DEVELOPMENT OF PCBS MANAGEMENT POLICY WITH LIFE-CYCLE MANAGEMENT APPROACH FOR DEVELOPING COUNTRIES: A CASE STUDY IN VIETNAM

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Introduction

Polychlorinated biphenyls (PCBs) were widely used as coolants, insulating materials and lubricants in electrical equipment (such as transformers and capacitors), and to a lesser extent in applications such as hydraulic fluids, plasticizers, surface coating, etc. Like many other countries, Vietnam has never produced PCBs but imported PCB-containing oils as industrial oils (such as transformer oil, hydraulic oil, air turbine oil, lubricant oil, and plastic additives) from about the 1940s to 1980s. A significant amount of PCBs still exists in Vietnam, primarily in oils used in electrical transformers and capacitors. With no new import of PCB-containing oil or equipment, since 1990s, the main issue in Vietnam is environmentally sound management of PCBs, PCB containing equipments, articles and contaminated sites. It has been noted that PCB management policy requires the involvement of various agencies of different sectors such as trade, industry, environment, labor safety and public health. Currently, Vietnam is still lacking of legal instruments for sound management of PCBs, and therefore there is a need to develop an effective, integrated PCB management policy framework towards the objectives of Stockholm Convention on protection of environment and human health related to the releases of PCBs into the environment [1].

Recently, there is increasing attention to a way of improving environmental performance of products and processes in industries and businesses, which is Life Cycle Assessment [4]. An LCA allows a decision maker to study an entire product system hence avoiding the sub-optimization that could result if only a single process were the focus of the study. The benefits of adopting a life cycle assessment is among others (i) it establishes a comprehensive overview of a complex matter, (ii) it shows the relation between different phases of a product, (iii) it gives the possibility to treat the important aspects of a product in a systematic way, and (iv) information developed in an LCA study should be used as one component of a more comprehensive decision process assessing the trade-offs with cost and performance [6]. The purpose of the paper is to present the application of LCA methodology in the development of legislation for PCBs management in Vietnam. The outcome of the paper is a proposed policy framework for PCBs management in Vietnam.

Research methodology

In order to understand the practical situation of PCBs, surveys on relevant stakeholders and facilities related to PCBs use, discharge, releases to environment and management practices were carried out. Different groups of stakeholders were selected to be interviewed and/or investigated, including: owners of the transformers, electrical transmission systems, service workshops repairing transformers, waste treatment facilities and potential PCB contaminated areas. This facilitated the identification of practical need, the objectives and scope of sound management of PCBs.

The approach of Life Cycle Assessment (LCA) and Life Cycle Management (LCM) in environmental management was studied to identify possible application of LCA and LCM for management of PCBs, PCB containing articles and to facilitate the development of a comprehensive policy. The objectives, history and all aspects of the LCA and LCM approach were studied; the development of PCB management policies and guidelines in various countries, including the countries like the EU, USA, Japan, Korea to Thailand, Philippine, were reviewed to learn the experiences.

On the other hand, legal framework and current practices of PCBs management in Vietnam were investigated to assess the effectiveness and efficiency of the existing policies. The legislation gaps with regards to the life cycle management of PCB were identified and so new policies are proposed to develop what meets the practical requirements and also what is feasible with regards to the Vietnam legal and institutional framework.

Results and discussion

In Vietnam, for many years, PCBs have not previously been considered as toxic chemicals which need to be fully controlled, thus data of PCBs have not been collected systematically. Additionally, due to constraints derived from a lack of awareness of the issue in Vietnam, only preliminary results of a PCBs inventory have been obtained. The preliminary inventory data originated mainly from the electrical sector, mostly relating to big transformers and capacitors. Other relevant sectors (estimated to account for approximately 30% of total amount) have no data. The initial inventory of PCB shows that, before 1985, the total amount of imported PCBs to Vietnam (in electrical equipment from various countries like the USSR, China, Romania, USA, France, and Germany, etc.) may have reached 27,000-30,000 tones/year. A significant amount of the electrical equipment imported from the United States to southern Vietnam before 1975 also contained PCB oils [1, 3].

Currently, many transformers still use PCB oils because the scheduled date for oil replacement has not been reached. Furthermore, it was found that cross contamination between old and new electrical transformers happened during the maintenance or repairing of the equipments because of the reuse or retro filling of the transformers' oils. This increased the amount of PCB contaminated equipment and the complexity of the PCB situation in Vietnam [5]. Data from the electrical sector covering only 70% of the estimated total PCB information in Vietnam. The distribution of PCB contaminated equipment is complicated and can be spread nation-wide, including the rural areas.

There are also suspected PCB-containing oil stockpiles in Vietnam. Sources of PCB releases into the environment are mainly from uncontrolled discarded waste oils from transformers or capacitors. Some studies on PCBs pollution have shown that PCBs are found in the air and sediments, especially the sediments in urban regions (for example, the Thi Nghe canal in Ho Chi Minh city, and soil in areas nearby transformer stations in Hanoi) [1].

