Water Quality and Diffusion Characteristics in the Eastern Sea of the Geoje Island

Young Ho Han* and Young-Seup Kim**

In order to provide the basic data required for setting up the proper strategies to minimize the future marine pollution in the vicinity sea area of the Geoje Island, the general water quality parameters and dye diffusion experiment were carried out from January to March, 1983.

Although TSS and COD level in the investigated sea area showed still slightly lower than the area of Seaside Industrial Complex Zones, seriously increasing due to the construction of heavy industrial plants.

Dissolved oxygen showed more than 8 ppm, and inferred still enough for the reservation of the investigated sea area.

The dye patches moved south-eastward with forming an elliptical shape and then turned slowly to the area of Kujora during flood tide, and it moved north-westward and then blocked the entrance of Jangseungpo during ebb tide.

The diffusibility in the area may be assessed to be quite better than other coastal areas.

**Introduction**

Geoje Island is the second largest island in Korea. The coastal area of this island is connected with Jinhai Bay and the estuary of Nakdong River to North and north-east side and also the starting point of Hanreo National Marine Park. Many marine farms culturing oyster, ark-shell and sea mustard gathered so that this area is very important for fishing industry. In addition, recently so many heavy industrial plants are being constructed that the population in this area is increased rapidly, and the water quality is getting worse day by day.

Therefore, it is need to investigate the present marine conditions of this area in order to provide the basic data required for the proper assessment on the future marine environment.


The authors carried out an investigation of general water quality parameters, circulation pattern and dye diffusion experiment in order to provide the data required for setting up good strategies to minimize future marine environmental pollution in the vicinity sea area of Geoje Island.

**Materials and Methods**

The water circulation pattern needed for this study is estimated by use of the data which made by the Fisheries Reserach and Development Agency.

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(FRDA, 1978) on the surrounding sea of Geoje Island.

Among the water quality parameters, TSS, VSS, DO and COD level were investigated from January to March, 1983 by authors. The water samples required for the water analysis were collected from the sea surface at 17 stations according to the tides (Fig. 1.). Samples kept in the polyethylene bottles analyzed in the laboratory according to the standard methods.

Dissolved oxygen at sea surface and 5 meter depth was checked in situ by a DO-meter.

Rhodamine B was used for dye material. In order to match the density of dye solution with that of sea water, Rhodamine was mixed with methanol and prepared 100 liters of dye solution in every experiment. The dye solution was released instantaneously at the sea surface of point A during flood tide on January 28 and point B during ebb tide on January 29, 1983 (Fig. 4.). Dye patches were tracked by a small boat, and dyed water was sampled with the DC-pump (3V). Fluoro-spectrophotometer was used to determine the concentration of samples. Position of the boat was checked by use of a sextant and a magnetic compass. Variance, apparent diffusibility and elongation rate of patches were computed to know the diffusion characteristics by the standard statistical method.

Results and Discussion

A. Current

The water in the investigated sea area flowed southward from the east side of Jangseungpo to the east-west side of Jishimdo at a speed of 0.6-1.0 knot during flood tide (Fig. 2), while the water near around the coast flowed a little slowly (at a speed of slower than 0.5 knot) than the east side of Jishimdo (at a speed of 0.5 to 1.0 knot).

The pattern of current, as a whole, was simple and the maximum speed during flood tide was slightly stronger than that during ebb tide.

The current during ebb tide circled counterclockwise at near around Jishimdo, that is, flowed southward at the east-west area of Jishimdo, northerward at the area between Jisepo and Seoimal at a speed of 0.04 to 1.0 knot, south-eastward at the far eastern area of Jishimdo and south-westward at near around Seoimal.

B. Water Quality

The TSS level in the investigated sea area ranged 1.93 to 11.49 ppm and averaged 5.77 ppm during flood tide, 2.97 to 13.00 ppm and averaged 6.73 ppm during ebb tide, and wholly averaged 6.73 ppm. The tendency of high level is appearing around the southern area of Kujora can be inferred by the effect of topography and tidal current.

The VSS level ranged 0.86 to 9.42 ppm and averaged 3.98 ppm during flood tide, 2.13 to 9.50 ppm and averaged 4.76 ppm during ebb tide, and conspicuously varied by stations.

The containing rate of VSS in the TSS showed approximately 0.7, similar to that of Onsan Bay of 0.84.

