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Research Article

Evaluation of the effects of surfactants in the water of Kim Nguu River, Hanoi

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Abstract: Surfactants are one of the new pollutants of current concern worldwide. Many studies show the toxicity of surfactants to human health and microorganisms. Kim Nguu River is one of Hanoi's wastewater drainage rivers, and the number of residents in the river area is quite dense. In addition, around the river area, there are many hospitals, factories, and industrial parks in operation. Especially the 8/3 textile factory where a lot of detergents are produced due to the bleaching and dyeing processes in the river. In this study, the author conducted sampling and analyzed the concentration of pollutants in the Kim Nguu River according to the method of Kadokami. This is a comprehensive analysis method that is both qualitative and quantitative According to analysis, there are currently two substances belonging to the group of surfactants: Nonylphenol and 4-tert-Octyphenol with concentrations measured in 2018 and 2019 of 4.1-12.45 µg/L, 11.4 to 29.56 µg/ L and 2.02-3.21 µg/L and 3.95-6.7 µg/L. The concentration of surfactants in the Kim Nguu River tends to increase sharply over time, and the level of impact of the concentration of surfactants in the Kim Nguu River on the ecosystem is at a high level. Kim Ngu River is just one of Hanoi's wastewater drainage rivers. Further research is needed on other wastewater drainage rivers to have clearer conclusions about the appearance of surfactants. in rivers draining wastewater.

Keywords: Surfactants; Nonylphenol; 4-tert-Octyphenol; Pollution.

1. Introduction

There have been several studies around the world showing the toxicity of surfactants to the ecosystem [1]. We can mention research on crustaceans, yeast, and algae to find out the effects of surfactants on organisms [2]. Some studies on the toxicity of Nonylphenol to the environment include research by Shaukat [3] about the effects of Nonylphenol on Brine shrimp: Artemia sinica and the results obtained are that compared to n-heptyl phenol, Nonylphenol, t-butyl phenol, 2,4-dichlorophenol, and bisphenol A, Nonylphenol has a strong harmful effect on artemia. second only to n-heptyl phenol. Another study by [4] with Fish: Pseudochromis fridamani and Algae: Selenastrum capricornutum showed surprising results, all fish died after only 8 days of exposure to Nonylphenol, the ability to produce and form cells in green algae decreased significantly [5].

In Vietnam, there are very few studies on surfactants in water. One of the few studies showed that Nonylphenol compounds have caused serious effects on the vitality and reproduction of crustacean species C. cornuta, D. lumholtzi, and D. magna. This can lead to a decline in the number of zooplankton and the loss of ecological diversity in water bodies

with high Nonylphenol content [6]. This study can be a premise for further research on surfactants in the river and also partly warns about the currently quite high concentration of surfactants in the river.

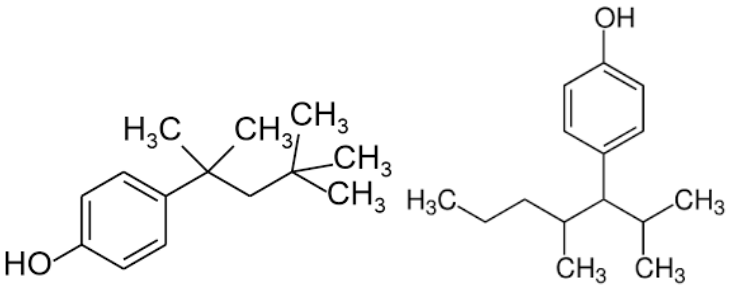

Figure 1. Structure of Nonylphenol and 4-tert-Octyphenol.

Surfactants are amphiphiles consisting of both hydrophilic and hydrophobic parts, which can participate in intermolecular interactions that contribute to their surface activity. When the hydrophilic parts are arranged together on the outside and the hydrophobic parts are arranged together in the center, it is called a Micelle. These micelles increase the solubility of pollutants while increasing the toxicity of the surfactant.

