NGO eco-SPES, town of Dzerzhinsk, Nizhegorodskaya province, Russia

eco-dzerzhinsk@yandex.ru

PCBs: Progress in Waste Management

Report

2019
Abbreviations

AMAP – Arctic Monitoring and Assessment Programme
EU – European Union
IPEN – International POPs Elimination Network
PCBs – polychlorinated biphenyls
POPs – Persistent Organic Pollutants
REA – Russian Energy Agency
eco-SPES – NGO social and legal environmental partnership
Sovol - mixture of tetra and pentachloro biphenyls
TCBs – trichloro biphenyls
UNIDO – United Nations Industrial Development Organization
Poly-chlorinated biphenyls (PCBs) belong to the group of chemicals known as persistent organic pollutants (POPs). They are characterized by toxic properties, they are persistent and bioaccumulative, and they can be transferred over long distances in various media.

PCBs get into the environment by various routes. This happens as a result of modern industrial use, and also, as a by-product of industrial processes. PCBs make their way into the environment from technical products, transformers, capacitors, varnishes, paints, chemicals, construction materials, etc. Out of all the volume of PCBs, produced 35% ends up in the environment [17].

PCBs are extremely toxic for people and for the environment. PCBs are listed under Annex A of the Stockholm Convention on Persistent Organic Pollutants for elimination by 2028. PCB congeners are close to dioxins in their physical and chemical properties.

The development of intrauterine pathobiology proves the fact that PCBs are capable of passing the placental barrier. In the same way as dioxins, some dioxin-like PCBs can interact with AhR-receptors, causing related changes in cell metabolism [18].

**Production of PCBs in Russia**

The manufacturers of PCBs in the USSR, and then in Russia, were the factories “Orgsteklo” (Town of Dzerzhinsk, Nizhegorodskaya province) and “Orgsintez” (Town of Novomosskovsk, Tulskaya province).


For the whole operating period of the above factories - 1939 until 1993 - they produced 180 thousand tons of various PCB brands.

Trichlorobiphenyl (TCB), or a blend of tetra- and penta trichlorobiphenyls (sovols), were used in many ways in diverse industries.
PCBs mixed in various ratios with electric 1,2,4-trichlorobenzene were produced under the trademark of Sovtol and were used as dielectric fluids for filling transformers. The blend of Sovtol with 1,2,4-trichlorobenzene was sold under the trademark of Sovtol-10 since 1957.

**PCBs-containing equipment in the territory of Russia**

An inventory was carried out by the Ministry of Nature and Ministry of Industry and Science of the Russian Federation under the AMAP project in 1999 at the chemical and petrochemical factories, in iron and steel companies, engineering companies and the forest-industry complex, including paper and paperboard industry. According to the data based on the results of the inventory, the volume of PCBs available in these enterprises amounted to 9900 tons, including in 3342 transformers – 9000 tons, and in 44382 capacitors – 900 tons.

In 1999, in the companies of fuel and power complexes, they operated or kept on standby 175,837 pieces of electric equipment, where polychlorinated biphenyls were used; the total volume of polychlorinated biphenyls amounting to 3140 tons. The inventory in fuel and power complex companies showed that 22 power transformers were found, where the insulation fluids were polychlorinated biphenyls.

7 territorial subjects of Russia out of 89 did not submit information on the presence of PCBs-containing equipment in place in the course of the first inventory of PCB sources in Russia (1999).

The information obtained from 82 territorial subjects of the Russian Federation was not complete enough, because it did not include data on some enterprises. According to expert estimates, the volume of PCBs in the equipment of those enterprises could amount to around 5,800 tons.

Railway transport does not normally use PCBs–containing equipment. However, according to the expert estimates, out of 12000 railway stations around one half – 6000 - could use equipment containing PCBs. According to these same estimates, at the time of the inventory process, there could be up to 1000 tons of PCBs in the electric equipment at railway stations.

The distribution of PCBs across various branches of industry in Russia for that moment corresponded to the distribution of industrial units in those regions. Thus, the major part of the chemical factories and engineering companies were located in Povolzhie regions (Volga basin), so in the course of inventory development they detected major volumes of PCBs in the equipment there. The majority of PCBs in PCBs-containing equipment in this region were found at JSC “KFMAZ” (2053 tons) and “AVTOVAZ” in the town of Samara (1940 tons).

In the Urals region, the major quantity of the ferrous metallurgy companies are located in Sverdlovsk and Cheliabinsk provinces and, accordingly, they found high content of PCBs in the equipment at 1643 and 1246 tons, respectively.
Table № 1. PCBs in transformers and capacitors in the territory of the Russian Federation

<table>
<thead>
<tr>
<th>Years</th>
<th>Q-ty, pcs</th>
<th>PCB tons</th>
<th>Years</th>
<th>Q-ty, pcs</th>
<th>PCB tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1939-1949</td>
<td>1 000</td>
<td>1 800</td>
<td>1950-1959</td>
<td>2 000</td>
<td>3 600</td>
</tr>
<tr>
<td>1960-1969</td>
<td>2 600</td>
<td>4 800</td>
<td>1968-1979</td>
<td>750 000</td>
<td>14 900</td>
</tr>
<tr>
<td>1970-1979</td>
<td>7 400</td>
<td>14 000</td>
<td>1980-1989</td>
<td>450 000</td>
<td>9 100</td>
</tr>
<tr>
<td>1980-1989</td>
<td>5 200</td>
<td>10 000</td>
<td><strong>Total</strong></td>
<td><strong>18 200</strong></td>
<td><strong>34 200</strong></td>
</tr>
</tbody>
</table>

More than a half of PCBs (61%) were found in decommissioned PCBs-containing electric equipment (in 124 transformers and in 5222 capacitors) in ferrous metallurgy companies. The highest quantity of the capacitors in ferrous metallurgy companies is concentrated in the Urals, in the JSC “Cheliabiskiy Metallurgy Combine” – 1901 pcs and JSC “Verkhnesaldinskoye Metallurgy Corporation” – 1690 pcs, and also in Povolzhie, including “Samarskiy Metallurgy Plant” (500 pcs).

According to the data of 1999, in the fuel and power complex of Russia, 91 companies operated 19 657 capacitors and 3872 transformers filled with PCBs.

According to the inventory results, the total amount of the capacitors operated at the enterprises of the Russian Federation was 193 179, where 3439 tons of trichlorobiphenyl (TCB) were filled.

The amount of detected PCBs in PCBs-containing equipment in the territory of Russia was 27 000 tons, and, taking into account the PCBs in the waste, the total value of PCBs identified in the territory of Russia through the inventory of 1999 amounted to 33 600 tons [1].

