DEVELOPMENT OF OBSERVATION TECHNOLOGY FOR GLOBAL-SCALE MARINE POLLUTION WITH HAZARDOUS CHEMICALS DEPLOYED ON VOLUNTARY OBSERVATION SHIPS

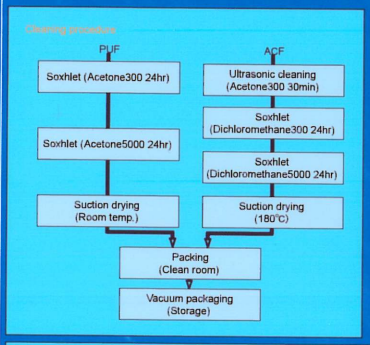
Kunugi M[1], Fujimori K[2], Nakano T[2]
1: Environmental Chemistry Division, National Institute for Environmental Studies (E-mail:kunugi@nies.go.jp)
2: Environmental Safety Division, Hyogo Prefectural Institute of Public Health and Environmental Science

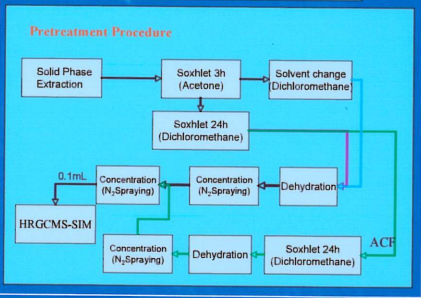
Introduction

Hazardous chemicals in the sea are liable to accumulate in marine ecosystems, and are transported by mechanisms such as oceanic and atmospheric currents. It is important to study these transport mechanisms in the ocean in order to better understand the nature and extent of marine pollution from hazardous chemicals. On May 2001, Persistent Organic Pollutants (POPs) Convention was adopted in Stockholm, and taken effect on May 2004. We believe that frequent spatial and seasonal observations are required in order to fully understand the mechanisms of marine pollution with hazardous chemicals such as POPs. For this purpose, we investigated solid phase extraction and developed the hazardous chemical sampling system, then it was installed on merchant vessels.

Cleaning and pretreatment procedure

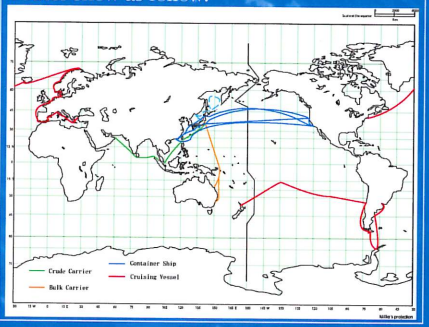
Cleaning procedure of solid phase extracting materials shows following flowchart. Hazardous chemicals were extracted by the Soxhlet extraction with acetone (24hr) and dichloromethane (24hr) from these columns. POPs were determined by high resolution gas chromatograph/high resolution mass spectrometry (HRGC/HRMS, JMS-700).





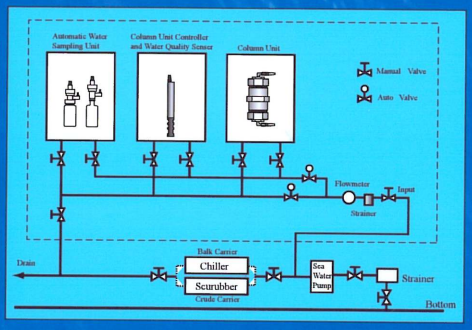
Sampling

We had been sampling hazardous chemicals in seawater around the world from 2001 using these systems. Typical sampling routes show as follow.



