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Reduction & Elimination of PCBs Prioritizing the Power Sector in India

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ABSTRACT: Global warming, hazardous and toxic chemicals are really threatening sustained life on the planet. Large quantities of carbon dioxide and number of hazardous and toxic chemicals are creating a shift in the environment causing irreversible damage to the environment. A hazardous and persistent chemical such as Polychlorinated Biphenyls is one among them.

I. INTRODUCTION

Polychlorinated Biphenyls PCBS are synthetic chemicals which are no longer produced in the world. However they are still found worldwide. PCBS can build up in the environment and can cause harmful effects over the period of time. Manufactured prior to the eighties , PCBS have been used as coolants and lubricants in transformers , capacitors and other electrical equipments because they do not burn easily and are good insulators

A " PCB transformer" is a transformer that is known to contain PCBS at concentrations > 500

Parts per million (ppm) as an insulating fluid or oil PCBs were imported by many countries including India during pre and post independence industrial development efforts . Many such transformers have unfortunately been scrapped in an unsafe manner. While in others , the oil has been replaced with other suitable mineral oils and the transformers still continue to be in service with PCB contaminated insulations and other components . There are instances where some of the transformers leak pure PCB or PCB contaminated oil and the oil seeps into the soil and water to be ingested by plants and mammals.

Prior to knowing some of the unintended consequences due to their widespread use, PCBS were also sprayed on dirt roads to keep the dust down . Waste from the manufacturing process that contained PCBS were placed in dump sites or landfills . Occasionally accidental spills and leaks from these facilities or transformer fires resulted in PCBS entering the environment

In the 1960s, when initial research results were released , traces of PCBS were detected in people and animals around the world not just in heavily populated cities but also in remote areas as far as the arctic regions . The migration of PCBS occurred due to Transboundary movement.

Transboundary Movement includes :

- Chemicals that are transported through erosion , flood plains water biota etc
- Chemicals that are semi volatile
- Chemicals that evaporate over warmer regions and condense in colder atmospheres including regions where there use is non-existent

Health & Ecological Effects of PCBS

- Suppresses the immune system , making the animal more likely to fall ill and die when exposed to infections
- Disturbs the behavior and reproduction in birds , fish and mammals
- Contributes to population decline and health problems in fish eating mammals in PCB polluted areas
- Acts as a cancer promoter and can cause birth defects , damage to the nervous system, immune system and liver in humans

Therefore if proper care is not taken in the collection and safe disposal of these materials ,the cost incurred to correct the consequences will be very high .There are no remedial medical solutions available to combat the harm caused by these pollutants.

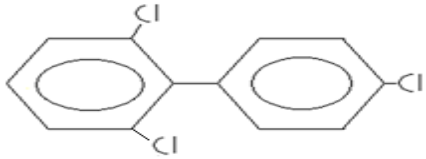
The objective here is to create awareness about PCBs that still exist in our power generating stations and other industries . Further, the plans made by the Government of India and United Nations Industrial Development organization (UNIDO) to support the stakeholders (having such equipment /oil contaminations) in disposing them in safe and cost effective manner are included so that the environment is free from the hazardous contamination caused by PCBS . It is helpful to note that a PCB filled transformer , even though in service does not pose a threat to the environment if it is well sealed and leak proof.

Regulations Governing PCBS and PCB Containing Equipment Awareness about pollution and toxicity of PCBS contributed to its ban in 1979 and has resulted in an International Environment Treaty, the Stockholm Convention on Persistent Organic Pollutants (POPs). POPs are substances which

- Persist in the environment
- Bio accumulate and are toxic in nature
- Have long range transport Potential and can result in adverse environmental and human health effects at locations even far from their sources

The convention promotes environmental sound management and disposal of PCBS . Under this convention , more than 160 countries have resolved to eliminate such polluting materials from their countries . The republic of India Signed the Stockholm (SC) on POPs on 14 May 2002 and ratified it on 13 January 2006

The Ministry of Environment, Forest and climate Change (MoEFCC) was appointed as the National Focal Point for the SC. Being a signatory to this convention ,our country is obligated to eliminated these types of materials by 2025. Under the guidelines of MoEFCC and UNIDO, the paper " Reduction and Elimination of PCBS, prioritizing the Power Sector in India " has been taken up



II. PCB STRUCTURE

- Two benzene rings with 1 to 3 chlorine atoms.
- 209 possible congeners or forms of PCBs
- Produced by the reaction of Biphenyls with cl2 using a catalyst