The mechanism of action of surfactants is to reduce the surface tension of the solvent they contain, making the solvents easily disperse into each other. Surfactants can remove dirt and grease but cannot treat them and carry them out into the environment. When exposed to the environment with a mechanism of action to reduce surface tension, surfactants carry impurities that make it difficult for oxygen and sunlight to penetrate, leading to a serious decrease in dissolved oxygen. This is the cause of disturbance in the activities of microorganisms [7].

Nonylphenol is a pale-yellow liquid that is sparingly soluble in water but soluble in organic solvents. Nonylphenol is used to produce antioxidants, detergents, and cleaners. Since Nonylphenol was first synthesized in 1940 its use and production have increased rapidly [8, 9].

4-tert-Octyphenol is also a surfactant. 4t-OP is very toxic to aquatic organisms. In rainbow trout, juvenile salmon growth was significantly reduced when exposed to 4t-OP. 4-tert-Octyphenol and Nonylphenol are both endocrine disruptors for humans and organisms [9–11].

2. Materials and Methods

2.1 Methods of investigation and data collection

The section of the Kim Nguu River studied is 4km long, from the beginning of Kim Nguu Street to the end of the Yen So wastewater treatment plant. Through the process of field investigation, the author selected 6 sampling locations, each location characteristic of the waste source discharged into the Kim Nguu River. M1 is the starting point for research, determining the initial concentration of the Kim Nguu River; M2 is the point with waste sources from residential areas and 3 hospitals; M3 is the concentration point of waste sources in a new urban area; M4 is the point with waste sources from residential areas and a hospital; M5 is the point with waste sources from Vinh Tuy Industrial Park, wholesale markets, and residential areas; M6 is the treated wastewater point of Yen So wastewater treatment plant.

Table 1. Location of sampling sites in the Kim Nguu River.

Numerical order	Location Description	Longitude	Latitude
1	M1: The beginning of Kim Nguu Street	21°00’25.7”N	105°51’39.7”E
2	M2: Lac Trung Bridge	21°00’10.8”N	105°51’41.5”E

Numerical order	Location Description	Longitude	Latitude
3	M3: Mai Dong Bridge	20°59’46.5”N	105°51’44.0”E
4	M4: KuO Bridge	20°59’17.0”N	105°51’47.3”E
5	M5: In front of the Yen So wastewater treatment plant	20°58’33.6”N	105°51’55.3”E
6	M6: Yen So regulating lake	20°58’13.5”N	105°51’36.8”E

2.2. Sampling method

The six water samples were all taken in April of 2018 and 2019 (Figure 2). All water samples were taken according to TCVN 6663-3-2008 standards. After taking water samples, they were refrigerated and brought back for analysis at the Laboratory of the Institute of Environmental.

Figure 2. Location of the study area.

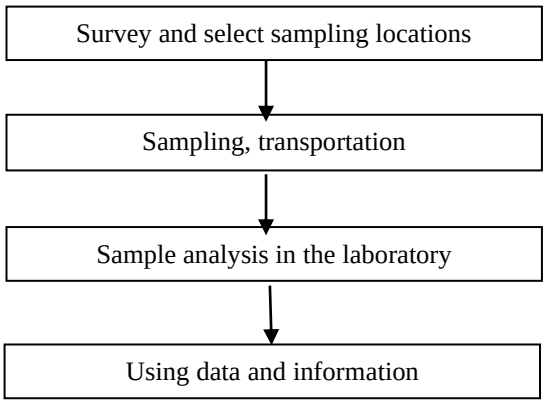

Figure 3. Research structure diagram.

2.3. Methods of sample analysis

Bring the water sample to room temperature. Take a 500ml water sample, add 30g of anhydrous NaCl, and shake well. Add 100ml of dichloromethane to the solution and continue shaking for 10 minutes, Let the shaking solution rest for 10 minutes, and then filter the extract through a funnel containing anhydrous Na_2SO_4. Repeat the above process two more times, each time with 50ml of dichloromethane. Use a rotary vacuum evaporator to concentrate the

obtained extract. Clean the newly concentrated solution using an activated Silicagel column to obtain the cleaned solution. Continue to concentrate the cleaned solution using a rotary vacuum evaporator until the solution remains about 5ml. Concentrate the solution to 1ml by blowing N_2 gas. The solution, after being blown with N_2 gas, was stored in vials, and then put into a gas chromatograph-mass spectrometer for analysis [12].

