

On the trail of pollutants



MICROPOLLUTANTS IN WASTEWATER

ACTION RECOMMENDATION FOR MUNICIPALITIES



Legal notice



PUBLISHER

Kompetenzzentrum Spurenstoffe
(KomS) Baden-Württemberg
c/o Universität Stuttgart
Bandtäle 2 · 70569 Stuttgart
Phone: +49 (0)711. 685-65420
Fax: +49 (0)711. 685-63729
E-mail: info@koms-bw.de
www.koms-bw.de

EDITORS

Dr Klaus Zintz
Responsible in the sense of German Press
Law: Dr.-Ing. Marie Launay, KomS
André Hildebrand, KomS c/o DWA BW

All web addresses mentioned in this brochure
were active at the time of publication.
However, the specified links may change over
time or be deactivated.

DESIGN, LAYOUT AND PRINT

Schröter Werbeagentur GmbH
Mülheim an der Ruhr

IMAGES

Titles: lotus_studio/Adobe Stock, Only background/shutterstock.com, Dmitri Ma/shutterstock.com, joekingstock/
Adobe Stock, ESB Professional/shutterstock.com, Viktoriya/shutterstock.com; Impressum / p. 01: Roman Babakin/
shutterstock.com, Evgeny Karandaev/shutterstock.com; Ministerium für Umwelt, Klima und Energiewirtschaft (UM)
BW; p. 02/03: KomS, BMU, Juergen Wackenhut/shutterstock.com, Africa Studio/shutterstock.com, Bespaliy/shutter-
stock.com, Aliya Salsabila/shutterstock.com, Africa Studio/shutterstock.com, Andrei Kuzmik/shutterstock.com,
belkos/shutterstock.com, Rostislav Stefanek/shutterstock.com, Pressmaster/shutterstock.com; p. 04/05: Archiv
Seespiegel, KomS, UM BW, UM BW, KomS, New Africa/shutterstock.com; p. 06/07: DWA BW, EBS Pforzheim/Weber-
Ingenieure GmbH, Stadt Karlsruhe/Weber-Ingenieure GmbH, KomS, esfera/shutterstock.com; p. 08/09: KomS,
DWA BW, KomS, KomS, DWA BW; p. 10/11: Rolf Mugele, KomS (2 x), KomS/Marie Launay, KomS, LRA Bodenseekreis,
KomS, KA Böblingen-Sindelfingen, Azat Valeev/Adobe Stock; p. 12/13: ZV Gruppenklärwerk Wendlingen a. N., KomS
(3 x), Weber-Ingenieure GmbH (2 x), 1989studio/shutterstock.com; p. 14/15: KomS, Kläranlage Stockacher Aach, KomS,
EBS Mannheim²/Kay Sommer, EBS Mannheim², KomS, Kläranlage Stockacher Aach; p. 16/17: Klaus Zintz, ARA Neugut,
KomS/Marie Launay, LRA Bodenseekreis, ARA Neugut, Weber-Ingenieure GmbH; p. 18/19: UM BW, lightpoet/shutter-
stock.com, Alex_Traksel/shutterstock.com, Mr_Mrs_Marcha/shutterstock.com, aleks333/shutterstock.com, image-
hub/shutterstock.com, Fotaro1965/shutterstock.com; p. 20/21: KomS, DWA BW, KomS (2 x), lovelyday12/shutterstock.
com, UnderhilStudio/shutterstock.com; p. 22/23: SES/Michael Fuchs Fotografie, UM BW, DWA BW/Christina Cott,
Conny Pokorny/shutterstock.com, Hekla/shutterstock.com; p. 24/25: Only background/shutterstock.com, Valenty
Volkov/shutterstock.com, People Image Studio/shutterstock.com; Rückseite: Roman Babakin/shutterstock.com,
Viktoriya/shutterstock.com

This brochure was facilitated and funded by the **Ministry of the Environment, Climate Protection and the Energy Sector Baden-Württemberg**.
Printed on paper from sustainable forestry.

