

Eidg. Anstalt für Wasserversorgung
Abwasserreinigung u. Gewässerschutz

Hazardous Heavy Metals:
Cadmium, Mercury, Lead and Arsenic

An excerpt by Dr. Gustav Rohde from the off-print of the ANS-Mitteilungen (Arbeitskreis für die Nutzbarmachung von Siedlungsabfällen) October 1973 issue on heavy metals, their importance and possible concentration in the soil through refuse and refuse sewage sludge composts.

The rapid development of modern industry and conventional industrial waste disposal have led to a constant increase in air and water pollution. Nowhere is air and water more polluted than in Japan, the Federal Republic of Germany and the US. Whether this pollution also affects the soil will be discussed in a separate chapter of this article. First it is necessary to describe air and water pollution.

Toxic mineral substances in the air

20 million tons of dust containing the toxic heavy metals cadmium, mercury and lead as well as the poisonous chemical arsenic are the yearly air polluting load in the Federal Republic of Germany and settle on plants, soil and water surfaces by way of dew, rain or snow. Approximately 320 kg of dust a year drizzle down on every German citizen, while only 260 kg of refuse per head have to be dealt with for the same period of time. In large towns and industrial areas, air pollution has increased to such an extent that human health, in particular that of children and the sick, as well as that of animals may be severely impaired.

Tolerance limits of air pollution were determined in the maximum concentrations of toxic air. Air pollution tolerance limits are circumscribed by maximum emission concentration (MIC) values, which represent 1/4 to 1/10 of the maximum admissible concentration at the place of work (MAC values). If the threshold of these concentrations is not exceeded, no detrimental effects on

humans need be feared. An adjustment to MIC values, however, can only be made gradually, especially in industrial conglomerations.

The tolerance limits for hygienic air determined by Russian scientists are the basis for the data established by Hungarian hygienists (table 1). The maximum concentrations of toxic air for the Federal Republic of Germany have been suggested by the Association of German Engineers.

Table 1

Maximum emission concentrations (MIC)

toxic substance	Hungary	Federal Republic of Germany
cadmium		0.05 mcg/m ³
mercury	0.3 mcg/m ³	
lead	0.5 mcg/m ³	2 mcg/m ³
arsenic	3 mcg/m ³	

1 mg = 1000 mcg (microgram)

Cadmium emissions which contaminate the air are always found where zinc or zinciferous lead and copper ores are smelted or recast, as well as where Diesel fuel, fuel oil, coal or paper is used as a source of energy. Cadmium is an accompanying metal of zinc. At present, the normal cadmium content in the air lies below 0.001 mcg/m³ Cd; in large towns it is 0.05 mcg/m³,

while in industrial areas the weekly and monthly mean value reaches up to 0.3 mcg/m³ Cd. One single cigarette already contains one to two thousand times more toxic cadmium than one cubic metre of normal air. Up to 20% of the 1 to 2 micrograms of cadmium contained in each cigarette are inhaled. At least 25% is absorbed by the smoker. The resorption rate in the alimentary tract amounts to only about 6%. Cadmium dust contained in the air settles on plants, soils and water surfaces by way of dew, rain and snow.

In the vicinity of sources emitting heavy metals, the parts of plants above ground are richer in heavy metals such as Cd, Hg, Pb and Zn due to dust stratification than the roots. The contrary occurs under normal conditions. The accumulation of dust rich in cadmium is especially great in the vicinity of refineries and heavy traffic roads. Ashes of German mineral oil contain more than 1000 ppm Cd.

The air's natural *mercury* content originates primarily from the volatilization of substances of the earth's crust. Soil and stones contain about 0.1 ppm of mercury which also evaporates into the open air at an increasing degree whenever temperatures rise. Artificial sources emitting mercury are above all the industry turning out chlorine and caustic soda as well as the burning of coal which contains approx. 1 ppm Hg and releases 1000 t Hg into the atmosphere every year.

Mercury returns to the earth again through rain and dust. In the vicinity of a mercury processing factory, the highest Hg concentration (approx. 20 ppm) is to be found in the leaves and blossoms and the lowest concentration in the roots of plants. In the US, 12 cigarette brands contained 0.04 to 0.55 ppm Hg, the cigarette paper 0.072 to 3.0 ppm Hg. Red blood cells are damaged 100 times more by mercury than by cadmium. In industries, the inhalation of mercury vapour is the main cause of poisonings.

Car exhaust gases and emissions from *lead*-refining plants are the main air polluting sources. 350 000 tons of lead from antiknock agents are discharged every year into the atmosphere of the northern hemisphere. At present, a constant 2 mcg/m³ lead value is considered harmless in the Federal Republic of Germany. However, this value is still considerably exceeded in our cities every day, especially during rush hours.

