Complete Mineralization of Fluorinated Ionic Liquids Using Low-Temperature Superheated Water

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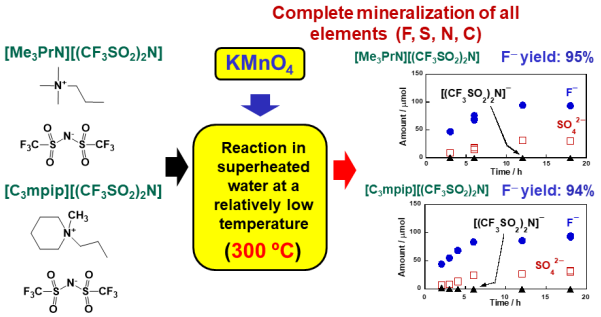
Ionic liquids (ILs) are cutting-edge materials for green chemistry applications because they have unique characteristics such as negligible vapor pressure, high thermal and chemical stability, and high solvation ability, and they are non-flammable. Among them, fluorinated ILs, which are combinations of an organic cation and a perfluorinated organic anion, are used as electrolytic media for energy-related applications in batteries, dye-sensitized solar cells, supercapacitors, and actuators, because they not only have the common characteristics of ILs but they also fulfill crucial requirements for electrochemical devices.

The increasing number of industrial usages of fluorinated ILs has led to increased examination of their aquatic toxicity. Several ILs are reported to be biodegradable; however, their biodegradation is limited mostly in the organic cation moiety and does not result in complete mineralization of the IL. Furthermore, the perfluorinated anion moiety, bis(trifluoromethanesulfonyl)imide, $[(CF_3SO_2)_2N]^-$, the most common anion used in fluorinated ILs, has been shown to not biodegrade. Under these circumstances, waste treatment technologies that allow complete mineralization of fluorinated ILs are needed.

We report herein an effective method that allows almost complete mineralization of two fluorinated ILs—$[Me_3PrN][(CF_3SO_2)_2N]$ and 1-methyl-1-propylpiperidium bis(trifluoromethanesulfonyl)imide, $[C_3mpip][(CF_3SO_2)_2N]$—in superheated water (often referred to subcitical water or pressurized hot water) at a relatively low temperature (300 °C) by using $KMnO_4$ as an oxidizing agent. $KMnO_4$ is a safe oxidizing agent that is currently used at drinking water treatment plants to remove iron component and to control the formation of trihalomethanes and other disinfection byproducts.



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