Acta Montanistica Slovaca Ročník **17**(2012), číslo 4, 336-340

Influence of chemical sprinkle on the processes in activated tank of wastewater treatment

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The research deals with processes occurring in the activation tank during the snow-melt inflow of chemical component of road salt. Chemical composition of the suspension in the activation tank is changing following the metabolism of organisms and chemical composition of the influent wastewater. Sludge and wastewater in nitrification tail of the activation tank has higher conductivity, higher contents of chloride, higher sludge index and other characteristics are changing during snow – melt. The amount of the inflow road salt is a determining factor of lyses of microorganism cells.

Key words*: nitrification, conductivity,* $N - NH_4^+$*,* *$MgCl_2$, Na^+, road salt, temperature*

Introduction

Thaw is a moderate snow-melt during tepefy, when the temperature of air rises above 0 °C and water changes its state from solid to liquid.

During snow–melt, bigger amount of cold wastewater flows in wastewater treatment from the sludge. The inflowing cold wastewater is changed by the chemical components of the road salt and nitrificants. Consequently the microorganisms in the biological stage of wastewater treatment are subcooled.

Winter road maintainance

Winter road maintenance is using salt and sand mixtures with chemical matter or moisture innert matter (sand). Maximum sprinkle amount is 500 g m^{-2}.

As chemical the following materials are used:

- sodium chloride NaCl,
- calcium chloride $CaCl_2$,
- mixture of sodium chloride and calcium chloride,
- soladin (industrial name),
- tonacal (industrial name),
- urea (carbanit).

Totall amount of chemical deicing agents matter used in winter season must not exceed 2 kg m^{-2} by number of maintainance days up to 100. Total deicers batch in a town [1] is 100 g m^{-2} and it depends on the actual local climatical condition. Sand sprayer is equipped by moistener with batching control of spreading solid mixture, which garantees balanced deicing in all width of sprinkle. Moisture solid is prepared from NaCl and in protected water areas it is prepared from $CaCl_2$, or other chemicals that unload the environment [2]. During spring snow melt soluble deicing from road runs off into sewages of towns and villages, into underground water and water bodies, causing changes of chemical composition [4].

Today, chemical deicers of $MgCl_2$ mixture is tested with inert Ekosprinkle, which is a winter deicing mixture from natural zeolite [3] or with Biomag and Solmag, that are industrial deicing mixtures based on $MgCl_2$.

Road salt based on NaCl is used. It is a mixture of rock salt and industrial road salt that originate salt mines in Prešov (Slovakia), Belorussia and the Ukraine.

Chemical from compound of road salt is hygroscopic and ferrokyanide potassium is added as an antiagglomerate agent.

Deicing on road splashes from the automobile wheels and contaminates the area of 3 to 5 m away from the roadway.

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In biological stage of wastewater treatment the nitrification is slowed down, or even stopped, depending on the amount of chemical compound of road sprinkle that flows into the activated tank of wastewater treatment.

Biological stage of wastewater treatment

The salt from the road in-flow in the sewage and in the activated tank influences the increased conductivity in the tank. Conductivity is measured on the outflow from the wastewater treatment and these values are valid for all treatment process.

It also causes an increase in ammonia nitrogen $N-NH_4^+$ which is a signal of worsening of the conditions of nitrificants metabolism. The first thaw of winter 2008/09 was in November (Fig. 1).

