STUDIES ON IMPROVING THE QUALITY OF DRINKING WATER IN AN AGRICULTURAL DISTRICT WITH A SPECIAL REFERENCE TO A METHOD TO REMOVE AGRICULTURAL CHEMICALS

BY

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ABSTRACT

Agricultural chemicals will be mixed in underground and surface water by penetration farms sprinkling in the air or on the ground, sewer, waste water and the like. It is said that organic agricultural chemicals will be gradually resolved chemically or biologically in the water, or adhered to suspension, but they surely remain for a comparatively long period. If those organic agricultural chemicals would remain for a long period and would deteriorate the water quality, some special treatment for water quality is inevitably necessary. However, there has been few studies on this matter.

The present investigation was undertaken to remove agricultural chemicals. Satisfactory results were realized by use of powder active carbon only between two glass fibre plates in the filter and of MF filter medium. Especially the MF filter medium containing 77.2% aragonite calcium carbonate completely eliminated parathion and PCP under 1.22 ppm concentration.

INTRODUCTION

Drinking water is taken daily and that for a long period through our lives as the most insistent requirement of the body. It should be hygienic without including harmful chemical substance, to say nothing of pathogenic microorganism. Its sources are roughly divided into river waters, lake waters, reservoirs and underground waters. When any harmful substances are detected in these waters by the water quality test, they are removed through various kinds of purifying methods. After the treatment water is conveyed to human use.

The rate of public water supplies owned and operated in Japan was only 63.7% by the end of 1963, including city water, private supply and simplified water supply system. Data classified by prefecture show that there is some areas where the rate is about 30%, revealing significant difference between the urban and rural areas. According to our research on the source

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of water supplies at the agricultural districts in Chiba Prefecture, they consist of well water in 82.2%; city water in 14.8% and others in 3.0%. To make matter worse, 39.2% of the above well water proved to be unpotable as the result of water quality tests.

Recently a special problem is created in these agricultural districts by various kinds of agricultural chemicals poured into the drinking water. Such chemicals have brought revolution in agriculture. On the other hand, it contaminated the nature on a large scale, damaging directly the health of the farmers and animals.

There are about 500 kinds of agricultural chemicals available, such as organic phosphorus, chlorine and mercury. Even a small amount of its infiltration into food and drinking water will incur possibility of developing into chronic poisoning because the intake of the chemical will be continued for a long time. To purify the drinking water easily subject to bacteriological and chemical pollution through comparatively simple appliances and operation is urgently needed. Since 1963 the authors have been studying on a filter that was devised to eradicate iron and bacteria in Hokkaido peat moss. The filter was partially improved and basic experiments to remove agricultural chemicals were conducted with following interesting results.

Experimental Method

Filter: The shape of the filter used is cylindrical as shown in Fig. 1. It is 50 cm high and weighs 9 kg. There are three types, electrical, direct coupling and manual pumping system. The water poured in from the lower pipe gets into the cylinder, and the filtrate which is reservoired outside the cylinder is poured out by turning the faucet at the bottom. The cylinder is

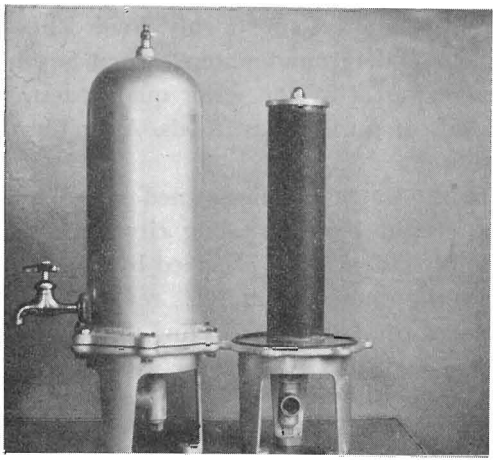

Fig. 1. M. F. Filter

made of 2 mm thick glass fibre with numerous 1–2 μ holes for electrical foaming. Filter medium can be padded with 4 mm thick between outer and inner glass fibres. To purify the water with peat in Hokkaido, MF filter medium which composition is as follows was used. For the purpose of eliminating the agricultural chemicals, the same MF filter medium as it and powder active carbon only as a control were used.