JSC “Transregional distribution network company of Siberia” reported the decommissioning and recycling of equipment containing PCBs in the year of 2015 in the amount of 28 tons. The “Transregional distribution network company of Siberia” and “MRSK of Siberia” in May 2009 obtained a joint license for activities in the collection, use, decontamination, transportation and disposal of hazardous waste.

The “MRSK of Siberia” includes the following branches: Altaenergo, Buriatenergo, Gorno-Altaiskie power lines, Krasnoyarskenergo, Kuzbassenergo-RES, Omskenergo,

Table № 2. The amount of PCBs by the sectors of industry in 1999 in the territory of the Russian Federation

<table>
<thead>
<tr>
<th>№</th>
<th>Industry branch</th>
<th>Transformers</th>
<th>Capacitors</th>
<th>Total PCBs in the eqpt (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chemical, petrochemical, iron and steel, non-ferrous industry, forest chemical industry, paper and paperboard industry, engineering companies</td>
<td>3543</td>
<td>9028</td>
<td>48515 879</td>
</tr>
<tr>
<td>2</td>
<td>Fuel and power Complex</td>
<td>22</td>
<td>40</td>
<td>175815 3139</td>
</tr>
<tr>
<td>3</td>
<td>Data from territorial environmental protection bodies</td>
<td>3599</td>
<td>4175</td>
<td>133170 2745</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>7164</td>
<td>13243</td>
<td>357500 6763</td>
</tr>
</tbody>
</table>

In particular, En + company reported that it conducts replacement of high-voltage capacitors containing trichlorobiphenyl in its subsidiaries. As Mr. Boris Karataev, the Director General of Irkutsk Grid Company said to BG, “... by now, more than 1,000 capacitors out of 6720 have been replaced. The replacement plan for 2017 covers 1800 items. Dismantled trichlorobiphenyl-containing capacitors were completely utilised under a contract with specialised organisations. In the period from 2015 to 2016, 59.77 tons were utilised” [4].

It is necessary to point out, that a significant amount of the Russian companies conceal information on the presence of electric equipment containing PCBs and / or PCB waste at their sites, refusing to provide it not only to NGOs but also to UNIDO, or even the governmental bodies.

The companies are unwilling to disclose the information on the disposal of contaminated oil. The representatives of the companies often say to the experts, that the investigation of the oils in the equipment for the presence of PCBs was already done and no hazardous substances had been found. However, no company discloses information on the brand of the oils for capacitor filling, or the additives used or the composition of such additives.

We asked, for example, the JSC “Kamaz”, and they answered that the analysis had been already done, PCBs were found and destroyed. However, the company did not answer the questions about the scope of equipment inspection and the particular method of the hazardous waste disposal, according to UNIDO expert Yekaterina. In the JSC “Kamaz” they also did not respond to the request of “Ъ” newspaper [8] for information.
According to the inventory by AMAP done in 1999, 76 companies of fuel and power complexes operated electric transformer units, where the electric equipment was filled with PCBs. The distribution of the PCBs-containing equipment was as follows:

- power generation - 173378 capacitors and 1144 transformers of various outputs at 53 power generating companies;

- petroleum industry – 2036 capacitors and 20 transformers of various outputs at 14 companies;

- coal mining industry – 401 capacitors and 2 transformers of various outputs at 8 companies.

According to the estimates that experts of Ministry of Natural Resources and Ecology of the Russian Federation gave, in 2009 84 fuel and power companies installed 188 740 pieces of electric equipment containing PCBs, including 960 transformers and 187 780 capacitors. The total volume of PCBs-containing oil was measured as 4298.4 tons. In 2009, according to expert estimates of the Ministry of Natural Resources of Russia, 188740 units of PCBs-containing electric equipment, including 960 transformers and 187780 capacitors, were installed in 84 organisations of the fuel and energy complex. The total amount of PCBs-containing oils was estimated at the level of 4298.45 tons.

The processing of the resulting data demonstrated that in 81 enterprises they accumulated 7147 tons of synthetic PCBs-containing transformer oil. On the books of the enterprises they have 152 254 pieces of electric equipment containing PCBs, including 1311 transformers and 150 943 capacitors.

More than 80% of the capacitors and 92% of the transformers containing PCBs are currently in operation. The working lifespan of the majority of the equipment reaches 25-30 plus years.

PCBs-containing transformers are concentrated in 5 enterprises (PJSC “Enel Russia”, JSC “Evraz Holding”, State Corporation “Rosatom”, PJSC “Sevestal” and JSC “Gazprom”). Around 80% of PCBs-containing capacitors are on the books in 3 enterprises (JSC “FSK YES”, JSC “Russian networks” and SC “Kurganenergo”).

The highest volumes (4730 thousand tons) of synthetic PCBs-containing oils are owned by PJSC “Enel Russia”, one of the leading Russian wholesale producers of electric and heat energy. The main volume of PCBs is concentrated at 2 regional hydro-electric power plants - Reftinskaya and Sredneuralskaya in the Ural region.

Half of all the transformers containing PCBs at power generation enterprises is concentrated at the companies of the Urals Federal District. The highest quantity of capacitors is accumulated at the enterprises of the Urals and the Central federal districts. More than a half of the total volume of PCBs-containing oil is concentrated at the enterprises of the Urals federal district. Almost one third is found at the enterprises in the Central Federal District, and an insignificant amount at the enterprises of North-West and Privolzhskiy federal districts [5].

In 2015, within the frame of the UNIDO project in cooperation with the Russian Energy Agency, and with the support of the Ministry of Energy of Russia, the pilot inventory of fuel and power companies was carried out to determine the availability of PCBs-containing equipment. The inventory data revealed that in 79 enterprises they accumulated 7147 tons of PCBs-containing synthetic transformer oil. These companies have on their books 152 254 pieces of electric equipment containing PCBs, including 1311 transformers and 150 943 capacitors [6].
PCBs-containing transformers are concentrated in 5 major enterprises (PJSC “Enel Russia”, LLC “Evraz Holding”, State Corporation “Rosatom”, PJSC “Sevestal”, and JSC “Gazprom”). Around 80% of equipment containing PCBs are on the books in 3 enterprises (JSC “FSK YES”, JSC “Russian networks” and SC “Kurganenergo).

Virtually all the volume of PCBs-containing oils (96%) is concentrated in 3 fuel and power enterprises: PJSC “Enel Russia”, PJSC “Machine Building Plant” (State Corporation “Rosatom”) and LLC “Evraz Holding”. The highest volumes of synthetic PCBs-containing oils are owned by PJSC “Enel Russia” - one of the leading Russian wholesale producers of electric and heat energy.