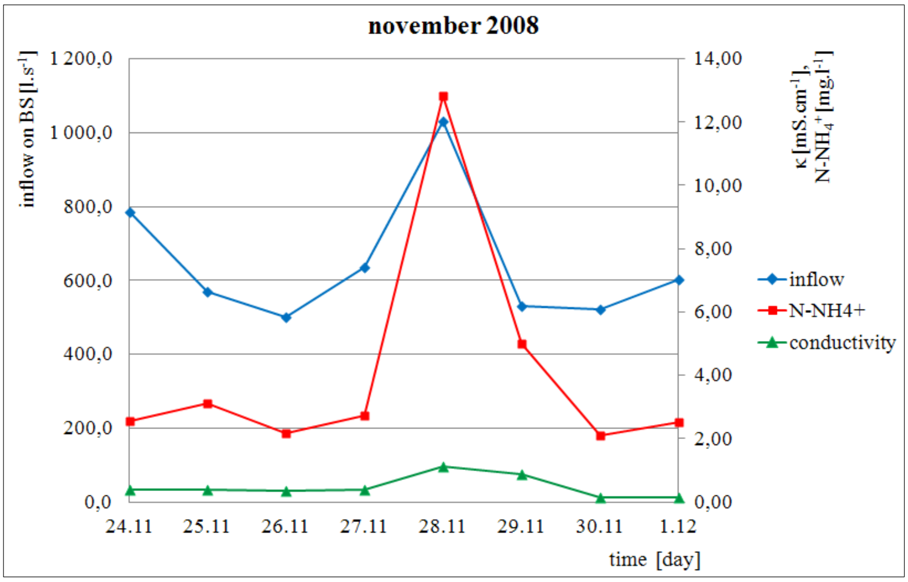

Fig. 1. Dependence of inflow, NH_4^+ amount and conductivtity of the sludge in the activated tank on time during the first snow-melt in november 2008.

The values of *pH* in activated tank are kept in the range required, they have no influence on nitrification.

The size of the activated tank is 26 210 m^3 and the time of stay is 7.55 hour. A total renovation of the suspension of the activated tank occures in average of 10 days depending on the in-flow in the activated tank. During snow-melt the flow of wastewater into the sewage is increased, which causes a reduction of detention time of wastewater in the activated tank. Nitrificants are undercooled and egested from the tank by inereased inflow.

Material and methods

During three terms of snow-melt one litre of sample of suspension from the activated tank per day was collected. From the samples *BOD*, *COD*, magnesium Mg^{2+}, sodium Na^+, total chloride Cl^-, sludge index (SI) were measured. *T* - temperature and *κ* - conductivity was also measured.

T and *κ* were measured using Hanna Combo HI98130. *COD* was etimated by dichromate method from filtered sample of 20 ml. *BOD* was provided by oximeter Oxi 538. Amount of Na^+ ions was measured from filtered samples by AAS. Amount of Mg^{2+} ions was provided by chelatometric titration. Amount of Cl^- ions was provided by argentometric titration [5].

Results and discussion

Magnesium was provided because $MgCl_2$ is used for the pedestrian zone in the city of Košice. Concentration of Mg^{2+} decreased daily because the air temperature rose and there is no connection to the sprinkle of road salt. Magnesium is an element that is necessary for the microorganisms in the tank.

The first monitored snow-melt was in 2008. Autum values of chloride, sodium, and magnesium, shown in Tab.. 1, are the highest during the second day when the snow melt and chemical road salt flow with sewage into wastewater treatment (Fig. 2, 3, 4).

Tab. 1. Values measured during three snow-melts.

Date	**T** [°C]	**Mg^{2+}** [mg.l^{-1}]	**Cl^-** [mg.l^{-1}]	**Na^+** [mg.l^{-1}]
25. XI. 2008	13.9	0.024	0.080	0.0015
26. XI. 2008	13.8	0.053	0.130	0.0020
27. XI. 2008	13.9	0.045	0.094	0.0015
28. XI. 2008	13.9	0.021	0.074	0.0014
29. XI. 2008	13.9	0.007	0.069	0.0014
15. I. 2009	15.0	0.056	0.055	0.0016
16. I. 2009	15.6	0.026	0.147	0.0025
17. I. 2009	14.9	0.040	0.137	0.0012
20. I. 2009	14.3	0.038	0.130	0.0023
21. I. 2009	13.8	0.118	0.172	0.0027
22. I. 2009	15.0	0.018	0.152	0.0022

In the fig. 2 κ of the suspension from the activation tank and the values of Cl^-concentration are presented.

