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MERCURY POLLUTION: ITS ORIGIN AND CONTROL MEASURES FOR THAILAND

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Mercury pollution has been a great threat to human health since the beginning of the industrial revolution. Mental disorders resulting from mercury poisoning gave rise to the phrase "mad as a hatter", during the 19th Century when mercury compounds were used in treating felt for hats. Importance was placed quite high on the mercury pollution after the occurrence of Minamata disease.

Origin of Mercury Pollution

Probably no one thought that industry would contaminate surface water with mercury because of the economic fact that mercury is an expensive metal. Norwald Fimreite, a Norwegian graduate student at the University of Western Ontario is credited by many people as the first one to uncover the existing problem. Fimreite's discovery was prompted by finding alarming levels of mercury in pheasants and red-tailed hawks in Alberta. Next, Fimreite found that fish taken from Lake St. Clair, near Detroit, were also contaminated. Further study revealed a plant discharging 200 pounds of mercury per day into the lake. Since then, numerous cases of mercury pollution have been brought before the public.

In 1966, Gunnel Westoo, an employee of the Swedish Government reported that the total mercury contaminated in fish was in the form of methyl mercury, which is poisonous and easily absorbed by the body. Miettenen[1] at the University of Helsinki, Finland reported the retention of radioactive methyl mercury in different species. The times to lose half of the radioactive methyl mercury administered to various fish are shown below:

Flounder	400 to 700 days
Perch	500 days
Pike	500 to 700 days
Eels	900 to 1000 days

The occurrence of Minamata disease in Japan was the first major incident which diverted the attention to the pollution by heavy metals. In the beginning of May 1956, several patients displaying very severe neurological symptoms were carried into the Chisso Factory Hospital in Minamata City, a small industrial city in the southwest portion of Kyushu Island. These patients were trembling, shouting like barking dogs and struggling violently day and night. At the time fifty patients were discovered and of them 17 died. Since that time the number of officially recognised typical patients were gradually increasing and by July 1970 the number had reached 121 among whom 46 had died[2]. Before the outbreak of the symptoms in human beings appeared, similar symptoms were observed in cats in the same fishing village with the cats ultimately destroying themselves by jumping into the sea. The fishermen called this phenomenon cat suicide, but unfortunately this serious sign of impending disaster in the environment was neglected. Later the Chisso Minamata Factory was found discharging its waste containing mercury into the shallow Minamata Bay for a long time without any treatment and the bay was highly contaminated. The Minamata disease was named after the Minamata bay disaster.

Major Sources of Mercury Pollution

Mercury is a useful metal and is employed in some form in nearly every major industry. As fungicides, mercury compounds are useful in manufacturing, laundries, paints, plastics, paper, lawn care preparations and other uses identifiable at present. One of the most common mercury fungicide is phenyl mercury acetate (PMA). PMA is popular with commercial laundries, particularly diaper services, to control mould. There are reported cases of acute poisoning as a result of ineffective rinsing to remove the PMA.

Increasingly paints are being mixed with PMA and other mercury compounds and this industry has become a large user of mercury. The use of antifouling paints containing mercury on boats and in damp environments has been recognised as a hazard and is being replaced by non-mercurial agents. Mercury evaporating from paint as it dries may sometimes reach toxic concentrations and cases of poisoning from paint vapour have been reported. In addition, there is the possibility of ingestion of indoor mercury paints by children.

Mercury is also used as a catalyst in a number of chemical manufacturing processes. Vinyl chloride, the basis for many plastics is an example of this type of use.

Mercury compounds are very effective in controlling fungi and have been employed by farmers for many years. Cereal grain seeds are subject to attack by fungi. To prevent this problem, mercury seed dressings, liquids or powders, are used to coat the seeds during storage. Germany is credited with the development of such dressings. Since 1914, mercury compounds have come into widespread use. At about the time of World War II, liquid preparations of alkyl mercury were introduced. Due to the nature of application and effectiveness of fungi control, the liquid became an almost universal treatment for wheat and barley seeds.

At present, everyone knows that mercury pesticides leave residues. Mercury compounds are easily absorbed by plants and can pass from one part of the plant to another (translocation). Therefore, when apple trees are sprayed, some of the mercury is absorbed by the leaves and may appear later in the fruit when it develops. By the same token, treated seeds absorb the liquid mercury fungicides and then distribute them throughout the plant. As a result, some portion of the mercury appears in the harvested grain.

