Journal of Environmental Sciences (China) Vol. 5, No. 1, pp. 63–67, 1993 ISSN 1001-0742

Renovated water reuse for rapid infiltration system

Li Ruqi, Duan Zhenbo and Gao Erjing

Beijing Municipal Research Institute of Environmental Protection, Beijing 100037, China

Wu Xueqing

Beijing Agronomy Institute, Beijing 102208, China

Abstract— The renovated water in the rapid infiltration system (RI) as area for fish and duck farming is feasible. The flesh of fish and duck is edible. The farming of fish for 5 months and duck for 120–130 days can be accepted. It is beneficial to environment and economy, especially in developing countries. The production of fish and duck can make up for the cost of wastewater treatment.
Keywords: wastewater treatment; rapid infiltration; water reuse.

The industries in China have been developed accelerately in last decade. The industry and large population in China have caused seriously environmental pollution. The total volume of wastewater discharged is 36.8 billion m^3 per year. It is impossible to treat it with secondary treatment systems because of shortage of financial backing and energy. Now water shortage has been a social problem and limit for the development of economy in dry and semi-dry area, such as Beijing. Land treatment systems may be one of the methods for the solution of pollution. Rapid infiltration system (RI) provides one means of utilizing the treatment capabilities of soil system.

The effluent of RI system is good enough to reuse. It would be great saving, if we can use the effluent for fish and duck farming. The research of toxicity impact of effluent to fish and duck has been done in the top-state research program.

FACILITIES, MATERIALS AND METHODS

The rapid infiltration system (RI) located at Changping in the north suburb, 32 km from Beijing. The system treated 500 m^3/d of municipal and industrial wastewater. Construction of the RI system was accomplished between May, 1988 and March, 1989. The system consisted of four basins. Total site encompassed about 0.36 ha. Effluent storage lagoon is 5700 square meters. The system was operated from April 1989 to August 1990.

Samples of the influent and effluent were collected at the wastewater chanel and central manhole of drainage. Quality of the renovated water is shown in Table 1.

Table 1 Quality of influent and renovated water

	COD, mg/L	BOD_5, mg/L	SS, mg/L	NH_4-N, mg/L	Org-N, mg/L	T-P, mg/L	Fecal caliform, No. /100ml	TOC, mg/L	NO_3-N, mg/L
Influent	479.3	126.0	191.3	4.13	7.02	0.55	7.4×10^4	78.6	2.09
Effluent	38.8	5.9	4.0	0.64	1.18	0.17	38.8	13.8	0.96

The toxicity of renovated water is low or undetected, such as cadmium and lead undetected, copper < 0.0025 mg/L, chromium < 0.0019 mg/L, fluoride < 0.52 mg/L, arsenic < 0.0134 mg/L, cyanide < 0.002 mg/L and zinc < 0.03 mg/L. The quality of renovated water is the key for breeding the fish and duck. The analysis of fish and duck was done by poultry experts and professors. More than 7000 fishes, including carp, grass carp and silver carp which are the most popular fish in China for eating, were put into lagoon in April 1990 and caught by fishing net after 5 months' breeding. The fry of carp is weighed 63 – 72 g/fish, 7 – 25 g/fish for grass carp and silver carp. The samples of fish were observed, weighed, dissected, then cut into sections of tissues for microscopic examination (paraffin sections H-E method) and analysed for the toxic residues in the body of fish.

The nitrite level was determined by colorimetric analysis. The mercury was determined by cold atomic absorption analysis and arsenic by arsenical spot analysis.

300 ducks were bred in the storage lagoon since April 1990. The 35 samples of ducks were chosen by random sampling for examination.

RESULTS AND DISCUSSION

The weight of fish after five months' breeding is shown in Table 2.

The growth of carp is normal. The growth of silver carp is slightly slow because algae did not grow very well in lagoon (pH value of water in the lagoon is about 6.8 – 6.9).

The results in observation of all the fishes, including shape, scale, colour of fish, mocosa of esophagus, liver and kidney, are normal.

