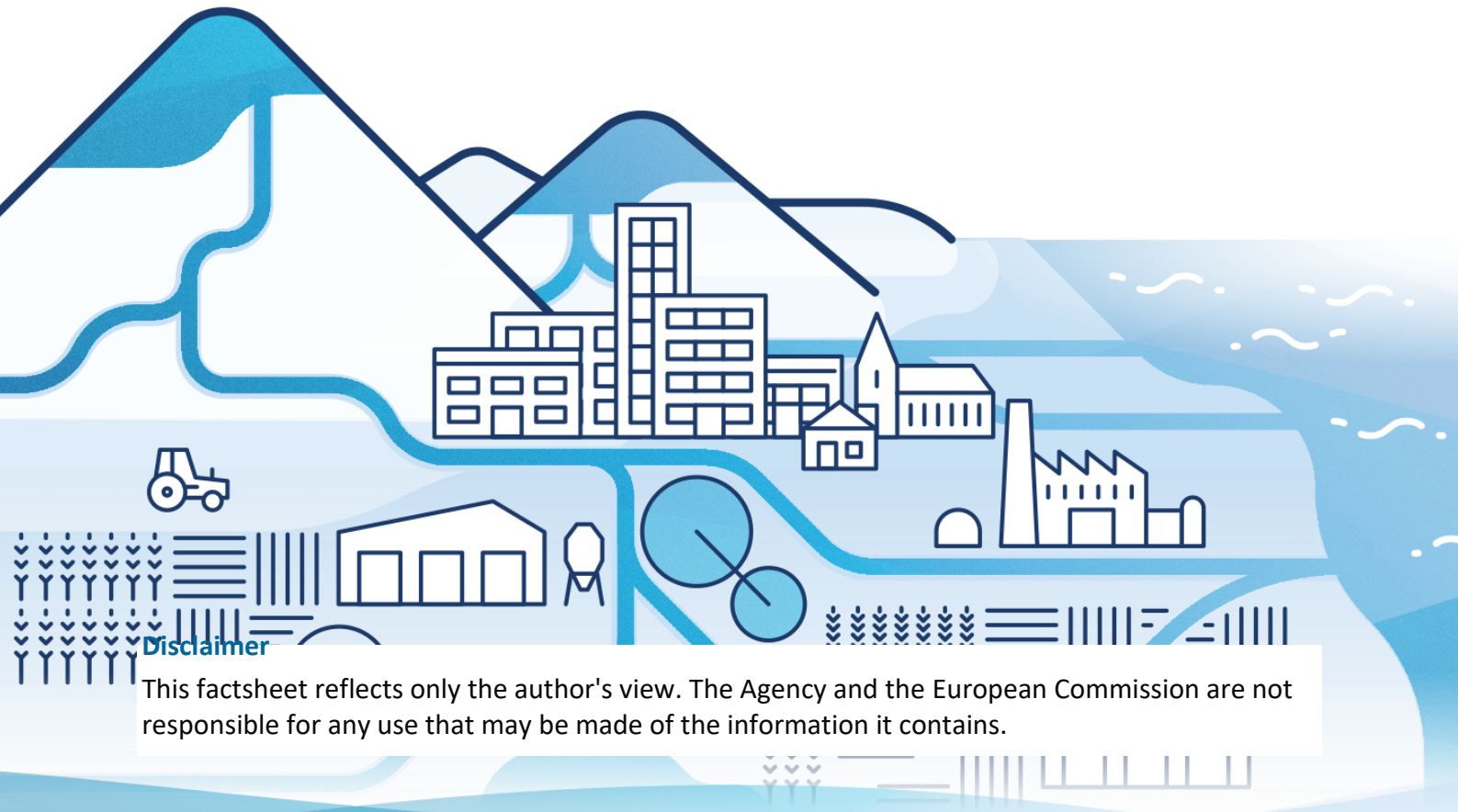


# Factsheet – Activated carbon treatment coupled to an AOP

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# Activated carbon treatment coupled to an AOP



### Unique selling points:

- ✓ High removal percentages related to the influent for emerging/priority substances and organic degradation by-products (nearly 100%), metals and high elimination of oxidant species.
- ✓ Cost-effective posttreatment.

