– Keep the Promise at COP4

Open System Uses of PCBs
"Blowing in the Wind"

Introduction:

In 1992 some of the concerns of the environmental movement in relation to PCBs were succinctly summarised by Peter Montague [1] who wrote:

"Between 1929 and today, Monsanto made, or licensed someone else to make, a total of 1.2 million tons of PCBs[Tanabe[1]] .Of this total, 31% (370,000 tons) has so far escaped into the general environment. An estimated 4% of original production has been fed into incinerators, in hopes of destroying it. However, 780,000 tons of PCBs are still in use in transformers and capacitors, or have been sent to landfills where they are waiting patiently to escape. Thus the amount waiting to be released into the environment is approximately twice as large as the amount that has already been released."

The numbers have been improved slightly but the current situation is not very different from that of 20 years ago. Almost all the international efforts have, however, been focussed on uses of PCBs in capacitors and transformers. Whilst these are important stockpiles there is increasing evidence that "open system" use of PCBs, such as for building sealants, are a more important source of contemporary contamination.

These open source uses, releases and residual contamination should not be over-looked. Initiatives like the PCB Elimination Club that is proposed at COP4 should include these uses within their remit.

PCB Production:

Perhaps the best available data currently available for total PCB production is that published by Breivik [2] which shows a total global production of approximately 1.3 million tonnes over the period from 1930 to 1993:

Total PCB production as reported in the literature (in tonnes)

Producer	Country	Start	Stop	Amount	%	Reference
Monsanto	USA	1930	1977	641,246	48.4	de Voogt and Brinkman (1989)
Bayer AG	West Germany	1930	1983	159,062	12.0	de Voogt and Brinkman (1989)
Orgsteklo	U.S.S.R. (Russia)	1939	1990	141,800	10.7	AMAP (2000)
Prodelec	France	1930	1984	134,654	10.2	de Voogt and Brinkman (1989)
Monsanto	U.K.	1954	1977	66,542	5.0	de Voogt and Brinkman (1989)
Kanegafuchi	Japan	1954	1972	56,326	4.2	Tatsukawa (1976)
Orgsintez	U.S.S.R. (Russia)	1972	1993	32,000	2.4	AMAP (2000)
Caffaro	Italy	1958	1983	31,092	2.3	de Voogt and Brinkman (1989)
S.A. Cros	Spain	1955	1984	29,012	2.2	de Voogt and Brinkman (1989)
Chemko	Czechoslovakia	1959	1984	21,482	1.6	Schlosserová (1994)
Xi'an	China	1960	1979	8,000	0.6	Jiang et al. (1997)
Mitsubishi	Japan	1969	1972	2,461	0.2	Tatsukawa (1976)
Electrochemical Company	Poland	1966	1970	1,000	<0.1	Zulkowski et al. (2003)
Zaklady Azotowe	Poland	1974	1977	679	<0.1	Falandysz (2000)
Geneva Industries	USA	1971	1973	454	<0.1	de Voogt and Brinkman (1989)
Total	Global	1930	1993	1,325,810	100	

