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SURFACE WATER POLLUTED WITH PETROLEUM-DERIVATIVE SUBSTANCES IN PODLASIE REGION

ZANIECZYSZCZENIE WODY POWIERZCHNIOWEJ SUBSTANCJAMI ROPOPOCHODNYMI NA PODLASIU

Abstract: Subject of this work is to reveal the occurrence of petroleum-derivatives substances in surface water in Podlasie. Water samples were taken in test points localized on rivers cut by varied amount of traffic routes and roads with different surface quality. In water was determined: total suspension, COD_{Mn}, chlorides, sum of petroleum hydrocarbons, mineral oil index and lead.

The result of conducted research in water samples was content of petroleum-derivative substances expressed in mineral oil index and sum of hydrocarbons, lead and chlorides, high concentration of easily decomposable substances and variable suspension value. Presented material indicates problem's seriousness and proves necessity of making more.

Keywords: surface water, petroleum-derivative substances, motorization

The petroleum-derivative substances introduced into the environment origin mainly from motorization means, including private cars, city transport vehicles, cars for transporting products and services, city services, privileged, and agricultural vehicles. It is not possible to lower the number of these vehicles along with the industry, economics, and civilization development; worse – the number increases at a very fast rate.

Continuous increase of vehicles number, thus the traffic intensification, makes threats for large groups of people and natural environment growing [1]. A transit localization of Podlasie region (between Eurasian east and west) caused a road and rail transport more intensive, and in consequence, enhancing the risk of some threats. Due to insufficient road network or their insufficient technical parameters, Podlasie region is a bottleneck in a system of transit goods and passengers transport in this part of Europe. About 150 road and rail cisterns pass daily through the frontier crossings in Podlasie region. *International Road Transport* (TIR) and transport of dangerous materials, in

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practice is realized along all regional roads (7610 km in total) and is associated mainly with gasoline, diesel oil, and propane-butane supply to fuel distributors. About 1 200 000 Mg of dangerous substances (namely petroleum derivatives, although significant amounts of vinyl chloride and other more dangerous materials) are transported annually through Podlasie region roads.

Due to growing contamination of natural environment with petroleum-derivative hydrocarbons [1–4], it is necessary to consider the problem within frames of environmental and social medicine. The substances with recognized carcinogenic, neurotoxic, and embryotoxic properties, exert their influence on an organism not only suddenly, but also in chronic way, which is difficult to diagnose and prove. Most of hydrocarbons, after epoxidation or hydroxylation, is removed out of the organism through lungs. Unfortunately, some are accumulated in fat tissue and damage of internal organs can occur. Chronic exposure to petroleum-derivative contaminants (consumption of contaminated water and food) often leads to hormonal and hematopoietic processes [5].

The paper presents the status of petroleum and its derivatives contamination of selected surface waters. These results are a synthesis of author's own survey realized within frames of own research and available literature data.

Material and methods

Three rivers flowing through Podlasie region and localized as close to Bialystok as possible were selected to the survey. Water samples were collected from 10 points distributed on rivers: Suprasl, Narew, and Biala from September 2009 to February 2010. Two of these points were situated near busy streets of Bialystok (Kollataja and Produkcyjna Streets), other six – possibly close to high traffic roads near Bialystok, and other two – 1 km away from a road (national No. 8, 19, and 65, as well as regional No. 671 and 676) [6]. The water samples were collected in early autumn after heavy rainfall.

Collected water samples were subject to the following determinations: total sediments, COD_{Mn} (*chemical oxygen demand permanganate method*), chlorides, lead, sum of petroleum hydrocarbons and mineral oil index. All determinations were carried out in accordance with commonly accepted and recommended analytical procedures. Data presented in the paper are mean values from at least three replicates made simultaneously.

Results

Within seven years, total number of cars registered in Podlasie region increased by 50 % in relation to 2000. According to data of *System for Road Surface Assessment* (SOSN), about 12–13 % roads need to be renovated (ie being in very bad condition now) in Podlasie region (data for 2006–2007) [2, 4], while 62 % of national roads length in the region, are in good condition (Fig. 1).

Improvements of roads quality status cannot keep up with the increase of vehicles number, which in turn has negative consequences for the environment.

