# Comparative Study of Different Leaching Procedures

Dechen Chezom[1], Kinley Chimi[1], Sangay Choden[1], Tashi Wangmo[1] and Dr Shashi Kumar Gupta[2]

[1]Students, Department of Civil Engineering, K. L. University, Vaddeswaram, district Guntur, India

[2] Professor and Head Department of Civil Engineering, K. L. University, Vaddeswaram, district Guntur, India

Email- yangselchoden161@hotmail.com

**ABSTRACT -** Leaching is a natural process by which water soluble substances, (such as Ca, fertilizers, pesticides) are washed out from soil or wastes. These leached out chemicals, called leachate(s), cause pollution of surface and subsurface water. Experts in Municipal Solid Waste Management often require conceptualization of the leachability of metals in order to assess the risk of landfills to human health and environment. Literature identifies more than 100 leaching methods to remove soluble components from a solid matrix. In this study four potential leaching procedures used for municipal solid wastes are studied and compared to suggest the effects of these metals to the environment

**KEYWORDS -** Solid Waste Management, Leachate, Heavy metals, Laboratory tests, Water Pollution, Sanitary landfills, Comparative studies,

## INTRODUCTION

Disposal of Municipal Solid Waste (MSW) without source segregation in landfills is the usual practice in developing countries. In such practice usually other hazardous wastes, e.g. pesticides, e-wastes, batteries, paint residues, incineration residues, are indiscriminately also added which increases the heavy metal content in MSW dumpsite environment (Pare et al., 1999).

When large quantities of waste are being dumped, emanating pollutants contaminate the ground water and the soils, especially as a result of leachate of heavy metals such as zinc (Zn), cadmium (Cd), lead (Pb), copper (Cu), nickel (Ni), iron (Fe) and arsenic (As) in varying concentration. Thus it is important to know both the total content of hazardous substances and the chemical forms in which they are present in sludge.

The mobility and toxicity of heavy metals present in landfills depend on the chemical form of the metals. It has been reported that a major portion of the total metal content in MSW is inert form, unlikely to undergo chemical reactions in landfills but leach from the waste bed (Tessier et al., 1979). The toxic effects of solid wastes are known to be greatly influenced by their heavy metal contents (Esakku er al, 2006). Knowledge of heavy metal content, their species and the leachability at various environmental conditions from the dumpsite is a prerequisite for the assessment of reclamation and hazardous potential of the reclaimed waste, when it is used as compost for agricultural applications. Since the effect of heavy metals is influenced by their form of existence (Norvell, 1984) assessment of the species of metal ions enable to evaluate the sustainability of mined waste as compost or cover material.

Leaching tests are used to reveal the soluble phases of a sample help quantify toxic inputs due to mobilization of contaminants, helps to know what proportion of metals present in residue can be removed by leaching, to know the behavior of a dump of the material when exposed to external influences and how it will affect the environment.

Professionals in MSW management often require interpretation of the leachability of metals in order to assess the risk of landfills to human health and environment (Scott et al., 1990). Leaching tests are often applied in assessing worst case environmental scenario where components of the samples become soluble and mobile. Various leaching methods *viz.*, acid digestion, TCLP, ELT, SE, MEP etc., to remove soluble components from solid matrix have been cited in literature (Hesbach et al., 2001).

In this study four important tests, e.g. TCLP (Toxicity Characteristic Leaching Procedure), SPLP (Synthetic Precipitation Leaching Procedure), Column Leaching Test, EPTOX (Extraction Procedure Toxicity Test) are studied in detail because these tests have been widely used to generate leachate concentrations for all types of solids for a number of metals and organic chemicals. The pros and cons of these tests are discussed in he light of their usefulness in assessing the travel of metal ions through leachate in solid waste dump environment.

## LEACHING METHODS:

## TCLP (toxicity characteristic leaching procedure):

It is used to determine the mobility of organic and inorganic contaminants in liquid, solid and multi-phased wastes. It is also used to classify wastes (hazardous or nonhazardous) for purposes of disposal in a landfill.

