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Short Communication

Characteristics of total organic carbon and correlations between organic matters of industrial wastewater

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ABSTRACT

Background: The industrial development has increased and diversified refractory organic compounds in wastewater. The Ministry of Environment of South Korea is reviewing the introduction of a new organic pollutant index and discussing the conversion of the existing indices to the total organic carbon (TOC). Thus, specific research on this issue is required. Methodology: The characteristics of existing organic pollutant indices (BOD, CODMn, and CODCr) and TOC by industry were examined for 210 samples of waste effluents generated in Busan in 2017 and 2018.

Findings: The TOC and COD were the highest in the chemical materials and products manufacturing industry, followed by the food production industry and waste disposal industry. The BOD was the highest in the food production industry, followed by electronic parts/semiconductors manufacturing industry, waste disposal industry, and chemical product manufacturing industry. The ratios of organic oxidation of CODMn and CODCr to TOC were 51.9 % and 88.7 %, respectively. This confirms that the existing organic pollutant index COD is underestimating the amount of refractory organic compounds. For the correlations between TOC and the existing organic pollutant indices (CODMn, CODCr, BOD5), CODMn (r=0.970) showed the highest correlation, followed by CODCr (r=0.956) and BOD5(r=0.812).

Conclusion & Significance: TOC and COD showed a particularly high correlation. This suggests that TOC is a valid organic pollutant index for the water quality of waste effluents that can replace COD in the future. In conclusion, the introduction of TOC with a high organic matter oxidation rate is required to evaluate various refractory organic compounds contained in wastewater. This study examined the applicability of a new organic pollutant index (TOC) for water quality management of industrial wastewater discharged to public waters and will provide important data for the introduction of related standards.

Introduction:

The idea of 'clean' water has evolved over the years as we further our understanding of human impact on the environment, and the subsequent impact of a polluted environment on our health. The 20th century brought a wealth of technological advancements that improved our ability to mitigate our impact on environmental systems and protect the public from the health issues related to unsafe drinking water. Water and wastewater treatment have become critical aspects of our society's ability to coexist with Earth's natural systems. As industrial activity and population continue to grow in the 21st century, continuing improvement of water treatment technology is of vital importance. With the rapid growth of pharmaceutical needs, large quantities of wastewater containing products, raw materials, solvents and detergents from complex manufacturing processes are generated. Even conventional biological wastewater treatment facilities produce effluent organic matter with high chemical oxygen demand, salinity, color, limited biodegradation, and toxicity, which increase the potential risk to receiving waters and human health. Therefore, further EfOM removal during pharmaceutical wastewater treatment is an urgent need. Advanced chemical oxidation processes have attracted much attention for the advanced treatment of industrial wastewater, such as the base process of O3, H2O2, Peroxone, sulfate radical and photocatalytic. Among these AOPs, the catalytic ozonation process has a strong ability to degrade refractory organic pollutants and effectively decolor water via hydroxyl radicals and broad application potential for wastewater treatment. However, studies on the application of the COP for the advanced treatment of pharmaceutical industrial wastewater have been rarely reported. For COPs, MnOx-based catalysts are promising catalysts with great advantages, such as high stability, low water solubility, environmental friendliness and ease of manufacture, and they have been widely studied and applied. In addition, porous materials with large surface areas and abundant porous structures have been widely used as metal oxide carriers because of their good performance for increasing the active surface area and adsorption capacity. Among these carriers, attapulgite (ATP) is a type of natural, hydrated magnesium silicate mineral with unique pore channels, a large surface area, a high adsorption capacity, and water-insolubility. Many studies have been performed with the COP to examine removal efficiencies in simulated organic pollution and actual wastewater prepared ceramic, honeycomb-supported manganese catalysts via an impregnation method in a solution of manganese salt and explored the effects of the main operating variables, such as the initial pH, reaction temperature and amount of catalyst, on the degradation efficiency of nitrobenzene. Although the ozonation/Mn-ceramic honeycomb system resulted in a removal rate of approximately 74% for nitrobenzene under the optimal experimental conditions, the quality of the background water was different from that of actual industrial wastewater treated heavy oil-refinery wastewater by an integrated ozone and activated carbon-supported manganese oxide method and observed a total organic carbon reduction efficiency of 38% due to the catalytic effect increased the COD removal efficiency of refinery wastewater by approximately 30% using ozone and alumina-supported manganese and copper oxide catalysts compared with a single ozonation process.

In summary, most studies have focused on the following characteristics:

1.new catalyst preparation and characterization of the structure and components,

2. organic pollutant degradation efficiency,

3. the influence of key operating parameters,

4. catalytic mechanism, and

5. catalyst reusability and stability.

Thus far, systematic and detailed research on the changes in pharmaceutical EfOM during the COP is lacking.

In this study, ATP was used as a carrier and directly mixed with MnO2 particles to prepare the MnO2 ceramsite catalyst. The main aim of this study was to investigate the characteristics, removal, and toxicity of EfOM from a pharmaceutical wastewater treatment plant during a COP in the presence of MnO2 ceramsite to provide a theoretical basis for advanced treatments of pharmaceutical wastewater using catalytic ozonation technology. The effectiveness of the COP was measured by the UV254 and the TOC removal rate of the pharmaceutical wastewater. Second, the color degradation during the COP was explored via Fourier transform infrared (FT-IR) spectroscopy analysis, and the color degradation in the hydrophobicity/hydrophilicity of the EfOM. Then, the changes in the EfOM during the COP were observed by studying the changes in the soluble microbial products (SMPs, containing proteins, polysaccharides, and humic acid), molecular-weight distribution and hydrophobicity/hydrophilicity of the EfOM and performing gas chromatography-mass spectrometer analyses. Finally, the toxicity of the pharmaceutical EfOM after the COP treatment was assessed to determine its potential risks, as mentioned earlier.

Conclusion:

TOC is a common parameter that utilities use to monitor for changes in organic load. However, studies have shown that this test is not sufficient for determining the full impact of complex organics on treatment. Organics with similar amount of carbon may have vastly differing molecular structures; therefore COD provides insight into the oxygen demand, and reactivity, of the wastewater load. While COD is a common parameter for wastewater utilities to monitor within the plant, the 3-hour time requirement for the standard dichromate COD test makes it unsuitable for use as an influent and effluent monitor. peCOD is a new method of COD determination that solves this challenge, providing a COD result in less than 12 minutes. This allows the utilities to be proactive and fine-tune their treatment processes based on the actual organic load at any given time. In addition, the oxidation potential of the peCOD chemistry is double that of the dichromate method, which indicates that it is more suitable for detecting and quantifying oxygen demand of complex organic molecules. As we move forward in the 21st century, utilities and industries are under constant pressure to improve their treatment processes. Safeguarding human health and the environment is of critical importance, and as population and industry expand so too must our ability to monitor and treat the water and wastewater we produce. Treatment plants, both municipal and industrial, rely on their monitoring tools to provide optimal treatment and benefit greatly from having as many of these tools available as possible. PeCOD is the tool which can deliver the COD results quickly, effectively, and with the greatest ability to detect changes. It is simple to operate in any environment, 24/7, and a low cost for investment.