University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

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BSc (Jiangsu University of Technology, 2015)

# "The Application of Whole Oyster Shells in Stormwater Treatment Removing Heavy Metals"

Department of Mechanical Engineering

Wednesday, August 1, 2018
1:00 P.M.
Engineering Office Wing
Room 502

Supervisory Committee:
Dr. Caterina Valeo, Department of Mechanical Engineering, University of Victoria (Supervisor)
Dr. Rodney Herring, Department of Mechanical Engineering, UVic (Member)

External Examiner:
Dr. Angus Chu, Civil Engineering, University of Calgary

Chair of Oral Examination:
Dr. Francis Nano, Department of Biochemistry and Microbiology, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

## Abstract

Oyster shells are normally applied in wastewater treatment in the form of powder, but the possibility of whole oyster shells removing metal ions in stormwater has not been investigated. The objectives of this research are to assess the application of whole oyster shells for removing metals in low concentration solutions and to explore the following factors: surface area of shells, initial concentration and exposure time, for their influence on removal efficiency.

Experimental results demonstrated very good removal efficiency by oyster shells for removing copper, followed by cadmium and zinc; but was not effective in hexavalent chromium removal. Up to 70% removal can be reached in just one hour for copper with initial concentrations of 0.2ppm and 550cm2 surface area of shells in a beaker experiment treating two-liter solutions (with an accompanying PH increase from 5 to 6.42). A removal efficiency (RE) of 57.7% and 33.3% was found for cadmium and zinc, respectively, with one day contact using shells of 300cm2 surface area treating one liter of the lowest concentration solution; while only 14.3% was achieved for chromium under the same conditions. Mid-scale experiments with continuous inflow based on the 6-hour Saanich Design Storm demonstrated an 85.5% and an 83.9% RE of cadmium and copper in one day's worth of contact time. There was no removal but in fact an increase in chromium and zinc was found for the mid-scale experiment.

There was a positive relationship between initial concentration (IC) and removal efficiency for copper and zinc, but a negative relationship for chromium, while no relationship was found for cadmium. Up to 80% of copper can be removed at IC of 2.4ppm compared to 60% with IC of 0.65ppm with same amount of shells (by surface area). RE of 70%, 75% and 83% was observed for IC of 0.3ppm, 0.58ppm and 1.07ppm for zinc, respectively with 154 cm2 shell surface area (SA). When IC of chromium is reduced from 1 ppm to 0.2ppm, RE tends to drop from 60% to 26%. There was also a positive relationship between SA and RE, and ET and RE. However, after a certain exposure time, increase in RE was negligible and sometimes, desorption would occur. Additionally, when the difference in surface area is small, the influence of the factor on RE was also small. When treating certain amounts of sample solution, the effect of surface area over a range on RE is hard to distinguish. Moreover, the role of HRT in stormwater systems was not clearly found.