Half of all the transformers containing PCBs at the power generation enterprises are concentrated at the companies of the Urals Federal District. The highest quantity of capacitors is accumulated at the enterprises of the Urals and the Central federal districts. More than half of the total volume of PCBs-containing oil is concentrated at the enterprises of the Urals federal district. Almost one third is found at the enterprises in the Central Federal District, and the remaining part at the enterprises of North-West and Privolzhskiy federal districts [7].

The Ministry of Environment and Natural Resources (Ministry of Nature of Russia) was appointed, as an authorized body, responsible for the implementation of the provisions of the Stockholm Convention. The Federal Service for Natural Resource Usage (Rosprirodnadzor) was included into the list of responsible authorities for the provisions, relating to the Stockholm Convention by the Governmental Decree of the RF from 29.06.2015 N 651. The Ministry of Ecology and Natural Resources (the Ministry of Natural Resources of Russia) has been appointed the authorised governmental body of the Russian Federation in charge of implementation of provisions of the Stockholm Convention. By RF Government Decree # 651 of June 29, 2015, the Federal Supervisory Natural Resources Management Service (Rosprirodnadzor) was incorporated into the list of responsible authorities as pertains to the Stockholm Convention on POPs.

At the same time, as evidenced in practice, the officers of this department (Rosprirodnadzor) either do not have complete information on the stock of PCBs or PCBs-containing waste, or are unwilling to provide this information to environmental NGOs.

Thus in the letter № 11-57/1412 from 14.03.2019, the management of the Rosprirodnadzor for Far East Federal District informed the interested parties, that they do not have the information on the PCBs-containing electric equipment. In particular, by its letter No. 11-57/1412 of March 14, 2019, senior managers of Rosprirodnadzor Office in the Far Eastern Federal District reported that the Office had no information on volumes of PCBs-containing electric equipment.

Similar responses about lack of information were provided by the departments of Rosprirodnadzor for the Southern Urals, Central, and Urals federal districts.

The Transregions Management of Rosprirodnadzor for the Krasnoyarkiy Krai and the Republic of Tyva reported that as of April 2019, the SC “Tyvaenergo” owns 302 pieces of equipment containing 17,516 tons of PCBs. The decommissioning of the above equipment is planned for the period from 2020 to 2022. Here it is necessary to point out, that at the time of the inventory of 1999 the information for the Republic of Tyva was not available.

The branch of SC “RZhD” Krasnoyarskaya railroad, SC “Krasmash”, PJSC “MRSK of Siberia-Krasnoyarskenergo”, FGUP “GKhK” and PJSC “Krasnoyarskenergosbyt” confirmed the lack of PCBs-containing equipment.
It is fair to assume that the major companies of Kraisnoyarskiy Krai: JSC “KraMZ”, SC “Rusal Krasnoyarsk”, JSC “Krashtsvetmet”, Kraisnoyarsk branch of JSC “SGK” and PJSC “GMK Norilskiy Nikel” have on their books the PCBs-containing equipment, as before. The Management of Rosprirodnadzor for Kraisnoyarskiy Krai has no information, as of April 2019, about the presence of PCBs-containing equipment and PCBs-containing waste at the above companies. The licensed companies which operate activities on collection, transportation, processing, recycling, decontamination and disposal of PCBs at the territory of Kraisnoyarskiy Krai, based on the information from the Management of Rosprirodnadzor for Kraisnoyarskiy Krai, are non-existent.

Pic.1 The response of Rosprirodnadzor Dept. for the Far East District. (In the response it is written that the Rosprirodnadzor Dept. for the Far East District has no information on the availability of transformers and capacitors containing PCBs at the above territory because the items relating to the inventory of electric equipment containing PCBs are out of the scope of their responsibilities).
In 1999, SC “Omsk Oil refining plant” (Omskaya province) had 2 decommissioned capacitors containing 0,008 tons of PCBs, as well as 10 transformers in operation. Currently in the 2019, the company continues to operate 10 transformers TH3-40/10. There are no capacitors in operation and, according to the plan, the operational fleet of transformers will be decommissioned by 2025. The content of PCBs-containing oil in them amounts to 205 kgs. The volume of “Sovtol” in each is calculated at 2,050 tons.

In 1999 at SC “KuibyshevAzot” (Samarskaya Province) there were 21 decommissioned capacitors containing 0,21 tons of PCBs. Currently, according to the report of the company, there are 2 transformers and 177 capacitors containing PCBs.

In 1999 JSC at “Samarskiy Metallurgical plant” (Samarskaya province) there were 1 decommissioned transformer and 500 decommissioned capacitors containing 12,71 tons of PCBs. According to the response from the SC “Arconic CMZ”, now, in 2019, there isn’t any PCBs-containing equipment in the company.

In 1999, at the JSC “Norilskiy Nikel” (Kasnoyarskiy Krai), there were 3 decommissioned transformers and 246 decommissioned capacitors containing 10,76 tons of PCBs, as well as 222 operating transformers for that period. By 2019 there is no publicly available information on availability or lack of PCBs-containing equipment or waste at the plant. The plant provided no answer to the request in 2019.

In 1999 the JSC “Production association “Volzhskiy Pipe Factory” (Volgogradskaya province) had 12 decommissioned transformers and 99 decommissioned capacitors containing 24,2 tons of PBCs. By 2019 the company has at its disposal 55 transformers, including: 35 in operation, 9 on standby, 4 – decommissioned and 7 - recycled. The company has 1076 capacitors, including: 549 – in operation, 98 – on standby, 60 – decommissioned and 369 - recycled.

In 1999, at JSC “GAZ” (Gorkovskiy automobile plant), in the city of Nizhniy Novgorod, they had 149 transformers and 3368 capacitors, having the maximum amount of PCB oils in the territory of the Nizhegorodskiy region - 580,79 tons of PCBs and 12,3 tons of PCBs in the waste. In 2005 at JSC “GAZ” (according to the plant’s data) they found 154 pcs of equipment containing PCB oils as a result of the inventory made by SPES. In 2019 the plant management did not respond to the request, which may signify the continuation of operating the equipment containing PCBs.

In 2005, in the course of the inventory made by SPES at the SC “Vyksunskiy metallurgical works” (town of Vyksa, Nizhegorodskaya province) and according to the information from the company, it was found that they held 22 transformers and 198 capacitors. As a result of the calculations it was estimated that the amount of PCB oils in total constituted 47,5 tons of PCBs.

In 2005 SC “Lukoil – Nizhegorodneftorgsyntez” (town of Kstovo, Nizhegorodskaya province) held 4 transformers containing “Sovtol-10”. In 2005 in the company they planned to decommission 2 transformers.

In 1999 at the SC “Plastik” (town of Dzerzhinsk, Nizhegorodskaya province) they held 35 transformers and 128 capacitors. In 2005 they held 27 transformers of TNZ type filled with “Sovtol 10”. In 2019 the company did not respond to the request.
PCBs-containing waste

According to the data for 1999, the highest quantity of contaminated capacitors was stored in the Urals region and amounts to 4857 pieces containing 65.7 tons of TCB.