// I would like this brochure to help you identify the positive aspects of eliminating micropollutants in wastewater treatment plants and facilitate decision-making in favour of building such systems where appropriate.”

FRANZ UNTERSTELLER MEMBER OF THE STATE PARLIAMENT |
FORMER MINISTER OF THE ENVIRONMENT, CLIMATE PROTECTION AND THE
ENERGY SECTOR BADEN-WÜRTTEMBERG



DEAR READER,

Baden-Württemberg has already achieved a lot with regard to wastewater treatment. This is true for the plant finalisation rate of more than 99 percent and the technical standard of the plants likewise. Our state takes a leading position in this field. Nevertheless, we are facing new challenges. We know that chemicals and pharmaceuticals enter wastewater treatment plants through domestic wastewater. Despite the high extension standard of the plants, conventional processes are still not able to eliminate all substances from wastewater to a sufficient degree. The consequence is that micropollutants enter our water bodies. Nowadays, we can identify pharmaceutical substances, X-ray contrast media, synthetic musk fragrances from cosmetic and cleaning products, biocides, flame retardants, perfluorated chemicals (PFC) as well as hormone-like substances. Even very low concentrations of some of these substances are known to have adverse effects on sensitive aquatic organisms such as fish, shells or snails – and these substances should not enter our groundwater as the majority of our drinking water supply in Baden-Württemberg is produced from groundwater.

For the sake of prevention, we have started to equip wastewater treatment plants that are located near particularly sensitive water bodies or polluted areas with tertiary treatment stages in order to eliminate micropollutants. In this context, our concept follows a preventive and consensus-based approach with the operators. At national and international scale, the group of supporters of the concept is increasing. The concept stipulates that additional treatment measures in municipal wastewater treatment plants may not result in the neglect of decentralised measures such as the pre-treatment of industrial wastewater as well as measures taken at the source.

I would like this brochure to contribute to showing you as well-informed citizens and decision-making persons the positive aspects of eliminating micropollutants in wastewater treatment plants and facilitate decision-making in favour of building such systems where appropriate. This mindset is also supported by KomS (Kompetenzzentrum Spurenstoffe Baden-Württemberg), the Micropollutants Competence Centre Baden-Württemberg, which is available as a reliable contact, providing their competence and services to operators who are planning to extend their wastewater treatment plants.

Franz Untersteller Member of the State Parliament

Former Minister of the Environment, Climate Protection and the Energy Sector



Böblingen-Sindelfingen wastewater treatment plant
Adsorption stage using PAC



River Murg in Gernsbach, Baden-Württemberg



MICROPOLLUTANTS ARE EVER-PRESENT



Active substances in pharmaceuticals, pesticides, cosmetic products, cleaning products, industrial chemicals and other products: a multitude of substances contained in our wastewater continue to enter bodies of water, causing severe harm to the ecosystem, even though the extension of wastewater treatment plants has progressed to an exhaustive degree. However, an advanced treatment stage is able to eliminate the majority of these micropollutants in wastewater treatment plants. This way, bodies of water can be protected much better and at more reasonable costs than by using conventional technology, which reaches its limits with regard to micropollutants.

What are micropollutants in the environment?

We all suffer from the occasional headache and are grateful for the fast relief painkillers can offer. Everybody who has ever been pestered by mosquitoes has hardly ever hesitated to grab the bottle of insect repellent. However, ingredients not only show their effects inside and on the body. Their area of influence is way larger: active substances and their degradation products enter wastewater via domestic and industrial water disposal. And due to the fact that they can only be eliminated to an insufficient degree in wastewater treatment plants, we find them in streams, rivers and lakes. This is where these chemical compounds, which are contained in products of our daily lives, may have effects that result in unnatural and undesirable consequences on small organisms and animals. This not only applies to pharmaceutical substances, but to a variety of other micropollutants such as X-ray contrast media, synthetic sweeteners, synthetic musk fragrances, pesticides, industrial chemicals

and flame retardants. The Baden-Württemberg State Institute for the Environment (Landesanstalt für Umwelt Baden-Württemberg (LUBW)) has described the situation in Baden-Württemberg in their "Spurestoffinventar der Fließgewässer in Baden-Württemberg" (Inventory of micropollutants found in running waters across Baden-Württemberg) (2014).