3. Results and discussion

3.1 Evaluation of insecticide contamination in the water of the Kim Nguu River

After the sample is extracted and put into 1ml vials, it will be put into a GC-MS-MS-SRM 9TSQ Quantum XLS machine, Thermo Fisher Scientific, USA for analysis. The machine has a library of more than 900 substances, however, that library does not contain some typical surfactants such as Sulfate-based substances and Sodium-based substances, these substances are found in many domestic wastewaters. Kim Nguu is the recipient of domestic wastewater from a densely populated area. It is possible that these substances will not be detected by this analytical procedure. Surfactants in Vietnam are still limited in research on their accumulation in organisms, and only a few substances have been studied.

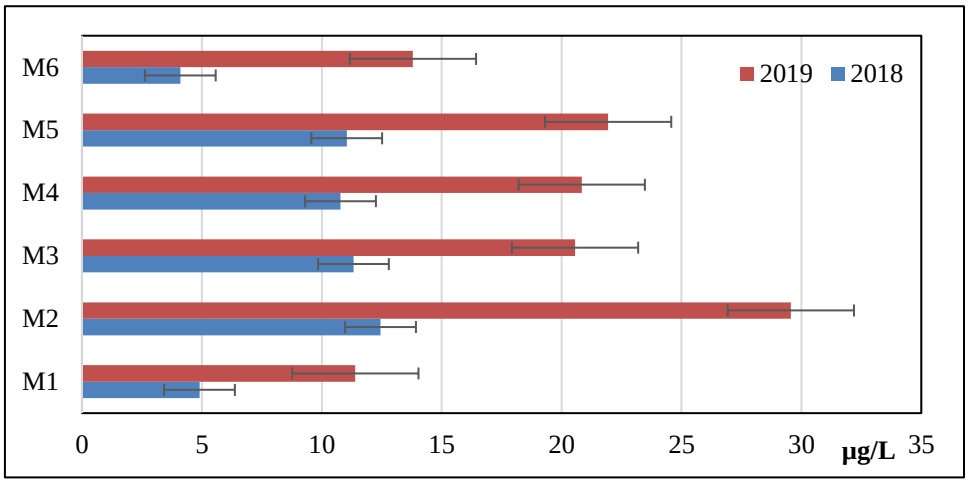

Figure 4. Nonylphenol concentration in Kim Nguu River.

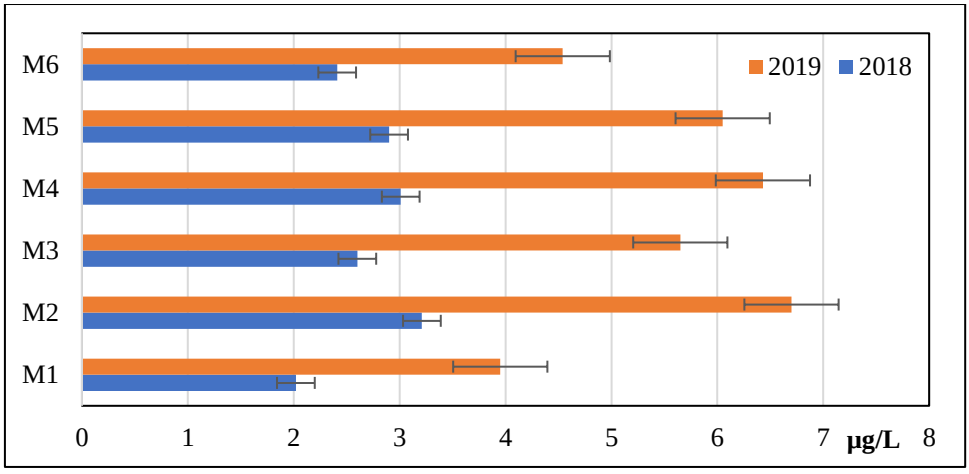

Figure 5. 4-tert-Octyphenol concentration in Kim Nguu River.

