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ЗНИЖЕННЯ ЗАБРУДНЕННЯ НАВКОЛИШНЬОГО СЕРЕДОВИЩА ПРИ ТРАНСПОРТУВАННІ ВУГІЛЛЯ

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REDUCING OF ENVIRONMENTAL POLLUTION DURING COAL TRASPORTATION

Представлені результати лабораторних експериментів з дослідження інтенсивності виносу вугільного пилу з піввагонів. Розглянуто чотири випадки: винос вугільного пилу з піввагона, завантаженого з «шапкою», винос пилу з піввагона з додатковими вертикальними бортами, винос пилу з піввагона з додатковими бортами типу «крило», винос пилу з піввагона з додатковими бортами типу «внутрішнє крило». Представлені дані показують, що зменшити інтенсивність виносу вугільного пилу з піввагона можна за рахунок застосування додаткових бортів, розглянутої форми.

Представлены результаты лабораторных экспериментов по исследованию интенсивности выноса угольной пыли из полувагонов. Рассмотрены четыре случая: вынос угольной пыли из полувагона, загруженного с «шапкой», вынос пыли из полувагона с дополнительными вертикальными бортами, вынос пыли из полувагона с дополнительными бортами типа «крыло», вынос пыли из полувагона с дополнительными бортами типа «внутреннее крыло». Представленные данные показывают, что уменьшить интенсивность выноса угольной пыли из полувагона можно за счет применения дополнительных бортов, рассмотренной формы.

Introduction. It is well known that coal dust from coal trains (Fig.1) can cause intensive environmental pollution. That is why the problem of reduction of coal dust emission is still of great interest, especially on routes where the intensive coal transportation takes place. To solve this problem many methods are used [1, 2, 3]. Some of them are effective but very expensive. Others are less effective but cheap. For example: watering of coal surface, usage of special solutions which cover the coal surface, usage of covers, canvases, formation of special coal pile shape in the wagon etc. Every method has its advantages and its disadvantages but the process of finding convenient and not expensive methods is still going on.

Study of coal emission from trains shows that emission from coal trains depends on many factors [3-7]. A lot of these factors are out of control during coal transportation. One of the most important factor is local wind speed near the surface of coal pile in wagon. The **goal** of the study performed was evaluation of screens application for reduction of coal dust emission from the wagon. Application of screens makes influence on the wind flow pattern at the top of the wagon so we decided to study the influence of such screens on coal dust emission from the model of the wagon.



Fig. 1. Wagon for coal transportation

Experimental setup. We performed experiments at the laboratory of Hydraulics and Water Supply (*National University of Railway Transport named after academician V. Lazaryan*). The goal of the experiments was visualization of contaminated zone near the models of the coal wagon with screen on the wagon and estimation of coal dust emission rate. Sketch of experimental setup is shown in Fig. 2.

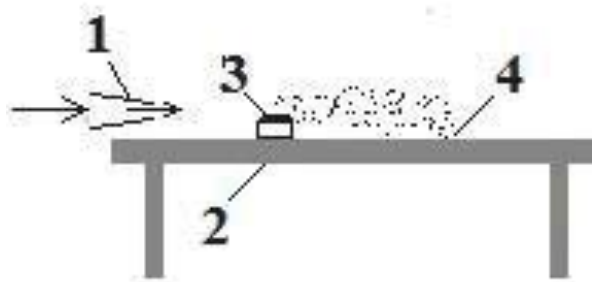


Fig. 2. Sketch of experimental setup: 1 – fan; 2 – table; 3 – model of the wagon; 4 – contaminated zone

The model of the wagon was made in scale 1:100 and this model represented the real wagon № 12-1592. As the dynamic criteria, the Reynolds number was used ($Re=10^4 - 10^5$). During the experiments, we took photos of contaminated zones, which were formed near the model. After each experiment the coal dust, which had fallen on the surface of the table, was weighted to estimate the emission rate.