The population of big cities inhales 40 to 80 mcg of lead dust every day. A human being absorbs additionally through food about 30 mcg of lead. Only 5 to 10% of the lead contained in food are resorbed in the alimentary tract, while the lead dust that is deposited in the lungs is almost entirely assimilated by the body, i.e. it passes into the blood stream. Lead poisoning in animals near lead emitting industries such as in Nordenham is due to the absorption of food contaminated with lead dust or soil rich in lead. The increasing lead content in plants growing on soil in the immediate vicinity of heavy traffic roads (up to a distance of approx. 100 m) is also to be attributed to layers of plumbiferous dust. Many dust-protected parts of plants such as grains, bulbs and beets have the same low lead content everywhere.

The content of lead in the blood of human beings who breathe the air in large cities over a long period of time and where the tolerance limit for lead has already been exceeded by far, has increased to an extent which is causing alarm. Cellular damage occurs, the formation of red blood cells is disturbed and the resistance to pathogenic agents greatly reduced. Lead is partly also deposited in the bones for a long period of time; in 30 to 70 years lead deposits form and amount to approx. 260 mg in men and 150 mg in women.

The washing of *arsenic* ores in metallurgical works as well as the incineration of coal which may contain up to 1500 ppm of As are the most important sources of arsenic concentration in the air above large cities and industrial areas. Arsenic contained in exhaust gases, fly ash and soot settles in the same way as Hg, Cd and Pb by way of dew, rain and snow and concentrates on plants and on the surface of the soil. Latest studies have shown that the fever sometimes occurring at foundries is caused by arsenic and not zinc. Arsenic flue-dust from foundries has repeatedly increased the arsenic content of neighbouring soils up to toxic levels. In the vicinity of some works near Freiburg (Saxony) for example it was found that the soil contained at a distance of 100 m 2500 ppm As, at 1 km 155 ppm and at 5 km 15 ppm.

Near a lead-refining plant, the As content decreased from 9000 ppm at 15 m to 40 ppm at 45 m distance. In the vicinity of an aluminium mill the incineration of a coal containing 0.51 to 1.04 kg As per ton yielded 41.4 kg As/km²/year. The As content of the soil's dry substance thus increased in the course of the year to 232.7 ppm As. In these cases the arsenic concentrations can certainly be called dangerous.

Table 2

Tolerance limits from the International Drinking Water Standard of the World Health Organization (WHO 1963)

	<i>Acceptable limit</i>	
mercury	0.001 mg/litre	
cadmium	0.005 mg/litre	
lead	0.05 mg/litre	
arsenic	0.05 mg/litre	
(arsenic in mineral springs)	1.0 mg/litre	
	<i>Limit of objection</i>	<i>Limit of drinkability</i>
manganese	0.1 mg/l	1 mg/l
iron	0.3 mg/l	0.5 mg/l
copper	1 mg/l	1.5 mg/l
zinc	5 mg/l	15 mg/l
magnesium	50 mg/l	150 mg/l
calcium	75 mg/l	200 mg/l
sulphates	200 mg/l	400 mg/l
chlorides	200 mg/l	600 mg/l

Toxic mineral substances in the water

Banat, Förstner and Müller deduced from the results of extensive studies that the rivers of the Federal Republic of Germany carry heavy metals in dissolved or suspended form in quantities that often reach or in some cases even exceed those of Germany's own metal production, and generally amount to 0.1 % to 1 % of the world's yearly output. The Rhine is said to carry half of the yearly zinc production of the Federal Republic of Germany each year.

Cadmium is an accompanying metal of zinc and has also been found in galvanized mains. It may also reach drinking water sources through drain water and river water and cause poisonings leading to death. The sick die a painful death as a result of the so-called Itai-Itai disease which causes the bones to soften and the body to shrink. Considerable quantities of cadmium may accumulate in sewage and river sludge.

Approx. 4000 to 5000 tons of *mercury* (the world's yearly production 1967: 9200 tons) are discharged through watercourses into the oceans every year. One cubic metre of rain-water contains 0.05 to 0.48 mcg of mercury (average 0.2) while lead is missing. Tap water in Karlsruhe contains if run slowly 0.01 to 0.02, but 0.05 mcg/l Hg if run quickly. Mercury condenses in waterpipes in the course of time and is carried along with the sediments of the pipes if the water runs off quickly. Mercury also reaches distilled water through tap water. 0.15 or 0.8 mcg/l Hg were found in distilled water.