4-tert-octyphenol concentrations recorded in 2018 and 2019 were 2.02-3.21µg/L and 3.95-6.7 µg/L, respectively. Like the concentration of Nonylphenol, the concentration of 4-tert-octyphenol also increases over time for the same reason. Looking at Figure 5, it can be seen that the concentration trends at the sampling locations of Nonylphenol and 4-tert-

octyphenol are almost the same, the only difference is the concentration of 4-tert-octyphenol at the location. M5 is not the position with the second highest concentration. This may be explained by the fact that 4-tert-octyphenol is not a substance widely used in the textile dyeing industry.

The concentration of Nonylphenol in Kim Nguu River water in 2019 ranged from 11.4 to 29.56 µg/L, with an average concentration of 19.68µg/L. With this concentration, the Nonylphenol concentration in Kim Nguu River water is much higher than the average of 24 surface water samples in Yellow River China (average concentration 0.805µg/L) [13]. Some other countries such as Germany (average 0.13µg/L) [14], Switzerland (average 0.48µg/L) [15], and Austria (average 0.89µg/L) [16] are all much higher.

3.2 Ecological risk assessment of Nonylphenol in Kim Nguu River water

There are many studies around the world on the effects of Nanolphenol concentrations on aquatic organisms. As for 4-tert-octyphenol, the toxicity is added to the same Phenol groups. Within the scope of this study, only the ecological effects of Nonylphenol will be presented.

To evaluate the ecological effects of Nonylphenol, studies have used several parameters: Criteriton maximum concentration- CMC, and Criteriton continuous concentration - CCC. The values of the CMC and CCC parameters are specified in the National Recommended Aquatic Life Criteria table [17–19].

From Figure 6, it can be easily seen that the Criterion continuous concentration - CCC of Nonylphenol in 2018 has 2 positions M1 and M6 are at the chronic threshold and the rest are above the acute threshold. By 2019, concentrations at all locations had exceeded the acute threshold, no location in 2 years was below the chronic level.

From Figure 7, it can be seen that the Criteriton maximum concentration - CMC of Nonylphenol in 2018 was all below the acute level, positions M1, and M6 were below the chronic level, and the remaining positions were above the chronic level. In 2019, at location M2, the concentration exceeded the acute level and the remaining locations exceeded the chronic level.

Table 2. National Recommended Aquatic Life Criteria.

Pollution	Freshwater CMC (Acute µg/L)	Freshwater CMC (Chronic µg/L)	Freshwater CCC (Acute µg/L)	Freshwater CCC (Chronic µg/L)
Nonylphenol	28	7	6.6	1.7