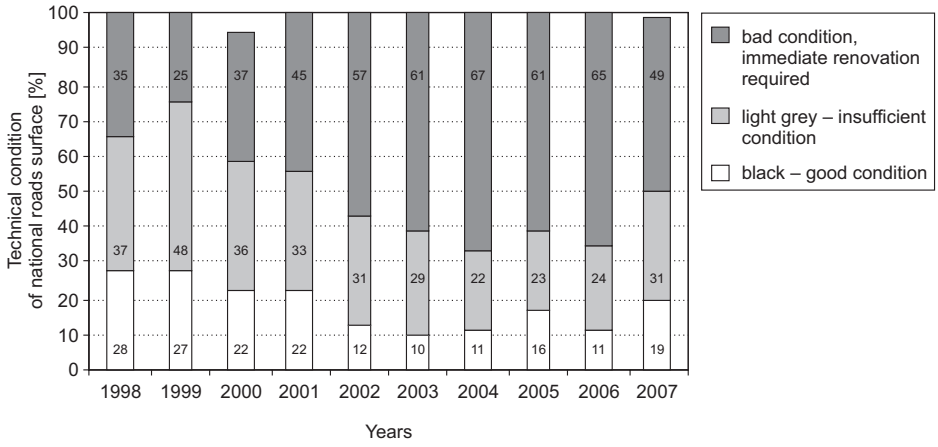

Fig. 1. Technical condition of national roads surface in Podlasie region in 1998–2007 according to SOSN

The largest amounts of mineral oils, 6.52 mg · dm^{-3} (Table 1), were determined in water sample No. 10 – Suprasl locality, Suprasl River. Such high level indicates the very bad technical status of mechanical vehicles, large traffic intensity, and poor road infrastructure. However, water in that river can be fast self-purified, because it contains large quantities of humus substances that increase the saturated hydrocarbons solubility about twice. Colloidal properties of humus substances imply that water pH and salinity changes may lead to their precipitation [1, 3].

Table 1

Quality of examined surface waters at selected sampling points (N = 10)

Sampling point									
1	2	3	4	5	6	7	8	9	10
Mineral oil index [mg · dm^{-3}]									
1.05	5.154	0.622	1.182	0.716	3.156	0.34	3.654	4.63	6.52
Lead [μg · dm^{-3}]									
24.01	39.6	20.22	21.39	21.39	26.8	20.67	37.14	34.88	26.8
Sum of petroleum-derivative hydrocarbons (C_6–C_{35}) [mg · dm^{-3}]									
0.02	0.14	0.02	0.01	0.01	0.11	0.05	0.07	0.09	0.12

Data presented in Table are mean values from three replicates; N – number of repetitions.

Samples No. 2, 6, 8, and 9 appeared to have high contents of mineral oils: oscillations ranged between 3.2 and 5.2 mg · dm^{-3}. All those samples were collected in places with high traffic intensity and dense infrastructure. Contents of mineral oils in other water samples ranged from 0.34 up to 1.2 mg · dm^{-3}. Points of those samples collection were much distant from high traffic and dense infrastructure. The examina-

tion revealed that about 70 % of samples, lead and petroleum-derivative hydrocarbons concentrations increased along with the increase of mineral oil index.

Determined concentrations of studied motorization contaminants indicates their migration into the surface waters, thus it should be supposed that their quantities are going to increase along with the traffic intensity rise [7, 8]. Despite of modern systems for collecting and purifying the rainfall water, there is a danger of environmental pollution during heavy and prolonged rainfalls, as well as during spring snow thawing, and penetrating contaminants into improperly sealed wells, melioration ditches, and sewage systems.

However, to counteract the contamination due to petroleum-derivatives, their quantities and behavior in water and soil environment should be recognized. Depending on physical properties of subsoil, contaminants flow along a surface or is infiltrated through the aeration zone into the water-carrying layer, and in consequence, it is adsorbed on rocky material, while the remaining part reaches the surface of a groundwater layer.

The technical condition of vehicles also considerably affects the scale of contaminants emission into the environment. The worse technical status of a vehicle, the more intensive negative effects on the environment it exerts. Unfortunately, facts referring to technical conditions of vehicles are alarming, because every third car driven over Polish roads is 16–30-years-old. About 300 000 new cars are sold annually in our country, while up to four times more used vehicles (about 1 200 000) are sold at the same period.