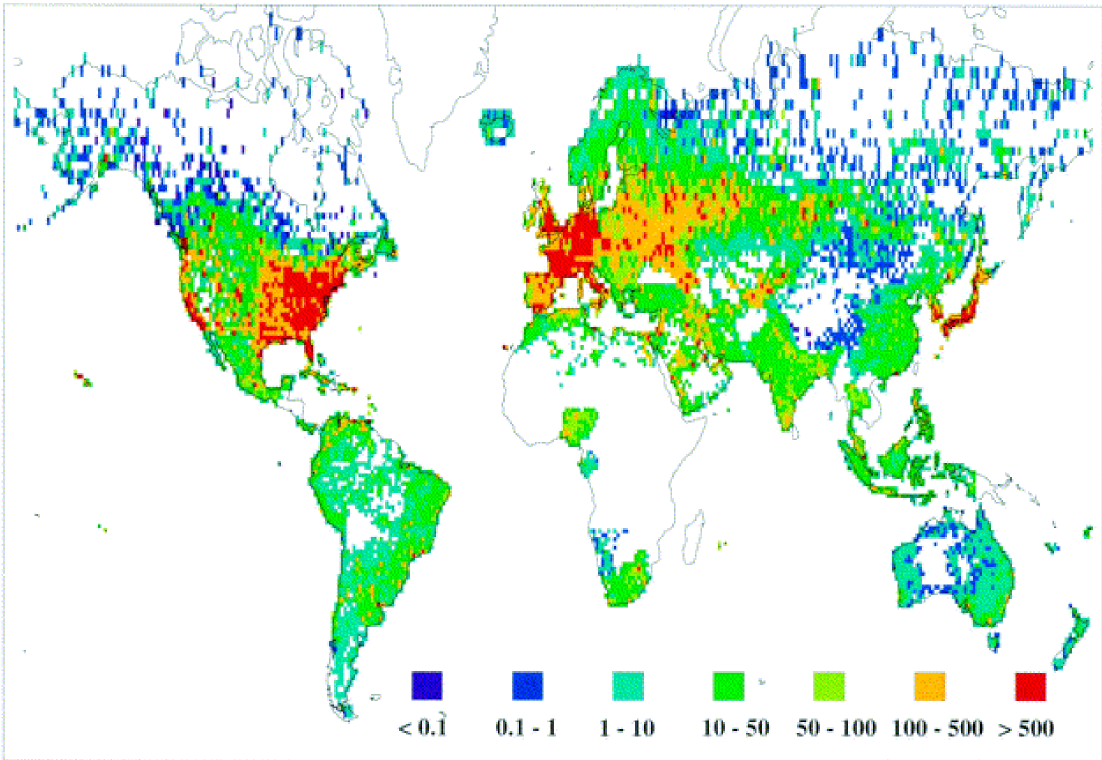
Approximately half of the total production was in the United States and only 10% of the total was manufactured outside either the USA, USSR, West Germany, France, UK or Japan.

PCB Usage:

[1] Shinsuke Tanabe, "PCB Problems in the Future: Foresight from Current Knowledge," ENVIRONMENTAL POLLUTION Vol. 50 (1988), pgs. 5-28

Approximately 48% of PCBs were used for transformer oil; c. 21% for small capacitors; 10% for other ‘nominally closed’ systems; and 21% for open uses.

Breivik [3] plotted global usage and suggests that almost 97% of the global historical use of PCBs have occurred in the Northern Hemisphere:



Remaining Stocks:

Whilst global production of PCBs ceased in 1993 [3] it is estimated that between 12.9% and16.5% of the original PCBs remain in use – the majority of which are in long-lived closed systems [2]. Many electrical transformers containing, or contaminated with, PCBs remain in use and it is estimated that c. 4 million tonnes of such equipment will eventually require environmentally sound waste management [4].

The real figure may be even higher. The Stockholm Convention secretariat reviewed the PCB data in the National Implementation Plans from the 88 parties who had submitted them by December 2008[2]. The results show that >6,431,886 tonnes of PCB contaminated oil together with 472,853 tonnes of contaminated equipment are listed by these 88 parties alone [5].

Treatment and Disposal Costs:

With current total treatment costs of US $2,000 to $5,000 per tonne (including packing, transport and destruction) this would amount to an estimated US $8 to $35 billion to manage transformer-associated PCBs alone. A comparison to the US $550 million allocated GEF funding for the Stockholm Convention from 2003 to 2010 demonstrates the magnitude of the financial challenge to implement the PCB obligations of the Stockholm Convention by the target date of 2028 [4].

The costs of a failure to act are even higher. The clean up and rehabilitation costs a single transformer fire in the US in the 1980s over the ten years after the accident ran to more than $40 million[3] [6]. The building had only cost $17 million to construct. Fires in less affluent countries will have resulted in lower costs but almost certainly greater levels of damage to human health and the environment.

[2] 98 NIPS had been received by 24th April 2009 had been received – a further 64 are currently outstanding – 46 of which are overdue – many by nearly two years

[3] Equivalent to significantly more than 100 times the budget of the PEC at current values.

