A report

on

CSIR-Harnessing Appropriate Rural Intervention and Technologies (HARIT)

AcSIR

Project Theme

Environmental Management within CSIR-Indian Institute of Petroleum: To improve Sustainability within the Campus

(Laboratory chemical waste management in CSIR-IIP)

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1. Introduction:

Chemical waste is a broad term and encompasses many types of materials. Proper chemical management is necessary to protect the health and safety of the CSIR-IIP institute, surrounding communities and the environment. Chemical waste should be reduced to minimize environmental pollution, and it is important that the amount of waste is minimized in CSIR-IIP laboratories to reduce the negative impact on environment as well as the disposal costs of university. There are several ways to minimize the waste generated in chemical laboratories, namely, (1) elimination or reduction of the source of pollution, (2) recycling and reusing the chemicals, (3) treatment of waste to minimize its hazards, (4) better management of chemical inventories in the laboratories.

There may be circumstances where the source of pollution cannot be reduced, and the next alternative is to recycle or reuse waste products generated from the source. If recycling or reusing is not possible, the wastes have to be treated for the ease of disposal, especially if the waste is hazardous. Although disposal is the least preferred step, as the amount of waste generated is not reduced. Methods that fall under this category also do not fall under the 12 Principles of Green Chemistry, as disposal does not reduce or eliminate the use and generation of hazardous substances. The amount of waste generated is also not reduced. Overall, waste minimization methods should focus on the first three steps, namely, source elimination or reduction, recycling or reusing, and treatment.

Examples of Chemical Waste include, but are not limited to:

Organic waste Examples:

Phenols: Phenol or phenol mixtures, phenol-chloroform mixtures and phenol-acid mixtures.

Halogenates: chloroform, 1, 1, 1-trichloroethane, methylene chloride etc.

Corrosives: non-halogenated solvent-acid mixtures, non-halogenated organic acids such as acetic acid, trichloroacetate, acetic anhydride.

Non-halogenates: acetone, toluene, acetonitrile, ethyl acetate, heptane, hexane, alcohol with less than 20% water.

Acids: hydrochloric acid, sulphuric acid, nitric acid, chromic acid, hydrofluoric acid.

Inorganic/acid mixtures: iron (III) chloride, aluminium trichloride, mercury compounds dissolved in acid, other inorganic compounds dissolved in acid. Corrosive waste - Alkali Examples: hydroxides, phosphates, ammonia.

Alkali mixtures: compounds dissolved in hydroxides, phosphates, ammonia.

Reactive waste Examples: air and water sensitive materials such as Grignard reagent, alkaline metals, reactive halides.

Waste oxidizers Examples: all nitrates, potassium dichromate, metal peroxides such as chromium dioxide.

Inorganic wastes:

Heavy metal compounds and solutions such as those of mercury, lead, copper and zinc (except those dissolved in acid), other inorganic compounds not covered by another category.

Hazardous waste:

Other Examples: All waste in this category must be segregated. It includes radioactive waste, bio hazardous waste, highly hazardous waste, and explosive waste or surplus chemicals.

Explosive or other highly hazardous materials: peroxide formers such as aged ether, di and tri - nitro compounds, old flares, azides. These materials require special disposal.

Toxic:

The toxic 'characteristic' is where the regulations start to get into listing specific chemicals. To determine whether a chemical waste exhibits the toxic characteristic, it is necessary to check the federal toxic list, known as the 'D' list.

The concentration listed next to the chemical names below refers to a very specialized analytical method known as the TCLP test (the Toxic Characteristic Leachate Procedure). The TCLP test is designed to simulate the concentration of contaminant that would leach out of the material if it were in a landfill under acid rain conditions. EHS can provide TCLP analysis if necessary. However, in most cases the right thing to do is to collect wastes with any concentration of the chemicals listed below.

Chemicals on the federal toxic List:

Material	TCLP Concentration (mg/l)	CAS Number
Metals		
Arsenic	5.0	7440-38-2
Barium	100.0	7440-39-3
Cadmium	1.0	7440-43-9
Chromium	5.0	7440-47-3

Material	TCLP Concentration (mg/l)	CAS Number
Lead	5.0	7439-92-1
Mercury	0.2	7439-97-6
Selenium	1.0	7782-49-2
Silver	5.0	7440-22-4
Pesticides		
Chlordane	0.03	57-74-9
Endrin	0.02	72-20-8
Heptachlor	0.008	76-44-8
Lindane	0.4	58-89-9
Methoxychlor	10.0	72-43-5
Toxaphene	0.5	8001-35-2
2,4-D	10.0	94-75-7
2,4,5 TP Silvex	1.0	93-72-1
Organics		
Benzene	0.5	71-43-2
Carbon Tetrachloride	0.5	56-23-5
Chlorobenzene	100.0	106-90-7
Chloroform	6.0	67-66-3
o-Cresol	200.0	95-48-7
m-Cresol	200.0	108-39-4
p-Cresol	200.0	106-44-5
Cresol	200.0	

1,4-Dichlorobenzene	7.5	106-46-7
1,2-Dichloroethane	0.5	107-06-2
1,1-Dichloroethylene	0.7	75-35-4
2,4-Dinitrotoluene	0.13	121-14-2
Hexachlorobenzene	0.13	118-74-1
Hexachloro-1,3-butadiene	0.5	87-68-3
Hexachloroethane	3.0	67-72-1
Methyl ethyl ketone	200.0	78-93-3
Nitrobenzene	2.0	98-95-3
Pentachlorophenol	100.0	87-86-5
Pyridine	5.0	110-86-1
Tetrachloroethylene	0.7	127-18-4
Trichloroethylene	0.5	79-01-6
2,4,5-Trichlorophenol	400.0	95-95-4
2,4,6-Trichlorophenol	2.0	88-06-2
Vinyl Chloride	0.2	75-01-4

2. Background Report of CSIR-IIP:

We have visited various divisions of CSIR-IIP. Collected the data and prepared report reflecting the amount of solid chemical waste generated.

