WASTE TREATMENT ALTERNATIVES FOR WOOD PRESERVING FACILITIES USING WATERBOURNE PRESERVATIVES

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INTRODUCTION

The principal waterbourne preservative in use in North America is chromated copper arsenate (CCA). As a generalization, the CCA industry recycles its process waters, and wastes are typically related to solids, referred to as sludge. Through proper plant operating practices this solid waste source can be effectively managed. This is not likely to be the principal source of "waste" to face the industry in the near future.

In August, 1989, the B.C. Ministry of Environment established regulations governing the maximum permissible concentration of pentachlorophenol and other surface applied anti sapstain agents in surface runoff from sawmills and pressure treaters. Other chemicals will be included in the regulations over time.

The initial efforts of the Ministry were directed towards pentachlorophenol. It may be assumed that this priorization was public driven, given public perception of the environmental issues related to chlorinated compounds discharged to the environment. It is now expected that greater attention will be focused on the pressure treating industry at large, and in particular at the CCA treaters. The regulatory agencies primary concern is anticipated to relate to environmental implications resulting from contaminant discharges off site in storm runoff as well as to health and environmental issues related to contamination of groundwater. To address these issues the industry will most probably be required to control, and where necessary treat, storm water runoff, contaminated soils and where groundwater contamination has occurred, groundwater. Several technologies are currently available for treatment of soils and groundwater and several are in varying stages of development.

SOIL CONTAMINATION

Contamination of site soils is likely at most plants sites, and in particular at older sites as well as sites where treated product has been stored on the yard prior to achievement of complete fixation. Several methods are available for remediating or managing contaminated soils.

Soil Washing

Soil washing is a process whereby the chemicals of concern (Copper, chromium, arsenic) are "washed" from the soil. Contaminated soils are slurried in a solvent. The choice of solvent is dependent upon its ultimate disposal, among other factors. At operating treatment facilities a solvent should be selected that is compatible with the wood preservation facility operation. An aqueous solution, to which acids have been added to reduce the pH to approximately 4 are best suited to CCA plant operations.

At pH levels of approximately 4, the metal contaminants are soluble and are readily removed from most soil particles. Granular soils are best suited to this technology. Organic soils are not, however, well suited to soil washing as the metals are likely to be bound to the organic soils in a similar manner in which they are fixed to the treated wood. The effectiveness of the technology to silts and clay type soils will vary from site to site and is specific to the individual soil chemistry and physical characteristics.

Ionic bonding, between positively charged metals and negatively charges soil particles, may interfere with the washing process.

In application the treated soils are redistributed on the site following treatment. Contaminants which are not removed from the washing process, at low pH, are not likely to leach from the soil under natural environmental conditions. The spent solvent is returned to the wood treating plant as makeup water. Cleanup of this solution will likely be required to minimize the solids introduced to the wood treating process, and the resulting increased generation of sludges.

Stabilization/Fixation

Stabilization and fixation are terms used to refer to several types of remedial actions. The most common stabilization technique involves the application of a soil ammendment to raise the soil pH. Lime, soda ash or fly ash are all effective. These chemicals are simply mixed with the soil to raise the soil pH to levels of 10.5 to 11. At the elevated pH, the metals are insoluble in water and are less likely to carried offsite with storm water runoff or percolate through the soil with infiltration to the groundwater table. Also, at the elevated pH, ionic bonding between metals and soil particles is enhanced by increasing the positive valence of the metal ions.

As a long term solution, this form of soil stabilization requires ongoing monitoring and maintenance of the soil pH through addition of chemical. It does not remove the contaminant of concern from the soil, only immobilizes it, providing a means of managing the contaminant on site. It may present a tool for use at plant sites to prevent or minimize the probability of offsite transport of contaminants.

Several new stabilization techniques are in developmental stages. One process involves the encapsulation of the individual soil particles in a silicate. The contaminated soil is heated in a silicate rich environment. The process equipment is at full scale stages of development, however the long term effectiveness of the technique is not known at this time. As the metals are left on the soil particles, and the silicate encapsulation is applied to "fix" the metal in the soil/silicate matrix, the long term effectiveness will be dependent upon the integrity of the silicate and its ability to withstand weathering over several decades. As the contaminant is not removed from the soil the technique may not represent a permanent solution.

Stabilization through encapsulation in a concrete admixture provides an immediate option, however, leaching of metals from concrete mixtures has been demonstrated to occur.

In situ vitrification is perhaps the latest technology to be considered. In situ vitrification involves the actual melting of the soil creating a glass like structure on cooling. Contaminants such as metals are bound in the vitrified matrix and cannot leach. The technology is applied by the application of current through the soil between two or more electrodes. The electrical resistance of the soil results in heating, and, with sufficient power application, the melting or vitrification of the soil. The cost and power requirements of this technology will likely discount its application at small wood preservation sites.