Results. The experiments, which were performed, simulated 3 different cases.

Case 1 (basic case). First of all, we studied the process of formation of contaminated zone near the model of poorly loaded wagon with coal. Sketch of the wagon (cross section) is shown in Fig. 3.

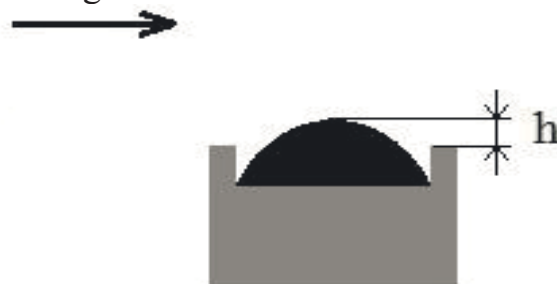


Fig. 3. Sketch of poorly loaded wagon (cross section)

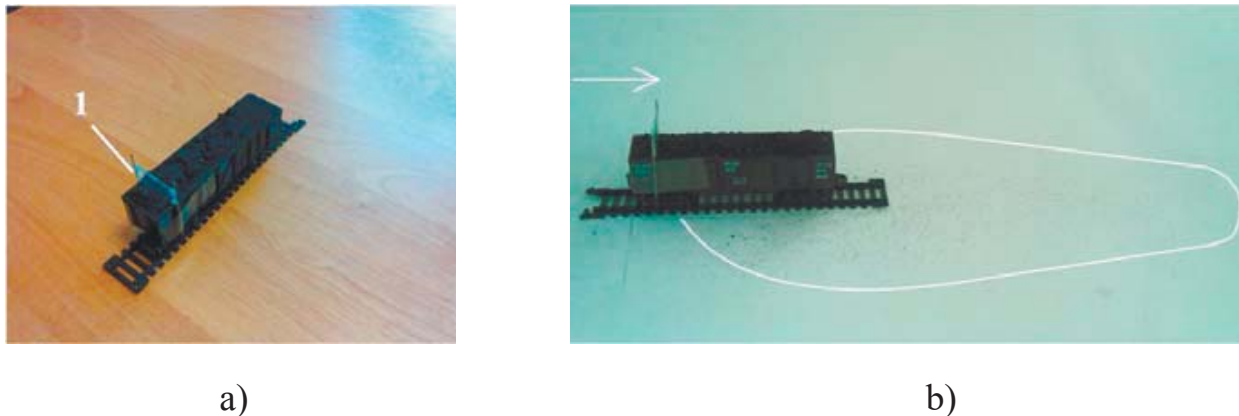
Model of this wagon is shown in Fig. 4a. The results of the experiment are shown in Fig.4b.



a) Model of poorly loaded wagon;
b) Contaminated zone (abrupted) near poorly loaded wagon.

We see from Fig. 4b, that the contaminated zone near the wagon is definitely large. The length of the contaminated zone is about 6 length of the model. It has the form of the long cone. The black color of this zone indicates on intensive coal deposition, especially near the wagon, which means the high intensity of coal dust emission from the model. Mass of emitted coal was about 0.07 mg for this case.

Case 2. At the next step, we studied the process of coal dust emission from the model, which had additional vertical screen on wagon (Fig.5a). This screen changes the fluid dynamic structure near the top of the wagon. Results of the experiment are shown in Fig. 5b.



a) Model of wagon with screen: 1 – screen on the wagon;
b) Contaminated zone near the wagon with screen.

As we can see from Fig. 5b, the intensity of contaminated zone is less than in Case 1 and dimensions of this zone is less than in Case 1. The form of the contaminated zone is like the “bottle”. It is clear that the “light” particles flew from the top of the wagon. Mass of emitted coal was about 0.03 mg.

Case 3. At the next step, we studied the process of coal dust emission from the model with two screens on the wagon. Model of this wagon is shown in Fig. 6a and results of the experiment are shown in Fig. 6b.