The "Policy Paper" on the Trace Substance Strategy published by the German Federal Government defines micropollutants as "substances that even at very low concentrations can have adverse effects on aquatic ecosystems and/or can adversely affect the extraction of potable water from raw water." Over the past decades, these substances have increasingly become a problem. Last but not least, for the sake of prevention, it is advisable to take active measures against the pollution of water with micropollutants wherever and whenever this seems particularly reasonable and worthwhile.



// Even at very low concentrations [micropollutants] can have adverse effects on aquatic ecosystems and/or can adversely affect the extraction of potable water from raw water."

POLICY PAPER BY THE GERMAN FEDERAL GOVERNMENT | 2017

www.dialog-spurestoffstrategie.de/spurenstoffe-wAssets/docs/PolicyPapier_FINAL.pdf



How micropollutants function

As their name suggests, micropollutants can be found in the environment at extremely low concentrations: in the range of micrograms, i.e. millionth grams per litre ($\mu\text{g/l}$), sometimes even in the range of billionth grams, i.e. nanograms (ng) per litre. However, even at these low concentrations, some substances affect aquatic organisms. For example, the active substances of the contraceptive pill are not the only ones to have hormone-like effects. The same applies to bisphenol A, which is used in the plastic industry, and flame retardants that contain bromine. Therefore, technical jargon refers to these substances and a multitude of other micropollutants as 'endocrine disruptors'. Being environmentally active hormones, they can disrupt the hormonal balance of aquatic organisms, thus causing long-term damage. One example are male fish that feminise under the influence of such compounds.

The analgesic and anti-inflammatory substance diclofenac can cause harm to the gills of fish, but also to the liver and kidneys. A high level of consumption and a relatively high level of stability in the environment have resulted in an extensive spread of the substance in bodies of water. Persistent micropollutants, which are particularly stable in the environment, can also accumulate in the food chain. This applies to durable perfluorinated and polyfluorinated compounds (PFC), which are contained in outdoor apparel, for example, due to their water and dirt-repellent properties.

As micropollutants accumulate in animals, their importance for humans is growing, since they are absorbed through food.

Protect water bodies

Therefore, the primary principle has to be that such compounds must be prevented from entering our water in the first place. This is easy when it comes to expired pharmaceutical products – simply dispose of them in the household waste and do not flush them down the toilet. Unfortunately, pharmaceutical substances and their degradation products enter our wastewater via human excrements. Biocides from house facades or pesticides enter the wastewater path diffusively via storm water. And afterwards, the micropollutants have to be eliminated once more in the wastewater treatment plant in order to keep their effects on the environment to a minimum. However, this is only possible to a limited extent with the current wastewater treatment methods, i.e. mechanical and biological treatment. An advanced treatment stage is able to eliminate a broad spectrum of micropollutants from wastewater in a targeted manner. Therefore, over the past years, Baden-Württemberg has seen an increasing number of wastewater treatment plants being equipped with an advanced treatment stage in order to eliminate micropollutants even further.



www.koms-bw.de/cms/content/media/BAAn_Bericht-Teil1_veroeffentl_final.pdf



Kressbronn wastewater treatment plant located at Lake Constance and equipped with a treatment stage for targeted micropollutant removal



Third congress on "Micropollutants in the Aquatic Environment"



Information on the proper disposal of expired pharmaceutical products



WHAT NEEDS TO BE DONE?

Do one thing without neglecting the other: in Baden-Württemberg, this phrase refers to the strategy of reducing the negative impact of micropollutants to a minimum. On the one hand, this means reducing their entry into the wastewater to the greatest possible extent. On the other hand, eliminating the substances that have still found their way into the wastewater in the best possible way and equipping wastewater treatment plants with an advanced treatment stage in particularly relevant cases.

