論　文　の　要　旨

題　目　Research on Removal of Arsenic and Manganese from Water using Polymer Gel

(高分子ゲルを使用した水からのヒ素とマンガンの除去に関する研究)

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Due to a shortage of surface water supplies, a considerable population in many regions of the world already uses groundwater as a source of drinking water. Unfortunately, unwanted compounds are present in groundwater sources because of anthropogenic causes and the geological makeup of aquifers, and these compounds limit the use of shallow aquifers. Arsenic-contaminated groundwater is a significant health problem across the world. The research gaps in removing arsenic are selectivity, regeneration and effective removal rate at neutral pH levels.

To improve the removal rate of arsenic through adsorption, I developed an adsorbent, which is a cationic gel composite of N,N-dimethylamino propylacrylamide, methyl chloride quaternary (DMAPAAQ) and Iron(III) Hydroxide (FeOOH) particles. FeOOH is reported to increase the adsorption performance of the adsorbent for both forms of arsenic. The preparation of the gel is different from the other polymer gels used for adsorption of arsenic and other metals, and it ensures that the gel contains 62.05% FeOOH particles. It should also provide good selectivity, be simple to use and be cost-effective in terms of reusability. The study showed that the gel selectively adsorbed arsenic effectively at neutral pH levels. The results demonstrate that the maximum amount of As(V) adsorption was 123.4 mg/g, which is higher than the other adsorbents. In addition, the gel adsorbed As(V) selectively in the presence of Sulphate. Also,

regeneration of the gel was performed for eight consecutive days with 87.6% effectiveness. Additionally, the adsorption mechanism of this gel composite and time required for reaching the equilibrium adsorption is discussed in this dissertation.

The iron contents in the gel were detected and its maximum impregnation was ensured. We found that the gel contains 62.05% FeOOH components. In addition, the Mössbauer spectroscopy was used to examine the type of impregnated iron in the gel composite and found that it was γ-FeOOH. Finally, Fourier transform infrared spectroscopy (FTIR) was used to examine the surface functional groups present in the gel and the differences in those groups before and after iron impregnation. Similarly, the differences of the surface functional groups in the gel, before and after the adsorption of both forms of arsenic, was also investigated.

The most predominant arsenic species in groundwater is As(III), which has a toxicity of 25–60 times that of As(V). It was discovered that the gel could adsorb highest quantity of As(III) at neutral pH levels. The DMAPAAQ+FeOOH arsenic adsorption isotherm resembled the Langmuir isotherm very well. At neutral pH levels, the maximum adsorption capacity of the DMAPAAQ+FeOOH gel composite (27.68 mg/g) was computed. As(III) was converted to As(V) through oxidation and was then adsorbed on the gel surface by both the amino group and FeOOH particles. In addition, the results indicated that in the presence of Sulphate and Chloride ion, the DMAPAAQ+FeOOH gel composite preferentially adsorbs As(III). Furthermore, because the gel composite can be renewed, it is both cost-effective and environmentally beneficial. The regeneration experiment was carried out for eight days in a row with an efficiency of 48.7 percent. Finally, unlike other techniques now in use, DMAPAAQ+FeOOH does not require any extra separation steps, resulting in easy gel handling and a straightforward adsorption procedure.

The groundwater in approximately 50% of the Bangladesh landmass contains Mn concentrations greater than the limit prescribed by the WHO drinking water guidelines. Although studies have suggested that γ-FeOOH can effectively remove Mn from water, its practicability has not been investigated, considering that the additional

processes required to separate the adsorbents and precipitates are not environment-friendly. To improve the efficiency of adsorptive Mn-removal under natural conditions, DMAPAAQ+FeOOH gel composite, and a non-ionic polymer gel composite, N,N'-Dimethylacrylamide (DMAA) loaded with iron hydroxide (DMAA + FeOOH), was employed. The results suggest that the higher efficiency of the cationic gel composite is owed to the higher γ-FeOOH content in its gel structure. The maximum adsorption of Mn by DMAPAAQ + FeOOH was 39.02 mg/g. Furthermore, the presence of As did not influence the adsorption of Mn on the DMAPAAQ + FeOOH gel composite and vice versa. DMAPAAQ adsorbed As and the γ-FeOOH particles simultaneously adsorbed Mn.