The value of COD, determined by use of KMnO₄ are shown in Fig. 3. The figure shows COD ranges

Fig. 1. Map showing sampling stations in the study area.
Water Quality and Diffusion Characteristics in the Eastern Sea of the Geoje

Fig. 2. Tide current pattern.

Fig. 3. Distribution of COD.
Table 1. Results of SS and DO level according to tides

<table>
<thead>
<tr>
<th>Station</th>
<th>Flood TSS</th>
<th>VSS</th>
<th>DO</th>
<th>Ebb TSS</th>
<th>VSS</th>
<th>DO</th>
</tr>
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<tr>
<td>A</td>
<td>4.22</td>
<td>2.48</td>
<td>8.2</td>
<td>4.40</td>
<td>4.20</td>
<td>8.8</td>
</tr>
<tr>
<td>B</td>
<td>3.23</td>
<td>2.73</td>
<td>8.1</td>
<td>5.88</td>
<td>5.46</td>
<td>8.8</td>
</tr>
<tr>
<td>C</td>
<td>6.14</td>
<td>3.93</td>
<td>8.3</td>
<td>2.97</td>
<td>2.18</td>
<td>8.8</td>
</tr>
<tr>
<td>D</td>
<td>4.51</td>
<td>2.56</td>
<td>8.1</td>
<td>3.56</td>
<td>2.93</td>
<td>8.3</td>
</tr>
<tr>
<td>E</td>
<td>5.26</td>
<td>4.01</td>
<td>8.2</td>
<td>4.92</td>
<td>4.51</td>
<td>8.3</td>
</tr>
<tr>
<td>F</td>
<td>3.70</td>
<td>1.56</td>
<td>8.2</td>
<td>6.95</td>
<td>6.55</td>
<td>8.1</td>
</tr>
<tr>
<td>G</td>
<td>4.73</td>
<td>2.58</td>
<td>8.3</td>
<td>7.23</td>
<td>5.98</td>
<td>8.4</td>
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<tr>
<td>H</td>
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<td>1.75</td>
<td>8.5</td>
<td>5.85</td>
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<td>8.5</td>
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<tr>
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<td>0.86</td>
<td>8.3</td>
<td>10.87</td>
<td>8.10</td>
<td>8.6</td>
</tr>
<tr>
<td>J</td>
<td>11.49</td>
<td>9.42</td>
<td>—</td>
<td>6.15</td>
<td>3.24</td>
<td>—</td>
</tr>
<tr>
<td>K</td>
<td>6.42</td>
<td>3.98</td>
<td>—</td>
<td>6.16</td>
<td>3.20</td>
<td>—</td>
</tr>
<tr>
<td>L</td>
<td>4.74</td>
<td>3.75</td>
<td>—</td>
<td>7.79</td>
<td>3.77</td>
<td>—</td>
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<tr>
<td>M</td>
<td>9.38</td>
<td>9.18</td>
<td>—</td>
<td>13.00</td>
<td>9.50</td>
<td>—</td>
</tr>
<tr>
<td>N</td>
<td>6.89</td>
<td>5.71</td>
<td>—</td>
<td>10.83</td>
<td>5.54</td>
<td>—</td>
</tr>
<tr>
<td>O</td>
<td>6.29</td>
<td>3.65</td>
<td>—</td>
<td>6.73</td>
<td>4.24</td>
<td>—</td>
</tr>
<tr>
<td>P</td>
<td>10.83</td>
<td>7.09</td>
<td>—</td>
<td>7.96</td>
<td>4.98</td>
<td>—</td>
</tr>
<tr>
<td>Q</td>
<td>4.17</td>
<td>2.50</td>
<td>—</td>
<td>3.19</td>
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<td>8.24</td>
<td>6.73</td>
<td>4.76</td>
<td>8.51</td>
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<tr>
<td>range</td>
<td>1.83—</td>
<td>0.86—</td>
<td>8.1—</td>
<td>2.97—</td>
<td>2.13—</td>
<td>8.1—</td>
</tr>
</tbody>
</table>

2 to 7ppm, and it is a little higher in the area from Jansseungpo to Seoimal than in the area of Kujora around.

Assuming that the standard level of the cleanliness of the sea area by the value of COD should be less than 3ppm, pollution of the investigated is considerably growing up.