Mercury concentrations in coastal waters of the Baltic and the Minamata Bay in Japan have led to mercury accumulations in fish, in particular predatory fish, and to hydrargyris in sea-birds and fish-consuming inhabitants of coastal areas. Authorities constantly warn coastal inhabitants to beware of an excessive consumption of fish on account of the possible excessive absorption of mercury. It has been pointed out that for more than 1000 years mercury has concentrated in the organism of fish and that the concentration is greater in larger fish than in smaller ones. Mercury contamination of our environment has in the meantime not changed significantly.

The various oceans are likely to contain approx. 100 million tons of mercury from natural sources. In comparison, only 100 000 tons of Hg are discharged into the environment by human activities and the Hg concentration in the oceans has not increased by more than 1 %.

On the other hand, in salt and fresh water, the much more poisonous methyl mercury is formed from mineral mercury compounds through the activity of anaerobic bacteria. Living organisms especially fish absorb this methyl mercury which then passes into the intestines and gills and is accumulated for a long period of time. Precipitated mercury in the sludge of watercourses and lakes may again be activated by methyl. Inorganic mercury compounds are usually harmful to liver and kidneys but under normal conditions they do not remain in the

animal organism long enough to lead to dangerous concentrations. Methyl mercury or other alkyl mercury compounds are much more harmful since they affect the central nervous system and remain much longer in the organism of animals. Thus, even slight Hg concentrations in the water may have a detrimental effect.

Every year, 250 000 tons of *lead* from antiknock agents are deposited in the oceans and only 100 000 tons remain on the continents. Even part of the lead deposited in the soil finally also reaches the oceans through watercourses. The content of lead on the surface of the oceans is said to have increased since the utilization of lead as anti-knock agent 45 years ago from approx. 0.01–0.02 to 0.07 mcg/l Pb. Small quantities of lead may also be found in tap water. Man's lead absorption through tap water is very small; in general it amounts to less than 10% of the total lead absorption.

Arsenic is not only diffused in soil, water and air but generally also in plants and animals. The tolerance limit for arsenic in water lies at about 0.05 mg/l As, the one for arsenical mineral sources at 1 mg As/l. Mineral water containing arsenic is prescribed for secondary exhaustions, skin diseases, scrofula and nervous diseases. Arsenic is used in medicine in order to increase the forming of blood in the marrow and in the spleen.

Recently, however, a certain connection has been established between the arsenic content in the water and the incidence of skin cancer in Taiwan. Detrimental effects, however, occur only once the arsenic concentrations exceed by far the proposed limit of tolerance of 0.05 mg/l As.

Toxic mineral substances in the soil

Most soils contain:

0.03—	0.08	(average	0.055)	ppm Hg
0.01—	0.8	(average	0.2)	ppm Cd
1	—100	(average	5—10)	ppm As
10	—100	(average	20)	ppm Pb
50	—300	(average	50)	ppm Zn

The top limits of tolerance for normal soil are:

- 10 ppm Hg
- 100 ppm Cd
- 500 ppm As
- 2000 ppm Pb
- 2000 ppm Zn

These tolerance limits are still higher in the case of calcareous soils and heavy soils rich in humus and lower for acidulous sandy soils lacking humus.

The bigger the calcium content, clay minerals, ferro-manganese and alumina as well as organic substance is,

the lower is the solubility and absorbing capacity by plants of heavy metals in soils. ***The total heavy metal content in soil is thus not decisive in determining the absorption capacity of plants or its possible detrimental effect.*** In most cases less than 1% of the existing accumulations of heavy metals can be absorbed by plants. Manganous oxides together with heavy metal and other polyvalent cations easily form amphoteric oxides which develop into Co, Ni, Fe, Mo, Cu, Zn and other concretions after some time. Fe-Mn-concretions combine irreversibly with heavy metals, in other words, they can neither be dissolved by the roots of plants nor by diluted mineral acids. Fe-Mn-concretions in loess-soils contained for instance 55 ppm Co while the average content of the same soils contained 1 to 2 ppm Co without concretions. Approx. 80% of the total molybdenum in loamy and clay-soil as well as 50% in sandy soil may be combined with Fe and Al-oxides between pH 2 and 6.5 and pH 2 and 5 respectively, and finally made irreversible by the enlargement of the particles and ageing of the oxides.

Whenever organic mineral compounds are created, heavy metals may at the same time be formed in the soil.

Mercury forms 21 of about 1800 minerals and is contained in 70 in quantities of $> 0.1\%$, in 200 of $> 10^{-4}\%$ and in 800 of $> 10^{-7}\%$. As already mentioned, there is a constant evaporation of metallic mercury into the open air at temperatures above 20°C . This, of course, prevents any mercury concentration in the soil. In the vicinity of large cities drops of pure mercury have been found underneath some moss.