— MF filter medium —

Powder active carbon	20.0 (%)
Aragonite calcium carbonate	77.2
Silicic acid	0.58
Iron	0.56
Aluminum	0.63
Others	1.03

Experiment Operation

Agricultural chemicals used for the test are 46.6% emulsion of ethyl parathion (0-diethyl-0-P-nitrophenyl thiophosphate) and 86.0% solution of PCP (pentachlorophenol).

After the instillment of a chemical into a tank of 400 l distilled water and the measurement of its density in the water, the amount of agricultural chemical in the filtrate following 20 l, 200 l and 400 l filtration was determined, keeping 1.0 kg/cm hydraulic pressure during the whole procedure. The measurement of parathion was made by PNP method taking out 400 ml filtrate and extracting twice with 80 ml/n-Hexan : PCP, by 4-amino-antipyrin method, taking out 400 ml filtrate and extracting with 10 ml Xylene.

Results

Table I shows the results of the elimination of parathion and PCP by filtration through powder active carbon only: Parathion was not detected

Table I. The elimination by powder active carbon

Agricultural chemical	Concentration	After 20 l filtration	After 200 l filtration	After 400 l filtration
Parathion	0.51 (ppm)	0 (ppm)	0 (ppm)	0 (ppm)
	1.20	0	0	0
	5.41	0.37	0.91	0.99
PCP	0.45	0	0	0
	1.12	0	0.14	0.12
	5.20	0.35	1.07	1.14

Table II. The elimination by MF filter medium

Agricultural chemical	Concentration	After 20 l filtration	After 200 l filtration	After 400 l filtration
Parathion	0.31 (ppm)	0 (ppm)	0 (ppm)	0 (ppm)
	1.22	0	0	0
	6.17	0.026	0.068	0.089
PCP	0.06	0	0	0
	1.22	0	0	0
	4.44	0.112	0.196	0.236

in the filtrate following 400 l filtration of 0.51 ppm and 1.20 ppm instilled water. 0.37 ppm parathion, however, was found following 20 l filtration of 5.41 ppm water. In case of PCP 0.45 ppm was successfully removed, however, 0.35 ppm was detected following 1.12 ppm 200 l and 5.20 ppm 20 l filtration, respectively.

Table II shows the results of the use of MF filter medium containing 77.2% aragonite calcium carbonate. MF was more effective in its filtration of parathion and PCP than powder active carbon only: 1.22 ppm parathion was possibly removed to the last. Very small amount was only detected in filtration at 5–6 ppm water of agricultural chemicals. There found no PCP following 1.22 ppm 400 l filtration, and only 0.1–0.2 ppm was detected following 4.44 ppm filtration.

Conclusion

Collman reported that 0.05 ppm toxaphene instilled into the lake had remained for 265 days and that fishes and aquatic plants had been extinct. Nikolson reported that sprinkled parathion on the orchards had remained in the ground for nine months with its concentration of over 0.41 ppm.

In 1945, Caroro reported that about 80% of 10.0 ppm DDT was eliminated by condensed precipitation and filtration. Kohen reported in 1960 that powder active carbon was most effective in eliminating such chemicals from water among the treatment of carbon, chlorine and chlorine dioxide.

The authors experimented the filtration of water with the filter used for peat water in Hokkaido. Powder active carbon only eliminated to the extent of 400 l filtration parathion under 1.22 ppm concentration and PCP under 0.45 ppm (See Table I). MF filter medium removed to the 400 l filtration parathion and PCP under 1.22 ppm (See Table II). From the results of this elimination, it is concluded that MF is the more effectual filter medium.

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