Following human consumption of contaminated foodstuffs, mercury appears in the urine. Sewage treatment plants have reported of sludge containing concentration of mercury making it unsuitable for use as a fertilizer.

Mercury fungicides are also used in the production of paper. Fungicides used in the paper-making industry keep the machinery free of fungus growths which enjoy the warm, nutrient-rich pulp. Large amounts of fungicides are added to the circulation water to prevent clogging. As a result, some of the fungicide is incorporated into the paper . When mercury compounds are employed in the fungicide, the resulting paper is not usable for food containers.

Mercury is also used to protect wood during storage. Sweden and Canada export significant amounts of wood pulp which is made economical by the abundance of forests and hydroelectrical power in that country. Apparently, the pulp is made mechanically with hydroelectric power in the seasons when power is plentiful and then stored to await paper production. Sweden exports principally to England, and Canada provides part of the pulp needed in making inexpensive papers in the United States. The mercury incorporated into the paper eventually reaches the air when the paper is burnt. However, few studies have been made on the magnitude of this air pollution.

So far the major impact of the "mercury shake down" has been on the chlorine and alkali (caustic soda) industry. Some portion of the chlorine and caustic soda produced comes from electrolytic cells, which use mercury as an intermediate cathode to help breakdown salt brine. The mercury attracts and forms an amalgam with the sodium ions of the brine. In a secondary cell, the mercury releases the sodium to from sodium hydroxide, or caustic soda. Unfortunately, traces of mercury end up in the spent brine. Some companies discharge the brine directly to receiving streams,

others divert it through lagoons with the hope of the mercury evaporating, while others send the brine underground.

The additional costs of pumps and plumbing necessary to check the mercury leakage plus the possibility of libel suits tend to make the mercury cell process unattractive on an economic basis. Dow Chemicals planned to substitute an alternative process where a diaphragm is used instead of the intermediate electrode to keep the products of electrolysis segregated. The drawbacks in the diaphragm process are the cost of evaporation to concentrate the weaker caustic soda and lower degree of purity of the product.

In the past, various plant officials had the impression that the relatively inert and insoluble metallic mercury released in a factory's effluent collected safely on river bottoms. However, it has been shown that there is evidence that anaerobic bacteria found in receiving waters with highly concentrated industrial waste and low oxygen levels are capable of converting the mercury to the methylated form. All microorganisms capable of vitamin B_{12} synthesis are capable of methyl mercury synthesis. Mercury in this more soluble, organic state is extremely toxic. Even with the elimination of the mercury input, the stream bottom would remain a long-term source of methylated compounds.

Elevated mercury concentrations have been found in waters with no known source of mercury pollution. An article by Payne[3] in the Raleigh Times (North Carolina, U.S.A.) stated the discovery of mercury in fish taken from the Grape Creek which flows through Nantahala National Forest in North Carolina. According to the head of the Water Pollution Division of the Water and Air Resources, there are no obvious sources of direct mercury pollution in Grape Creek. Therefore, absence of direct mercury pollution is no assurance against elevated mercury contents in rivers and lakes. Air borne transportation and natural deposits are two possible explanations of the high background level noted.

Mercury Pollution in Thailand

Thailand is not free from mercury pollution. The mercury pollution problem started being noticeable after the case of Asahi Glass Company in 1973. In the same year, Siam Rath, a vernacular daily newspaper in Thailand, revealed information on the mercury pollution by Thai Asahi Caustic Soda Company (TACS). The Newsletter 'Polluted Japan'[4] stated that on the 5th of August, 1973 the TACS factory discharged wastewater into Chao Phraya River and the wastewater contained mercury and caustic soda. This action resulted in a large fishkill and people living along the river ate the floating dead fish. The same bulletin reports that on the 7th of August 1973 pollution of the waterways caused by TACS covered the Phrapradaeng District. The farmers could not supply water to their fields because it was contaminated with mercury and the products of chlorine chemicals. Lobsters and other

fishes were killed and the land in this district did not yield any crops. The other details are available in the Japanese bulletin and is not repeated here. However, on the 5th of September, 1973, the Ministry of Industry published the results of the study of the quality of the wastewater being discharged from the 3 drainage locations into the Chao Phraya River by the Thai Asahi Glass plant. The results of mercury contents were:

Chlorine Treatment Section	0.89 ppm
Chlorine Purifier Section	1.67 ppm
Chlorine Storage Section	0.06 ppm

It is learnt that measurements of mercury in Chao Phraya has been done recently and the results when published should be of interest.

