Vertical water body effect of benzene hexachloride

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Abstract

Based on the analysis on the transfer process of benzene hexachloride (HCH), this paper proposed the theory of vertical water body effect, vertical water body cumulative effect, and vertical water body dilutive effect, including definition, main function, and concept model. Furthermore, this paper applied vertical water body effect in analyzing the transfer processes of HCH in Jiaozhou Bay Waters. Results showed that this theory was useful and effective in revealing the changes of HCH under the effects of vertical water body.

Keywords: Benzene hexachloride; Vertical water body; Cumulative effect; Dilutive effect; Jiaozhou Bay

Introduction

HCH used to be one of the widely used pesticides, and had been recognized as one of the persistent organic pollutants (POPs). Ocean is the sink of various pollutants. Researching the transfer process of HCH is essential to understand the persistent pollution caused by HCH [1-13].

Jiaozhou Bay is a semi-closed bay, located in the south of Shandong Province, eastern China (35°55′-36°18′ N, 120°04′-120°23′ E). There are both economic developed regions (Qingdao etc.) and agricultural developed regions (Jiaonan etc.) [3]. Previous studies showed that this bay has been polluted by HCH, and the transfer processes of HCH were research hotspots [1-13].

In order to provide theory and methodology to better understand the transfer processes of HCH, this paper proposed the theory of vertical water body effect, vertical water body cumulative effect, and vertical water body dilutive effect, including definitions, main functions, and concept model. Furthermore, based on investigation data on HCH in Jiaozhou Bay water in April, July and October

1982 [14], this paper applied vertical water body effect in analyzing the transfer processes of HCH in Jiaozhou Bay Waters.

Background of vertical water body effect

HCH is difficult to dissolve in water, yet is absorbable to suspended particulate matter, plankton and sediment [15] The growth and reproduction of marine organism (especially phytoplankton) are increasing from spring and reaching the peak in summer [16]. The growth and reproduction of phytoplankton generate a lot of colloid, enhance the adsorption capacity of the suspended particulate matter, and increase the sedimentation of HCH. Hence, HCH contents in surface waters is closed to bottom waters, and the vertical distribution is homogenous. What is more, HCH contents in both surface and bottom waters in summer are higher than in spring. By means of sedimentation, high HCH content in surface waters leads to high HCH content in bottom waters. Generally speaking, during the transferring from surface water to bottom waters, HCH content is changing. In order to quantitatively reveal the changing process, the vertical water body effect was proposed.

Definition of vertical water body effect

During the transfer process from surface waters to bottom waters, the effects of water body are militating, leading to the changing of HCH content. We defined this phenomenon as vertical water body effect. In case of during the transfer process from surface waters to bottom waters, by means of the effects of water body, HCH contents were decreasing. We defined this phenomenon as vertical water body dilutive effect. If HCH contents were increasing. We defined this phenomenon as vertical water body cumulative effect. Here, we described these effects as in Fig. 1.

