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Retention Of Residual Chlorine By Green Infrastructure

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Water pollution by micro-pollutants such as chlorine and chlorine compounds is a new growing environmental challenge. Studies report increased surface waters' (rivers, lakes) pollution by residual chlorine up to 2-4 times in recent years (Chu et al., 2020; Sotirov, 2021). This is a consequence of intensive outdoor spaces disinfection by sodium hypochlorite (NaClO) in order to kill viruses and to avoid infections. After spaces disinfection residual chlorine remains on washed surfaces for the certain time and later is carried by runoff to the rivers and the lakes. The World Health Organization recommends sodium hypochlorite concentration of 1000 ppm (World Health Organization, 2020) for outdoor disinfection. However some countries have used higher concentrations for a faster effect. Research report residual chlorine impacts on stormwater pollution indicators (pH, conductivity, turbidity, color) and poses a risk to aquatic ecosystems, as well raises the surfaces corrosion (Valentukeviciene et. al., 2022; Zhang et al., 2022; Valentukeviciene et al., 2023; Bonin et al., 2020).

There is a lack of research on the treatment methods related to the reduction of residual chlorine concentrations in stormwater. Agenda 2030, Green Deal and Circular Economy declares to apply green solutions for retention of hazardous substances and micro-pollutants in stormwater (Oral et al., 2020). European Commission calls to reduce pollution at its source by Green infrastructure (GI) (European Commission, 2022). GI contributes to the sustainable stormwater treatment, mitigates climate change as well creates an attractive and green landscape (Tubridy, 2020; Meng et al., 2019; Li et al., 2019). GI by the help of the plants, soil, filtration and drainage layers absorbs pollutants present in stormwater. Therefore, it is very important to choose the proper materials for GI layers.

In order to find out the material which retains residual chlorine the most efficiently and which could be used as filtration layer in GI have been tested different low cost, local materials: peat soil, wood chips, sawdust. The results reported the retention of residual chlorine depends on following materials' characteristics: its structure, particle size, pore dimensions and pore volume as well on the contact time of tested material and residual chlorine. The transfer coefficients' values of tested materials are presented in the table 1.

Table 1. The transfer coefficients of residual chlorine.

Residual chlorine	Material	Concentration' limits ($mg \cdot dm^{-3}$)	$D_{ef.} \cdot 10^6, cm^2 s^{-1}$
Cl^-	Peat soil	5-25	0.19
Cl^-	Wood chips	5-25	0.30
Cl^-	Sawdust	5-25	0.40

Experiments revealed the different capacities of tested materials to retain residual chlorine in stormwater (Table 1). The best efficiency to transfer residual chlorine has resulted the sawdust. After laboratory testing of different types ceramzite's type to retain residual chlorine was determined about 20 – 70 % the retention capacity. Research present the retention efficiency of residual chlorine in stormwater also depends on the composition of soil substrate, plants species and top layer (mulch). Vegetation and soil structure are important of

their abilities to retain runoff and absorb pollutants, as well mulch layer regulates humidity and protect soil from weeds (El-Beltagi et al., 2021). All these parameters should be evaluated before designing green infrastructure.

Research report stormwater treatment is necessary to protect water bodies from the enter of residual chlorine after outdoor spaces disinfection. Following Green deal policy and the requirements for sustainable stormwater treatment is recommended to use the local, recycled materials for filtration and drainage layers in green infrastructure based on phytoremediation processes to remove the chlorine and chlorine compounds. In this regard the future research should be focused on the field experiments installing test green infrastructure in selected area in order to evaluate GI efficiency to retain residual chlorine in stormwater before its release to water bodies.

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