Among examined samples, the highest contents of suspensions (74 mg · dm^{-3}) were recorded in sample No. 1 – Fasty locality, Biala River (Fig. 2). The high content mainly resulted from the surface runoff from the road that is under bad technical condition and runoffs from adjacent cultivated fields, because the traffic intensity was quite low in that place. Point No. 7 – Bialystok, Produkcyjna Street, Biala River – was at the second rank in a view of suspensions amount. It is fairly crowded place in dense urbanized surroundings. The smallest suspension quantities were found at point No. 3 – Rzedziany, Narew River. Such low content of suspensions might result from a long distance to the road and low traffic intensity on a bridge that cuts the rivers. Other water

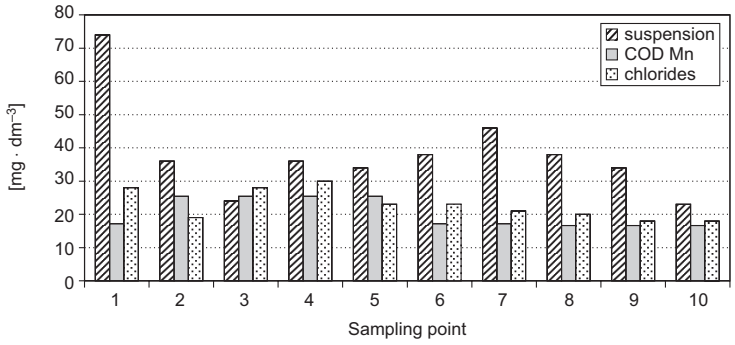

Fig. 2. Concentrations of some contaminants in studied water samples

samples revealed similar values of suspension contents within the range of 34–38 mg · dm^{-3}. Total suspensions originate mainly from the surface runoff from the infrastructure surrounding the road.

Discussion

Water from snow thawing, that flow out of the road surface in early spring, are contaminated very much, namely when the snow lies on the roadside for a longer time. Considerable contaminants accumulation occurs in a snow and ice, including large amounts of suspensions, lead, zinc, petroleum ether extractable substances (oils and other petroleum-derivative agents), and chlorides. High chlorides concentrations result from application the salt for slippery surfaces; hydrocarbons are not so easily decomposed in winter as during warm seasons, thus their contents can be also elevated. The largest runoffs of thawing snow water are present in spring with subsequent decrease till the complete snow and ice thawing [3, 4]. In the case of an excessive rainfall, light fractions of crude oil partially return to deeper layers or are washed out along with rain onto the ground surface and float on a water surface.

The water examining for COD_{Mn} values gives only the possibility to find out the readily-decomposable agents; however, if water contains petroleum-derivative substances, it would be reasonable to determine the COD_{Cr} (*chemical oxygen demand chromate method*) level, which is going to be made in nearest research.

Conclusion

Summing up, it can be concluded that the amounts of petroleum-derivative substances in surface waters of Podlasie region is significant what proves their migration from roads to surface water. Presented material only touches the problem and suggests the necessity of further and detailed studies upon that issue.

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ZANIECZYSZCZENIE WODY POWIERZCHNIOWEJ SUBSTANCJAMI ROPOPOCHODNYMI NA PODLASIU

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Abstrakt: Przedmiotem pracy są substancje ropopochodne w wodach powierzchniowych Podlasia. Próbki wody pobierano w punktach zlokalizowanych na rzekach przecinanych przez zróżnicowaną liczbę tras komunikacyjnych o kontrastowym natężeniu ruchu oraz trasy o różnej jakości nawierzchni. W wodzie oznaczano: zawiesinę ogólną, ChZT-Mn, chlorki, sumę węglowodorów ropopochodnych, indeks oleju mineralnego i ołów.

W wyniku przeprowadzonych badań w próbkach wody stwierdzono zawartość substancji ropopochodnych wyrażonych poprzez indeks oleju mineralnego i sumę węglowodorów, ołowiu i chlorków, duże stężenie substancji organicznych łatwo rozkładalnych i zmienną zawartość zawiesiny. Przedstawiony materiał sygnalizuje wagę problemu i dowodzi konieczności dalszych, szczegółowych badań w tym zakresie.

Słowa kluczowe: woda powierzchniowa, substancje ropopochodne, transport