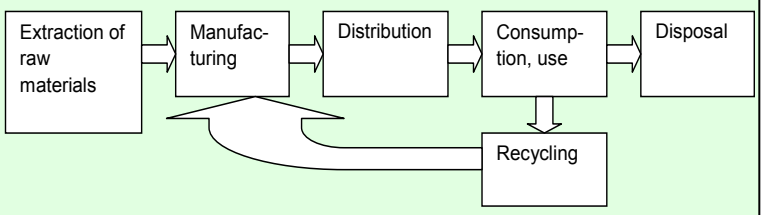
Regarding the existing PCBs management policies, the review of current policy and legal framework indicated that there is no specific regulation governing management of export/import, use, labeling, transport and disposal of PCBs and PCB-contaminated equipment; there are yet no technical guidelines on safe handling of PCBs. PCBs oils and equipment are now mainly managed through some temporary guidance issued by the Vietnam Electricity Cooperation.

Vietnam ratified the Stockholm Convention 22 July 2002, and adopted a National Implementation Plan (NIP) in 2006. The NIP proposes a long range of activities to safely manage POPs in the future. Among those with specific reference to PCBs are: Develop and finalize policy, legislative and institutional frameworks for effective management of POPs in order to reduce and finally eliminate POPs; Properly phase out and safely eliminate PCBs and PCB-containing equipments; Reduce the release of PCBs into the environment, eliminate the use of PCBs in equipment by 2020; and safely dispose of PCBs by 2028; Develop and implement a national program for the sound management and the phase-out of PCB-containing fluids, electrical equipment and industrial products, with due attention for the electricity sector; Thorough treatment of PCBs and POPs pesticides contaminated hotspots; and Sound management, disposal and phase-out of PCBs and PCB-containing electrical equipments and industrial products [1].

The life cycle concept has been used for a number of decades, in particular within environmental science and management. The life cycle concept does not represent new thinking, because the life cycle is a natural thing for all living organisms, as they all pass through a number of life phases, from "cradle to grave". This life cycle concept or approach has been transferred to non-living things like products, materials and substances, as it has proved to be very useful for explaining many aspects of the environment and the ecosystems, and for the managing environmental problems connected to products, materials and substances. The LCA process is a systematic, phased approach and consists of four components: goal definition and scoping, inventory analysis, impact assessment, and interpretation of the preferred product, process or service. On the other hand, LCM

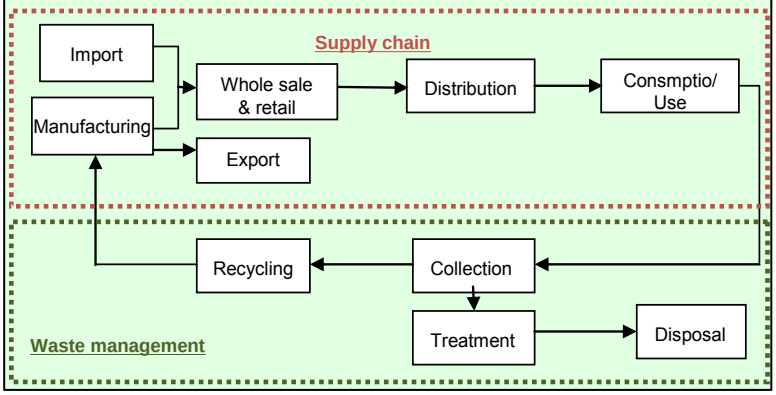
represent the managing tool for creating new products by taking all its lifecycle phases into consideration from the beginning. In some cases it has been used for developing "green solutions". An ISO standard for LCM is under preparation [4]. A principle illustration of the life cycle for a product is shown in Fig.1:

Fig. 1. Principle life cycle for a product.



In line with the general principles for describing life cycles, a life cycle for a PCB containing product in a national perspective is shown in Fig. 2. It should be mentioned that the above diagram does not show the environmental problems connected to the life cycle of PCB containing products, but for each step there is the risk of release/emission of PCBs to the environment.

Fig. 2. Principle life cycle for PCB containing products in a national perspective.



The first step in the life cycle of a PCB containing product is either ***import*** or ***manufacturing*** of the product. Manufacturing may include extraction of basic raw materials from the environment. In case of Vietnam there is no and has been no production of basic PCB chemicals, so all PCB chemicals and PCB containing products have been imported at a certain stage. After import and manufacturing the following step in the life cycle is typically ***wholesale*** and ***retail***. This step might include repacking and storage for some time of the PCB chemicals or PCB containing products. This is followed by ***distribution*** of the products, which basically means transportation of the product from the wholesalers and retailers to the consumer/user. The ***consumption/use*** of the product represents the primary purpose of the product. "Use" is probably the best expression for PCB containing products, as they usually have a very long life. The users may include both private households and companies. When the PCB containing products are discarded after use, it is usually ***collected*** for either treatment or recycling. It should be mentioned that there might be examples on direct dumping of the PCB containing product in the environment after use. ***Recycling*** has been a normal procedure for only few types of PCB containing product, e.g. PCB containing oils in large capacitors, because it has been economical feasible. Often the oil was sent to a workshop, where the oil was refined and/or maybe supplied with new PCB containing oil. In this process some old PCB containing oil has been spilled or used for other purposes. In those cases where PCB containing products have been discarded they are either ***treated*** or directly disposed of. In the early stages of use of PCB containing products only treatment and recycling of PCB containing oil for large capacitors and transformers has taken place. All other discarded PCB containing products (e.g. fluorescents light ballasts and carbonless copy paper) have probably been disposed of. It is only in recent years that PCB containing waste has been treated as hazardous materials. In countries where PCB has been used as e.g. old-based paint, caulking and cable insulation, the PCB may still remain in the buildings. The last destination for discarded PCB containing products has been ***disposal*** at dump sites, landfills or special landfills for hazardous waste. It should be mentioned that some parts of the PCB containing products underway in its life cycle have been lost, whereby the PCB before or later will be released to the environment.

