Circular Ocean
ChemHack solution
July 2017

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Environmental Research Institute
North Highland College

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Circular Ocean #ChemHack

Towards a solution to remove anti-foulants from waste fishing nets

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Northern Periphery and Arctic Programme 2014–2020

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Circular Ocean

In pursuit of innovative and sustainable solutions for marine plastic waste, the Circular Ocean project seeks to inspire enterprises and entrepreneurs to realise the hidden opportunities of discarded fishing nets and ropes in the Northern Periphery & Arctic (NPA) region.

As increasing levels of marine litter is particularly pertinent to the NPA region, the Circular Ocean project will act as a catalyst to motivate and empower remote communities to develop sustainable and green business opportunities that will enhance income generation and retention within local regions.

Through transnational collaboration and eco-innovation, Circular Ocean will develop, share and test new sustainable solutions to incentivise the collection and reprocessing of discarded fishing nets and assist the movement towards a more circular economy.

Circular Ocean is led by the Environmental Research Institute, (Scotland, www.eri.ac.uk), and is funded under the European Regional Development Fund (ERDF) Interreg VB Northern Periphery and Arctic (NPA) Programme http://www.interreg-npa.eu. It has partners in Ireland (Macroom E www.macroom-e.com), England (The Centre for Sustainable Design www.cfsd.org.uk), Greenland (Arctic Technology Centre www.artek.byg.dtu.dk), and Norway (Norwegian University of Science and Technology www.ntnu.edu).

Introduction

The #ChemHack Challenge took place as part of the 17th European Meeting on Environmental Chemistry (EMEC17) on 29th November 2016, organised by the Environmental Research Institute (ERI), North Highland College, part of the University of the Highlands and Islands (UHI). The aim of the #ChemHack Challenge was to develop innovative solutions to ‘end of life’ problems associated with contaminated fishing nets and ropes (FNRs), specifically:

- Washing processes to remove anti-foulants and other chemical compounds impregnated into nylon fishing nets and ropes (FNRs) and cages
- Processes to decontaminate the waste water arising from the washing process
- Processes to extract copper compounds from FNRs and cages for metals recycling

The background to the #ChemHack Challenge is that anti-foulants are impregnated in FNRs and cages to protect and extend the life of those that equipment. However these chemical treatments make the recycling of FNRs and cages problematic at the “end of life” stage.

> *“The unique #ChemHack event was a wonderful opportunity to bring together world-class expertise to help solve a practice and pressing issue. As a special session at the EMEC17 conference, Circular Ocean’s #ChemHack was able to focus the minds of environmental chemists, and tap into their knowledge and extensive experience*”
> Dr Neil James, Project Coordinator, Circular Ocean and Senior Researcher, ERI, UHC, Scotland

The #ChemHack Challenge provided a platform for participants to think, develop and co-create eco-innovative solutions to the aforementioned challenges faced by the fishing industry. The workshop included doctoral, post-doctoral and senior environmental chemists from the ERI and other international institutes. The Challenge(s) associated with contaminated FNRCs and cages were introduced to the participants and groups were established and provided with a selection of FNRs impregnated with anti-foulants. Delegates were then led through a number of creative processes which ultimately resulted in two potentially viable solutions. The report draws out the overall conclusions from the process.

> "*The #ChemHack was a very useful and enjoyable exercise, bringing together the ideas of people from different backgrounds, to collectively think of solutions to a problem – the washing of anti-foulants from FNRs*"
> Paul Gaffney, Environmental Chemist and #ChemHack participant

The #ChemHack Challenge was devised and facilitated by Professor Martin Charter from The Centre for Sustainable Design ® at University for the Creative Arts and built on his unique GreenThink programme that enables co-creation of sustainable solutions.

The Challenge

1. To consider and develop washing process(es) to remove anti-foulant impregnated into or coated onto the nylon and nylon 6 (and possibly other polymers) the fishing nets and ropes (FNRs)
2. To consider and design physical washing equipment to wash out the anti-foulant impregnated into or coated onto the polymers in the FNRs
3. To consider whether washing would be more effective if the FNRs are cut into strands or bundled together prior to washing?
4. To develop a process(es) to de-contaminant the wastewater arising from the washing process
5. To consider, evaluate and/or develop processes to extract copper compounds from FNRs for metals recycling

The Solution

Questions 1 to 3

The consensus between the groups was that a washing process to remove wax and copper should be feasible. The simplest treatment could be washing the FNRs with hot water and detergent. However, if more severe conditions were required, such as using solvents, this would give rise to additional engineering and environmental issues (removal and recycling of the solvent). It was thought that for whole FNRs the washing equipment could be based on that used in the textile dying industry. These are typically large cylinders in which long pieces of material are cleaned and dyed, Figure 1. These are able to operate at high temperatures and can cope with moderately corrosive chemicals. If the FNRs were to be cut into smaller pieces then a more conventional stirred reactor could be used

Figure 1. A. Schematic of a textile dying machine showing the route of the fabric through the equipment, B. Textile dying machine, C. Stirred tank reactor.