Current Sources of Emissions:

The approach adopted to PCBs by many parties cover only the 'closed system' use of PCBs in transformers and transformer oil. Whilst transformers and electrical equipment were the major uses of PCBs and are still important reservoirs [7] they may not be the most environmentally damaging source.

Data presented by Meijer [8] confirms the conclusion of Bignert et al [9] that at the present time PCB levels in background European air are still mostly controlled by primary emissions, rather than recycling/ secondary emissions from the major environmental repositories such as soils or water bodies.

Du et al [10] reported that whilst Aroclors represent more than 70% of all the PCBs produced in the US they only comprise about 27% of the atmospheric PCB burden in their study of Camden. The authors wrote the "*reasons for this discrepancy are not immediately apparent*". The most likely explanation, however, and one that is often overlooked, is that open system applications of PCBs are the major contributor to the atmospheric burden of PCBs.

Historically approximately 50% of the total[4] emissions have come from 'open system' uses. These open systems, such as building sealants, have resulted in total emissions about five times higher than closed systems. Whilst some countries have taken positive steps to address remaining open system uses (notably Norway, Sweden, Finland and Switzerland) other countries known to have similar problems have not even acknowledged these uses in their National Implementation Plans This is in spite of the increasing evidence indicating that these 'open system' uses of PCBs may currently be responsible for higher health risks and more environmental contamination than the remaining use of PCBs in transformers.

Open System Uses:

Open system applications of PCBs have included plasticisers, carbonless copy paper, lubricating oils, inks, laminating and impregnating agents, paints, adhesives, waxes, additives in cement and plaster, casting agents, dedusting agents, sealing liquids, fire retardants, immersion oils and pesticide extenders [de Voogt and Brinkman, 1989 quoted by [11]].

In Japan, most of the open use was for carbonless copy paper (Masuda et al., 1972; Tatsukawa,1976 quoted by [11]). Whilst much of this paper has been archived it has been noted as a source of contamination in paper recycling.

In the USA plasticisers were the principal open use (Nisbet and Sarofim, 1972). In 1972, Monsanto, the only North American manufacturer of PCBs, voluntarily ceased marketing them in dispersive uses, e.g. in commercial products such as carbonless carbon paper, printing inks, sealants, paints, etc [12]. The manufacture of PCBs for all other uses stopped in 1977.

The elastic polysulphide sealants used on prefabricated residential buildings, was identified in the 1990s in Germany, Sweden and Finland as a source of PCB contamination and Wong [13] recently noted:

The "fresher" signature observed in urban areas is presumed to be due to emissions from past and present uses of the chemicals [14]. For example, fresh emissions include those from banned "legacy" substances such as PCBs that are incorporated into the urban fabric within building sealants and other building materials.

Since the mid 1990's the increasing importance of urban areas as current source regions of PCBs to the atmosphere has been identified [11, 15-18].

Many houses and, especially, public buildings constructed with PCB containing materials during the period from 1950–1970s still exist [19]. It is estimated that in the Federal Republic of Germany alone about 20,000 tons of PCBs were used in the construction of school and office-buildings [20]. Estimates for the UK are 500 tonnes [21]. In Denmark it is estimated that 75 tonnes of PCB is still in buildings [22].

Usage has also varied in different countries. In Germany, PCB-containing sealants were used more often in indoor seams whilst in Finland PCBs were mainly used in outdoor seams between concrete blocks.

[4] including those from accidental releases; direct emissions; open burning, landfill and incineration

Estimates of the volume of PCBs used in sealants in Finland vary from 130 t to 270 t [23]. The most frequently applied commercial mixture was Aroclor 1260 or Aroclor 1254. A large block of flats can contain as much as 40–50 kg of PCB [23].

It appears that the use of PCBs in sealants and similar uses has been restricted mainly to the more developed countries. Devanathan [24] noted, for example, that although the suburbs the metropolitan cities tested for PCBs in ambient air and breast milk were industrialised "*PCBs levels are still low, indicating minimal usage of PCBs in open systems in India*".

