# ICUD-0539 Removal of small particles from urban snow melt mixture by coagulation/flocculation and sedimentation

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## Summary

This abstract presents a laboratory study of a coagulation/flocculation process on an urban snow melt mixture. Coagulation/flocculation is ubiquitous in water treatment, but has seen little use in the stormwater context. Using a jar-test procedure five different chemicals are evaluated as primary coagulants and their treatment performance on urban snow melt with respect to solids removal and metal content. Particle-size distribution measurements will indicate the process effect on different size fractions in the urban snow melt. Analysis for metal content will show the extent of metal reduction that occurs, either by separating out the particulate fraction or due to precipitation reactions.

## Keywords

particle separation, coagulation, flocculation, sedimentation, metal removal, particle size distribution

## Introduction

New innovative stormwater treatment methods are highlighted as an area in need of further research in terms of both performance and cost-benefit perspective (Meland, 2016). Traditional Best Management Practices (BMPs), such as retention basins, primarily aim at retaining stormwater flows, but treatment also occurs through sedimentation. An inherent weakness of retention basins is the physical inability of finer (<20 µm) particles to readily sediment during the retention period. Thus, these particles are at risk of being discharged into the receiving waters. These particle fractions are important to include as a treatment target since they expose a large surface area where pollutants can be adsorbed.

Chemical treatment or coagulation/flocculation (C/F) is a well-studied unit process used in water treatment with ability to destabilize the colloidal fraction and cause it to sediment due to flocculation (Bratby, 2016). However, only in a few studies chemical treatment for stormwater has been investigated (Kang, Li, et al., 2007; Sansalone and Kim, 2008), but with promising results. This underscores the need for further research of C/F and its performance as a unit process in stormwater treatment.

This laboratory study will investigate C/F in urban snow melt, and compare process performance (solids and metal removal) with process characteristics (coagulant concentration, pH, alkalinity and conductivity). These results, taken together, will provide essential information about C/F in the context of treatment of snowmelt and stormwater.

## Methods and Materials

Five chemicals (PIX-111, PAX-215, PAX-XL360, plus Alum and Chitosan), will be used as primary coagulants in a jar test of a turbid urban snow melt mixture. PIX-111, PAX- 215, PAX-XL360 were provided by Kemira. PIX-111 is an iron chloride, PAX-215 is a pre-hydrolyzed aluminum chloride, PAX-XL360 is a pre-hydrolyzed aluminum chloride with an organic polymer combined, alum is the traditional aluminum sulphate coagulant and chitosan is a cationic polysaccharide obtained through the deacetylation of chitin, the shell harvested from crustaceans.

The snow melt mixture used in the jar tests comprised of traffic-exposed snow collected along a road (>15 000 annual average daily traffic) in the city of Luleå, northern Sweden; mixed with equal volume pristine snow. Coarse particles were removed by a one hour sedimentation. The resulting snow mixture was subjected to a battery of tests and analyzed for pH, alkalinity, total suspended solids (TSS), turbidity, conductivity, particle-size distribution (PSD), TOC, DOC and metal content.

A standard jar-test procedure was performed for each coagulant. The coagulant was dispersed during the initial rapid mixing phase for 60 sec at 200 rpm. This was followed by a slow mixing phase for 15 min at 30 rpm to promote floc aggregation. Lastly, a 30 min sedimentation phase allowed formed flocs to settle. The water column was transferred to a new beaker and same test battery performed on the untreated snow melt mixture was repeated on the treated snow melt mixture, excluding TOC, DOC and metal content measurements which are only done for the concentration point with the greatest turbidity reduction.

## Results and Discussion

Preliminary results (reported as mean±SD, or a range) show that the urban snow melt mixture exhibits a high turbidity (1079±303 NTU) and TSS (705±157 mg/l), a slightly basic pH (7.3-8.9) and moderate buffering capacity (34.6±9.6 mg/l as $CaCO_3$). The one hour sedimentation, the mixture underwent, shifted the particle size distribution from colloid- and clay-sized (1-10 µm) fraction to a predominantly colloid-sized (0.1-2.0 µm) fraction.