Moreover, the roots of plants are provided with effective barriers (lignines) which limit the absorption of mercury from the soil considerably. Seeds of spring wheat grown on soil fertilized with 0.05 and 1 respectively 10 ppm of mercury contained only traces of this heavy metal. In a sandy soil with a low diffusion of cations and a high mercury content (10 ppm) comparatively much mercury was deposited in the roots, stalks and leaves but only very little (0.01 ppm) in the seeds.

At a dry dressing carried out appropriately, 6 g of mercury are added to the soil with 150 kg/ha of wheat seeds. In soil where wheat dressed with mercury had been grown for 30 years, no signs of an increase in the mercury content could be found in harvested wheat. According to present figures, the mercury content of soil would double only in about 1000 years in the 1 m deep top layer of the soil where dressed wheat would be grown with normal crop rotation. A yearly precipitation rate of 500 mm discharges 1 to 10 g/ha of mercury into the soil. According to Tiewes, the present level of mercury contamination of our food is not alarming. The general tolerance limit for mercury in food (0.05 ppm) is rarely or practically never exceeded. A higher tolerance limit of 0.5 ppm Hg is generally approved only for fish products on account of the longer chain existing in the foodstuff industry. As a rule, this limit is not exceeded although this value is occasionally exceeded in the case of tinned tunny and fresh-water fish.

Mercury being a normal element in the human organism, nearly all organs contain this metal.

The amount of mercury in the food absorbed by the organism of animals is primarily discharged through the intestines without reaching the blood; the small part absorbed proceeds to the kidneys and is very slowly eliminated through urine. Man absorbs in his daily food about 5 mcg of mercury and discharges the same amount; i.e. 0.5 to 1 mcg in the urine and 3.5 mcg in the excrements. There are no indications pointing to a mercury concentration at an advanced age.

Rather large quantities of ***cadmium*** may be found in crude phosphates, for instance 2100 ppm Cd in apatite and 1 to 870 ppm Cd of this metal in superphosphate. ***Our arable land is therefore continuously supplied with considerable quantities of cadmium present in the superphosphate fertilizer.***

Cadmium has a low solubility in the soil and is mainly stationary. Great differences in the content of cadmium in the soil hardly cause any changes in the plants' content of this heavy metal. Lime reduces the content of cadmium in plants. Damage to plants due to surplus cadmium does not occur when sewage sludge rich in cadmium is applied. The use of iron (II) compounds or hydrogen sulfide has the same effect. Cadmium from the air concentrates in moss and lichens, which can therefore be used to test the cadmium content in the air.

Acute cadmium poisonings may be caused by the consumption of acidulous food or beverages stored in cadmium coated containers. In France and the US cadmium-plated containers for preserving human food is prohibited.

Lead in the soil appears harmless

The lead contained in the soil is hardly soluble in water. Lead present in the water-soluble lead-nitrates is quickly absorbed by the soil. Lead dust from car exhaust gases quickly turns insoluble at the surface of the soil. The thin roots of plants have approx. the same content of lead as the soil surrounding them, the leaves, however, have only 0.5 to 3%. Only a small quantity of lead absorbed by plants is passed on from the roots or leaves to the other parts of the plants because lead is generally insoluble in the plant. It may combine with the cellulose of the cutin of the cell walls.

According to the latest studies by the English Greenland Research Institute in Hurley, there is hardly any danger that the large quantities of lead deposited in the soil will be absorbed by the plants via their roots and reach the human organism by way of the animals grazing on the pastures. ***English records claim, however, that the lead content in the air has dangerously increased.*** Greenland's scientists planted ray grass on 16 different types of agriculturally cultivated soils and prevailing conditions were supervised. After the fourth cut, the grass-roots were harvested and examined in the same manner as the parts above the ground. The largest lead quantity absorbed by the plants concentrated in the roots. The

yield harvested above ground was larger than the one below ground but the former only contained 16 to 10% of the total lead absorbed by the plants.

Ruminants accumulated only about 1% of the lead taken up by the ray-grass and discharged 99% in excrements and urine. A large part of the accumulated lead was deposited in the bones which are not consumed by human beings.

It is assumed that 5 to 10% of the lead traces absorbed by man in the food are accumulated in the intestines. If albumen supplies 40 or 60% of the total calories, 5 to 7 times more lead ought to be deposited in the organism than at 20%. The supply of calcium and phosphoric acid in the food, however, limit lead absorption by the intestines.

Since 1940, the content of lead in food has not changed significantly. Animal food usually contains less lead than vegetable food which accumulates lead on its surface.