General / Analytical identification of PCB

In accordance with the toxic Substance control act ,proper PCB identification labels must be visible near the access to the transformers and also on the transformer itself

As a common measure it is helpful to note that a basic physical parameter such as density can help in differentiating between mineral oil and PCBS . Mineral oil has a density range of 810-860 Kg/m3 while PCB containg oil ranges from 1000-1150 Kg/m3 or even more depending upon the concentration of PCBs . Generally a transformer will have a nameplate attached to the unit indicating the name of the dielectric fluid , the approximate weight in pounds or kilograms and the amount of fluid , usually in gallons or liters. However this is not a completely reliable method. Trade name for pure hazardous PCBS include : Asbestol, Askarel, Clophen, Chlorextol, Fenclor. Inerteen, Kanechlor, Noflamol, Phenoclor, Pyralene, Pyranol, Safkuhl, Sovol, Sovtol, Hydol, Therminol etc. In the absence of the oil brand name on the nameplate , an alternate way to determine the presence of PCBS accurately is to test the dielectric fluid.

Typical Gas Chromatogram patterns obtained from oils " Aroclor" standards is shown in the figure. The varying concentrations are indicated by the peaks

PCB Toxicity Classification

Classification	PCB concentration	Nature
Type I	>500ppm	Hazardous
Type II	50-500ppm	Highly Toxic
Type III	2-50ppm	Toxic

PCB Management and Disposal Initiatives

During the National Implementation Plan(NIP) development ,it was established that PCBs management and disposal is one of the top priorities for a post NIP program , requiring immediate action and attention with well defined time frames. The project focuses on the following

- Improve legislation on POPs
- Eliminate PCB containing equipment
- Reduce PCB releases from industrial wastes and sewages
- Improve environmental performance in the industrial sector and
- Identify PCB wastes and PCB contaminated sites and promote their environmentally sound and safe management

A decision was taken by the National Steering Committee during a meeting held on 31 March 2010 that appointed Central Power Research Institute (CPRI) as the national executive agency

For this project.

Indian Inventory, CPRI initiatives and post NIP Plans

If any equipment has been imported prior to 1980s it is recommended to investigate further about the possible presence of PCB material in it. Summary of the work in progress/Post NIP Plan is given below

1.Create awareness among the environmental officers inform the public about the harmful effects of PCBs

2) Compile accurate inventory of PCB containing equipment and material in the country

Planning and conducting Inventory

- Preinventory preparation and communication
- Selecting facilities to be inventoried
- Communicating with facility managers
- Selecting those facilities that are likely to have significant quantities of PCBs and also considering facilities that may have disposed PCBs inadequately on site or off site
- Self reporting or physical inspection
- Ensuring integrity and safe management of PCB containing equipment
- Determining disposal/ destruction needs
- Stake holders role Inspect both the equipment and corresponding records , maintenance of trust transparency with executing agency
- Recording information in the form of an inventory and verifying the same
- Status of equipment: retro filling, leaking scrapped etc
- Sample collection : typically 200ml oil collected in a safe manner by following standard procedure
- Simple screening tests and rigorous instrumental analysis
- Density and chlorine content
- Laboratory testing for PCBs: Gas Chromatograph (GC) with Electron Capture Detector(ECD)
- Comparison of results with standard chromatograms of known arclor concentrations
- Established guidelines for PCB Management,Identification,Tracking and Record Keeping ; Waste collection Packaging and transportation; Interim storage and disposal
- Creation of Disposal Facilities adopting the best available dechlorination / incineration Technologies, Intermediate Storage Facilities , Strengthen Analytical Facilities
- Final outcomes planned : Strengthen country wide capacity for PCB Management , financial mechanism and compliance with the Stockholm convention (SC) obligations related to PCBs , increase public awareness along with well trained technical personnel and improve cooperation among key stakeholders , government public and private enterprise involved in PCB Management
- Role of Electrical utilities and other PCB Containing organizations is to interact with Central Power Research Institute with the following details
- Collect information from O& M staff/ Records Numbers of Transformers installed prior to 1985
- Nameplate details and locations of these transformers
- Details of oil Maintenance that is topping up or replacement of oil
- Submit oil samples

III. CONCLUSION

There is a need to develop close involvement of social partners to meet the challenges ahead in
the assessment and control of workplace risks by mobilizing local resources and extending
protection to such working population and vulnerable groups where social protection is not adequate.