	Year (2018-2019)		
Division	**Carbon waste (g)**	**Metal waste(g)**	**Other solid chemical waste(g)**
Chemical and Material Sciences Division	**-**	**12**	**60**
Materials Resource	**24**	**18**	**6**

Efficiency Division			
Distillate and Heavy Oil Processing Division	**120**		**120**
Light Stock Processing Division	**60**	**48**	**288**
Analytical Sciences Division	**12**	**-**	**120**
Tribology and Combustion Division	**240**	**-**	**240**
Separation Processes Division	**12**	**-**	**480**
Total	**468**	**78**	**1,314**

3. Strategies for chemical waste management in CSIR-IIP:

The objective to improve the sustainability inside the campus and to reduce the resource utilization pattern. Initiative taken by CSIR-IIP towards the proper disposal of waste:

1) Green bin waste: paper, filter paper, tissue paper

2) Blue bin: plastic bottles, used paraffin.

3) Red bin: Gloves, syringes, Aluminium foil, broken glass.

BUT

[4] White bin: for solid chemical waste

And before the disposal of solid chemical waste, we can follow the following strategies

a) To reduce waste

One can use less toxic reagents, substituting for products with lower toxicity. In this context, it is possible to consider the replacement of products such as benzene, used as a solvent, with hexane or xylene, halogenated solvents with non-halogenated solvents. Replacement is not always possible because some substitutes do not always produce fully satisfactory results, or are toxic or too expensive. Thus, it is necessary to evaluate if the replacement material is suitable and delivers acceptable results.

b) Reuse and Recycle

Reuse and recycle processes when possible in a new way, or treat otherwise reuse it in the same way, or in another type of activity. Some examples of recycling are:

• Distillation of used solvents;

• The glassware can be initially washed with used solvents in cleaning processes;

• Purchase only compressed gas cylinders from manufacturers that accept the return of empty or partially used ones;

• In pesticide studies, it is advisable to establish the practice of returning any unused material to the research sponsor;

• Avoid the contamination of fuel with solvents or heavy metals;

• Share chemical agents among the various university units;

If the above procedures are not suitable for specific situations to minimize waste, an alternative may be the final chemical treatment of the generated hazardous waste. The techniques routinely used in reducing chemical waste are: neutralization, precipitation, oxidation, reduction and distillation.

c) Neutralization

The most common treatment is to neutralize highly acidic or alkaline solutions, leading to a desirable pH of 6 to 9. Thus, if this solution does not contain other toxic compounds it can be treated as regular trash and discarded in the sewage. Strong acids or bases must be neutralized before being released into the sewage, including those with the following cations: Al^{3+}, Ca^{2+}, Fe^{2+}, Fe^{3+}, H^{+}, K^{+}, Li^{+}, Mg^{2+}, Na^{+}, $(NH4)^{+}$, Sn^{2+}, Sr^{2+}, Ti^{3+}, Ti^{4+}, Zr^{2+}; and anions:$(BO_3)^{3-}$, $(B_4O_7)^{2-}$, Br^{-}, $(CO_3)^{2-}$, $(HSO_3)^{-}$,$(OCN)^{-}$, $(OH)^{-}$,I^{-},$(NO_3)^{-}$, $(PO_4)^{3-}$,$(SO_4)^{2-}$,$(SCN)^{-}$.

d) Precipitation, oxidation and reduction

These processes can remove hazardous components of chemical waste and the final product can be discarded as common trash. Precipitates derived from these reactions may require more effective waste treatment. The application of these procedures for chemical treatment in laboratories, apart from reducing hazardous waste, allows the responsible management of chemical waste. The recycling of solvents, among other materials used in technical analysis, allows the reuse of material, which otherwise would be discarded as hazardous waste. Solvent recycling, if well done, brings advantages to the academy in terms of risk reduction, harmful waste reduction, and lower costs.

Chemical Waste Management in Personal level

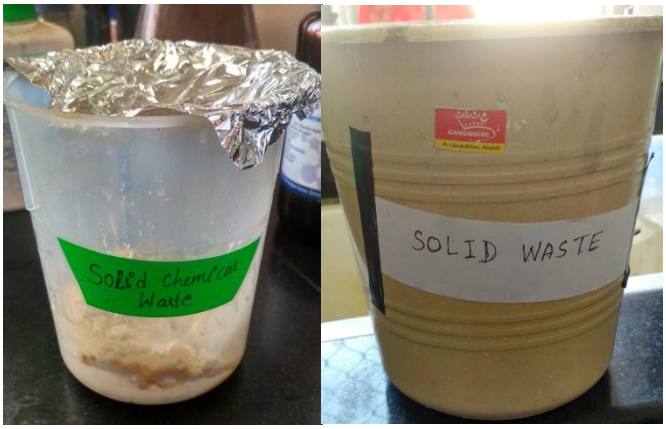
1. When possible, seek ways that will minimize the quantity of waste generated inside the laboratory.
2. Only use appropriate containers for the storage of waste materials.
3. Store chemical waste in a designated area.
4. Properly label all waste containers.
5. Keep waste containers closed.

4. Conclusion:

It is important to manage the disposal in an eco-friendly manner. CSIR-IIP has already benefited the campus by providing several disposal bins for different kind of waste and following the proper channel of segregation.

5. Recommendations:

In our visit to various labs in CSIR-IIP, we found that very few labs have separate open bin for disposal of solid chemical waste. However, we realized that for the proper disposal of solid chemical waste there is a strict need to have separate closed bin for this.



6. Acknowledgement:

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