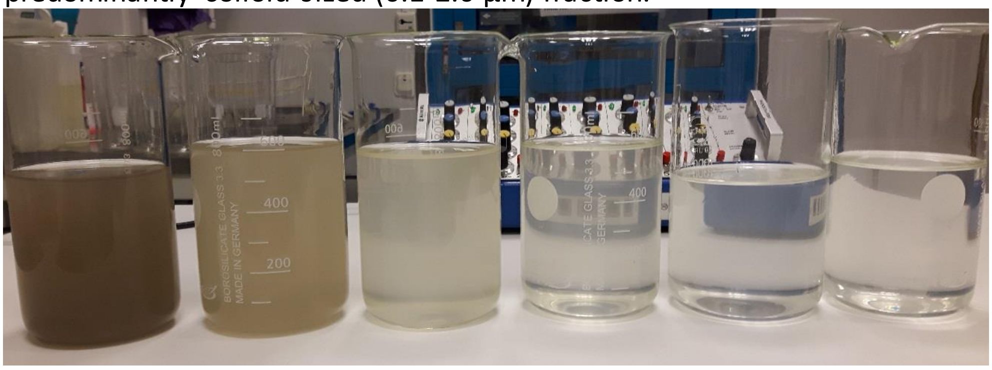

***Fig. 1.*** *Left-most beaker contains untreated urban snow melt mixture. The following beakers have been treated with an increasing concentration of PAX-215.*

Furthermore, initial results show turbidity reduction rates were 95-99%, with good water clarification (Fig. 1). PIX-111 reduced turbidity the most, by 2.2 log10 units (>99%), resulting in a clarified snow melt with a residual turbidity of 4.7 NTU (Fig. 2). Overall, the results indicate promising treatment potential. Further data outlined in materials and methods, such as process characteristics (PSD, conductivity, pH, alkalinity) and pollutant removal (TSS, turbidity, metals), will be obtained and analyzed during spring of 2017.

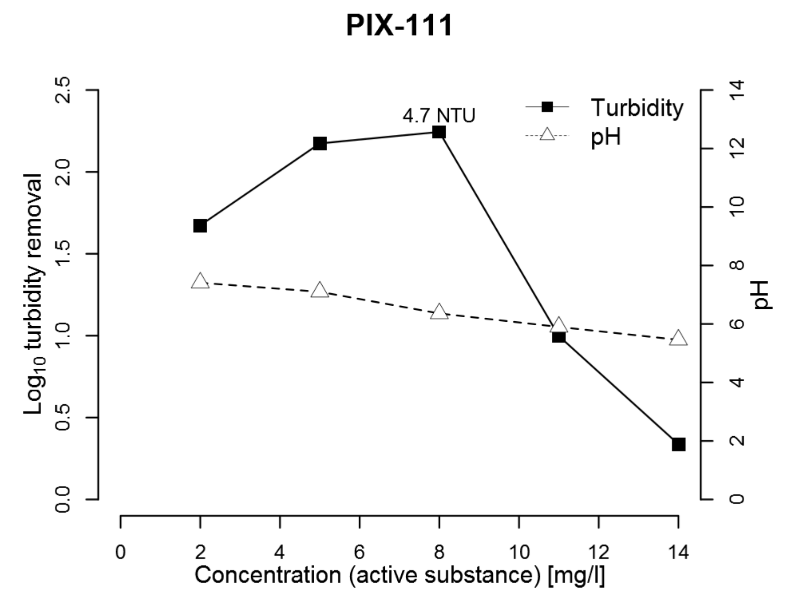


***Fig. 2.*** *Turbidity log-removal and pH in the snow melt mixture after C/F using PIX-111, an iron chloride coagulant. The residual turbidity for the concentration that yielded the highest turbidity removal is indicated.*

## Conclusions

- A panel of different coagulants will be evaluated in laboratory scale on an urban snowmelt mixture with regards to removal efficiency of particles (TSS, turbidity and PSD) and metal content. In addition measurements of pH, alkalinity and conductivity will provide information on the coagulation/flocculation process characteristics for the coagulants.
- Results obtained will provide information for the treatment performance of a coagulation/flocculation technique in the stormwater context.

## Acknowledgement

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