Government stands committed to review the National Policy on Safety, Health and Environment at Workplace and legislations through tripartite consultation, improve enforcement, compilation and analysis of statistics; develop special program for hazardous operations and other focus sectors, set up training mechanisms, create nation-wide awareness, arrange for the mobilization of available resources and expertise

PCB's were found to highly stable and refuse to be degraded in soil, water, algae, fungi bacteria
and other oxidative mechanisms operating in environment in a natural manner. Different
countries have used various methods to avoid pollution and to destroy these compounds.

Combustion

This method of destruction is the most widely used but not considered as environmentally sound
technique. PCB's get pyrolysed to water, Carbon dioxide and Hydrochloride (HCl) when burnt at temperatures 1400ºC-1600º C. This method has potential danger of producing highly dangerous chemical species which are highly dangerous and toxic and can cause serious implications on living organisms. This is more likely when the temperature of combustion is lower than 1200ºC.

Encapsulation / burial: Though this method is not a destruction method but can effectively seal the material and avoid the pollution of this compound for long periods. Concrete capsules can be made and used to bury the PCB's and seal them off by concrete. Once this is done and when the concrete looses its capacity and without allowing leakage of PCB material and finally reach out and contaminate the water resources.

Chemical treatment of PCB's with Sodium Hydroxide: The method has been tried for destruction of PCB's. In this method sodium hydroxide is made to react with PCB's to generate sodium chloride and biphenyl and phenolic mixtures are being generated as side products.

Though the technique appears to be simpler, the method has not acquired popularity as the side
products of the reaction are phenols and have higher solubility with water and has easy mode of spreading the toxic material by travelling in aqueous systems for long distances. This situation can be very threatening as it can cause much higher damage immediately as compared to PCB's themselves.

Super Critical Water oxidation of PCB's: Super critical conditions can be achieved for any material in which liquid and vapour states co-exist and are not distinguishable.

Water achieves this condition when its temperature is above 374°C & pressure at 221 bar. PCB's, PAH's (Poly Aromatic Hydrocarbons), Waste plastics and other materials can be converted in to simple hydrocarbons and can be reused and recycled. The technology is not yet perfected and needs lot of technological developments to meet the requirements of PCB destruction.

Sodium metal based conversion of PCB's: In this process Sodium metal reacts with chlorinated systems to dechlorinate the molecules at much lower temperatures than combustion.

Whereas combustion seems to be the alternative for much faster and cheaper method. Keeping in view of the geographical conditions we may have to use combination of technologies to get rid of this problem.

Physical tools to be used

- Hand gloves
- Shoes
- Jackets
- Implementation of physical tools by the workers
- Implementation of basic instructions on arrival
- Minimum certificate course on PCB awareness to all the workers in the premises

Monitoring systems

- Physical inspection
- Inspection of health authorities
- Inspection of the maintenance engineers
- Soil testing
- Water testing
- Air testing
- Documentation

Reporting

- Reporting formats : Compliance reports of physical tools of safety
- Reporting formats: Compliance reports of awareness brochures
- Reporting formats: Inspection reports

Reporting formats should include the following threat perceptions and their probabilities

Threats to the equipment owners: working staff and others

- Possible leakages in the given equipment, maintenance of gaskets, valves, storage

containers, filtration systems and other accessories

Threat of pollution by spillage

- Leakages of valves, taps, gaskets and all other possible components are to addressed

on top priority. Management will ensure all the necessary funds will be given for such

maintenance activity.

Threat of pollution by contamination

- Engineers would fully educate the working staff that the contaminated oil should not

be mixed with any other oil and further contamination will be avoided.

- The accessories which come in to contact with the contaminated equipment will be cleaned and washings are also stored as contaminated and would be taken up for cleanup procedures
- All the cleaning consumables like waste cloth, cotton, tissues and any other

consumables should be collected and would be taken up for clean up procedures. Threat of pollution by combustion

- All the possible causes of fire near the contaminated equipment should be pre meditated and precautionary measures are to be in place
- In case of fire necessary instructions

- Instructions for the people to move away and opposite to the direction of wind Instructions for the fire extinguishers with special instructions about the PCB materials 2.4.5. Threat of pollution by oil vapors - Prevent the high operating temperatures in the transformers having PCB or its contamination by taking measures like reduction of load and other associated activities