The total emissions and releases from all the 8687 transformers, which were in operation during the time of inventory in 2000, amounted to 130 tons/year. Taking into account that the working lifespan is 25 years, the emissions and releases of PCBs into the environment from the operating transformers could be estimated at 3300 tons.

Some companies of the power complex for that period (1999) provided information about disposal of their faulty capacitors, which contained PCBs and TCB, at the municipal landfills.

In the Russian Federation the waste substances and waste goods containing or contaminated by PCBs to the level of 50 mg/kg (within the guidelines of the Transnational GOST 30774-2001 “Efficient use of resources. Management of waste. Hazardous Waste Data Sheet. Key requirements”) are qualified as waste of the first class (extremely hazardous waste).

In the current federal waste classification catalogue (FKKO) for the Russian Federation, transformer and other used oils containing polychlorinated biphenyls are also qualified as the first class hazardous waste for the environment- extremely hazardous waste.

The highest quantity of PCBs and PCBs-containing equipment, as of 1999, was located in the territory of Krasnoyaskiy krai (total for the krai area - 990 tons) and concentrated in the following cities:

- city of Krasnoyarsk – around 396 tons of PCBs in 197 transformers and 821 capacitors; a major owner is Krasnoyarskiy pulp and paper plant (Krasnoyarkiy pulp and paper mill TsBK), where there around 290 tons of PCBs in 151 transformers and 242 capacitors. JSC “Krasnoyarskenenergo” is a major owner of PCBs-containing capacitors = 1669 pcs;

- city of Norilsk - around 461 tons of PCBs in 223 transformers and 397 capacitors, the only owner is Norilsk ore mining and smelting combine.

In Yamalo-Nenetskiy autonomous district the highest quantity of PCBs (total for the district around 235 tons) and PCBs-containing equipment are concentrated in the cities of:

- Novyi Urengoi - around 118 tons of PCBs in 67 transformers;

- town of Noyabrsk – around 114 tons of PCBs in 75 transformers and 41 capacitors.

[2]

Facts on unauthorized transportation and disposal of waste containing PCBs in the territory of the Russian Federation

Count 1. In the territory of the urban district of the town of Vyksa, Nizhegorodskaya Province, in two hangars and basements close to Doschatinskoye highway, 700 tons of waste (including waste containing PCBs -pentachorbibhenil, hexachlorbibphenyl and tetrachlorbibphenyl) were illegally buried without authorization in 2008-2009.

In the hangars by Doschatinskoye highway, buildings 50/1 and 50/2, just 200 meters from the gardeners' partnership houses and 50 meters from residential construction, the businessmen
from “Nizhegorodbusinessecologia” set up a landfill for paintwork materials, PCBs and oil sludge.

In 2014, according to the data from the analytic survey made by Testing Laboratory Centre of the Chemical Research Institute of the Nizhegorodskiy State University, the name “Lobachevskiy” was found there: chromium compounds, compounds of zinc, lead and copper and polychlorinated biphenyls, which are listed under the Stockholm Convention and are POPs (persistent organic pollutants)- pollutants of the first hazard class. The Russian Federation is a Party to and has ratified the Stockholm Convention, In 2014, according to results of analytical studies conducted by Chemical R&D Institute of N.I. Lobachevskiy Nizhny Novgorod State University, the following components were identified in these wastes: chromium, lead, zinc and copper compounds, as well as polychlorinated biphenyls, classified as 1st Hazard Class substances and subject to the Stockholm Convention on Persistent Organic Pollutants (POPs) ratified by the Russian Federation.

In 2015 a part of the waste, namely 20 tons, including PCBs waste, was moved out for disposal purposes in Omsk province. However, the waste was not treated, because the company “Merk” not only lacked the license for treatment, but also made unauthorized burial of the waste.

The samples of soil, water and other solid waste also contain the salts of heavy metals: copper, chrome, zinc, lead, iron. Most likely the heavy metals came in with galvanic sludges buried in this store. The hazard class of the waste is 3 - 4.

The samples of soil contaminated by oily sludge contain chlorinated biphenyls: the sample 4 was taken from the depth of 4-5 meters, the sample 5 – from the next store. These samples belong to hazard class 1- carcinogen, which are extremely dangerous for people and the natural environment.
Пробы грунта, воды и других твердых отходов содержат также соли тяжелых металлов: меди, хрома, цинка, свинца, железа. Скорее всего тяжелые металлы поступили вместе с гальванишламами, захороненными в этом складе.
Класс опасности данных отходов 3 - 4.

2. Пробы № 4 и № 5 – это грунт, загрязненный нефтешламами, содержащими в своем составе хлорированные бифенилы: проба 4- взята с глубины 4-5 м, проба 5- взята из соседнего подземного склада. Эти пробы относятся к 1-му классу опасности, канцерогенные, чрезвычайно опасны для человека, и окружающей природной среды.

Pic. 3. Final report of the Chemical Research Institute of the Nizhegorodskiy State University the name of Lobachevsky (ч/д № 4205/17 18.10.2014г.) Expert conclusions of Chemical R&D Institute of N.I. Lobachevskiy Nizhny Novgorod State University (# 4205/17 of 18.10.2014)

Count 2. The director of the JSC “Merk”- Dmitriy Zolotarev from the city of Omsk - obtained the license for processing waste of I-V classes of hazard from Omsk management of Rostechnadzor. The same person, D. Zolotarev, being the director of the JSC “Nature protection enterprise “Merk”, received a lifetime license from the Omsk management of Rosprirodnadzor. At this time both companies had at their disposal only mercury removal equipment. After that, both companies started to receive contracts for recycling of transformers and capacitors from electrical substations all over Russia.

According to the data from the investigative agencies, “Merk” company - under 8 contracts for 20 million rubles - delivered transformers and capacitors with the total weight of 200 tons containing poisonous trichlorbiphenyl and pentachlorbiphenyl from various branches of MRSK (interregional distribution grid company) of Siberia and other companies. The equipment was delivered from Zabaikalskiy and Altaiskiy krais, Cverdllovskaya, Ulyanovskaya, Irkutskaya, Penzenskaya and Lipetskaya provinces, and also from the Republic of Bashkoria. Under the contract all the waste should have been transported to Omskaya province. But according to the evidence from the investigation, they were transported in an “unidentified direction” and buried “in unidentified location” [9].

In the city Tiumen, a criminal case relating to poisoning of soil by a chemical substance is under governmental investigation. Here the companies from Omsk poured chemicals on the soil instead of recycling.