### Description of the technology

Activated carbon is frequently used as a posttreatment process to refine water quality, *i.e.*, to diminish the quantity of different types of organic compounds such as certain degradation by-products generated in the previous Advanced Oxidation Process (AOP) (such as **hydrogen peroxide photolysis**, ozonation, **UV/ozonation**, etc.). It is based on the adsorption of several chemical species on its surface or on its low-volume porous.

Activated carbon is usually derived from charcoal. When granulated, it is called granulated activated carbon (GAC). Recently, different types of activated carbons have been prepared from dried sewage sludge using CO<sub>2</sub>, air, alkali metal hydroxides, etc. as activating agents (Monsalvo, *et al.*, 2011). They are characterized by its high surface area, pore size distribution, absorptive and catalytic properties, all of them depending on the raw materials and manufacturing processes that produce them (National Research Council (US) Safe Drinking Water Committee, 1980).

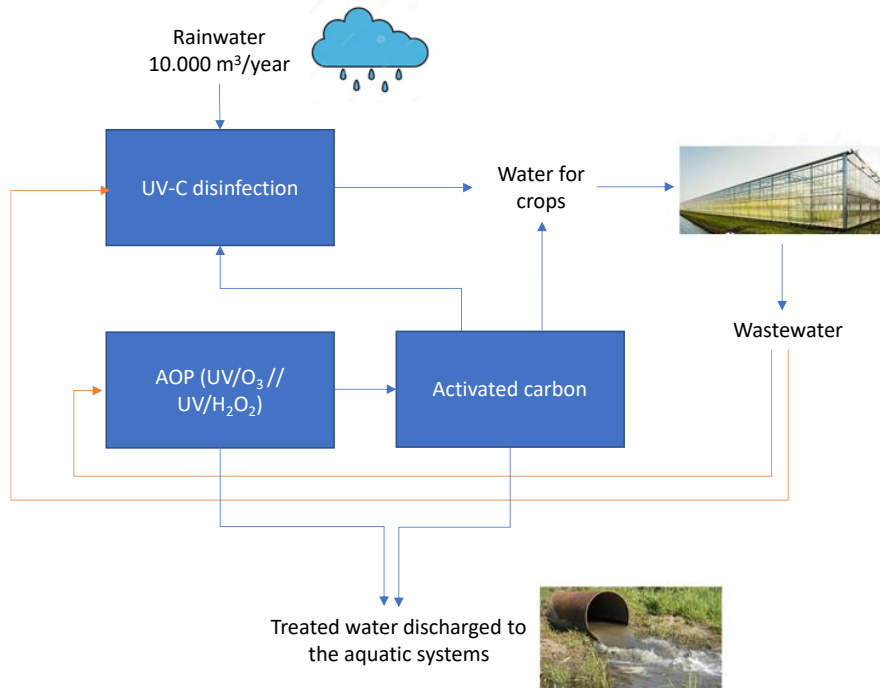
In the Nextgen project, activated carbon will be used as single treatment to remove some specific organic trace compounds but also coupled after an **UV/H<sub>2</sub>O<sub>2</sub>**, ozonation or **UV/O<sub>3</sub>** systems.

The capacity of NextGen's pilot is 0.75 – 3.0 m<sup>3</sup>/h.



**Flow scheme of the technology**

Simplified diagram of one of the NextGen strategies where the activated carbon process coupled to an AOP is being applied (Westland region).



**Figure 1.** Simplified diagram of one of the NextGen strategies.

**Pictures of the technology**



**Figure 2.** Example of an activated carbon equipment.

**Synergetic effects and motivation for the implementation of the technology**

- ✓ **Reduction of the organic metabolites that reach aquatic systems.**

The impact to the environment due to the release of certain degradation by-products, which can present higher toxicity than the original pollutants, can be minimized by removing them by coupling the activated carbon to an AOP such as the **UV/H<sub>2</sub>O<sub>2</sub>** or **UV/O<sub>3</sub>** processes.