It has been reported that mercury concentration is increasing in the Gulf of Thailand. The second pollution survey[5] of October (20-31) 1973 reported the highest mercury concentration of 4 ppb in sea water at Phai Island sampling station. However, the concentration of Hg in sediments were as high as 49.3 ppm. This concentration of mercury is higher than the average concentration in sediments of other seas. As reported in November, 1974, a relatively large quantity of mercury was found in samples from the upper area of the Gulf and the area near Samui Island.

The quantity of mercury measured in marine fauna in the Gulf in the same year reported the followings:

(i) The highest concentration of mercury, 0.1 ppm was found in Leiognathus in the central area of the Gulf.

(ii) The organisms in the lower part of the Gulf showed a concentration of 0.022 ppm.

(iii) The average amount of mercury in the eastern coastal area of the Gulf was 0.031 ppm.

(iv) The average amount of mercury in the organisms in the central area of The Gulf was 0.020 ppm.

(v) The average concentration in the western coastal area of the Gulf was 0.011 ppm.

Mercury contamination if not controlled will start increasing. Mercury is also neglected in many studies because rational standards for mercury are not developed with proper studies. In U.S. prior to 1969, the Army Corps of Engineers asked companies with permits to itemize any substances in their effiuent which might have environmental effects but no company mentioned mercury in their list. Most of the companies discharging mercury do not have permits and there is no strong legislation and management for such control. Proper control measured should sherefore be developed, studying the record of mercury import and uses in Thailand.

Control Measures

Once the effluent is not controlled and is allowed to reach the river, the responsibility is shifted from industrial waste control authorities to water quality

management authorities. Water quality monitoring usually avoids testing for the presence of mercury although guidelines in some countries list it as a poisonous substance. On a mass production basis, mercury tests were thought to be too expensive, especially since the presence of mercury was not expected.

When mercury reaches a water supply system, the problem is shifted to the water supply authorities. However, no mention of mercury is found in the World Health Organization Standards or even in the standards of U.S. Public Health Services Bureau of Water Hygiene. It may be recalled that in 1969 the U.S. PHS administration ruled that they could act only against substances that produce infectious disease. Needless to say mercury could not be included.

The control of mercury pollution can only be effective by control of use of the metal at the source at which it is released. Decreasing the rate of formation of methyl mercury has been tried in the past by dredging heavily polluted areas, covering sediments of heavily polluted areas, etc. However, none of the measures seemed to solve the problems. Dredging is not successful because it will tend to mix up and distribute inorganic mercury over a large area. Minamata Bay had more mercury after dredging than at the a time of Minamata disasters.

It is felt that without the lack of close and mutual interlocking relations of cooperation between industries and the government, the pollution problem cannot be solved in Thailand. Industries always try to cover up their pollutants until the pollutants start showing up themselves. The government is either too stringent or too negligent. If they find the industries discharging some pollutant or hear public complaints, they usually order the industries to close or take the industries to court. There is no atmosphere to solve the problem with mutual cooperation of the government and industry. This was one of the reasons why it took more than six years to determine the cause of Minamata disease in Japan which is a simple cause and effect relationship in this pollution disease problem. The largest obstacle in the search was the total lack of cooperation on the part of Chisso Company (which was discharging mercury) in relation to process information. The option of solving pollution problems in court should only be the last resort of pollution control.

It is true that the public awareness of the pollution problem and public groups are not strong in Thailand. Nevertheless, whenever some public complaints arise, the industries and the concerned authorities have a tendency to avoid them. In may be stressed that in Thailand most of the people suffering from pollution are in the lower classes of society. Their complaints should be taken as symptoms of the problem.

It is certainly the time for Thailand to give serious attention to the problem of mercury pollution. Build-up of mercury is reported in rivers and Gulf of Thailand and the atmosphere of Bangkok is also not free from mercury. It is not advisable to seek a solution when the problem is serious. To begin with, a rational standard should be developed, backed by a good legislation. Registration of the industries using mercury should be done and the solution and control approaches be drafted with the mutual cooperation of the industries. Registration and proper record of mercury imports should also be done. Guidelines for its transportation, handling

and use may be prepared. Discharges from the industries with the concentration of mercury present should be recorded and the treatment technology made available. Most important of all, mercury balance studies in Thai environment should be made which will show the problem area and decide the control approach to be taken. Last but not the least, the public should be made aware of the pollution problem and their opinions respected.

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