

**Q: How can we purify water using solvated electron?**

Typical routine techniques of water purification are based on *oxidative processing* (e.g., using ozone, “active chlorine”, etc.). These methods are good for sterilization (purification from biological burden) and removal of some organic impurities. However, they cannot help, when we deal with some very important toxic contaminations, which are not readily oxidized (heavy metal ions, chlorinated compounds, etc.). Solvated electron is a very strong reducing agent, so it reacts with many of these substances with diffusion-limited rate constants, in particular, with metal ions ( $\text{Pb}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Cu}^{2+}$ , ...), chlorinated compounds (via dissociative electron capture), carbonyl compounds. The examples of these reactions were given shown in lecture. The detailed mechanism is rather complicated (and not completely studied); meanwhile, basically, these processes result in formation of insoluble products (residues), e. g., mixed metal oxides and hydroxides, “heavy” hydrocarbons or polymers. This concept was applied in the *electron-beam purification technology* (also known as “radiation-chemical treatment”). Indeed, irradiation of water with fast electrons produces *both* strong oxidizer (OH radical) and very efficient reducing species (hydrated electron) in nearly balanced amounts. At present, this technology is commercially used for a large-scale wastewater treatment, in particular, in South Korea (also in Japan, USA and some other countries).

There are also some studies on generation of hydrated electrons for water purifications using alternative methods (e. g., electric discharge and even ultrasound treatment); however, in my view, these data are not convincing yet and somewhat speculative.

Further references may be given for those interested in details.

**Q: What is the reason of so high difference in rate constants for methanol and Cd?**

The rate constant for  $\text{Cd}^{2+}$  is, in fact, diffusion-controlled (taking into account Coulombic interaction, see lecture) and it may be considered as a “normal” case for hydrated electron. As to reaction with methanol, it is, indeed, a very slow process. The given rate constant actually represents an upper limit because of complications originating from unavoidable presence of carbonyl impurities (this is a typical problem for measuring slow kinetic channels for highly reactive species). The mechanism of this reaction is not fully clear, but, in any case, it is not an elementary process. A single methanol molecule cannot adopt electron (in other terms, it has *essentially negative electron affinity, that is, the radical anion  $\text{CH}_3\text{OH}$  does not exist, similar to  $\text{H}_2\text{O}$* ), so the reaction should involve large methanol clusters. Informally, this can be understood as a “cavity deformation” occurring with low probability and involving multiple “trials”. Anyway, it is not yet understood and it is one of challenges for future dynamic computations.