According to the information from the investigation, the waste was stored not only in Tiumen, but also in the neighbouring regions – Omsk and Novodibirsk provinces. The businessman responsible for this activity did not disclose the burial sites of the hazardous waste.

According to the court verdict, a resident of Omsk - Dmitriy Zolotarev - used the companies “Merk” and “Nature Protection Enterprise “Merk” for recycling of waste from 2010 till 2015. In total, the companies received 489 tons of PCBs (Sovtol, trichlorphenyl and pentachlorphenyl) for decontamination and earned 41,8 million rubles for their decontamination (which in reality was not done).

“Nature Protection Enterprise “Merk” disposed of the capacitors and transformers with the aid of persons from gypsy community. The vans with the waste arrived at some bare place, then the gypsies found some workers from Tajikistan, who cut the transformers into pieces and buried the waste containing PCBs into the ground. The remaining iron was sold for scrap.

The public prosecution office of Tiumen carried out its own investigation and confirmed the existence of pollution. The extent of damage to the soil amounted to more than 137 million rubles.
The public prosecution office stated that more than 2.6 hectares of land was contaminated on the left bank of the river Tura, close to the street Alebashevskaya. In the Investigation Committee of the RF for Omskaya province they stated that on the contaminated land they erected a part of a building estates - “Evropeyskiy” - onto plots of land with the cadastral numbers 72:23:0110002:9089 и 72:23:0110002:9067. The prosecutor's office reported that more than 2.6 hectares of land were contaminated on the left bank of the Tura River, near Alebashevskaya Street. The Investigation Committee of the Russian Federation in Omskaya oblast reported that “European” residential block was partially built on poisoned land areas of two land plots with Cadastre numbers 72:23:0110002:9089 and 72:23:0110002:9067.

The Nature Protection Department of the public prosecution office named the developer - it is the financial and construction corporation “Zapsibinterstroy”, the owner of one of the plots contaminated by the hazardous waste - and warned the company on the impossibility of dwelling construction at the above plots [10] due to severe toxic contamination. The Environmental Prosecutor's Office specified the developer - "Zapsibinterstroy" financial and construction corporation, that owns one of the sites contaminated by hazardous waste - the developer has already been warned on inadmissibility of residential construction on that territory [10].

It is necessary to point out that 20 tons of waste contaminated by PCBs from the town of Vyksa, of Nizhegorodskaya province, were transported to Omskaya province for hand over to the companies “Merk” and “Nature Protection Enterprise “Merk” for treatment. In 2014 environmental NGOs warned the Ministry of Environment of Nizhegorodskaya province about the necessity of control over the shipments of such PCBs-containing waste. However, the Nature Protection Agency of Nizhegorodskaya province preferred not to monitor the procedure of waste treatment properly and limit themselves to a formal acceptance of the waste recycling report from the PCBs waste forwarding company that transported the waste from Nizhegorodskaya province to Omskaya province. It is also important to note that in the Ministry of Environment of Nizhegorodskaya province, until now, a representative of the company CJSC “Nizhegorodbusinessecologia” (which set up a landfill in the 2 hangars by Dostchatinsky highway in the town of Vyksa) holds the position of Deputy Minister.

Count 3. 80 tons of waste containing PCBs “disappeared” in the town of Roshal in Moskovskaya province. The company “Progress” performed the contract for recycling of hazardous waste.

Thus in December 2017 the head of the department of Rosprirodnadzor for Privolzhskiy Federal District (PFO) O.V. Kruchinin announced that his department will monitor the PCBs...
treatment process. “We assigned ourselves the task to monitor this process from the beginning to the end”, said Oleg Kruchinin.

According to the information from Rosprirodnazor for PFO, in October 2017 the experts of the department found 1300 capacitors containing trichlorobiphenyl in the course of administrative investigation of the facts of improper storage of the first class of hazard substances at the territory of “RUMO” company.

As the press service of the department pointed out, “a part of the capacitors were unsealed or positioned with inclination, which is a violation of requirements for the storage of industrial waste of the first class of hazard”.

The management of the “RUMO” company concluded the contract for treatment of the capacitors with the LLC “Progress”. This company had the license for the activities related to processing the waste of I-IV classes of hazard (including transportation, processing, decontamination and treatment of waste of the class I hazard).

According to Rosprirodnadzor, the capacitors, with the total weight was around 80 tons were shipped by a specialized transport for decontamination and recycling to the town of Roshal (Moskovskaya province) under direct monitoring of Rosprirodnadzor department for PFO. The cargo was escorted also by the experts of Rosprirodnadzor until the destination point [12].

In the course of journalistic investigation, the facts about the so-called PCB “treatment” under control of Rosprirodnadzor in 2018 came to light. The representatives of “Progress” company claimed that in the town of Roshal, of Moscovskaya province, they had an installation СКГО-10-ЭЭТ, which will provide treatment of PCBs. The contract was signed on December 4, 2017 (“Progress” company was responsible for all the works, including shipment).

The address of the company was the town of Roshal, Kosyakova street, house 18. In the time of the USSR this was the location of “Roshalskiy chemical combine”, the name of A.A. Kosyakov. Currently it is a huge area, the major part of which is covered by a newly grown forest. There are dozens of degraded administrative buildings and storages there [11].

Yet, in 2005, eco-SPES pointed out that, based on the results of PCBs inventory at the territory of Nizherodskaya province, the company “RUMO” refused to provide information on availability of lack of electric equipment containing PCBs on its sites.

Here it is necessary to point out, that according to the 1999 data from AMAP, the “RUMO” company had on site a little less than 949 capacitors containing 9,860 kg of PCBs.
"At the territory of the town there are no buildings designated for this type of licensed activities, as well as equipped areas and landfills, where it is possible to treat the waste of high hazard class. Besides no company applied to the town administration for the permission to ship hazardous waste to the territory of the town for further treatment”, the deputy head of the town Mikhail Karasev said to local journalists [11].

After the publication in Facebook on the official page of Rosprirodnadzor department for PFO of the information about the shipment of 80 tons of PCBs from Nizhniy Nogrorod to Moskovskaya province, eco-SPES made a proposal on the necessity of strict monitoring of the transportation and treatment of PCBs instead of just formal acceptance of work completion reports on the treatment of such waste. The charge for the “treatment” work plus transportation by the LLC “Progress” under this contract amounted to 60000 rubles for 1 ton of waste containing PCBs.

