning of research, I proposed a black-box model presented in Fig.5.

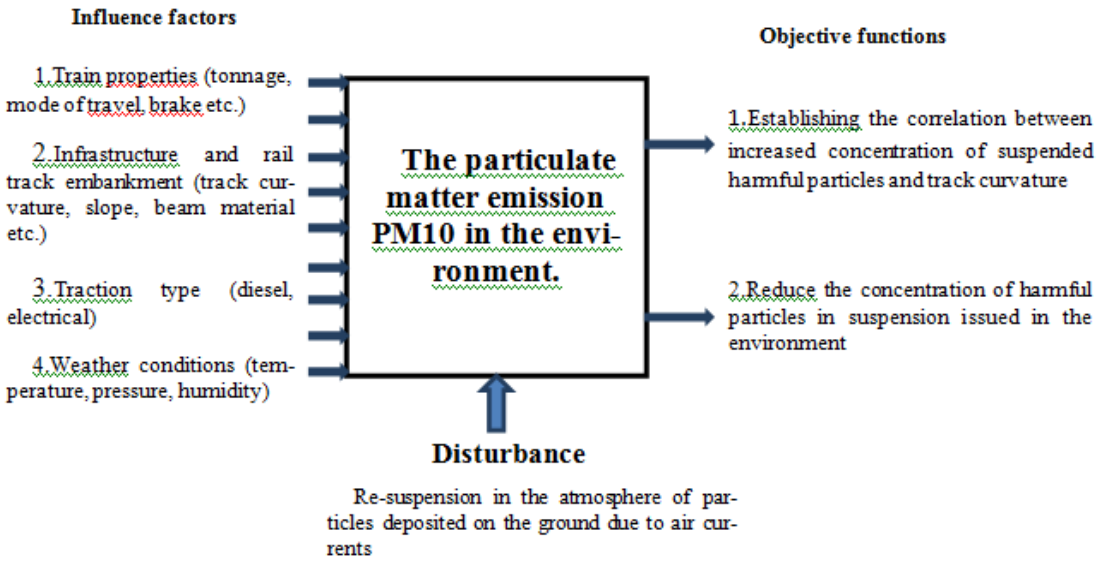

***Figure 5**. Black- box model for the emission of particulate matter*

3.RESULTS AND DISCUSSIONS

Due to the lack of essential data on emissions of harmful particles in the atmosphere, it becomes clear that an environmental impact assessment cannot currently be fully established. Also, I propose to determine a mathematical relationship between the concentration of particulate matter, atmospheric factors and characteristics of the railway line, and then to simulate this process for few particular situations in case of several types of trains.

I anticipate that there will be a clear correspondence regarding the concentration of particles in suspension and railway line characteristics due primarily phenom-

enon of friction that occurs between the wheel-rail track, dressing wheel-disc brake and mono-block wheel- brake pad.

Answering the question raised by the proposed research ("Which is the relationship between the concentration of particulate matter, atmospheric factors and characteristics of the railway line?") requires to establish the possible correlation existing between railway's track curvature on the particulate matter's concentration.

Taking into account the above consider that the current research is bringing an added value by further scientific research on the influence of transport on the railway with all its implications on environmental pollution.

4. CONCLUSIONS

Airborne particles generated from a sliding contact can be characterized by their size and number distributions[4].

At the current stage, the scatter in measured particle emissions is too high and the dependence on external factors too large to let particle emission measurements from a basis for track access charges [5].

My future research activity will be focus on finding viable solution to reduce harmful concentrations of particulate matter (PM_{10}) and a mathematical relationship between the concentration of particulate matter, atmospheric factors and characteristics of the railway track.

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