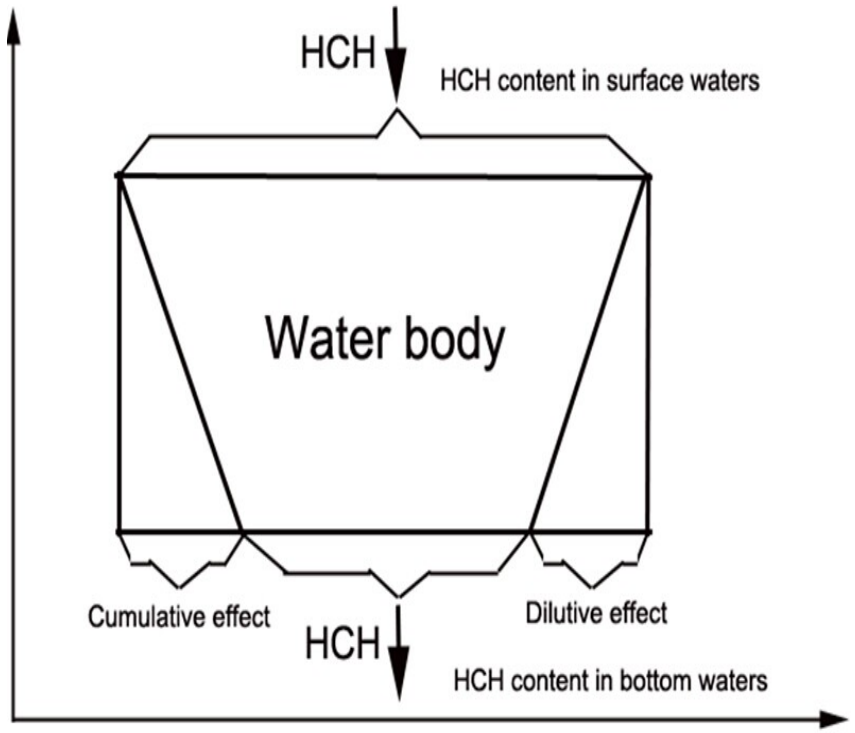

Fig. 1 Concept model of vertical water body effect

Main function of vertical water body effect

It is necessary to understand the effects of water body on HCH contents during the transferring of HCH from surface waters to bottom waters. Hence, based on the HCH contents in surface waters and bottom waters, in addition of theory of vertical water body effect, vertical water body cumulative effect, and vertical water body dilutive effect, the changing of HCH contents could be easily to be determined.

Theory of vertical water body effect

In case of HCH contents in surface waters (a) are lower than in bottom waters (b). Where, a is the lowest value of HCH contents in surface waters, b is the highest value of HCH contents in bottom waters, $a < b$. The reason is that a large amount of HCH is subsided to the bottom waters, leading to the accumulation of HCH in bottom waters. The vertical water body cumulative effect is that, after passing the water body, HCH contents in waters are changed from the lowest value in surface waters (a) to the highest value in bottom waters (b).

In case of HCH contents in surface waters (a) are higher than in bottom waters (b). Where, a is the highest value of HCH contents in surface waters, b is the lowest value HCH contents of HCH in bottom waters, a > b. The reason is that in addition of the migrating down of HCH, a large amount of HCH is subsided to the sediments, and is finally removed from water body. Hence, HCH contents in bottom waters (b) were lower than in surface waters (a). The vertical water body dilutive effect is that, after passing the water body, HCH contents in waters are changed from the highest value in surface waters (a) to the lowest value in bottom waters (b).

Application of vertical water body effect

HCH contents in Jiaozhou Bay surface waters and bottom waters in April 1982 ranged from 0.065-0.301μg.L-1 and 0.072-0.302μg.L-1, respectively (Table 1). The vertical water body effect was cumulative for lowest values, that was 0.072-0.065=0.007μg.L-1. For highest values, the vertical water body effect was cumulative, that was 0.302-0.301=0.001μg.L-1. Hence, it could be concluded that the vertical water body effect was in April was cumulative, that was 0.001-0.007 μg.L-1.

HCH contents in Jiaozhou Bay surface waters and bottom waters in July 1982 ranged from 0.171-0.409μg.L-1 and 0.160-0.254μg.L-1, respectively (Table 1). Both lowest and highest of HCH contents in surface waters were higher than in bottom waters, indicated that the vertical water body effect was in July was dilutive, that was 0.011-0.155 μg.L-1.

HCH contents in Jiaozhou Bay surface waters and bottom waters in October 1982 ranged from 0.136-0.211μg.L-1 and 0.129-0.206μg.L-1, respectively (Table 1). In the same way as in July, the vertical water body effect was in October was dilutive, that was 0.005-0.007 μg.L-1.

For the whole year of 1982, HCH contents in Jiaozhou Bay surface waters and bottom waters ranged from 0.065-0.409μg.L-1 and 0.072-0.302μg.L-1, respectively (Table 1). The vertical water body cumulative effect was 0.072-0.065=0.007μg.L-1, and the vertical water body dilutive effect was 0.409-0.302=0.107μg.L-1. It could be concluded that for the whole year of 1982, the vertical water body effect was cumulative for lowest values, and dilutive for highest values.

Table 1 The vertical water body effect of HCH in Jiaozhou bay 1982

HCH content/μg·L-1	April	July	October	Yearly
Surface waters	0.065-0.301	0.171-0.409	0.136-0.211	0.065-0.409
Bottom waters	0.072-0.302	0.160-0.254	0.129-0.206	0.072-0.302
Effect	Cumulative	Dilutive	Dilutive	Cumulative and dilutive

Conclusion

We took HCH as the indicator of water body, analyzed the effects of water body on HCH contents during the transferring of HCH in water body. We proposed the theory of vertical water body effect, vertical water body cumulative effect, and vertical water body dilutive effect, including definition, main function, and concept model. Results of the case study showed that this theory was useful and effective in revealing the changes of HCH under the effects of vertical water body.

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