The tissues of intestines, liver, pancreas, spleen, inner marrow pancreas cell in spleen, kidney, spermary of male fish were cut for microscopic examination. The result is normal. The change on the micro-structure of the fish has not been observed after five months' breeding. Liver of fish is very sensitive to the toxicity in waters. If

Table 2 The weight of fish

Unit: g/fish

Kind of fish	Number of fish	Average growth weight	Weight of organs	Note
Carp	35	256.1	36.8	not including
Silver carp	36	208.5	18.85	weight of fry

the fish were poisoned a little and were not observed by dissection, the change in the structure would be observed by the microscopic examination. None of significant decrease in the weight of tests, degenerative changes and shrinkage of liver has been observed. There is not inhibition of liver in carps. The results of microscopic examination confirm the feasibility of fishery.

The analyses of toxic residues show that the flesh of fish meet the hygiene regularity of food, as shown in Table 3.

Table 3 Analyses of toxic residues in fish

Kind of fish	Mercury, ppm	Nitrite, ppm	Arsenic, pph	Bioaccumulation factor ratios
Carp flesh	0.2028	1.2500	< 0,1	25.6
Organs	1.2768	1.7500	< 0.1	161.6
Grass flesh	0.1596	1.3750	< 0,1	20.2
Carp organs	1.2768	1.7500	< 0.1	161.6
Silver flesh	0.1200	1.2300	< 0.1	15.1
Carp organs	0.333	1.7500	< 0.1	42.1

Concentration of mercury in water is 0.0079 ppm

Hygiene regularity of food: mercury is equal of smaller than 0.3 ppm in flesh of fish; Nitrite is 70 ppm in flesh; Arsenic is smaller than 0.5 ppm in flesh of fish

Bioaccumulation factor ratios: concentration of mercury in organs/in water

The arsenic uptake by fish was dose-dependent but not time dependent (Syed, 1990). So the concentration of pollutant is main affecting factor for the level of toxic residues. The fish can be bred longer based on the stable good effluent of rapid infiltration system.

More mercury was accumulated in the organ of fish than in the flesh. But the organ of fish is not used for eating. The trace element can be detected by using the bioaccumulation factor (BF) ratios. According to the mercury accumulated in the different part of fish, bioaccumulation factor ratios were calculated, as shown in Table 3. The ratios in organs are greater than in the flesh. The ratios in carp is the greatest and is the smallest in silver carp. The metal accumulating ability of the fish

from aqueous solutions would seem to make fish an ideal biomonitor of dissolved metals in natural waters, as using Lichen biomass (James, 1990).

The weight of ducks is shown in Table 4. The growth of ducks for 120–130 days' breeding is normal.

Table 4 The weight of ducks

Unit: g

	Samples of ducks		
	Male	Female	Average
Average weight of alive duck	2530.0	2330.0	2473.0
Average growth weight per day	19.45	17.8	18.0

The observation of duck's behavior during breeding days and the outward appearance are very good. The dissection of duck is quite normal. The tissues of liver, intestines, spleen and pancreas were cut for microscopic examination. The results are normal.

Arsenic and mercury in liver, kidney and flesh of the ducks were undetected. The concentration of nitrite in liver was 5.5 ppm, 1.5 ppm in kidney and 4.0 ppm in flesh. The analyses of toxic residues show that the flesh and organ of ducks meet the regularity.

CONCLUSION

All the information shows that the renovated water as water area for fish and duck farming is feasible. In this work, wastewater treatment and water reuse are combined. The flesh of fish or duck is edible. Fish for five months' breeding and duck for 120–130 days' breeding can be accepted and be beneficial to environment and economy, especially in developing countries. The production of fish and duck can make up for the cost of wastewater treatment. It may be a new method for developing countries to treat wastewater in a certain ecosystem.

To ensure the quality of fish and duck for eating, the concentration of pollutant must be lower enough. Whether or not the fish or duck farming will be successful is due to the result of operation of RI system. Breeding silver carp or grass carp for one year is better according to the bioaccumulation factor ratios.

Acknowledgements— This paper was appraised by the committee consisted of officers of EPA (China), experts and professors. This work has received the First Science Reward of Beijing Municipal Management Council in Jan. 1991.

REFERENCES

James, N. Beck and Gerald J. Ramelow, Bull. Environ. Toxicol., 1990, 44: 302
Bagchi, P., Bull. Environ. Toxicol., 1990, 44: 871
Syed, M. Naqi, Bull. Environ. Toxicol. , 1990, 45: 94

(Received June 26, 1991)