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Present status of the Japan Sea chemical pollution: An overview*

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1. Introduction

From 28 to 31 of October, 1991 in Vladivostok (formar USSR) first consultative meeting of experts and national focal points on the development of NOWPAP took place (NOWPAP-Action Plan for Protection of Marine Environment in the North-West Pacific). This meeting was organised by UNEP in cooperation with the Center for International Projects (Moscow) and Pacific Oceanological Institute (Vladivostok). 29 participants from UNEP, China, Japan, Republic of Korea and USSR worked aboard the research vessel "Akademik Korolev" of Far Eastern Regional Hydrometeorological Research Institute (FERHRI). By March, 1992 National Focal Points will prepare for UNEP National Reports including the information on the state of marine environment, national policy, measures and relevant activities on marine pollution problems in their countries. This overview had been prepared for inclusion in the Russia National Report to UNEP.

It is based on the data of FERHRI and Vladivostok Center for Environmental Pollution Control. It is necessary to intercompare these data with the results of Japanese and Korean researchers on chemical pollution of the Sea of Japan.

Investigations of the NW Pacific chemical pollution have been carried out by FERHRI specialists since 1970-s. Regular expeditions to study chemistry, biology and pollution of the open ocean and its marginal seas are fulfilled aboard FERHRI research vessels. The Sea of Japan, located between USSR, Japan and Korea, attracts maximum attention.

In the coastal zone of the Sea of Japan, in the Peter the Great Bay, chemical pollution studies have been carried out by Vladivostok Center for Environmental Pollution Control as well as by FERHRI specialists.

In 1990 about 486×10^6 m^3 of municipal and industrial waste waters were discharged in the Peter the Great Bay (23% - without any treatment). 446×10^6 m^3 were discharged from Vladivostok, 26×10^6 m^3 - from Nakhodka. With these waste waters approximately 19×10^3 tons of suspended solids, 373 tons of petroleum hydrocarbons, 51 tons of detergents, 54 tons of iron and about 10 tons of other metals were introduced in the Bay in 1990. With the river runoff 36×10^3 tons of suspended solids, 230 tons of petroleum hydrocarbons and 94 tons of detergents were discharged in 1989. Accidental oil spills were about 30 tons in 1989 and 63 tons in 1990.

2. Materials and methods

Total non-polar petroleum hydrocarbons (PHC) in sea water and bottom sediments were analysed by IR spectrophotometry (KARLBERG and SKARSTEDT, 1972; ORADOVSKY, 1977; 1979). Aromatic hydrocarbons (AHC) in sea water were measured by modified spectroflorimetric method in chrysene equivalents (IOC, 1984). Hydrocarbons were extracted from 21 or sea water by n-hexane using magnetic stirrer during 30 min. After column chromatography on Al_2O_3 fluorescence intensity was measured on JASCO FP-550 spectrofluorometer (Japan). Excitation wavelength - 310 nm, emission -

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360 nm.

Synthetic surface-active substances (anionic detergents or surfactants) were analysed by spectrophotometric method with methylene-blue after chloroform extraction (ORADOVSKY, 1977). Chlorinated hydrocarbons were analysed by gas-liquid chromatography with electron capture detector (ORADOVSKY, 1977, 1979, 1982). Nutrients were measured by photocolorimethric methods (ORADOVSKY, 1977). Trace metals (TM) in sea water and bottom sediments were analysed by atomic absorption spectrophotometry (ORADOVSKY, 1979, 1982).

3. Total non-polar petroleum hydrocarbons

Average concentaration of petroleum hydrocarbons in the open Sea of Japan was 18 ppb in 1986–1988. In the Sea of Phillippines (to the south from 20°N) mean PHC content for the same period was 10 ppb, in the Kuroshio and Oyashio region-12 ppb (TKALIN, 1991a). Elevated PHC concentrations in the Sea of Japan are explained, probably, by its encloseness and lower water temperature (in comparison with the Sea of Philippines), which does not promote biochemical degradation of organic pollutants. In 1989–1990 average content of petroleum hydrocarbons in the Sea of Japan was approximarely the same.

In the coastal waters of the Sea of Japan PHC concentrations are significantly higher. In 1990 average PHC content in the Golden Horn Bay (Vladivostok is situated around this Bay) exceeded 50 ppb (maximum permissable concentration for the Russia coastal marine waters). In the Amursky Bay and the Bay of Nakhodka PHC concentrations were also close to this value.

Higher concentrations of. petroleum hydrocarbons in bottom sediments are observed near the main ports (Vladivostok, Nakhodka, Vrangel). In the Golden Horn Bay mean PHC content was about 10 ppt in 1990 (maximum - 40 ppt), in the Amursky Bay and the Bay of Nakhodka - 0.5–0.8 ppt (maximum - 2–3 ppt). Elevated PHC content was ovserved also near dredged material dumping sites. For example, in the Amursky Bay concentration of petroleum hydrocarbons in bottom sediments in the dumping area exceeded 4 ppt.

4. Aromatic hydrocarbons

Background level of aromatic hydrocarbons (AHC) in the North Pacific waters is about 0.04 ppb. In 1988 aromatic hydrocarbons content in the Japan Sea surface waters was 0.04–0.07 ppb (TKALIN, 1991b).