There is no need to dramatize the question of lead in food because the lead content in human blood has not altered for the last 30 years and besides, no great differences exist between the lead content in the blood of inhabitants from industrialized countries and those from developing countries. Tiews of the Institute for Food Psychology at the Veterinary Faculty of the University of Munich determined (1973) the following:

The lead concentration in our food remains within the tolerance limit. Particularly the latest research data are somewhat reassuring because they have shown that the lead content even in the milk of cows grazing near motorways with a high lead absorption increases distinctly but as a whole only insignificantly. Compared with the daily load of lead estimated to vary between 500 and 700 mcg/per head and day for the consumer of food, the increase in the content of lead in milk from a normal level of 20–40 mcg/l to 50–70 mcg/l in the milk of cows grazing near motorways is of no great importance.

However, the lead content can increase considerably in tinned food. The main quantity of lead in tinned fruit originates from the tin solder. The seam and soldering joints of the tins are very often not lacquered again or only very badly so that they lie partially or completely exposed and are susceptible to corrosion. Tomato-pulp in tins shows an alarmingly high content of lead. It has therefore been recommended to fill this aggressive material in glasses or tubes made from lacquered aluminium only.

An increase in the content of lead, copper and zinc in tinned goods after opening the tins may easily be avoided if the tin content is immediately poured into a bowl or jar made of plastics, earthenware or porcelain.

Arsenic deposits in the soil

Arsenic compounds are found in soils and composts together with humus and clay-minerals. These deposits are smallest in pure sand and largest in rich, black soils which for this reason and due to a lack of precipitation in their arid area of origin contain the highest content of arsenic.

Sodium arsenite causes more harm to plants than sodium arsenate; calcium arsenate is the least poisonous. Numerous microbes in the soil can cause arsenites to oxidize into arsenates resulting in a reduced toxicity in the roots of plants. This oxidation can also be the result of trivalent iron compounds. In addition, arsenic of ferric hydroxides may be deposited in a form which cannot be absorbed by plants. The productivity of soil contaminated by arsenic was accordingly reestablished by a repeated supply of trivalent iron salts. An abundant application of organic material, lime, sulphates especially zinkosite and larger quantities of nitrogen also have a beneficial effect on arsenic poisoned soils. *Composts in cities not only have a low arsenic content but they also contain large quantities of the already mentioned organic matter. They are thus valuable soil improvers for arsenic contaminated soils in large cities and industrial areas.* The large quantities of fungi, penicillia and aspergilli in soils and especially in composts are able to form *volatile* ethylcacodyl oxide from arsenite and can therefore reduce the arsenic content in the soil and especially in organic material during its decomposition which is accompanied by a rise in temperature. Consequently, the amount of arsenic in soils and above all in aerobic composts is constantly reduced. Repeated applications of pesticides, containing arsenic, on orchards increased the arsenic content in the soil from 1.8–4.6 to 40–115 ppm As. Meanwhile, however, these products have been replaced by others free from arsenic due to practical or toxicological reasons. The use of sodium arsenite to control weeds or destroy the potato vine may also increase the arsenic concentration in soils and plants.

Summary

The maximum concentration values for cadmium, mercury, lead and arsenic are much lower than the corresponding tolerance limit for water and arable land.

Table 3

Tolerance limit of environmental pollution with toxic substances in mg/m³

toxic substance	air	water	soil
cadmium	0.00005	5	70 000
mercury	0.0003	1	
lead	0.0005	50	1 400 000
arsenic	0.003	50	

The lead dust deposited in the lungs is almost entirely absorbed while only 5 to 10% of the lead in food are resorbed in the alimentary tract. 25% of cadmium is resorbed in the lungs and 6% in the alimentary tract.

Animals poisoned by heavy metals contained in forage crops that grow in the neighbourhood of metallurgical works have repeatedly been observed. These poisonings were caused by rich deposits of cadmium, lead or arsenic dust on the leaves.

The rivers of the Federal Republic of Germany carry heavy metals in dissolved or suspended form in quantities which often attain or even exceed Germany's total heavy metal production. The development of fish and the supply of drinking water can thus be negatively affected.

Toxic heavy metals can more easily be deposited in the soil than in the air and in the water (table 3). The solubility and the plants' absorption capacity of toxic heavy metals are greatly reduced in the soil by lime, diffusion of minerals, living or dead organic material, phosphoric acid, iron-, aluminium- and manganous oxides or concretions. Arsenic oxidizes and, owing to its combination with trivalent iron, can no longer be absorbed by plants. The solubility of lead sulphates in the soil is only negligible.

