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## NATURE CONTAMINATION WITH OIL SUBSTANCES USED AT FOREST MANAGEMENT

### ZANIECZYSZCZENIE ŚRODOWISKA SUBSTANCJAMI ROPOPOCHODNYMI UŻYWANYMI W CZASIE PRAC LEŚNYCH

**Summary:** The goal of this research is to assess the surface waters and soil contamination with oil substances and to determine biodegradability of the selected mineral oils. The mineral oils are the important indicators showing influence of forest wood management on ecosystem. We monitored some mineral oil leakages due to intensive machinery and truck exploitation after calamity in Protected Landscape Area - Biosphere Reserve Poľana. Oil substances were determined with extraction into the organic solvent and with measurements of infra-red spectra in the range of 2750-3150  $\text{cm}^{-1}$ . To complete surface waters monitoring, we also analysed soil and sediment samples. The most significant oil substances load was found in the locality of Stream Kamenistý, 78% of samples were over the permissible limit 0.1  $\text{mg/dm}^3$ . The soil near wood storages was also contaminated. We studied biodegradability of the typically mineral oils used in forest management. We found out that biodegradability of these products is in the range of 25-43%.

**Keywords:** oil substances, biodegradability, water contamination

The fundamental approach for the nature protection in the European Union is the implementation of two directives concerned with birds and biotopes, and creation of the protected area - Natura 2000. All associated EU candidate countries have been obliged to bring forward the list of protected species and biotopes; and to implement within two years suggested management precautions which should secure their protection. The usage in the forest mechanizations and trucks for felling, loading and haulage belong to the activities which results in small but long-term natural environment contamination caused by mineral oil substances.

Even though the negative effects of the mineral oil substances on water and forest ecosystem are generally known and studied most of all from the acute toxicity point of view [1, 2], less known are their long-term effects and changes which the mineral oil substances have on natural environment in time. The goal of this research is to assess the surface waters and soil contamination with oil substances and to determine biodegradability and toxicity of the selected mineral oils. We studied the mineral oil contamination in Poľana Biospheric reserve. This area was hit by a violent storm which caused the so-called "100 year" calamity. The disposal of the calamity consequences brought up another unwanted phenomenon, namely the environment contamination caused by the mineral oil substances which is connected with the utilization of used machineries and trucks.

### Material and methods

#### *Surface waters sampling*

Contamination of surface waters in Biosphere Reserve Poľana was monitored during the years 1997-2007. The mineral oil contamination mentioned above was monitored in

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profiles chosen according the places of forest intensive exploitation. Water samples were taken in as a point samples into fairly flushed glass bottles and processed next day.

### *Soil sampling*

Soil and shore sediment samples were taken from the depth of 20 cm. The average sample was prepared always from 3 sampling points and was treated according to the direction of methodology instructions for sampling and analysis of ground water and soil polluted by oil and chlorinated hydrocarbons [3].

### *Determination of oil substances*

Oil substances were determined by IR spectrophotometric method. The method is based on the extraction of oil substances from acidified water sample with Ledon 113 ( $\text{CCl}_2\text{FCClF}_2$ ), then the residual of polar substances is removed by adsorption on silica gel, the spectrum was recorded in the wave number range  $3150\div 2750\text{ cm}^{-1}$  characteristic for the CH groupings and in this way hydrocarbon component concentrations were determined [4].

By comparing concentration of biodegradable organic substances to the total concentration of organic substances it was possible to evaluate the biodegradability of selected petroleum products, the most commonly used in the forest management:

- 1) chain lubrication oil for chainsaw,
- 2) chainsaw fuel, oil - gasoline mixture,
- 3) used chain lubrication oil for chainsaw,
- 4) motor oil (madit super),
- 5) hydraulic oil used as a hydraulic fluid in the pumps.

## **Results**

### *Surface water*

In 1996 78% of studied samples exceeded the permissible limit ( $0.1\text{ mg}\cdot\text{dm}^{-3}$ ), in 1997 58% of samples exceeded it and in 1998 it was only 37% (Table 1).

Table 1  
Percentage expression of overrun the limit value  $0.1\text{ mg}\cdot\text{dm}^{-3}$  in profiles chosen in 1997

The name of the flow	Locality	[%] of samples exceeding the limit value ( $0.1\text{ mg}\cdot\text{dm}^{-3}$ )
Stream Kamenistý	under Sihla	0
Stream Kamenistý	below Sihla	88
Stream Slatinský	Kamenistá Valley	62
Stream Kamenistý	Klimentka	100
Stream Čierny	confluence with Stream Kamenistý	100
Stream Kamenistý	inflow into Water Reservoir Hronček	83

In 1999 the number of profiles monitored was significantly reduced, the contamination below the permissible level was found only in the locality of Stream Kamenistý and Osrblianka. The situation was strongly stabilised in 2000, when the increased values were

appeared only in Water Reservoir Hronček. On the base of spectral data we assume that the main part of oil substances belongs to motor crude oil and engine oil.

Nowadays we have found out that each more intensive forest felling caused oil contamination (Fig. 1).