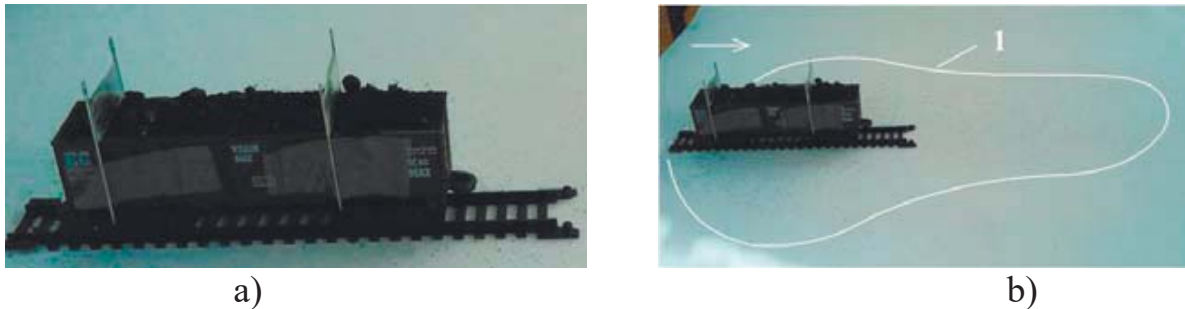


Fig. 6. a) Model of wagon with two screens;
b) Contaminated zone near wagon with two screens: 1 – contamination zone.

As we can see from Fig.6b, the contaminated zone is less than in basic Case 1. The contaminated zone is short. The form of the contaminated zone is like the “bottle”. Color of the contaminated zone indicates that the “light” fractions of the coal were emitted from the wagon. Mass of emitted coal was about 0.028 mg/s.

It is clear that the obtained results are the “pilot” ones but these results help to develop some strategy to reduce coal dust emission form wagons. Varying dimensions of screens, their position it is possible to reduce environment pollution near railways during coal transportation.

Conclusions. The obtained results show that installation of screens on the wagon allows to reduce emission rate of coal from the wagon. Implementation of screens is not expensive and installation of the screens does not take much time. Further investigations of this work will be directed to the development of CFD models to study the process of environmental pollution numerically.

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ABSTRACT

The results of the study, dedicated to the reducing emission rate of coal from the wagon, with using of small-scale experiments, which were performed for the model of the wagon, are presented.

The purpose of the study is evaluation of screens application for reduction of coal dust emission from the wagon.

The methods of the research are small-scale experiments.

Findings. The obtained results show that installation of screens on the wagon allows reducing emission rate of coal from the wagon.

The originality. New experiments have been performed to evaluate the efficiency of screen application for reduction of coal dust emission from the wagon.

Practical implications. Screen application on the wagon allows reducing coal dust emission from the wagon. Implementation of screens is not expensive and installation of the screens does not take much time.

Keywords: *dust, coal train, reducing air pollution*

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ЧИСЛЕННАЯ МОДЕЛЬ ДЛЯ ОЦЕНКИ ТЕРРИТОРИАЛЬНОГО РИСКА ПРИ ЭМИССИИ ХИМИЧЕСКОГО АГЕНТА В СЛУЧАЕ ЭКСТРЕМАЛЬНОЙ СИТУАЦИИ

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NUMERICAL MODEL FOR TERRITORIAL RISK ASSESSMENT IN THE CASE OF CHEMICAL AGENT EMISSION DURING ACCIDENT

Предложен экспресс метод оценки территориального риска при выбросе химического агента при экстремальной ситуации в условиях застройки. Выброс происходит вблизи зданий. Ставится задача разработки метода оценки территориального риска с учетом различных метеорологических ситуаций. Для оценки территориального риска используется разработанная численная модель. Приведено описание алгоритма решения задачи по оценке территориального риска при эмиссии химически опасного вещества при экстремальной ситуации. Представлены результаты вычислительного эксперимента.