Count 4. Currently, the services on treatment of PCBs-containing waste by fair dealing companies at the territory of Nizhegorodskaya province is 120 000 rubles for 1 ton of PCB waste. It is necessary to point out that at the territory of Nizhegorodskaya province, some companies, for example LLC “Evrokom” in the town of Dzerzhinsk (see pic 5), accepts for “treatment” the PCB waste for 35000 rubles for a ton valuating them from 1 to 3 classes. Case study 4. At the same time, PCBs waste utilisation services (including transportation) provided by bona fide enterprises in Nizhegorodskaya oblast are charged at the level of about ₽ 120,000 per ton of PCBs. It is also worth to note that, at the territory of Nizhegorodskaya oblast, some enterprises, (e.g. "Evrokom" JSC in Dzerzhinsk - see Figure 5), charge only ₽ 35,000 per ton for "utilisation" of PCBs waste, categorising them as substances from 1st to 3rd hazard classes.
In St. Petersburg, the charge for the recycling of PCB waste is 100000 rubles per 1 ton.

Thus, the relevance of the activities of LLC “Evrocom” in the recycling of PCBs-containing waste raises reasonable questions.

Count 5. In February 2019, under the municipal contract of 10 million rubles, they started works on the clean-up of the hangars near Doschatiskoye highway, where the PCBs-containing waste had earlier been stored. Case study 5. In February 2019, under a municipal contract worth ₽ 10 million, works were launched to clean the hangars at Doschatinsky Highway, where PCBs-containing wastes were stored earlier.

The evacuation of the waste was performed by the regional operator LLC “CityLux52” (waste removal company) to the solid municipal waste (TKO) landfill “ORB-Nizhniy”.

It is necessary to underline that both the waste removal company and the municipal waste (TKO) landfill are subject to federal environmental supervision by Rospryodorndzor department for PFO.
For updating the information on the quantity of the PCBs-containing equipment under the framework of this project, eco-SPES sent requests to the major companies of Russia having PCBs-containing equipment on their books.

The requests were sent to the companies that had previously operated the highest quantity of PCBs-containing equipment. Among them “KuybyshevAzot”, town of Togliatti; JSC “Samarskiy metallurgical plant”, town of Samara; JSC “Magnitogorskiy metallurgical plant”, town of Magnitogorsk; JSC “Saldinskiy metallurgical plant, Sverdlovskaya province”; JSC “Mechel”; Cheliabiski metallurgical plant” and JSC “Cheliabinski pipe-rolling plant”, Cheliabinsk; JSC “Pervouralskiy Novotrubniy Plant”, Pervouralsk; JSC “Sinarski pipe plant, town of Kamensk – Uralskiy; JSC “Novosibirskiy metallurgical plant”, Novosibirsk; JSC “GAZ”, Nizhniy Novgorod; JSC “KAMAZ”, town of Naberezghiye; Chelny, town of Volgodonsk; JSC “ EMK-Atomnash, and others.

However, only a few companies provided the information on the amount of PCBs in the operated equipment by April 2019. This information is available in this report.

In the course of implementation of the project, eco-SPES conducted, for the first time in Russia, a public inventory of the electric equipment containing PCBs. At the territory of Nizhegorodskiy region, the above volume amounted to 985 tons. However, in 2005, according to the information based on the inventory by eco-SPES, the enterprises of the region contained a volume of around only 8% in PCBs relative to the amount available in 1999 – 120 tons. In the course of the IPEN project, eco-SPES (a non-governmental environmental organisation from Dzerzhinsk) conducted the first public inventory of PCBs-containing electrical equipment in Russia. At the territory of Nizhegorodskaya oblast, their amounts reached 985 tons in 1999. Then, in 2005, according to eco-SPES inventory data, the relevant figure for facilities of the region, reached only 120 tons, or 8% of initial PCBs amounts in 1999.

In 1999 in Nizhegorodskiy region they had 336 transformers and 14 thousand capacitors, but in 2005 they operated only 53 transformers and 984 capacitors.

It is quite possible that the PCBs-containing equipment at many plants is not available “on paper” due to the loss of documentations and change of markings, but they are still in operation. Maybe the equipment was decommissioned, but the PCBs-containing waste was destroyed in an unauthorized manner, or handed over to private companies for “treatment”. Additionally, some of the companies previously holding this equipment went bankrupt or were closed down [13]. It is possible that PCBs-containing equipment was not “reported” in facility level records, but continues to be used due to loss of documentation or erased markings. Alternatively, such equipment might be decommissioned, and PCBs wastes might be illegally destroyed or transferred to private entrepreneurs for "utilisation". In addition, several facilities that previously had PCBs-containing equipment were made bankrupt or liquidated. [13].

On 15 March, 2019, in the course of the project implementation and in the territory of one of the depots in Nizhniy Novgorod, they found several dozen transformers containing from 340 to 720 kgs of oil each (the photo is on the cover). Samples of transformer oils were taken at these sites. It was found that the transformer oils belong to mineral oils (the mixture of branched saturated hydrocarbons with the presence of carbon atoms from C15 to C25) and do not contain PCBs or residual amounts of PCBs. In the course of the project implementation, on March 15, 2019, at the territory of one of bulk supply facilities in Nizhniy Novgorod, several dozens of transformers were found, containing from 340 to 720 kg of oils each (see photo on the cover page). Samples of transformer oils were collected on the site. Analysis revealed that these transformer oils belong to mineral oils group (a mixture of branched saturated hydrocarbons containing 15 to 25 carbon atoms) and do not contain PCBs or residual quantities of PCBs.
Under GOST 16555-75, the transformers filled with Sovtol should be serviceable within the transformers’ entire working lifespan. In practice the lifespan proves to be 25-30 years.

Conclusions

PCBs have the same toxic properties as dioxins, and their action on the human body are the same [16]. In the territory of the Russian Federation (RF), legal entities having on their balance sheet (enterprises storing or leasing) electrical equipment containing PCBs, decommissioned PCBs-containing equipment, as well as PCBs-containing waste must handle them in accordance with the requirements of the legislation on waste management of the Russian Federation. This activity may be subject to disciplinary, administrative, criminal or civil liability.

According to the current Russian legislation on waste management, financing of measures for handling equipment and wastes containing PCBs must be achieved at the expense of the owner of the waste, including financial responsibility for the elimination of negative environmental consequences and remediation of contaminated sites.

However, since 2014, no changes were made to the RF Code on Administrative Offenses (it was proposed to introduce Articles 8.48 and 8.49 of the Administrative Code) on liability for violation of the rules for handling waste and equipment containing PCBs, which imposes 50,000 to 100,000 rubles for persons engaged in entrepreneurial activities without forming a legal entity; from 100,000 to 300,000 rubles or administrative suspension of activity for up to 90 days; and for legal entities, from 500,000 to 1,000,000 rubles or administrative suspension of activities for up to 90 days.

At present, the Federal Service for Environmental Management (Rosprirodnadzor), as the leading environmental agency in Russia, does not exercise proper oversight of enterprises owning electrical equipment containing PCB and TCB. This is confirmed by the numerous facts cited in this review that describe the illegal transportation and illegal burial of PCBs-containing wastes in several regions of Russia.