In 1989, first USSR-DPRK expedition to study chemical pollution of the Japan Sea coastal waters near the Tumangan River mouth was carrid out aboard FERHRI research vessel. Average AHC content outside the area affected by the river runoff influence was 0.06 ppb, near the river mouth concentrations of aromatic hydrocarbons reached 0.96 ppb (TKALIN and SHAPOVALOV 1991). In the same period AHC content in the Korean Strait was 0.03–0.15 ppb. Maximum concentration of aromatic hydrocarbons in surface waters of the Japan Sea in 1989 was 0.33 ppb.

In 1990 second USSR-DPRK expedition to study chemical pollution of the North Korea coastal waters was fulfilled also aboard FERHRI research vessel. In the East-Korean Gulf AHC content varied from 0.03 to 0.15 ppb (TKALIN, 1991b).

5. Synthetic surface-active substances (Anionic detergents)

In 1986–1988 average content of anionic detergents in the Sea of Japan was 25 ppb, in the Kuroshio-Oyashio region - 21 ppb, in the Sea of Philippines (to the south of 20° N)- 17 ppb (TKALIN, 1991a). As in the case of petroleum hydrocarbons, elevated concentrations of detergents in the Sea of Japan are explained by its lower water temperature and relative encloseness.

In 1989, during the first USSR-DPRK expedition near the Tumangan River mouth maximum surfactant content reached 30–40 ppb. Concentrations of detergents outside the area affected by the river runoff influence varied from 5 to 10 ppb (TKALIN and SHA-

POVALOV 1991). In 1990 average content of surfactants in the East-Korean Gulf was 10 ppb, maximum- 29 ppb (TKALIN, 1991b).

In the coastal waste of the Japan Sea, near Vladivostok and Nakhodka, concentrations of anionic detergents are significantly higher due to disharge of municipal and industruial waste waters. Though average detergent content in the Golden Horn Bay did not exceed maximum permissable concentration (100 ppb), measured concentrations occasionally reached 150-250 ppb.

6. Chlorinated hydrocarbons and nutrients

During the last years, DDT, DDD, DDE, α-HCH and γ-HCH are found in the Peter the Great Bay constatly. In 1989-1990 average concentrations of chlorinated hydrocarbons in sea water near Vladivostok and Nakhodka varied from 0.2 to 4.6 ng/l, maximum concentrations reached 100 ng/l. Organochlorines are discharged in the marine environment directly from agricultural areas as well as with river runoff.

In the bottom sediments of the Peter the Great Bay, concentrations of chlorinated compounds are also considerable. In 1990, average content of DDT and its metabolites in bottom sediments varied from 1 to 25 ng/g, α-HCH and γ-HCH - from "not detected" to 10 ng/g. Maximum concentrations of DDT, DDD and DDE reached 100-150 ng/g, HCH isomers - 50-70 ng/g.

In summer 1989 near the Tumangan River mouth, maximum concentrations of organochlorines were as follows: DDT - 1.4, DDD - 0.9, DDE - 0.6, α-HCH - 3.1, γ-HCH - 0.8 ng/l. Outside the area affected by the river runoff chlorinated compounds were not detected (TKALIN and SHAPOVALOV, 1991).

In the coastal zone of the Sea of Japan, near Vladivostok and Nakhodka, very high concentrations of nutrients were observed in surface waters. In 1990 maximum content of ammonia in the Golden Horn Bay was 273 ppb, in the Nakhodka Bay - 184 ppb, in the Amursky Bay - 132 ppb. Maximum nitrate concentrations in the same areas were 230-290 ppb, maximum phosphate content also exceeded 100 ppb.

7. Trace metals

Dissolved trace metal contents in the open Sea of Japan are less than following figures: Cu - 0.1, Pb - 0.05, Co - 0.02, Ni - 0.02 ppb (TKALIN and SHAPOVALOV, 1991). In the coastal zone, near Vladivostok and Nakhodka, dissolved TM concentrations are significantly higher. For example, in 1990 average TM concentrations in the Golden Horn Bay were as follows: Cu-4.0, Pb - 1.8, Co - 0.4, Ni - 0.6, Cd - 0.3, Hg - 0.02 ppb. Maximum content of zinc was about 200 ppb, iron - 2000 ppb.

Higher concentrations of trace metals in bottom sediments were also observed near Vladivostok and Nakhodka. In 1990 mean copper content in the Golden Horn Bay was 91 ppm, in the Amursky Bay - 19 ppm, in the open Peter the Great Bay - 3 ppm. Concentrations of lead were as follows: 124, 21 and 6 ppm, cadmium - 4.9, 1.4 and 0.5 ppm, mercury - 0.72, 0.06 and 0.02 ppm respectively. Maximum content of lead in the Golden Horn Bay was 380 ppm, cadmium - 15 ppm, mercury - about 2 ppm.

Elevated TM content in bottom sediments was observed also in the dredged material dumping sites. For example, average content of zinc in the Amursly Bay dumping site was 539 ppm, lead - 187 ppm, copper - 136 ppm, cadmium - 2 ppm.

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