WATER CONTAMINATION

Treatment of water contaminated with CCA presents greater challenges for effective waste management than does soil. While options are available, most represent sophisticated technologies.

The most cost effective and practical method of dealing with contaminated waters in the CCA industry is to utilize the contaminated waters, whether they be surface runoff or groundwater, as makeup water in the preservation process.

In application storm water management techniques, commonly applied in municipal storm water management may be an important component of the facility design.. Storm water runoff generated during storm events will likely exceed the plant requirements for makeup water. Storage of the peak flows with return to the plant at controlled rates may achieve an ultimate disposal option. Similarly, contaminated groundwaters can be sent to the plant as makeup water.

Prior to use as makeup water, storm water should be treated to reduce the solids loading which will increase the generation of sludges at the plant. A portion of the sediments will be removed by settling in a storage impoundment, however, additional treatment by filtration may be required. Cartridge or sand filters could be employed for this purpose.

If groundwaters are to be used as makeup water, the total dissolved solids concentration and the chemical characteristics of the groundwater should be determined. High levels of chemicals such as iron and manganese will be precipitated from the groundwater at the low pH of the treating solution, increasing sludge generation. Pretreatment of groundwater may be required.

Where all contaminated waters cannot be accommodated in the plant, alternative means of treatment will be required. Water treatment technologies such as ion exchange, precipitation, activated alumina and other emerging technologies are available.

Precipitation is a physical/chemical process whereby some or all of the contaminants in solution are transformed into a solid phase and thereby removed from the solution. Precipitation involve the alteration of the chemical equilibrium relationship affecting the solubility of the chemicals of interest. This is achieved by oxidation/reduction, addition of a solubility shifting reagent and adjusting the temperature of the solution. Soluble arsenic in the wastewater can be removed by means of precipitation using either lime, ferric chloride or sulfide salts. Chromium can be removed using either lead salts or sulfide salts. The choice of the salts is dependent upon the valence of chromium ion in the wastewater. The sludge generated by precipitation would be collected, dewatered and disposed of offsite.

Ion exchange is a physical/chemical process which involves the removal of ionic species from the wastewater stream. This process may be considered as a reversible interchange of ions between an insoluble solid salt (ion exchanger) and a solution of electrolytes (metal ions). This is accomplished by contacting the metal ions with an appropriate exchange resin. In general if a species is known to be exchangeable in an aqueous solution, then ion exchange may be a potential alternative. The ion exchangers can include activated alumina and anionic and cationic exchange resins. The process has been broadly applied in many areas of wastewater treatment including the recovery and removal of chromium species. Chromium can be removed from the wastewater through contact with a strong base ion exchanger. The spent resin can be regenerated with sodium hydroxide solution.

A recent development in the treatment of wastewaters for removal of anions is a product produced by Alcoa, SORBPLUS^{TM}. SORBPLUS^{TM} is a metal oxide adsorbent which has high adsorbent capacity for aqueous anions. It is highly selective for divalent anions over monovalent anions. Alcoa's research has determined the following selectivity series for anions at pH 10:

$$CO_3^{2-} > AS(III) > SO_4^{2-} > Cr(VI) > As(V) > Se(VI) = Se(IV)$$

The adsorption capacity of SORBPLUS^{TM} for AS(III) and Cr(VI) at a solution concentration of 10 mg/L for each species is 126 and 80 mg/gram respectively. At higher concentrations, higher adsorption capacities are achieved. Once spent SORBPLUS^{TM} cannot be regenerated and must be disposed of.

SORBPLUS^{TM} also has an adsorption affinity for sulfate and carbonate. At a wood preserving plant applying fire retardant, the wastewaters will contain sulfate which will compete with the chromium and arsenic ions for adsorption preference.

CONCLUSIONS

Plant practices are the most important methods to control and minimize the leaching of chemicals from the treated product. While good housekeeping and improved fixation techniques will minimize site contamination, past practices or accidental releases of chemicals may have resulted in contamination of soils at most CCA plants.

At such time when the quality of storm water discharged from a treating plant site is regulated it will be necessary implement waste management techniques. These will involve implementing a combination of options including storm water collection and reuse in the plant, soil remediation and treatment of excess storm water runoff before discharge. The specific approach will vary from plant to plant and will be dependant upon a number of factors:

- Contaminant types, concentrations and extent.
- Soil type and characteristics.
- Hydrogeologic conditions.
- Site topography.
- Meteorologic conditions.
- Proximity of site to receptors.
- Future development plans.