Internship

Design and scale-up of a photo-reactor for dual wavelength advanced oxidation process

Areas of research:	Advanced oxidation process; Micropollutants; Transformation by-products; (Photo)chemistry
Duration; Start date	min.3 months; As soon as possible

Background

Did you know that sometimes up to 90% of the drug that you swallow is excreted? What happens to the shampoo you just lathered your hair with or the remains of the detergent that washes your clothes fresh? Once, they do their job they end up in ours waters and are called Organic micro-pollutants (OMP's). Since pharmaceuticals are toxic, persistent and bio accumulative and are designed to act at lower concentrations, it is not surprising that even low concentrations reaching the environment can be detrimental. For example, on exposure of contraceptive pills, male fish may feminize thus affecting their population. OMPs are now increasingly found in the water sources and we are committed to reduce any health impact it may cause. There are ten thousands of such OMPs released to the environment. One of the most popular approach to tackle the issue is to have an Advanced Oxidation Processes (AOP). AOPs are water treatment processes that produces and further uses the hydroxyl radicals ($^{\cdot}OH$), one of the strongest, highly reactive and (mostly) non-selective oxidant, for transformation or degradation of OMPs. One of the most widely used AOP is the UV_{254nm}/H_2O_2 where the UV radiation at 254nm (UV_{254nm}) photo-chemically splits the hydrogen peroxide (H_2O_2) molecule to produce $^{\cdot}OH$.

Project description

The UV_{254nm}/H_2O_2 process requires H_2O_2 to be added as an external oxidant, for the production of $^{\cdot}OH$, complicating the logistics of the entire process and increasing the cost of the process since any unused H_2O_2 has to be quenched. In this project, we combine UV_{254nm}/H_2O_2 process with Vacuum UV radiation at 185nm (VUV_{185nm}) that can directly split the H_2O molecule. Added advantages are that: the VUV_{185nm}/H_2O produces more radicals like the solvated electrons (e^-_{aq}) and the protons (H^+) helping to degrade a wider range of OMPs alongside the fact that the lamp that produces both UV_{254nm} and VUV_{185nm}, without any no extra energy input (see Figure *1*).

One of the major challenges about VUV is that owing to its high molar absorption coefficient by water (3.24 x 10^{-4} $M^{-1}cm^{-1}$) it is absorbed within 5-6mm in to the water path-length. Therefore, with regard to VUV, the photo-reactor remains heterogeneously illuminated. Smart hydrodynamic designing can help to tackle this issue to an extent. So, in this project we use computational fluid dynamic (CFD) using the commercial software Ansys® to come up with smart and practical designs for the dual-wavelength AOP that can be scaled-up to pilot-scale.

Your tasks

1. Design (generate geometries and mesh) various photo-reactors.
2. After grid independency have been proved, compare hydrodynamics, radiation and kinetics in different geometries.
3. Develop kinetic models for degradation of different OMPs.
4. Scale-up related CFD modelling (3D simulations).

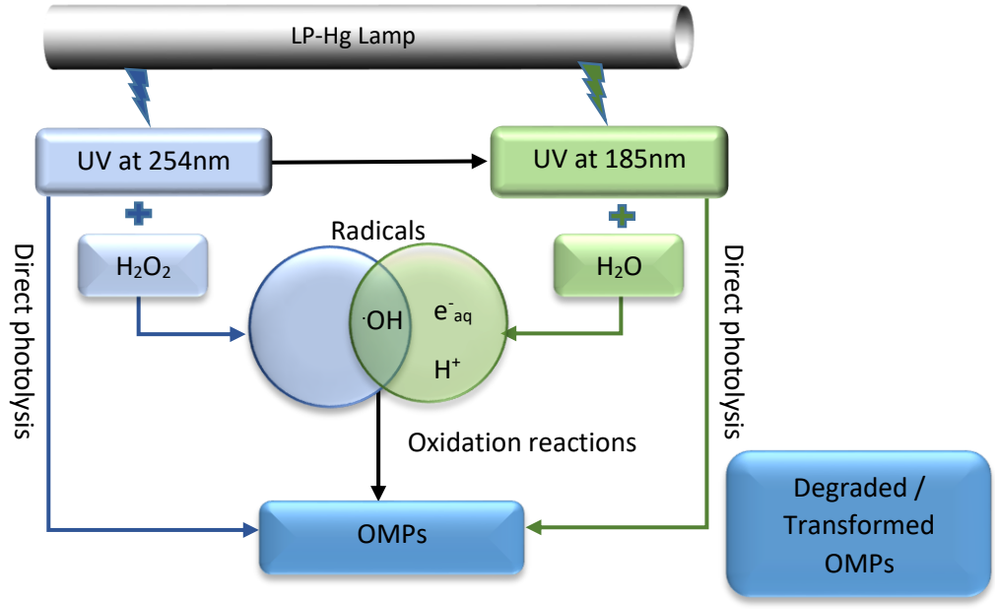

Figure 1. Graphical abstract

Requirements

1. Motivated, enthusiastic, team-spirted and independent
2. Experience in laboratory
3. Proficiency in English
4. EU/Non-EU student enrolled in any university within The Netherlands or EU student enrolled in universities elsewhere in the EU. Unfortunately, non-EU students enrolled outside the Netherlands cannot apply.

Application

Did this project instil interest in you? Do you want to know more to make a decision? Or do you want to apply right away? Contact me at nimmy.kovoor@wetsus.nl (to apply, please attach a motivation letter of 1 page and a CV of not more than 2 pages). To know more about the topic, please go through the reference papers.

References

1. Gonzalez, M., Oliveros, E., Worner, M. and Braun, A. (2004). Vacuum-ultraviolet photolysis of aqueous reaction systems. Journal of Photochemistry and Photobiology C: Photochemistry Reviews, 5(3), pp.225-246.
2. Zoschke, K., Börnick, H. and Worch, E. (2014). Vacuum-UV radiation at 185 nm in water treatment – A review. *Water Research*, 52, pp.131-145.