Question 4

The water arising from the washing process is likely to contain wax as the major contaminant along with detergent and other contaminants in smaller quantities. This waste could be treated in a conventional wastewater treatment plant. An initial settling tank followed by some sort of primary treatment involving flocculation and settlement would probably remove most of contamination. It may even be possible to recycle the wax material if it settles out in the primary settling tank.

Question 5

Copper, like other metals, can be removed from wastewater using ion exchange resins. These resins are however expensive. A more environmentally friendly approach, which has been shown to be effective in removing copper from wastewater, is biosorption. In biosorption low coast biosorbents , usually derived from agricultural residues or waste materials, are packed into columns and the wastewater is passed though these columns as part of the water treatment process. For example crab shell and spent grain from distilleries have been shown to effectively remove copper from distillery wastewater. The copper can then be recovered from the biosorbent or it could even be applied to agricultural land deficient in copper.

The over process envisaged for washing FNRs and subsequent treatment of the wastewater is shown in Figure 2.

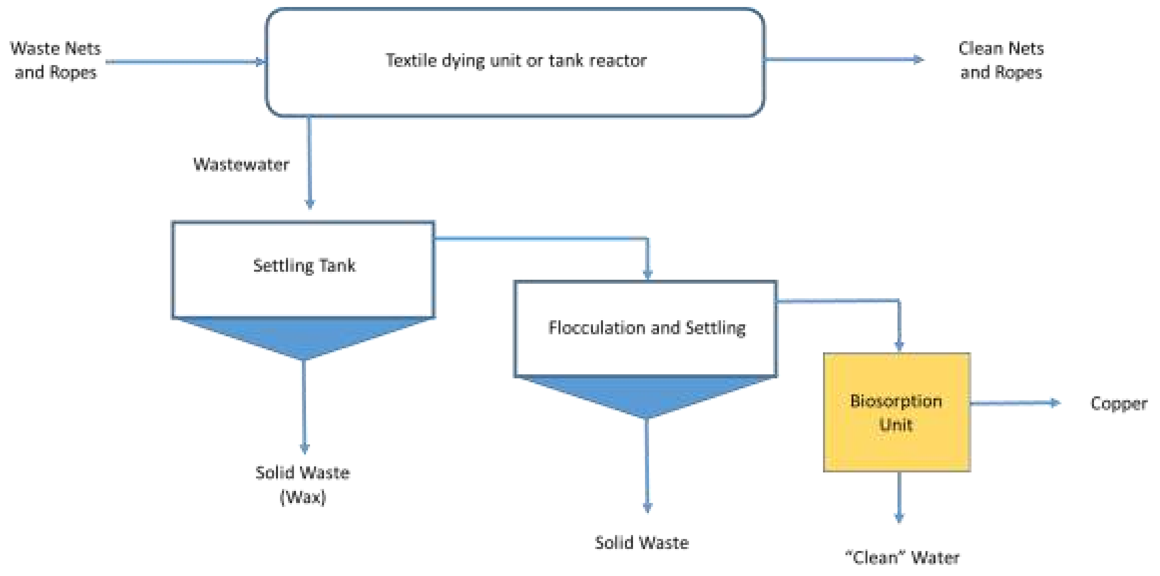

Figure 2. Schematic of proposed plant for cleaning FNRs and treating the wastewater that is produced.

Summary and Issues

The development of a process for cleaning the FNRs should be feasible based on currently available technology. However there are still likely to be technical issues that have to be overcome with respect to using FNRs in the process. Treatment of the waste streams will be specific to this process and is therefore not easy to evaluate. Waste streams would need to be fully characterised and comply with any discharge consents.

Questions which need to be answered include:

- How much will this cost?
- How much wax and copper are present in the FNRs?
- Is there a market for the wax if it is separated from the wastewater?

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