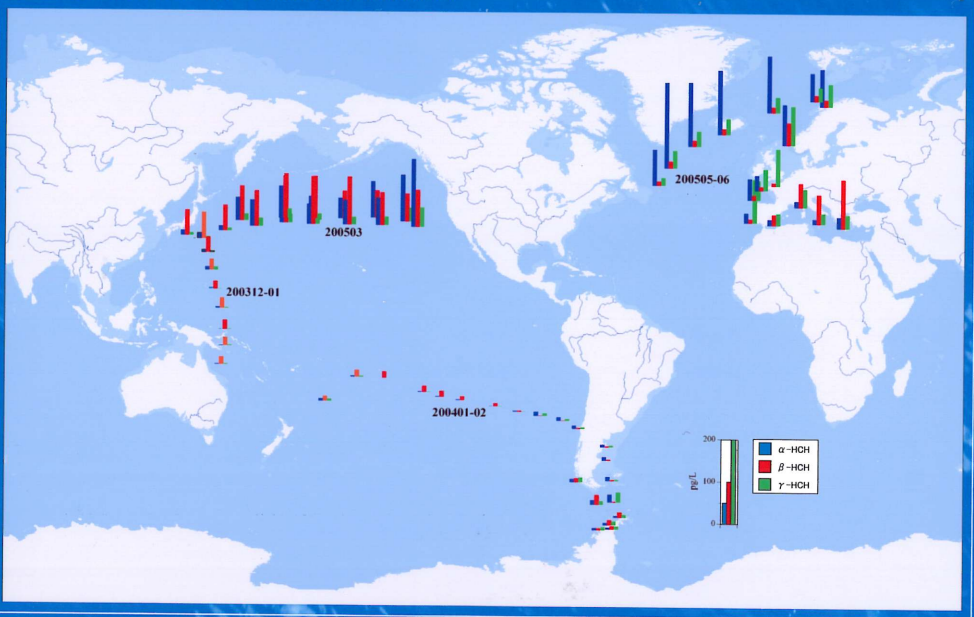
Sampling System

To know the occurrence and behavior of POPs and endocrine disrupting chemicals in marine environment, 3 types of automated sampling systems were developed and installed in the very large crude carrier transporting from the Persian Gulf to Japan, the bulk carrier from Australia to Japan, the container ship between Japan and USA, and the cruising vessel around the world. Photos and blockdiagram of the automatic sampling systems show as following.
Collection of each water sample was conducted for 200 minutes at a time, a total of 100 L at a flow rate of about 0.5 L/min, by solid phase extraction method. Solid phase extraction columns were containing a poly-urethane foam (PUF) and active carbon fiber filters(ACF). And we spiked ^{13}C stable-isotope standard mixture sample into a sampling line when sample collection was started at all sampling periods. Collection samples were conserved in the freezer at -20°C.



Results and Discussion

Concentrations of HCHs were very different in sea area. In general, HCHs in the Southern Hemisphere were low in the Northern Hemisphere. Between Japan and Australia the concentration of β-HCH gradually decreased from Japan to the equator and was constantly low at pg/l level from the equator to the Australia. The emission source of β-HCH is suspected to be Asian countries. In the South Pacific, the concentration of β-HCH gradually increased from New Zealand to Tahiti Islands, but those of α-HCH and γ-HCH decreased. β-HCH was detected near Tahiti Islands and central part of the South Pacific, nevertheless α-HCH and γ-HCH were not detected or detected only at very low concentration. From east part of the South Pacific to the offing of Chile, α-HCH and γ-HCH were detected, but β-HCH could not be detected. From the Patagonia fjord to the Antarctic Ocean, α, β, γ-HCH were detected. Then, from the Atlantic Ocean side of the Drake Channel to the offing of Argentina, α-HCH gradually decreased from south to north. We think that these distributions of HCHs depend on the temperature of seawater and distance of the emission source and sink of hazardous chemicals.



Conclusion

We developed a marine pollution observation system, suitable for mounting on a merchant vessel. By mounting these systems in bulk carriers, a container ship and a cruising vessel, navigated around the world. We observed the concentration of hazardous chemicals such as persistent organic pollutants, endocrine disrupting chemicals, organotin compounds, poly-aromatic hydrocarbons, and heavy metals in seawater a total of 10 tomes and confirmed the usefulness of the system. We detected α-HCH, β-HCH, γ-HCH, TBT, nonylphenol, parental PAHs in seawater in almost all observations.
From these results, it is clear that global scale observations are indispensable to gain a grasp of the dynamics of marine pollution by hazardous chemicals.

Acknowledgements

The authors are grateful to NYK Line Co. for ship of opportunity. This research was supported by "Global Environment Research Fund of the Ministry of Environment Japan" D-2.