In Nizhny Novgorod region, where the largest production of PCBs in the USSR previously existed, PCB contamination of the bottom sediments of the Volosnikha canal has been detected in the framework of IPEN projects, which is a result of untreated sewage discharge by chemical enterprises in Dzerzhinsk happening from 1936 to 1995. The same supertoxicants, in concentrations exceeding the maximum permissible level of the EU, are found in chicken eggs from small farms in the cities of Dzerzhinsk and Nizhny Novgorod, which are in the zone of influence of chemical enterprises.

It is worth noting that on the basis of the inventory that was held 20 years ago, the maximum volume of PCBs was detected in Povolzhye and Ural regions in 1999-2000. At the present time, according to the data of REA-UNIDO, the maximum quantity of PCB stores is concentrated in Ural and Siberian Federal Districts.

According to 1999 inventory data, the amount of PCBs in Russia ranged from 28,000 to 30,000 tons. Currently, complete and reliable information on the amounts of PCBs in the equipment used, or in reserve, as well as the amount of production waste containing PCBs, is not available in state environmental protection agencies (the Ministry of Natural Resources of Russia and the Federal Environment Protection Agency).

The situation with PCB contamination of the environment in Russia remains relevant.
Annex 1

Alternatives to incineration technologies for neutralisation/destruction of persistent organic pollutants (POPs)

1. Gas Phase Chemical Reduction (GPCR)

This technology provides the best results among all non-incineration technologies for destruction (neutralisation) of POPs, it was used for destruction of POPs-containing waste since 1995. In the GPCR process, decomposition of POPs takes place in a low pressure gaseous media in absence of oxygen, that prevents formation of dioxins and promotes decomposition of dioxins initially present in wastes. The process is based on a reaction of gas-phase thermochemical reduction, that includes interaction of hydrogen with organic and organochlorine compounds. At temperatures in the range from 800 to 900°C and at a low pressure, hydrogen reacts with such compounds as polychlorinated biphenyls, DDT, hexachlorobenzenes and mixtures of pesticides, decomposing these substances, mainly into methane and other hydrocarbons, including some light hydrocarbons. Liquid wastes can be injected into the reaction unit. Solid waste is processed directly without any pre-treatment shredding or size reduction of waste fractions.

Depending on waste amounts and installation capacity, this technology allows to process up to 100 tons of waste per day. This destruction technology can be applied to all POPs, including wastes with high concentrations of POPs, PCB containing transformers, batteries and spent oils.

---


2 "Disposal of Bulk Quantities of Obsolete Pesticides in Developing Countries”, United Nations Food and Agriculture Organization, 1996.


5 Environment Australia 1997

6 “Gas Phase Chemical Reduction (GPCR)”, Non-Incineration Technology Fact Sheet # 4 Greenpeace.


8 “Gas Phase Chemical Reduction (GPCR)”, Non-Incineration Technology Fact Sheet # 4 Greenpeace.
Technical parameters of the GPCR process: according to available information, this process demonstrates high destruction efficiency (DE) for HCB, PCB, waste containing dioxins and furans, as well as mixed organochlorine pesticides. In the case of testing industrial plants in Canada, DE values at the level of 99.999% were achieved for PCBs and HCB. Dioxins and furans, present as pollutants in polychlorinated biphenyl oils, were also decomposed by this process with DE value of 99.999%. Similar tests in Japan and estimates of levels of decomposition of dioxins and furans in wastes in the GPCR process also demonstrated high destruction efficiency reaching 99.9999%\textsuperscript{9,10}.

Environmental performance: In the GPCR process, all emissions and particulate matter can be captured for analysis and further processing, if necessary\textsuperscript{11,12}. Residues of the process include the produced gas, water of a scrubber, sand and sludge from the processing (purification) of the produced gas. In the resulting gas in the GPCR process, dioxins and furans were not detected. According to data provided by Canada, no uncontrolled emissions were found from use of this process for destruction of PCB-containing materials\textsuperscript{13}.

This technology has passed industrial level tests, it is licensed and applied in Australia, Japan and Canada. In addition, a pilot project on destruction of POPs is planned in the Slovak Republic with application of the GPCR process\textsuperscript{14}.

Basic catalytic destruction (BCD)

This technology has been used to process large volumes of wastes with high levels of POPs, such as DDT, PCB, dioxins and furans. BCD technology is an improved version of the catalytic dechlorinating process developed earlier by the US Environmental Protection Agency to rehabilitate soils and sediments contaminated by organochlorine compounds\textsuperscript{15}.

In the BCD technology, solid or liquid wastes are processed by heating them up to 300-350°C under normal pressure and in presence of a mixture of high-boiling hydrocarbons, sodium hydroxide and a catalyst. In the process, highly reactive atomic hydrogen formed in the preheated mixture decomposes organochlorine and other wastes with formation of inorganic


\textsuperscript{10}“Gas Phase Chemical Reduction (GPCR)”, Non-Incineration Technology Fact Sheet # 4 Greenpeace.


\textsuperscript{12}“Gas Phase Chemical Reduction (GPCR)”, Non-Incineration Technology Fact Sheet # 4 Greenpeace.

\textsuperscript{13}ELI Eco Logic International, Inc. 1996.


salts, inert residues and water. Then the catalyst used in the BCD process is separated from precipitates, recovered and reused16,17,18.

The BCD technology allows to process up to 20 tons of contaminated solid waste per hour and up to 9000 liters of liquids at a time. One may design lower capacity installations based on the BCD process. Contaminated soils and sediments require some pre-treatment before using the BCD technology, that is mainly applied for neutralisation of liquid waste19.

**Technical parameters of the BCD process:** Technical parameters of the BCD process: measurements of discharges and emissions from outdated plants with the BCD technology revealed presence of organochlorine compounds and dioxins, but modern versions of the technology can achieve DREs> 99.99999% for 30% DDT and> 99.999999 for 90% PCB16. In the course of experimental tests, higher destruction efficiencies (DEs) were obtained for HCB, DDT, PCB, dioxins and furans20.

**Environmental performance:** In the BCD process, all emissions and precipitates may be captured for analysis and re-treatment if necessary. In general, the BCD technology is considered as a low-risk technology7. The BCD technology was used to destroy 42,000 tons of PCB-contaminated soils 17. Similarly, this technology has also been applied at the highly contaminated by dioxins site of Spolana Neratovice enterprise in the Czech Republic. Unfortunately, processed sludge and used oils were burned in an incinerator operated by SITA Bohemia in the Czech Republic18.

This technology is licensed for industrial application in Australia, USA, Mexico, Spain, the Czech Republic and in neighbouring countries of the Central and Eastern Europe21.