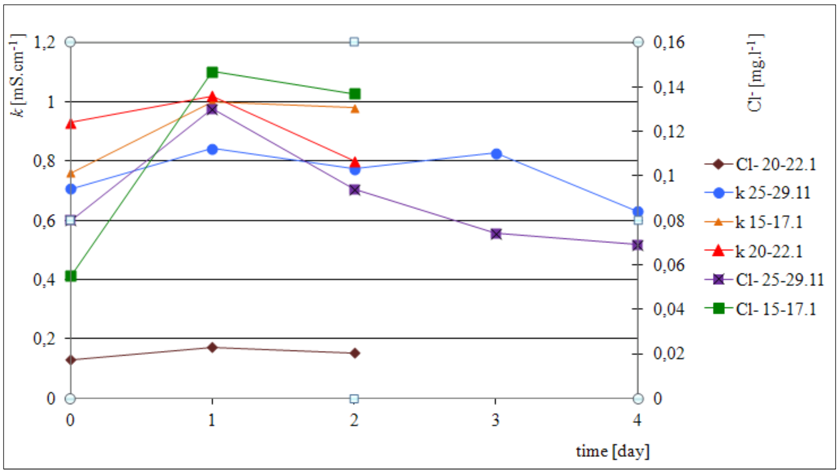

Fig. 2. Dependence of conductivity and concentration of Cl^- ions on time.

The values of *COD* decrease slighly in January but they are seatlered in November because of the influence of the antiagglomeration component (ferrocyanide potassium $K_4[Fe(CN)_6]$) which is an integral chemical component of the road salt (Fig. 3).

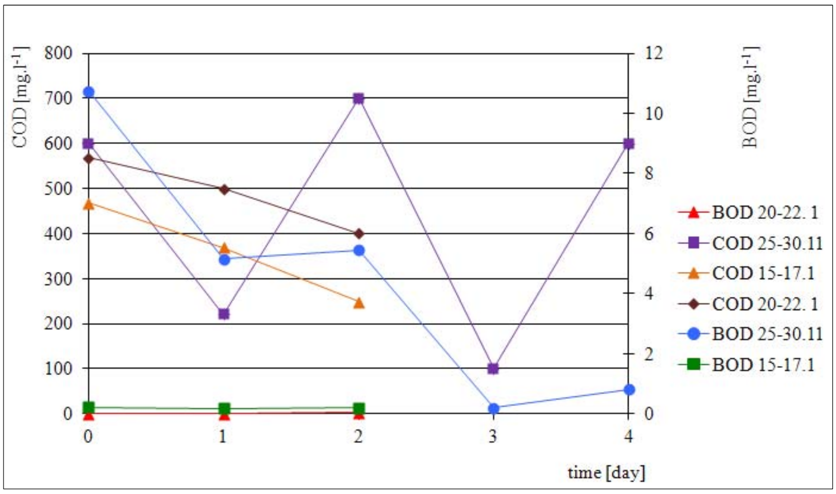

Fig. 3. Dependence of BOD and COD on snow-melt in 2008-2009.

Based on the fig. 4 it is possible to notice the connection between the amount of sodium and the conductivity in the samples. Concentration of sodium rises with increase of conductivity but there is no continual proportion between them. Conductivity of the samples represent the measured total salinity of the sample from activated tank during snow-melt. Total salinity included the influences of presence Na^+ and other ions dissociated in the inflow wastewater and in suspension from the activated tank.

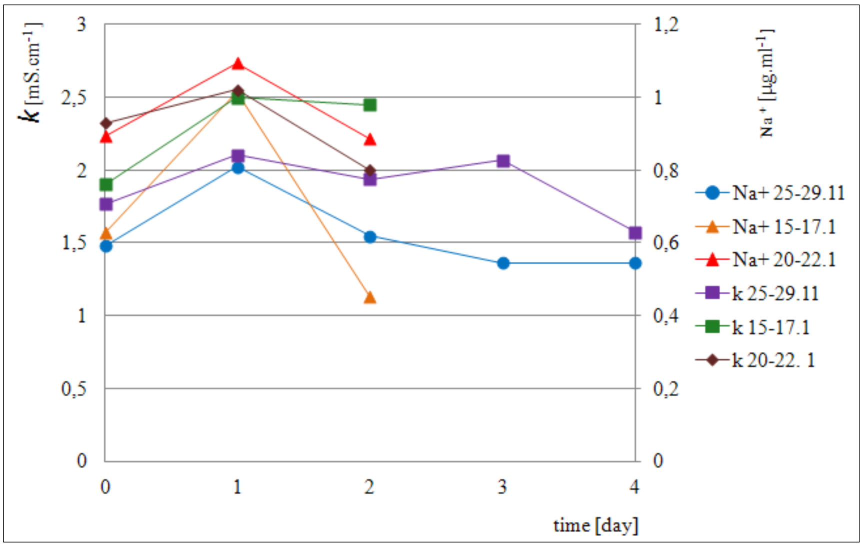

Fig. 4. Dependence of Na^+ concentration and κ on time.