It simulates the worst case scenario for disposal of waste in co-disposal landfill environment.

Particle size reduction is required, when the solid has a surface area per gram of material equal to or greater than 3.1 cm, or smaller than 1cm in its 2 narrowest dimensions.

Crushing cutting, grinding of the waste are done if the surface area is smaller or the particle size is larger than described above.

### SPLP(synthetic precipitation leaching procedure):

Chemical analyses of the filtered extract are conducted to determine the concentration of specified organic and inorganic constituents.

Used to determine the mobility of both organic and inorganic analytics present in liquids, soils, and wastes.

Is similar to TCLP except that the pH of the leachate is periodically adjusted up to specified maximum acid addition.

TCLP and SPLP are similar in test procedure. The primary difference between the two tests is the leaching media used. The acetic acid used in TCLP test is to simulate the major component found in leachate at any typical municipal waste landfill. The TCLP fluids are highly buffered and mildly acidic while the SPLP uses an un-buffered solution of sulfuric and nitric acids, at slightly more pH.

### EP-TOX(Extraction procedure toxicity test):

It is to determine whether a waste exhibits the characteristics of extraction procedure toxicity. Extraction takes place over a period of 24 hours with agitation. The liquid extract is analyzed for specific chemical constituents.

### Column test:

It is to determine the leachability of inorganic component from wastes as a function of the value of L/S ratio. The leachant is passed through a vertical column of the waste material in up-flow or down-flow manner, collected in fractions and analyzed.

## FACTORS CONTROLLING LEACHING UNDER FIELD CONDITIONS

Various physical, chemical, and biological factors influence leaching from waste and soil.

The physical factors are:

**Climate conditions:** The amount of net precipitation at a fill site will influence the amount of water available for infiltration through the site.

**Design of the fill site:** The depth of the fill will affect the quality of the leachate. The deeper the unit, the greater the contact time between the percolate and the fill material and thus there will be a greater opportunity for the leachate to reach saturation limits. Also, the deeper the unit, the longer it will take for contaminants to be depleted. Topography will affect the site's runoff pattern and the amount of water entering (via run-on) and leaving (via run-off) the site.

**Vegetation:** Vegetation limits infiltration by intercepting precipitation directly (thereby improving evaporation from the surface) and by taking up soil moisture and transpiring it back to the atmosphere (i.e., via evapotranspiration).

**Hydrogeological conditions:** Subsurface geologic conditions and depth to groundwater at a fill site can impact the generation of leachate. Materials below the water table provide a source of water provided precipitation and run on occurs.

The biological factors include the presence of microorganisms which on constant biodegradation can change redox potential and pH conditions affecting the solubility of contaminants.

In addition to the above for most in-organics the controlling factors for leaching are:

- **pH**
- **Redox conditions**
- **Solid to liquid ratio for extraction**
- **Solubility**
- **Solid phase compound**

And for most organic chemicals the controlling factors for leaching are:

- **Solubility**
- **Partitioning**
- **Presence of organic carbon**
- **Solid to liquid ratio for extraction**
- **Non-Aqueous phase liquid**