Strategies to tackle micropollutants

"Baden-Württemberg is pursuing a two-pillar strategy with regard to micropollutants: source and user-related measures combined with the support and funding of the extension of wastewater treatment plants to eliminate micropollutants in justified cases", says Dr Ursula Maier from the state's Ministry of the Environment. Among other things, this is ever more important as the consumption of pharmaceuticals has increased drastically over the past years. And it is going to increase even further as people tend to live longer. This means that the amount of pharmaceutical substances entering the water cycle is increasing, as the example of metformin shows us. This pharmaceutical agent is prescribed for type-2 diabetes and is one of the most frequently consumed drugs. Even though metformin degrades well in wastewater treatment plants, this micropollutant can still be found in many bodies of water due to the high input quantities – and not only as metformin itself, but also in the form of its degradation product, guanlyurea.

1st pillar: prevention is key

Not the largest, but an easily preventable source of micropollutants in waters are pharmaceuticals that are no longer needed and simply flushed down the toilet. They are estimated to represent 10 to 20 percent of pharmaceutical residues found in bodies of water. In order to raise people's awareness of the consequences of improper disposal, Baden-Württemberg's Ministry of the Environment has published the brochure titled "Protecting our bodies of water by properly disposing of out-of-date pharmaceuticals". Like the Trace Substance Strategy of the Federal German government, the state government also pursues the declared objective of promoting source-related and decentralised measures that reduce the intake of micropollutants in the environment. This way, wastewater from hospitals and clinics that dispose of large amounts of X-ray contrast media can be collected and treated and/or disposed of separately. Dr Ursula Maier demands that "we need to raise the awareness of all protagonists that are socially relevant for keeping our bodies of water clean."



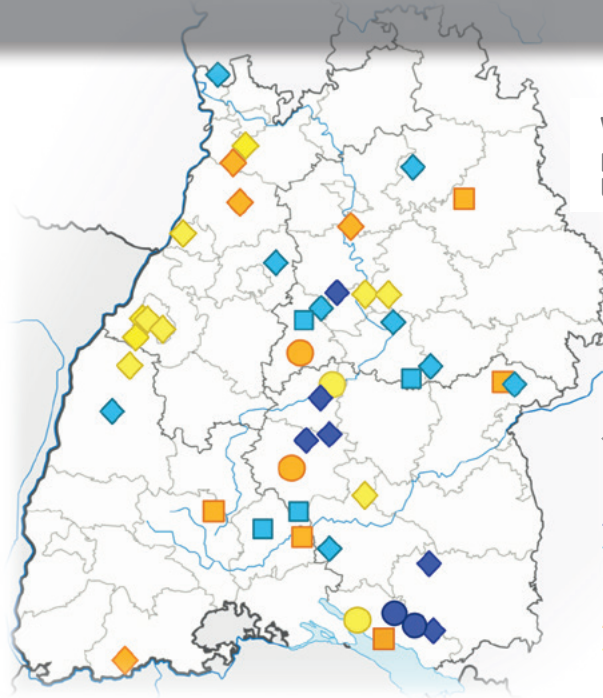
// Baden-Württemberg pursues a two-pillar strategy with regard to micropollutants: source and user-related measures as well as the promotion and funding of the extension of wastewater treatment plants in order to eliminate micropollutants near sensitive water bodies and contamination hotspots."

DR URSULA MAIER | BADEN-WÜRTTEMBERG MINISTRY OF THE ENVIRONMENT



2nd pillar: Upgrading wastewater treatment plants to eliminate micropollutants

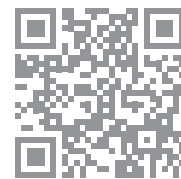
Even the best prevention and information regarding the impact of micropollutants is not sufficient in order to protect bodies of water against micropollutants in the best possible way. The pharmaceutical agent diclofenac is a good example. Conventional wastewater treatment plants are able to break down only 25 percent of the substance. According to a study that involves 40 wastewater treatment plants and was conducted by the Micropollutants Competence Centre Baden-Württemberg (KomS), the mean value of the concentration identified in the effluent of municipal wastewater treatment plants is 1.9 micrograms per litre (µg/l). This value is contrasted by a recommended environmental quality standard for diclofenac of only 0.05 µg/l (referring to water bodies), which has been derived on a scientific basis. Diluting the effluent of the wastewater treatment plant in the body of water to a ratio of 1:10 is not sufficient in order to fall below this threshold value. At present, we have not yet gained a sufficient level of knowledge about the environmental impact of a variety of other chemical compounds that can be found in water bodies and their degradation products, let alone the