Tab. 2. Sludge index during single days.

Date	**Solid-liquid interface** [ml]	**SI** [$ml.g^{-1}$]
25. XI	960	197
26. XI	1000	129
27. XI	975	86
28. XI	975	74
29. XI	860	87
15. I	960	236
16. I	970	201
17. I	980	184
20. I	970	163
21. I	968	178
22. I	950	147

From the volume of sludge in graduated cylinder after half an hour of sedimentation temporary deflocculation [5, 8] can be deducted. Increased contents of salt influence the temporary deflocculation. Values of sludge index of suspension show soft decline of sludge sedimentation because the mixture of classical sprinkle salt influences the sedimentation of sludge (Tab. 2).

Observation of influence of road salt mixture

Winter road maintainance with chemical sprinkle in the town of Košice is made on the streets with local public transportation and on the main streets. According to the map of local public transportation [6] the main street is 1/49 part of this map. On the main street there is winter road maintenance with chemical sprinkle of $MgCl_2$. Other streets are salted with rock salt (RS) and industrial salt (IS) [7]. Both salt types are based on NaCl but industrial salt is with anticlinker ingredient ferrocyanidepotassium.

Amount of test mixture was $0{,}5\ g.l^{-1} = 0{,}0102\ g.l^{-1}\ MgCl_2 + 0{,}2449\ g.l^{-1}$ RS $+0{,}2449\ g.l^{-1}$ IS.

Mixture of road salt was provided in this proportion.

The maximum value of κ of suspension from activated tank during three recorded snow-melts was on the second day. From the grafic analysis of conductivity of individual concentrations of the mixture approximate concentration of salts that flow in activated tank wastewater treatment during this three snow-melt was estimated (Tab. 3).

Tab. 3. Dependence of conductivity on concentration of mixture road salt.

Snow-melt	κ [mS.cm^{-1}]	Concentration of mixture [g.l^{-1}]
without salt	0.4 – 0.8	-
25-30. November	0.842	0.1
15-17. January	1	0.25
20-22. January	1.02	0.25

Conclusion

From the observation of influence of three snow-melts in winter 2008/09 in Košice on the processes in the activation tank of wastewater treatment it could be stated, that:

- the temperature a little decreased,
- the amount of total chloride increased,
- the conductivity increased,
- the concentration of sodium increased,
- dayly inflow on biological stage increased.

Recorded values of conductivity correspond to concentrations 0.1 to 0.25 g.l^{-1} of road salt mixture.

Acknowledgement: *This work was supported by the Scientific Grant Agency of the Ministry of Education of Slovak Republic under the grant VEGA 1/0590/11. This work was supported by the Slovak Research and Development Agency under the contract No. APVV-0068-07.*

References

[1] Predpokladané spotreby základných materiálov počas zimnej údržby ciest, Správa a údržba ciest Prešovského samosprávneho kraja. www.vucpo.sk/.../71ac7ef38aa10d4cc12571e00025c502/$FILE/Komplexna%20analyza%20zimnej%20udrzby%20ciest.pdf *20. 6. 2007.*
[2] Technológie zimnej údržby na ďiaľniciach a rýchlostných cestách vo vlastníctve NDS. www.ssc.sk/user/view_page.php?page_id=448 - 20k . *16. 6. 2007.*
[3] Pietriková, M. Búgel, M. Neubauer: Silniční obzor. *66. 10/2005. 263.*
[4] J. Růžičková, I. Hlásenský, L. Benešová, L. Piskáčková, I. Očásková: Chemizmus vody v lotických ekosystémech povodí Vydry a Křemelné (NP Šumava), *Limnologické noviny* ***1*** *(2008), www.cas.cz/c/s/kouty/kouty5.pdf 26. 5. 2008.*
[5] M. Horáková, P. Lischke, A. Grünwald: Chemické a fyzikální metody analýzy vod, *SNTL Praha, 1986.*
[6] Mapa Košice, http://www.cassovia.sk/dpmk/trace/, 12. 2. 2009.
[7] Ponuka priemyselných solí, www.nelux.sk, 20. 1. 2009.
[8] Výskumný ústav vodného hospodárstva Bratislava: Inhibičné a toxické vplyvy na proces čistenia odpadových vôd, 2, 2, (2000).