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**REMOVAL OF COPPER, CHROMIUM AND ARSENIC FROM THE
TANNERY AND TIMBER TREATMENT EFFLUENTS AND
REMEDIATION OF CHROMIUM CONTAMINATED SOIL**

**A thesis presented in partial fulfillment
of the requirements for the degree
of Master of Applied Science
at Massey University**



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Dedicated to
My Beloved Parents

ABSTRACT

Tannery and timber treatment effluents are considered to be the major source of Copper (Cu), Chromium (Cr) and Arsenic (As) heavy metal contamination into the environment. Chromium is used in tanneries for the treatment of hides and skins whereas, copper, chromium, and arsenic (CCA) solution is used as the timber treatment chemical. Chromium is used as Cr (III) in tannery industry and as Cr (VI) in timber treatment industry. Arsenic and Cr (VI) which are present in the timber treatment effluent are highly toxic and carcinogenic.

An initial survey has indicated that some tannery industries in New Zealand have not developed pre-treatment practices to reduce the heavy metal concentration before discharging the effluent into soil or waterways. The heavy metal pollution due to timber treatment industries may occur from the drips, leaks and spills due to poor handling of CCA solution while treating timber.

In this project, the potential value of industrial waste materials, such as *Pinus radiata* bark, fluidised bed boiler ash (FBA), flue gas desulphurisation gypsum (FGDG) and natural resources, such as zeolite, peat soil, and two soils (Tokomaru and Egmont soils) to reduce heavy metal concentration in tannery and timber treatment effluents was examined. The value of these materials in the remediation of soil contaminated with Cr was examined using a growth experiment.

The effect of pre-treatment of *Pinus* bark with acid, alkali or formaldehyde/acid on the retention of Cr was examined. Pre-treatment of *Pinus* bark increased the heavy metal retention only at low heavy metal concentration and did not significantly improve the heavy metal retention at high concentration. The extent of adsorption increased with an increase in surface area of *Pinus* bark material. Speciation of Cr indicated that Cr (VI) is reduced to Cr (III) and adsorbed onto the *Pinus* bark.

FBA was found to be most efficient in reducing the Cr (III) concentration from tannery effluent and As and Cu concentrations in the timber treatment effluent. In the

case of Cr (VI), the highest retention was shown by the *Pinus* bark and the peat soil. The increased retention of Cr (III), Cu and As by FBA was due to the precipitation of Cr (III) as chromium hydroxide, Cu as cupric hydroxide and As as calcium arsenate. A combination of FBA + *Pinus* bark or FBA + peat soil was efficient in reducing all the three heavy metal (Cu, Cr (VI) and As) concentration from the timber treatment effluent. The effluents contaminated with Cu, Cr and As can be passed through a column containing FBA and *Pinus* bark or peat soil.

A growth experiment using sun flower (*Helianthus annuus*) was set-up to examine the effectiveness of FBA, lime and *Pinus* bark to immobilise Cr in contaminated soil. FBA and lime amended soils were effective in establishing a normal plant growth of sun flower in Cr (III) contaminated soil even at high Cr (III) levels (3200 mg/kg soil). Incorporation of lime or FBA in Cr (III) contaminated soils causes precipitation of Cr (III) and thereby reduces the bioavailability of Cr for plants uptake. Only *Pinus* bark amended soil was found to be effective in remediating Cr (VI) contaminated soil even at 3200 mg/kg soil. *Pinus* bark material effectively retained the Cr (VI) present in the soil solution and thus reducing the toxicity and bioavailability of Cr (VI) to plants.

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