Activated carbon modelling to better understand micropollutant removal during rain events

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Picture: A. Frömelt

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Background

Being harmful to aquatic ecosystems already in low concentrations, micropollutants (MP) originating from different anthropogenic applications (e.g., pharmaceuticals, anticorrosive coating) have become a key topic on today's political environmental agendas. The Swiss Waters Protection Ordinance calls thus for the elimination of MPs in targeted WWTP.

The use of activated carbon has proven to be a successful option to eliminate MPs. However, many of these plants in Switzerland face problems to continually maintain the required elimination rate of 80%; especially during rain events. Despite the advanced process knowledge available, the elimination processes are still not fully understood. Furthermore, the complexity of a full-scale plant with various internal recirculations and highly interacting, dynamic processes make it difficult to understand the decisive mechanisms for a certain elimination behavior. However, knowing these responsible mechanisms would help to support the operation of activated carbon systems. Models – which are a simplification of reality – might be helpful tools to better understand such complex situations.

Objectives of the suggested topic

The goal of this thesis is to investigate whether we can explain the elimination behavior of a powdered activated carbon plant during rain events by using different modelling approaches. ARA Thunersee (about 150'000 PE) will serve as a case study for this thesis. The student will start with implementing a simple activated carbon model for the full plant (including recirculation to the activated sludge tanks). This could, for instance, be based on the model suggested by (Atallah Al-asad et al., 2022). For the implementation itself, it is intended to use a python-package for system modelling which is currently under development at Eawag. By extending the model with

different mechanisms (e.g. desorption) that can be switched on or off in the simulation, the student will try to reproduce the observed MP elimination during real rain events.

As the main goal will be a qualitative description of the underlying processes, the model will use literature values without an in-depth calibration. However, depending on the interests of the student and speed of progress, data mining tools (e.g. clustering, pattern recognition) could be used to further quantify and confirm the explanations for the elimination behavior of the plant.

Specific information / Requirements

Programming abilities are not a requirement, but the student should be highly motivated to acquire these skills during the thesis.

Advisors and Supervisors

Advisor: Dr. Andreas Frömelt
Supervisors: Prof. Dr. Eberhard Morgenroth

Contact information

Name: Andi Frömelt
Email: andreas.froemelt@eawag.ch

References

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