Therefore, preventing certain effects on the fauna related to endocrine disrupting process as well as protecting the flora.

✓ **Reduction of the drinking water consumption destined to irrigation.**

Activated carbon coupled to  $H_2O_2/UV$  or  $O_3/UV$  processes will remove the degradation metabolites from the original organic pollutants as well as it will reduce the content of oxidant species. Therefore, this treatment train produce regenerated water to be used for irrigation purposed in the greenhouses (focused on zero PPS discharge legislation of Netherlands). This will contribute to reduce the quantity of drinking water consumed for this application, therefore improving the availability of this resource.

✓ **Establishment of a circular economy concept (by using an activated carbon from sewage sludge).**

The valorisation of sewage sludge through its conversion to an activated carbon with enough capacity to remove certain trace organic compounds as well as several oxidant species is demonstrated during the NextGen project. The activated carbon coming from the pre-treated sewage sludge is a cost-effective material that can be applied after an AOP to obtain regenerated water with desired quality to be reused.

Therefore, this practice increases the circularity in the water process.

### Requirements of the technology and operating conditions

The activated carbon can be used as a ‘stand alone’ process or as refinement technology after the oxidation treatment. The following table summarize the most appropriated values of several parameters to be considered during the operation of activated carbon technology.

**Table 1.** Required specifications for the activated carbon process.

Parameter	Units	Min	Max	Reference
DOC	mg/L	1	10	Meinel <i>et al.</i> , 2015
Empty bed contact time (EBCT)*	min	5	120	Reungoat <i>et al.</i> , 2010
Upflow Velocity	m/h	5	15	Mulder <i>et al.</i> , 2015
Bed Volumes (BV)**	[-]	1,000	50,000	Reungoat <i>et al.</i> , 2010
Backwash	% of incoming flow	5	20	Mulder <i>et al.</i> , 2015
GAC replacement		After 7000 BV	Before 15,000 BV	Mulder <i>et al.</i> , 2015

\*EBCT =  $[(\text{Carbon Volume (m}^3) \cdot 60(\text{min/h})) / \text{Flowrate (m}^3/\text{h})]$

\*\* BV =  $[\text{m}^3_{\text{water}} / \text{m}^3_{\text{GAC}}]$



## Key performance indicators (KPIs)

As commented before, the activated carbon treatment is mainly focused in reducing the organic as well as the turbidity contents. Therefore, these will be one of the main KPIs to be monitored, together with the empty bed contact time (EBCT).

**Table 2.** KPIs for the activated carbon process.

Parameter	Units	Min	Max	Reference
Global removal yield of organic matter	Total organic content (TOC) removed (%)	20	99	Hatt <i>et al.</i> , 2013
Global removal yield of turbidity	Turbidity removed (%)	25	95	Hatt <i>et al.</i> , 2013
EBCT	min	5	120	Hatt <i>et al.</i> , 2013 Reungoat <i>et al.</i> , 2010

## Links to related topics and similar reference projects

Activated carbon treatment	Reference
NextGen – GAC treatment	<a href="#">Case study “Westland” (NextGen)</a>
NextGen – GAC production	<a href="#">Case study “Altenrhein” (NextGen)</a>

## References

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- Mulder, M., Antakyali, D., and Ante, S. (2015). Verwijdering van microverontreinigen uit effluenten van RWZI’s (Costs of Removal of Micropollutants from Effluents of Municipal Wastewater Treatment Plants). STOWA, Rapport 27. <https://www.stowa.nl/publicaties/verwijdering-van-microverontreinigen-uit-effluenten-van-rwzis>
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- Reungoat, J., Macova, M., Escher, B. I., Carswell, S., Mueller, J. F., and Keller, J. (2010). Removal of micropollutants and reduction of biological activity in a full scale reclamation plant



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## Outlook

**Case study specific information will be provided, when the results of the other work packages are available:**

- Lessons learned from the case study
- Outcome of the assessments
- Legal and regulatory information concerning the whole value chain concerning the technology
- Business opportunities