- Keep external cooling accessories in the place to prevent higher temperatures
- Keep the rooms ventilated and vapors getting pumped to get the vapors getting adsorbed in to air filter columns

2.4.6. Threat of pollution by oil spillage during transportation

- Keep the driver and his assistant informed of the material
- Keep the driver and his assistant informed of the precautionary measures like not to move with high speed, keep instructions to other vehicles that this vehicle is transporting hazardous material and keep distance.
- Avoid any other possible obstacles like trees and other blocks
- Keep the security agencies informed of the movement of the material
- Keep the emergency task force informed of the movement of the material
- Keep the control room informed of the movement track and updates on the present

locations

- Keep the emergency instruction kit
- Keep emergency announcements
- Keep crisis management plan document in the vehicle

2.4.7. Threat of pollution by accidental explosions or mishaps during dechlorination process

- Keep the chemical processing process well below the safety levels
- Keep the monitoring frequency strictly followed
- Keep the status and monthly reports regularly submitted to the Safety officer
- Keep necessary updates during the maintenance schedules and attend to all the replacement necessities such as valves, taps, temperature controllers and pressure controllers
- Keep all the monitoring and inspection documents submitted to safety officer

2.4.8. Responsibilities of Engineers towards prevention of pollution of water, soil, air, food and bio- system

- As engineers, working in the country, we have the responsibility towards preserving
environment, preventing pollution, avoid possible spillages by taking pre planned maintenance and avoid any catastrophic failures.
- It is our responsibility to inform and convince all the authorities concerned about the grave possibilities and measures to be taken to prevent such dangerous
situation.
- Being a citizen of the country and living being on the planet, we have the responsibility to prevent pollution of water, soil, water, air, food and bio system.
- We are responsible in taking action to prevent pollution of any form and get ourselves educated in taking such action.

3.0. Documentation to be made available for the necessary information at easily accessible
points for reference and use of all the concerned

- Guidelines for the general public
- Guidelines for the working engineers
- Guidelines for the working lab analysts
- Guidelines for the water boards and other authorities
- Guidelines for the agricultural authorities
- Guidelines for the de-chlorination working engineers

REFERENCES

[1]. Cocker ham, L. G., and Shane, B. S. (eds), 1994. Basic Environmental Toxicology. Boca Raton, Fla.: CRC Press.

[2]. Erikson, M. D., 1986. Analytical Chemistry of PCBs. Stoneham, Mass.: Butterworth's.

[3]. Nicholson, W. J., and Moore, J. A. (eds), 1979. Health effects of halogenated aromatic hydrocarbons. *Ann. N. Y. Acad. Sci.,* **320**, 1–730.

[4]. Safe, S., and Hut zinger, O. (eds), 1987. Polychlorinated Biphenyls (PCBs): Mammalian and Environmental Toxicology. Berlin: Springer-Verlag.

[5]. ATSDR. 2000. Toxicological Profile for Polychlorinated Biphenyls (PCBs). US Department of Health and Human Services, Public Health Service Atalanta, GA.

[6]. [ATSDR] Agency for Toxic Substances and Disease Registry. Addendum to the Toxicological Profile for Polychlorinated Biphenyls (PCBs). Atlanta GA [updated 2011 April; accessed 2014 February 01]. Available from:http://www.atsdr.cdc.gov/toxprofiles/pcbs_addendum.pdf

[7]. Aulerich RJ, Ringer RK, Safronoff J, et al. 1986. Assessment of primary vs. secondary toxicity of Aroclor 1254 to mink. *Archives of Environmental Contamination & Toxicology* **15**(4): 393-9.

[8]. Bahn AK, Rosenwaike I, Hermann N, et al. 1976. Letter: Melanoma after exposure to PCB's. *New England Journal of Medicine* **295**(8):450.

[9]. Barsotti DA, Marlar RJ, Allen JR, et al. 1976. Reproductive dysfunction in rhesus monkeys exposed to low levels of polychlorinated biphenyls (Aoroclor 1248). *Food & Cosmetics Toxicology* **14**(2):99-103.

[10]. Brown DP. 1987. Mortality of workers exposed to polychlorinated biphenyls--an update. *Archives of Environmental Health* **42**(6):333-9.

[11]. Calabrese EJ, Sorenson AJ, Calabrese EJ, et al. 1977. The health effects of PCBS with particular emphasis on human high risk groups. *Reviews on Environmental Health* **2**(4): 285-304.