The thin roots of the plants retain the absorbed toxic heavy metals and prevent them from being passed on to beets, bulbs, stalks, leaves and seeds. The limited solubility of toxic mineral substances in the soil, their accumulation in the roots of plants and their low absorption (a few % only) in the alimentary tract are effective barriers against the consumption of toxic heavy metals in food. Whenever the parts of plants above ground covered with toxic dust are fed, the favourable influences in the soil and the roots limiting the toxic content are eliminated. Besides, grazing animals near sources emitting heavy metals run the risk of inhaling air that contains a certain amount of toxic heavy metals which are subsequently deposited and absorbed by the lungs.

Similar considerations also apply to toxic heavy metals reaching rivers and lakes through wastewater. However, metallic mercury and its compounds are a greater hazard because under the anaerobic conditions prevailing in river and lake sludge, they are transformed into methyl-mercury which is ten times as toxic and taken up by fish and nearly 100% absorbed by the human alimentary tract.

Physical, chemical and biological reactions in fertile soils transfer the absorption and effect of the toxic heavy metals in plants under aerobic conditions to physiological fields. In addition, healthy men and animals are protected against the undesirable concentration of heavy metals contained in food originating from fertile soils with a high content of heavy metals by the low degree of absorption of toxic heavy metals in the alimentary tract, antagonistic interactions in the metabolism as well as a toxic heavy metal decrease in excrements, urine and sweat.

Favourable conditions for air and water conservation are achieved only if the toxic heavy metals *in the soil* contained in domestic wastes (above all in sewage sludge and refuse) are channelled into the natural cycle. There they turn into slowly moving heavy metal sources which lead to healthy growth and maximum plant yields.

The concentration of lead, cadmium and zinc in tinned food may be greatly limited if the tins are lacquered carefully and their content poured into other containers immediately after they have been opened.

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«IRCWD News»

Hazardous Substances in Solid Wastes

New obstacles — until recently unthought of — have come to complicate the reuse of solid wastes. Various toxic materials, especially heavy metals, pesticides, herbicides and disinfectants, have become ubiquitous, for in the past years, economic growth has been far more rapid than population development. Only approximately one-third of the raw materials used ever reach the consumer market (e.g. chemical industry). Most of the remaining two-thirds are discarded and a considerable part of the one-third sold to the consumer ultimately winds up as wastes as well (dish-washing detergents, cosmetics, varnish and paint left over after a do-it-yourself weekend, zinc surplus from the hot galvanization of refuse containers).

As early as 1959 the International Research Group on Refuse Disposal (IRGR) had published a German version of a methodology on the analysis of solid wastes; in 1970 this compilation was revised, translated into English by the IRCWD and re-issued. Since hazardous wastes, through their proliferation, are becoming more and more of a problem, the analysis methodology is gaining in importance for controlling waste treatment processes such as incineration, composting and sanitary landfilling.

The results of solid waste analyses are comparable and thus applicable only if they have been obtained through accurately normed, standardized analysis methods. Standard procedures have already been in use for some years in the field of wastewater analysis. The Solid Wastes Department of the EAWAG, Dübendorf, Switzerland, has now submitted for consideration methods of analysis for a number of characteristic values. Similarly, other institutes have worked out suitable methods. The ISWA therefore circulated a questionnaire among German-speaking specialists with the aim of establishing a standardized procedure for wastes analysis. A rough draft for international standardization is expected by the end of 1973.

Question to all Solid Wastes Specialists

We should like to request all readers to inform us briefly whether they:

- would like to receive a copy of the draft so that they can communicate their reactions and perhaps suggest improvements,
- would like one or several copies of the final version of "Standard Methods of Analysis for Solid Wastes",
- know of similar projects that are pending elsewhere and that could be co-ordinated with ours.

Stock Exchange for Re-usable Chemical Wastes

The Swiss Society for Chemical Industries has organized a temporary and experimental stock exchange for re-usable chemical wastes with a view to facilitating the disposal of such wastes.

It is hoped that a similar organization will soon exist in other countries.