**COMPARISON OF DIFFERENT METHODS:**

| TCLP | SPLP | EP-TOX | COLUMN TEST |
|---|---|---|---|
| evaluates metal mobility in sanitary landfills.<br><br>The purpose is to classify wastes (hazardous and non-hazardous).<br><br>uses 1:20 L/S ratio. | evaluates the potential for leaching metals into ground and surface waters.<br><br>The purpose is to determine the leaching potentials of soil, waste and wastewater.<br><br>-uses 1:20 L/S ratio. | determines whether a waste exhibits the characteristics of extraction procedure toxicity.<br><br>uses 1: 16 L/S ratio. | determines the release of constituents from material and with that the potential pollution of the environment with those constituents over a long period of time.<br><br>is a dynamic test to determine leaching from L/S ratio 0.1 to 10. |
| The TCLP extraction fluids were developed to stimulate a worst case scenario, when the waste is disposed with municipal solid waste. | The SPLP extraction fluid is intended to simulate precipitation. | The EP-TOX is used to simulate the leaching which a waste may undergo when disposed of in a sanitary landfill | is designed to simulate the flow of percolating groundwater through a porous bed of granular material. |
| The TCLP extraction fluid is buffered organic acid solution at pH 4.98 (the pH remains constant). | The SPLP extraction fluid is not buffered (the pH level fluctuates). | The extraction fluid is acetic acid solution at pH 5. | NA |
| Reagents- HCl, HNO3, NaOH, CH3CH2OOH | H2SO4, HNO3 | Reagents- CH3COOH, water | NA |
| The extraction time is 18 hours. | The extraction time is 18 hours. | The extraction time is 24 hours. | The extraction time depends on whether the test is meant to be a short, medium and long term. |
| Simulated weathering- 100 years in a landfill. | Simulated weathering- 100 years exposure to acid rain. | NA | NA |
| Static test. | Static test | Static test | Dynamic test |
| Inexpensive to perform | Inexpensive to perform | NA | Cost data are not available |
| Precision data are available | Precision data are available | NA | Relatively precise |
| Initial pH of the test may not reflect the actual field pH conditions | Initial pH of the test may not reflect the actual field pH conditions | NA | NA |
| Conducted under aerobic conditions | Conducted under aerobic conditions | NA | NA |
| Particle size reduction may be required | Particle size reduction may be required | NA | The size of the particles used in the test is controlled |

## ACKNOWLEDGMENT

We take this opportunity to express our thanks to Department of Civil Engineering, K L University, to undertake this work and to allow us to present our findings as our contribution to the development of knowledge in the field of Environmental Engineering.

## CONCLUSION

Background knowledge of the sources, chemistry, and potential risks of toxic heavy metals in contaminated sludge is necessary for the selection of appropriate remedial option. In order to minimize the health risks and environmental pollution, it is important to know both the total content of the hazardous substances and the chemical forms in which they are present in sludge. Leaching of heavy metals from the sewage sludge is of great importance to ensure safe disposal of sludge. The negative impact of sewage on the environment should be reduced by leaching procedures. At each leaching process, sewage should be purified to such an extent so that it would not detrimentally affect the environment. Therefore, constantly analyzing and checking the effectiveness of sewage leaching, in accordance with standards and regulations in force, provides an important criterion for the assessment of sewage treatment. The selection of the leaching methods is not a simple task. It varies according to the sample size, particle size distribution, the leachant volumes and pH and the duration of the leaching test. A careful investigation of these parameters is needed prior to finalization of the test procedure.

## REFERENCES:

1. APHA (1998). “Standard methods for examination of water and wastewater.” *20th edition, American Public Health Association-American Water Works Association, Water Environment Federation Publication*, Washington DC,.

2. Esakku, S., Selvam, A., Palanivelu, K., Nagendran, R. and Joseph, K. (2006). “Leachate Quality of Municipal Solid Waste Dumpsites at Chennai.” *Asian Journal of Water, Environment and Pollution*, Vol.3, No.1, 69-76.

3. Hesbach, P., and Lamey, S. (2001). Cited in http://www.mcrcc.osmre.gov/PDF/Forums/CCB3/4.2pdf.

4. Norvell W.A. (1984), “Comparison of chelating agents for metals in diverse soil materials”, Soil Sci. Soc. Am. J., Vol. 48, 1285 – 1292.

5. Pare, T., Diel, H., and Schmitzer, M. (1999). “Extractability of trace metals during co-composting of bilsolids and municipal solid wastes.” *Boil fertile soils*, Vol. 29, 31-37.

6. Scott, J., Beydown, D., Amal, R., Low, G., and Cattle, J. (1990). “Landfill Management, leachate generation and leach testing of solid wastes in Australia and overseas.” *Critical reviews in Environmental Science*. USEPA.

7. Tessier, Campbell, P.D.G., and Bisson, M. (1979). “Sequential Extraction Procedure for the speciation of particulate trace metals.” *Analytical Chemistry*, Vol. 51, 844-851.