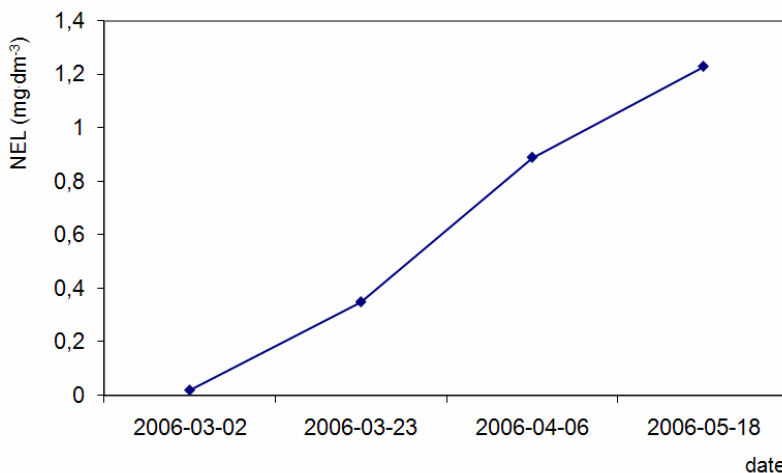


Fig. 1. Time dependence of nonpolar extractable substances (NES) concentration on the sampling site Čierny creek

Sampling site Čierny creek - timber felling since 15th March 2006 in the creek catchment area had a significant influence on the nonpolar extractable substances concentration increase in soil.

#### *Soil and sediments*

The most contaminated soil was that in the Predný - Osrblianka locality where after 24 hours 10 mg of oil substances per 1 kg of dry soil sample was determined. Around the 30 m from this place very close to the stream the value of oil substances concentration dropped to 7.3 mg·kg<sup>-1</sup> soil. Those values are relatively low, in natural conditions they decompose by oxidation and microorganisms activity, as long as oil substances are not close to the soil complex and have tendency getting into the waters during the long period with successive leaching.

#### *Biodegradation*

In recent years a microbial degradation of hydrocarbons is intensively studied worldwide. Microorganisms are capable of aerobic hydrocarbons degradation as well as anaerobic degradation. Aerobic conditions occur in most cases of natural microbiological degradation of water and soil contaminants.

Results in Table 2 indicate that used chain lubrication oil for chainsaw is least biodegradable and on the contrary, hydraulic oil used as a hydraulic fluid in the pumps is the most biodegradable from selected petroleum products.

Table 2

Biodegradation of selected petroleum products

Samples	Biodegradation ratio [%]
chain lubrication oil for chainsaw	40.05
used chain lubrication oil for chainsaw	25.30
chainsaw fuel, oil - gasoline mixture	41.72
hydraulic oil used as a hydraulic fluid in the pumps	43.20
madit super (motor oil) made by SLOVNAFT	36.38

## Conclusion

From the above presented data follows that in time of intensive exploitation of wood the contamination occurred in Biosphere Reserve Poľana with oil substances.

In conclusion it is possible to state that the approach to the wood exploitation and work management is necessary to change, because there is a danger of multiplying the damages in the environment. Using of naturally degrading oils, good technical condition of machineries and trucks and technology discipline has to be secured in such rare and valuable localities as Biosphere Reserve Poľana.

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## References

- [1] Srnský S.: Ochrana před úniky ropných látek. 1. vyd., Praha 1992, 5-15.
- [2] Kazantseva M.N., Gashev S.N., Soromotin A.V. and Rybin A.V.: Effect of crude oil on seed germination and development of seedlings of woody and herbaceous plants. Lesovedenie, 1993, 5, 64-68.
- [3] Mžp S.R. and Vúv H.: Metodické pokyny pre vzorkovanie a analýzy podzemných vôd a zemín znečistených ropnými a chlórovanými uhlíkovodíkmi. Bratislava 1995.
- [4] Horáková M. et al: Analytika vody. VŠCHT, Praha 2000, 253-258.

## ZANIECZYSZCZENIE ŚRODOWISKA SUBSTANCJAMI ROPOPOCHODNYMI UŻYWANYMI W CZASIE PRAC LEŚNYCH

**Streszczenie:** Celem tej pracy była ocena zanieczyszczenia wody i gleby substancjami ropopochodnymi, a także podatności niektórych z tych związków na biodegradację. Produkty ropopochodne są ważnym wskaźnikiem wpływu użytkowania zasobów leśnych na ten ekosystem. Monitorowano kilka polutantów wybranych ze względu na ich intensywne wycieki po awarii na obszarze parku krajobrazowego - Rezerwat Biosfery Pańana. Substancje ropopochodne były oznaczane, po wcześniejszym ich wyekstrahowaniu do rozpuszczalnika organicznego, na podstawie widma w podczerwieni w zakresie od 2750 do 3150  $\text{cm}^{-1}$ . Przebadano również próbki gleb i osadów dennych. Największe stężenia substancji ropopochodnych stwierdzono w miejscowości Strumień Kamenisty, w 78% próbek stężenia były większe od 0,1  $\text{mg}/\text{dm}^3$ . Gleba zebrana w pobliżu składów drewna była również zanieczyszczona. Zbadano podatność na biodegradację typowych substancji ropopochodnych używanych w trakcie eksploatacji lasu. Stwierdzono, że ich podatność na biodegradację wynosiła od 25 do 43%.

**Słowa kluczowe:** substancje ropopochodne, biodegradacja, zanieczyszczenie wody