Wastewater treatment plants with advanced treatment for micropollutant removal in Baden-Württemberg

- Process:**
- Granular activated carbon (GAC)
 - ◇ Powdered activated carbon (PAC)
 - Ozone
- In operation:**
- total flow
 - partial flow rate
- In planning or under construction:**
- in planning
 - under construction

combined effect of different substances. Therefore, in regions with sensitive water ecology and a particularly high level of wastewater pollution in water bodies or in regions where drinking water is gained, Baden-Württemberg started to equip wastewater treatment plants across the state with treatment stages that eliminate micropollutants several years ago. The positive effects of advanced treatment on aquatic organisms have been investigated and documented in an extensive research project, which has been conducted at the Schussen river in connection with the extension of the Mariatal wastewater treatment plant located in Ravensburg (SchussenAktivplus project within the "Risk management of new pollutants and pathogens in the water cycle" funding project by the Federal German Ministry of Education and Research).



www.schussenaktivplus.de





// Across Germany, Baden-Württemberg takes a pioneer role when it comes to eliminating micropollutants in wastewater treatment plants."

ANDRÉ HILDEBRAND
DWA BADEN-WÜRTTEMBERG REGIONAL CHAPTER



AN INVESTMENT IN THE FUTURE

For many years, the elimination of micropollutants has been a key topic in Baden-Württemberg. Out of all German federal states, Baden-Württemberg is at the forefront of technological development. This is considered an important investment in the future as this will protect water bodies even more effectively. The German Federal Government and the European Union are pursuing strategies against micropollutants in bodies of water.

Baden-Württemberg as a pioneer across Germany

The scientific fundamentals for the targeted elimination of micropollutants were developed at the wastewater treatment plant that treats the wastewater produced in the city of Ulm. With the support of the Ministry of the Environment, the Biberach University of Applied Sciences developed and tested a semitechnical system at the Steinhäule wastewater treatment plant (Ulm/Neu-Ulm) in cooperation with the plant operator in 2003. The effect is based on the adsorption of micropollutants on powdered activated carbon. In 2010, the first large-scale plant that eliminated micropollutants in a targeted manner started operation in Mannheim. Today, other techniques are applied on a large scale: granular activated carbon in order to adsorb micropollutants, or wastewater treatment by means of ozone.

»Baden-Württemberg takes a pioneer role when it comes to eliminating micropollutants in municipal wastewater treatment plants“, establishes André Hildebrand, Managing Director of the DWA Baden-Württemberg regional

chapter. In cooperation with the University of Stuttgart and Biberach University of Applied Sciences, the association operates the Micropollutants Competence Centre Baden-Württemberg (KomS), which scientifically supervises the new technique of eliminating micropollutants at wastewater treatment plants as a platform for knowledge transfer and supports operators in extending their plants.

At the beginning of 2021, 21 municipal wastewater treatment plants operated a treatment stage for the elimination of micropollutants. They allow for the significantly improved treatment of a wastewater volume of up to 2.7 million population equivalents. Another 23 plants are currently under construction or being planned. Even if the technology for the elimination of micropollutants reaches its limits with some substances such as X-ray contrast media, today, we are able to achieve an elimination rate of at least 80 percent on rain-free days – and this rate has to be achieved and proven by the extended wastewater treatment plants in Baden-Württemberg in every-day operation.