C. Dye Diffusion Experiment

The dye patch moved to the south-eastward from the discharged position with forming an elliptical shape during flood tide (Fig4), and then the patch slowly turned toward the area of Kujora at the cape of Seoimal according to the tidal current. It moved to north-eastward at the first, and remarkably elongated and then blocked the entrance of Jangseungpo.

Table 2 shows the results of diffusion experiment. Apparent diffusibilities after an hour of discharging was $1.1 \times 10^4$ cm²/sec during flood tide $4.5 \times 10^4$ cm²/sec during ebb tide, and somewhat greater than that in the Jinhae Bay (Ahn et al, 1982) and in the Suyeong Bay (Kim and Han, 1982).

The elongation rates should 0.83 during flood tide and 0.38 during ebb tide.

From the results, it can be inferred that the diffusion power in the investigated sea area is greater than that in the other coastal areas, in some extent. But so many heavy industrial plants are being constructed and the population also increasing rapidly, that the pollution problem in the investigated sea area will be serious in the near future.

Table 2. Results of the dye experiment

<table>
<thead>
<tr>
<th>Tide</th>
<th>Elapsed time(min)</th>
<th>$\sigma_{re}^2$ (m²)</th>
<th>$K_a$ (cm/sec)</th>
<th>Elongation rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood</td>
<td>20</td>
<td>540</td>
<td>$1.1 \times 10^3$</td>
<td>0.67</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>2318</td>
<td>$2.4 \times 10^3$</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>15494</td>
<td>$1.1 \times 10^4$</td>
<td>0.53</td>
</tr>
<tr>
<td>Ebb</td>
<td>20</td>
<td>238</td>
<td>$5.0 \times 10^3$</td>
<td>0.70</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>5412</td>
<td>$5.6 \times 10^3$</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>6494</td>
<td>$4.5 \times 10^4$</td>
<td>0.03</td>
</tr>
</tbody>
</table>
Conclusions

The investigation of some water quality parameters and the dye diffusion experiment were carried out in the vicinity sea area of Geoje Island from January to March, 1983.

The water at flood tide runs southward from the east side of Jangseungpo to the east side of Jishim-Do with speed of 0.6-1.0 knot. The current of ebb tide shows a circulating pattern at near Jishim-Do, with speed of 0.4-1.0 knot.

The TSS in this area is about 6.25 ppm, somewhat low compared with that of Banweol and Changwon seaside industrial complex zones, and a little higher in the south of Kujiro than in the east side of Seoimal.

The value of VSS/TSS showed approximately 0.7. Dissolved oxygen shows more than 8ppm at all stations.

COD showed 2-7 ppm and a little high in the area from Jangseungpo to Seoimal compared with in Kujiro area.

The dye patch moved south-eastward from the discharging point with forming an elliptical shape at flood tide, and then moved north-eastward with forming a long belt shape and blocked the entrance of Jangseungpo at ebb tide. Apparent diffusibilities after an hour of discharging are $1.1 \times 10^4 \text{cm}^2/\text{sec}$ at flood tide and $4.5 \times 10^4 \text{cm}^2/\text{sec}$ at ebb tide.

References


巨濟島 近海의 水質과 擴散特性

韓英鎬・金榮燮

巨濟島 近海의 海洋污染을 최소로 하기 위한 계획을 세우는데 필요한 基礎資料를 제공하기 위하
여, 當海域의 優佳지 項目の 水質調査 및 染料에 의한 擴散實験을 1983年 1月부터 3月 사이에 실시하
였다. 此海域의 龜洋遊形物質 濃度는 평균 6.25ppm정도로 다른 東海島嶼海域보다 다소 낮긴 하
지만, 高度工業工場들이 建設되고 있고 人口도 급격히 增加하고 있어 앞으로 급격히 높아질 것으로
예상된다.

調査結果 水溶性物質濃度는 8ppm이상으로 증분 하였으며, COD濃度는 2~7ppm정도로 나타났다.

일반에 染料懸浮은 南東쪽으로 移動하나가 北東쪽으로 흘렸으며, 檢査時には 北東쪽으로 이동하
여 長谷浦入口를 가로막았다. 此海域의 擴散能力은 다른 沿岸海域에 비해 약간한 것으로 나타났다.