Furthermore Breivik [3] suggests that almost 97% of the global historical use of PCBs have occurred in the Northern Hemisphere.

Only a few of the countries affected, including Sweden, Switzerland and Norway appear to have taken the issue seriously enough to recognize in their National Implementation Plans and to initiate action to address the problems.

The Swiss National Implementation Plan [25] says:

Joint sealants represent long-term diffuse sources for PCBs. The PCB inventory present in these materials is large enough to sustain elevated levels of PCB in indoor air for a very long period of time.

Joint sealants in concrete buildings erected between 1955 and 1975 and anti-corrosive coatings in large steel constructions (e. g. bridges, storage tanks, masts of high volume transmission lines) represent major inventories of PCBs in open systems. Removal and appropriate disposal of old joint sealants, coatings and paints from construction materials is crucial to prevent significant amounts of PCB being released into the environment and, eventually, incorporated in biota along the food chain.

Sweden is one of the few countries to have taken action in relation to these important reservoirs of PCBs. The Swedish National Implementation Plan said:

"Another important use is as a plasticizer in sealants used for joints in buildings: between prefabricated concrete cladding panels, in dilatation joints for large brick façades, around retail store fronts and around windows. Insulating glazing has been sealed with a sealant plasticized with PCBs. These sealants were mainly manufactured under licence in Sweden. The use of PCBs as hydraulic and heat transfer fluids was discontinued in the early 1970s, following the denial of permits. PCBs have also been used in paints for ships and corrosive environments. An application in the food industry was as a plasticizer in an acrylic, non-skid flooring material."

Legislation has recently been introduced requiring surveys and removal of these sealants and non-slip flooring materials.

Norway has undertaken an inventory of PCBs in building materials [26] and It has been calculated that around 85 tonnes, or approximately 18% of existing PCB, is present in plaster in Norwegian buildings. Other sources of PCB calculated include, glue in double-glazing (200 t), condensators (sic) (105 t), joint sealants (50 t) and paint (10 t). The consequence is that plaster regularly exceeds the threshold for hazardous waste as do some entire homes, schools and office buildings built in the period 1960-69.

The problem is not just an external one - Rudel [27] detected PCBs in indoor air in 31% of 120 homes tested on Cape Cod, MA.

Many sealants have been used internally together with PCB contaminated non-skid flooring and even floor polishes containing PCBs.

Evaporation and abrasion of PCBs can result in considerable house dust and indoor air contamination [19, 27, 28], leading to the increased PCB body burden of residents and occupants, probably through inhalation or ingestion exposure [27, 29].

Results of a US population-based case-control study that examined non-Hodgkin lymphoma (NHL) risk and exposure to PCBs in carpet dust as an exposure indicator suggest an increased risk of NHL associated with exposure to PCBs, with evidence of greater effects for PCB 180 [30].

While inhalation is the principal indoor pathway under a typical dust ingestion scenario, exposure via dust ingestion can exceeds that from either inhalation or diet for some North American toddlers [31].

Priha [23] demonstrated that in the most exposed cases of outdoor sealant use children can be exposed to daily doses near the level of the reference dose.

Direct transfer to food is possible in some applications. Sweeney [32] reported that while testing a bulk milk sample for pesticides in 1974, the Michigan Department of Agriculture detected PCB which was subsequently traced to a sealant called Kumar (33% PCBs) that had been introduced in Michigan in 1941[5].

Since exposure via food is gradually declining, indoor air is likely to become a more visible source for human exposure with dioxin-like PCB and should be urgently addressed because evaporation from non-remediated PCB sources in the indoor and urban environment continues over very long periods.

Most of PCB-contaminated public buildings erected in the 1960s and 1970s are still in use and will further be used for years or even decades. If the PCB issue is not addressed now then it is likely to become worse and especially when the buildings are finally demolished.

Ultimate Disposal:

Whether the PCBs for disposal are collected from open or closed systems particular attention should be given to disposal and environmentally sound management. Incineration of PCBs has resulted in some high levels of releases to the environment [33, 34] and non-incineration alternatives should be used where possible.

EndNotes

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