The study group "Soil, Water, Air" has suggested the establishment of a temporary and experimental "Stock Exchange for Re-usable Chemical Wastes" (e.g. ferruginous wastes from reductions, plasters, waste acids, waste lyes), [under the patronage of the SSCI, Swiss Association of Lacquer and Paint Manufacturers (SALP) and the Swiss Union of Soap and Detergent Manufacturers (SUSD)], The following proceedings have been considered:

1. Member companies of the SSCI, SALP and SUSD yielding re-usable chemical wastes whose utilization has not yet been organized, have the opportunity to report these wastes to the SSCI (Stock Exchange for Chemical Wastes) and record their data on a form.
2. Relevant information from member companies of the above-mentioned associations will be published in the following SSCI bulletin.
3. Incoming offers from companies for the disposal of such wastes (customer) are forwarded to the seller under safeguard of the cipher secret.
4. If the seller is willing to accept the offer, the SSCI secretariat, after securing the agreement of each party, will disclose the name of the opposite party; further waste disposal settlements are left to the parties involved.
5. The SSCI secretariat distributes forms to member companies of the above-mentioned associations interested in these proceedings.
6. *This stock exchange may not be called upon for the disposal of non-re-usable chemical wastes.*

The problem concerning the disposal of such industrial and trade wastes at the municipal or regional level is being examined.

Periscope

India

The following is a brief note on the use of coirpith for the manufacture of gaskets in India. Further information available from the Central Public Health Engineering Research Institute (CPHERI) in Nagpur, India.

Rubberised cork sheets are used as gaskets in automobile oil engines and similar equipment. In India these are normally made from imported cork granules. With a view to replacing these imported cork granules and at the same time using the indigenously available solid waste from coir industries, work was carried out at the National Chemical Laboratory, Poona, India. The material produced has been found to be comparable in properties with the rubberised cork sheets.

The process consists in mixing the coirpith with neoprene and other material and vulcanising the mixture in a press at a suitable temperature and pressure in moulds.

The coirpith based gaskets have been found to meet the required specification and the cost works out to about Rs. 21.00 per kg. (Rs. 7.50 = 1.00 U.S. Dollar). The cost estimates have been prepared for the process for a plant with an input of about 3 tons of coirpith per year to produce 5.320 tons gasket sheets valued at about Rs. 1,38,000/—.

For commercial exploitation of the process, the Secretary, National Research Development Corporation of India, 61, Ring Road, Lajpat Nagar III, New Delhi-24, should be contacted.

U.S.A.

The following is an abstract of the "Resource Recovery: The State of Technology" prepared for the Council on Environmental Quality by the Midwest Research Institute.

The Council on Environmental Quality, Washington D.C., recently completed a report entitled "Resource Recovery: The State of Technology". The study investigates forty of the most developed and technologically feasible of the emerging resource recovery systems.

It examines such processes as energy recovery, materials recovery, pyrolysis, and composting. The products that can be recovered through these processes include steam, oil, and electricity, in addition to paper, metals, glass, etc. The report concludes that technology is not a barrier to increased resource recovery from municipal wastes and that the economics of resource recovery are highly dependent on the developing markets for wastes.

United Kingdom

The Department of the Environment, London, has recently completed its "First Report of the Standing Committee on Research into Refuse Collection, Storage and Disposal".

The first meeting took place in September 1969 and met ten times up to the end of December 1972.

The general terms of reference of the Committee are to assess research projects which are in progress, recommending co-ordination where desirable; to study new techniques and processes; and to advise what new research, including collection of data, would be useful and by whom it could best be undertaken.

New Publications

The Research Institute for Water Resources Development, Budapest has recently published a report entitled "Vingt Années de Recherche Scientifique dans le Domaine de l'Aménagement des Eaux en Hongrie". This publication covers the years 1952 to 1971.

The Central Public Health Engineering Research Institute (CPHERI) in Nagpur, India, has brought out a new publication entitled "Indian Literature in Environmental Engineering, Annual Bibliography 1971". This reference tool enables the user to see references about various facets of environmental engineering carried out by Indian workers from this interdisciplinary field. It covers the literature output in the field for the year 1971 and contains 665 references by about 714 authors, scattered in 56 Indian and 4 foreign periodicals, as well as papers presented at 24 conferences, symposia, seminars, etc. Besides facilitating the retrospective search the publication also helps the researchers in locating complete bibliographical details. The bibliography covering the period 1972 and 1973 is under compilation and will be brought out shortly.

From 17th to 19th January 1973, the Indian Association for Water Pollution Control (IAWPC) and the Central Public Health Engineering Research Institute (CPHERI) convened jointly a symposium on "Environmental Pollution". The proceedings of the symposium were published in June and cover forty-four papers accepted for presentation at the symposium along with valuable discussions that took place following the presentations.

Abstracts

The following abstracts have been taken from our documentation on solid wastes which contains at the present moment over 2000 publications.

*Zeller, E.J.,
Saunders, D.F.:* Radioactive waste disposal. Suggestion for a permanent international polar high-level radioactive waste repository, 1973, 27, No. 3, 5755, 36pp, Report 1972 COO-1057-59, Avail. Dep. NTIS. From Nucl. Sci. Abstr.