**Supercritical water oxidation (SCWO)**

The technology relies on unique properties of supercritical water (with temperatures > 374 °C and pressures > 22 MPa) for complete oxidation and decomposition of toxic organic substances and wastes. In early systems, problems of reliability and corrosion of equipment materials were

---


18 “Examples of Commercial Scale POPs Stockpile Destruction Technologies”, Non-Incineration Fact Sheet #3, Greenpeace.


regularly encountered. Currently, these problems have been successfully resolved by use of corrosion-resistant materials and special design of installations. Now, an industrial scale unit with the SCWO process is operating in Japan. After an effective pilot-scale demonstration and refinement, this process has been recently approved for full-scale application in the United States.22,23,24

Supercritical water is known to have very high catalyst properties in oxidation/reduction reactions, by dissolving organic substances and oxygen. The SCWO process is a high-temperature one at high pressures in completely isolated systems at temperatures of 400–500 °C and pressures of about 25 MPa, promoting rapid completion of the oxidation process. The reduction products include carbon dioxide, inorganic acids and salts. Application of the system is limited to processing of liquids and solids with organic contents <20% and sizes of solid particles < 200 µm. Wastes with high PCBs contents produce acidic precipitates (low pH) in the process, and therefore, to avoid equipment corrosion, the material of reactors and attached pipes are treated with alkaline solutions for neutralisation.25,26

The existing demonstration installation based on the SCWO process has processing capacity of about 400 kg/h. There are plans to increase its processing capacity up to 2700 kg/h. The SCWO process was used to destroy a wide range of materials, including POPs, industrial organic chemicals, agro-chemicals, explosives, as well as to treatment of a wide range of contaminated materials, such as industrial effluents, sludges, household wastewaters contaminated by PCBs, pesticides, aliphatic and aromatic halogenated substances.27,28

Technical parameters of the SCWO process: Registered destructive and removal efficiency values (DREs) for the SCWO technology reach > 99.99994% for processing of dioxin-containing waste and > 99.999% for processing of various hazardous organic compounds (including chlorinated solvents, PCBs and pesticides). Experimental testing has demonstrated a significant potential for highly efficient destruction of PCBs with application of the technology.29


26 BCD CZ, “Project Spolana - dioxiny” report for EIA process, BCD CZ, Prague 2004.

27 Environment Australia 1997


**Environmental performance:** In the case of application of the SCWO process, all emissions and residues may be captured for further analysis and re-treatment, if necessary\(^{30}\). Gaseous emissions are minor with low carbon monoxide levels of \(<10\) ppm, without particulate matter, nitrogen oxides, hydrogen chloride or sulphur oxides\(^{31}\). Some studies have demonstrated that formation of PCDDs/Fs may occur under certain conditions in the course of PCBs decomposition by this technology,\(^{32}\) therefore mandatory monitoring of CO emissions and due and complete control over operational equipment is needed.

**Sodium reduction (SR)**

This technology is considered as a well-developed one, it was used at the industrial scale for several years to process spent oils with low and high concentrations of PCBs. The technology allows a mobile option and it is widely used to destroy PCBs at production sites where operational transformers are located\(^ {33}\).

In the SR process, chlorine is completely removed from PCBs by alkali metal reduction with use of sodium dispersed in mineral oils. The dechlorinating process is conducted by mixing the reactive mixture in a dry nitrogen atmosphere at normal pressure. Sizes of metal sodium particles, its concentration, and optimal reaction temperatures vary depending on types of the SR process used. Pre-treatment is limited to removal of moisture from the reagents. At the end of the reaction, excess sodium is removed by adding water. The SR process generates minimum amounts of solid precipitates. Reaction by-products includes water, sodium chloride, sodium hydroxide, and biphenyls. After the treatment, processed oils may be reused.\(^ {34}\)

A mobile unit using the SR technology, with processing capacity up to 15,000 liters of oil per day, was used to process contaminated transformer oil containing PCBs\(^ {35}\). Destruction efficiency (DE) exceeds 99.999\%, and destructive and removal efficiency (DRE) of 99.9999\% was found for chlorine and hexachlorobenzene. Emissions of nitrogen and hydrogen are possible, while no information is available on emissions of organic substances. Nevertheless, recycle of spent transformer oils by sodium reduction (SR) has successfully demonstrated compliance with the

---


\(^{34}\) “PCB Treatment Technologies Based on the Waste Disposal and Clean Up Law”, (29 Profiles), September, 2003.

legislatively set criteria of the US, EU, Canada, Australia, Japan, and South Africa. The technology is widely used all over the world.\(^36\)

**Other non-incineration technologies**

Non-incineration technologies for destruction of POPs-containing waste represent an area with great opportunities for development and introduction of new technologies, but knowledge about them and implementation of such technologies are limited. Many technologies already exist at the industrial scale of development (for example, the continuous circuit CDP process used in Cyprus\(^37\) for decontamination of PCB-contaminated transformers), as well as several promising technologies that can be used in the near future, for example, for decontamination of waste incinerators polluted with polychlorinated dibenzodioxins/furans (PCDD/F), flue ashes, and PCBs-containing wastes (based on different catalytic reactions\(^38,39\)).

\(^*\) The Working Group on development of the Basel Guidelines on POPs Waste Management agreed to recommend that the technologies used should provide destruction efficiency (DE) of 99.9999% for processing POPs waste or POPs-containing waste in concentrations over 1%. Among other things, the Working Group also agreed to recommend the technologies described above (GPCR, BCD, SCWO and SR) as “Environmentally Sound and Affordable” technologies. Recent studies also recommend assessing available technologies for destruction of POPs in terms of all technological parameters - TEQ (including both its elements: PCDD/Fs and PCBs), that would include formation of both PCBs and PCDD/Fs.

---


Sources

1. Results of inventory AMAP 2000.

2. Project of UNEP/GEF” Russian Federation” – Support to the National Action Plan on the Protection of Arctic Marine Environment. The final report on the implementation of the pilot project “Development of technical and logistic solutions for the implementation of the system for collection and recycle of PCB and PCB containing equipment in the Arctic Zone of the Russian Federation. LLC “Scientific development and production center TsBOO”) pages 22-23, 2010 St.Pb.

3. Same pages 22-23.


9. “In Omsk they started the court trial of the company who accepted the waste from all the country, the waste which causes cancer and mutations” Asker Abishov “ New Omsk” 28.08.2017 E-resource https://newsomsk.ru/news/61954-v_omske_nachali_sudit_direktora_kompanii_svozivshe/

10. “In Tiumen they found 2,6 hectars of land contaminated by toxic substance”. E-resource https://72.ru/text/gorod/427269864865792.html 04.05.2018. “In Zareka 2,6 hectars of land are contaminated by a super toxic substance: investigating the threat to health”.


