

CHAPTER 1

INTRODUCTION



1.1 Background

Organic compounds in natural waters are broadly categorized into natural organic matter (NOM) and synthetic organic matter based on their origins. NOM consists of those organic compounds that naturally originate from decomposing plants and animal tissues, collectively called humic substances. They generally stay in the forms of high molecular weight humic and fulvic acids. The latter group, synthetic organic matter, normally reaches aquatic systems via agricultural runoffs or industrial discharges. Despite a trace of the contamination, several are considered extremely hazardous and recalcitrant in water. Organic compounds in natural waters lead to (1) turbidity and color formation, (2) dissolved oxygen reduction, (3) undesirable taste and odor, (4) interference with water treatment processes, and (5) formation of disinfection byproducts (DBPs) when they are chlorinated (Qasim et al., 2000).

To quantify all organic compounds in water, total organic carbon (TOC) typically represents the unspecified term of them and dissolved organic carbon (DOC) is frequently used to narrow down to the dissolved species (APHA, 1998). Biodegradable organic matter (BOM) and nonbiodegradable organic matter (NBOM) are commonly chosen to classify organic compounds according to their biodegradability. DOC value is not a good indicator of available organics for microorganisms. To assess BOM level in water, two methods are commonly employed: assimilable organic carbon (AOC) and biodegradable dissolved organic carbon (BDOC).

BDOC value can be defined as a part of DOC, which can be mineralized by heterotrophic microorganisms where as AOC is that part of BDOC which can be converted by microorganisms to cell mass (van der Kooij et al., 1982 and Servais et al., 1989). Analyzing AOC content is based on the measurement of cell mass growth while BDOC is quantified by the difference between DOC before and after incubated the sample with natural microflora (van der Kooij et al., 1982; LeChevallier et al., 1993). Hence, AOC method is considered more suitable for the assessment of bacterial regrowth potential than BDOC (Huck, 1990 as cited in Yeh et al., 1999).

Although most of TOC is removed during water treatment processes and chlorine is provided to the finished water to meet the standard for biological water quality, the problems of undesirable color, taste, odor, and microbial regrowth are still prevalent in many water distribution systems. The causes of post-treatment deterioration can be attributed to (1) the ineffective disinfection by chlorine and (2) the presence of available organics measured as AOC that is derived from organics passing through treatment processes (van der Kooij 1992). In addition, high chlorine demands for disinfection will lead to the formation of carcinogenic chlorinated organic compounds: Trihalomethanes (THMs) and 5 haloacetic acids (HHA5) (van der Kooij 1992, Lykins et al., 1994, and Qasim et al., 2000). Thus, to avoid those aforementioned problems and achieve high water quality, growth-promoting substrates must be eliminated before entering distribution systems (van der Kooij, 1992 and Huck et al., 1991).

In most water environment, the majority of NOM will stay in the form of NBOM rather than BOM and that part of NBOM can be oxidized into BOM by disinfection residuals, eventually giving rise to available growth-promoting substrates within the pipelines. Several water treatment techniques have been studied and introduced to address these concerns. Among those techniques, advance oxidation processes (AOPs) have shown a great potential in increasing BOM, which is subsequently removed by biofiltration. The role of AOPs is to oxidize or breakdown organic compounds leading to partial fragmentation or even complete mineralization. When water is passed to subsequent biofilters, bacteria colonized on the surface of media, usually activated carbon, will metabolize the substrates; as a result, the biodegradable fraction will be removed (Servais et al., 1994 and Goel et al., 1995). Thus, selecting a potential oxidizing agent and optimizing its efficiency will greatly contribute to high removal of BOM within the subsequent treatment unit.

1.2 Problem Statement

Many studies have demonstrated ozonation as an effective means for enhancing biodegradability (Volk et al., 1993 and Malley Jr et al., 1993). BDOC and/or AOC increase after ozonation has been well documented. On the contrary, other AOPs have been rarely studied for their capabilities in enhancing biodegradability of low-level natural and synthetic organics in water. Another promising AOP is the application of hydrogen peroxide (H_2O_2) combined with iron salts, commonly known as Fenton's reagent. Fenton's reaction has long been used to treat a variety of hazardous organic compounds including landfill leachate, ground water contaminated with chlorinated aliphatics and aromatics, dry cleaning solvents, and waste streams containing polychlorinated biphenyls (PCBs) (Mckinzi and Dichristina, 1999).

However, the effect of Fenton's reaction on AOC has never been investigated. Fenton's reagent should enhance AOC in water since it produces hydroxyl radical ($OH\bullet$), which is a non-selective strong oxidizing agent. In this study, surface water and 2,4 dichlorophenol (2,4-DCP) solution were used to investigate how different variables in Fenton's reaction, such as pH, H_2O_2 and iron salt doses, and reaction time, affect the concentration changes in three types of AOC: AOCs determined by using *Pseudomonas fluorescense* strain P17 (AOC_{P17}) and *Spirillum* strain NOX (AOC_{NOX}) and total AOC ($AOC_{P17} + AOC_{NOX}$).

1.3 Objectives

The main objective of this study was to identify the effect of variables in Fenton's reaction on AOC concentrations in water. The specific objectives were:

- 1.3.1 To investigate the effect of pH of Fenton's reaction on AOC concentrations in surface and synthetic water.
- 1.3.2 To investigate the effect of H_2O_2 and ferrous (Fe^{2+}) doses on AOC concentrations in surface and synthetic water.
- 1.3.3 To investigate the effect of reaction time (kinetics) on AOC concentrations in surface and synthetic water.