Based upon a preliminary study, it is suggested that radioactive wastes be placed under the ice cap in Antarctica (or possibly Greenland). All available evidence indicates that if the wastes were converted to solid glass cylinders, they could be practically and safely transported to the interior of the ice cap. If placed on the surface of the ice, they would melt their own emplacement shafts which would rapidly reseal by freezing and plastic flow. The cylinders would sink to the ice-rock interface where they would remain safely isolated from the biosphere for 10 000–100 000 years. Scientific studies have indicated that the average temperature in Antarctica has remained below freezing for more than a million years so that the large thickness of polar ice may be expected to provide a good seal for at least a similar period into the future. Tentatively selected disposal sites are 400 to 500 miles inland from the nearest natural flora or fauna, isolated from the sea by mountain ranges as well as long horizontal thickness of ice and frozen ground. The sites were selected to effectively eliminate the chance of any harmful effects due to ice movements. A brief comparison of the ice cap approach with other suggested methods of ultimate disposal indicates that it holds much promise of being the most practical and safest solution to the problem and it deserves early and careful consideration by both the appropriate U.S. and international agencies.

Watanabe, S.: New processing technique for plastic waste: catalytic cracking, 1972, 10, No. 12, 31–35, Jap. Plastic Age.

Pre-melted plastic wastes are catalytically cracked yielding a product that can be separated into a heavy oil fraction, suitable as fuel oil, and a gas fraction. Production of gases, light oil and olefin fractions can be controlled, while carbon formation is almost eliminated. The yield is 95%.

*Wesche, J.,
Roszinski, H.:* Behaviour and effect of environmental pollution substances in composts from refuse and sewage sludge. 1. Influence on decomposition by a detergent, by diesel oil, and by a herbicide, 1972, 13, No. 5, 289–303, Z. Kulturtech. Flurbereinig.

Three composts which had been produced by different methods: pit composting, the Dano Biostabilisator method and the Multibacto method, were submitted to a post decomposition of 70 days in their pits. The remaining activity of these composts was determined from the pit temperature and the temperature curves showed the normal activity expected of such composts. When a detergent was added to fresh compost a slight increase in temperature set in over 20 days; when diesel oil was added a delay in the decomposition activity was effected whereas the herbicide caused no changes at all. When detergent was added to mature compost the reaction was considerably stronger, while diesel oil and herbicide caused no changes.

Keller, Th.: The effect of industrial sewage sludge on net photosynthesis of young forest plants, 1973, 92, No. 3, 105–111, Forstwissenschaftliches Zentralblatt.

The effect of an application of industrial sewage sludge (220 m³/ha) on net photosynthesis (infrared gas analysis) and chlorophyll content of potted young spruces, pines, larches, Douglas firs, beeches, Northern red oaks and sycamores was investigated in the laboratory. The species investigated differed in reaction: larch showed a strong stimulation of net photosynthesis (and of shoot length). Also in spruce and sycamore an immediate and sustained increase of CO₂-uptake was detected. Beech, red oak and Douglas fir reacted quickly (but for a few days only) with a stimulation of photosynthesis. Several weeks later photosynthesis tended to increase again, probably due to increased chlorophyll content. Pine reacted with a distinct depression of net CO₂-uptake over several weeks.

The sewage application in a forest thus will differ in effect with species and may even be negative.

Answers to Pollution Puzzle

1 F	2 I	3 R	4 E		5 A	6 T	7 O	8 M		9 P	10 E	11 L	12 T
13 I	C	O	N		14 L	O	R	E		15 A	L	A	I
16 A	S	S	T		17 L	A	G	S		18 L	A	I	N
19 T	H	E	R	20 M	O	D	Y	N	21 A	M	I	C	S
			22 O	U	T			23 E	N	O			
24 P	25 O	26 P	P	Y		27 R	28 G		29 T	I	30 A	31 R	32 A
33 A	N	O	Y		34 B	A	R	35 B		36 L	O	A	N
37 R	I	O		38 F	E	M	A	L	39 E		40 R	T	G
41 R	O	N		42 B	I	O	T	O	P		43 T	I	U
44 S	N	A	45 G		46 A	S	E	T		47 L	A	O	S
			48 E	49 R		50 E	S		51 R	A			
52 O	53 N	54 A	M	I	55 A			56 R	O	T	57 T	58 E	59 N
60 C	R	U	M	B	S	61 T	62 R	U	C	T	U	R	E
63 T	O	R	A		64 T	O	I	L		65 I	D	O	L
66 A	B	U	T		67 E	N	D	E		68 C	O	D	A
69 D	E	M	E		70 R	E	E	D		71 E	R	E	S