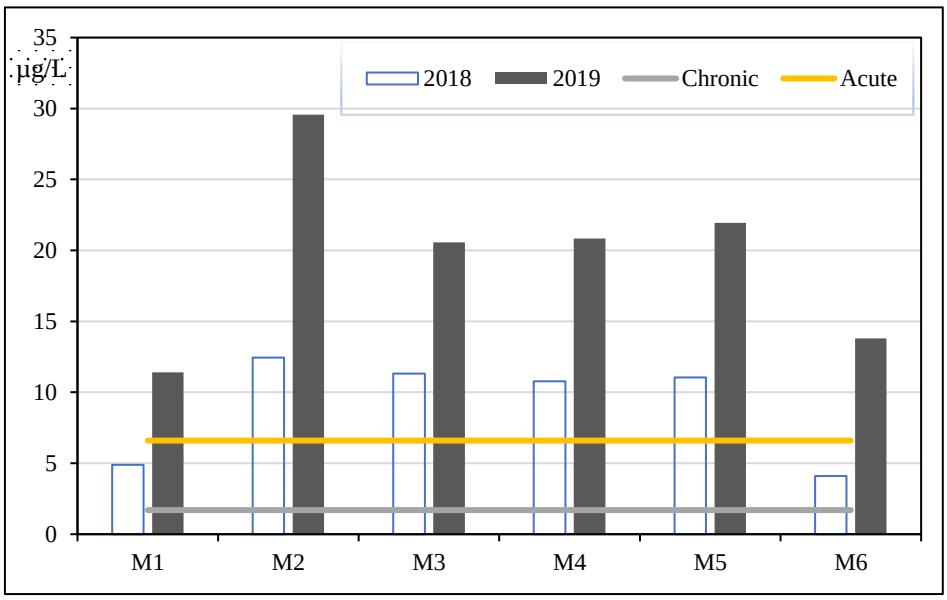

Figure 6. Criterion continuous concentration of Nonylphenol.

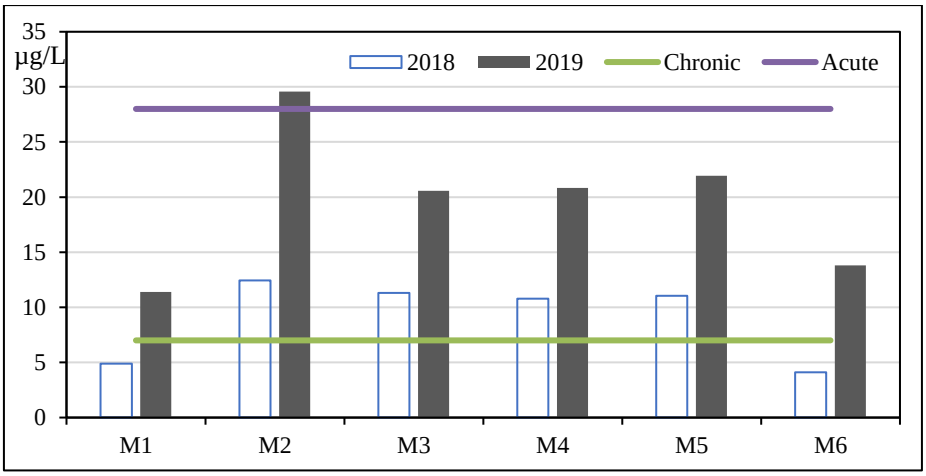

Figure 7. Criterion maximum concentration of Nonylphenol.

In general, the concentration of Nonylphenol in KimNguu River water is at an alarming level for the ecosystem, with an increasing trend each year, there is a high possibility that the level of impact will be even higher.

4. Conclusion

The analytical method of Kadokami et al can detect Nonylphenol and 4-tert-Octyphenol in water of Kim Nguu River, Hanoi. Research is needed to select appropriate analysis methods for surfactants so that more substances can be analyzed.

Through the analysis process, it was discovered that there are 2 surfactants in the Kim Nguu River. Nonylphenol and 4-tert-Octyphenol with concentrations measured in 2018 and 2019 of 4.1-12.45 µg/L, 11.4 to 29.56 µg/L and 2.02-3.21µg/L and 3.95-6.7 µg/L. The concentration of surfactants tends to increase each year.

Nonylphenol concentration in Kim Nguu River water is at a level that adversely affects the ecosystem at all locations. Nonylphenol concentration in Kim Nguu River water is also much higher than Nonylphenol concentration in water of some rivers in the world.

Author contribution statement: Constructing research idea: T.X.Q., V.D.T.; Select research methods: T.X.Q., V.D.T.; Data processing: T.X.Q., V.D.T; Sample analysis: T.X.Q.; Take samples: T.X.Q; Writing original draft preparation: T.X.Q., V.D.T.; Writing review and editing: T.X.Q., V.D.T.

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Competing interest statement: The authors declare that this article was the work of the authors, has not been published elsewhere, and has not been copied from previous research; there was no conflict of interest within the author group.

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