The review of various PCB legislation of different developed countries showed that, most of the countries, which first regulated the PCBs, seemed to start with a very specific regulation of special areas of PCB use.

However, soon after they implemented a more comprehensive regulation, covering several types of products and several steps within the life cycle of the products. In some countries/regions this regulation was implemented according to overall framework laws like chemical management laws or toxic substance control acts (e.g. USA and Japan). The EU regulation of chemicals, REACH, was approved very late in relation to the need for PCB legislation. Therefore, it has not been a framework for the PCB legislation. Instead the cornerstone in the EU for the PCB regulation has been the PCB/PCT Directive 96/59/EC. After a total phase out of the production of new PCBs the focus has been on regulating the collection, treatment and disposal of PCB containing discarded products and waste. Also unintentional movement of PCBs through air, water, soil, and food stuff has been regulated in order to limit the further spreading of PCBs and the environmental and health consequences. In most countries, the regulation of collection, treatment and disposal of discarded products and waste containing PCBs have been regulated according to the overall legislation concerning waste management and hazardous waste management, while regulation of the environmental quality aspects of PCB in air, water and soil have been regulated according to the environmental quality legislation. Regulation of the PCB content in food stuff and feed usually is regulated according to special legislation concerning food quality and feed usually based in the health and agriculture ministries. It is also clear that the countries have harmonized their legislation to overall international legislation underway. However, none of the countries have come to the end of PCB regulation as there still remain some unsolved problems with PCBs in buildings and in waste materials. As it appears, the PCB legislation has developed into a complex area of regulation, involving a number of ministries, with major responsibilities allocated for the environment ministries and in some countries the industry ministries. The development has taken place over 3-4 decades, and from an overall point of view it started with very specific legislation, developing into a phase with more comprehensive legislation involving several life cycle step, ending now with a phase of gap-filling, where focus to a great extend is on handling PCB containing waste products.

Fig. 3. Proposed structure for Vietnamese PCB legislation.

Title: Regulation on life cycle management of PCBs
Preamble: Reference to overarching and other relevant legislation
Article 1: Scope of Law;
Article 2: Objects of Application;
Article 3: Definition of Terms
Article 4: Legal definition of PCBs;
Article 5: Principles of PCB management;
Article 6: Data collection and reporting;
Article 7: Acts to be strictly prohibited;
Article 8: Requirement for management of PCBs and PCB waste:

- Import of PCBs and PCB containing products and materials
- (Manufacturing of products and materials containing PCBs)
- Trade of products and materials containing PCBs
- Distribution of products and materials containing PCBs
- Use of products and materials containing PCBs
- Recovery and recycling of products and materials containing PCBs
- Collection of discarded products and materials containing PCBs
- Storage of products and materials containing PCBs
- Treatment of discarded products and materials containing PCBs
- Disposal of discarded products and materials containing PCBs
- Recovery of sites polluted with PCBs
- Export of products, materials and waste containing PCBs.

Article 9: Standards for PCB in air, water, soil and food stuff
Article 10: Test methods for PCBs
Article 11: Information about PCBs
Article 12: Financial aspects of PCB management
Article 13: International cooperation
Article 14: Responsibilities of public and other relevant organizations
Article 15: Inspection and monitoring
Article 16: Complaints, Denunciations and Lawsuits
Article 17: Entry into Force
Article 18: Guidance for the Implementation

On the other hand, a large number of developing countries have started the regulation of PCBs and POPs after year 2000, often in connection with ratifying the Stockholm Convention. Maybe a few initiatives have been taken earlier, but very little has been converted into actual action. Many of the countries are still in the phase of preparing inventories, considering legislation and very little have been done to recover PCB containing materials and waste, and lack the possibilities to store and treat the waste.

With the assessment and studies mentioned above, we have proposed a structure of Vietnamese PCB legislation, which includes all PCBs in all its applications in all life cycle phases. It is however; appropriate to leave certain aspects, e.g. PCBs in food stuff, to other legislation, as this legislation have already been implemented. The overall structure of the proposed legislation is shown in Fig. 3. This overall and compressive policy is believed to strongly facilitate the sound management of PCBs in Vietnam in the future.

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