Pforzheim wastewater treatment plant, advanced treatment stage



Karlsruhe wastewater treatment plant, advanced treatment stage under construction



Steinhäule wastewater treatment plant, new sedimentation tank of the advanced treatment stage under construction

Strategy of the German Federal Government

In the meantime, the German Federal Government has also become active regarding the topic of micropollutants. In the first phase of the dialogue process, which was conducted across Germany between 2016 and 2019, a Policy Paper was developed. It contains a total of 14 recommendations on a Trace Substance Strategy pursued by the German Federal Government. The second phase of the project saw the design of a future schedule by specifying the recommendations. The “Orientative framework for the extension of wastewater treatment plants” is a key element, which provides advice on the tertiary treatment of wastewater in order to reduce micropollutants. The German Federal Government is planning further steps towards implementing the recommendations given in the Trace Substance Dialogue. An amendment to the German Wastewater Levy Act (Abwasserabgabengesetz) with the objective of reducing the level of pollution in water bodies is currently being discussed.

Europe is also becoming active

In March 2019, the EU Commission published their strategy on the future handling of “Pharmaceuticals in the Environment” in Europe. The EU also considers prevention to be the first pillar of the micropollutants strategy: they aim to support the development of pharmaceuticals that are less harmful to the environment. The second pillar includes downstream measures, such as reviewing

the introduction of an additional treatment stage in the context of revising the Urban Wastewater Directive. As a result, in future, the extension of wastewater treatment plants may be required by law across Europe.

A glance at neighbour Switzerland

Switzerland has declared the elimination of micropollutants from wastewater a high-priority task. According to the Swiss Water Protection Act, there are plans to equip around 100 out of 700 wastewater treatment plants with an advanced treatment stage by 2040. In March 2014, the first large-scale plant, which is located in Dübendorf and uses ozone for wastewater treatment, started operation. At the beginning of 2020, a total of ten plants were equipped with a stage that eliminates micropollutants and another 29 were either in the planning stage or under construction. A levy of nine Swiss francs has been imposed in order to fund the further extension of wastewater treatment plants – and the levy has to be paid by all Swiss citizens who have their wastewater treated.



www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Binnengewasser/ergebnispapier_stakeholder_dialog_phase2_bf.pdf





KomS information stall at the open day of the Mannheim wastewater treatment plant



9th KomS Technology Forum in Wernau



KomS test system for use at wastewater treatment plants



BUNDLE COMPETENCES — SUPPORT OPERATORS

The targeted elimination of micropollutants requires techniques extending beyond those of a traditional wastewater treatment plant. To achieve this goal, technological innovations have to be established. Since 2012, the Micropollutants Competence Centre Baden-Württemberg (KomS) has been supporting planners, operators and authorities in introducing the new technology and has also been involved in the further development of the elimination of micropollutants.



KomS Baden-Württemberg: The state's competence centre

In April 2012, the University of Stuttgart, the Biberach University of Applied Sciences and the Baden-Württemberg regional chapter of the Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA) [German Association for Water, Wastewater and Waste] founded the Micropollutants Competence Centre Baden-Württemberg (KomS) as a joint institute. The Baden-Württemberg Ministry of the Environment is funding the institute that has been tasked with supporting planners and operators in extending wastewater treatment plants by building a treatment stage that eliminates micropollutants and in starting up the plant until they have reached reliable operation. One important area of responsibility is to bundle and analyse findings and experience gained with the new technology and make it available to other users. Thus, the Competence Centre also serves as a platform for knowledge transfer in order to scientifically supervise and further develop the technology.

Studies and expert events

KomS have set themselves the task to further explore and thus improve options of eliminating micropollutants, i.e. to optimise procedural steps. Studies in which the Competence Centre is also involved cover other aspects such as cost factors and operating experience. In addition, new developments are to be given a chance, i.e. promoting and funding research on new procedures, which may potentially result in their technological implementation. In order to present the findings of such studies to experts, a wellfunctioning knowledge and technology transfer is essential, combined with the exchange of experience and the discussion of new technological approaches. For this purpose, KomS Technology Forums are organised on a regular basis, which are addressed to all parties that are involved in municipal wastewater treatment: operators of wastewater treatment plants, authorities, engineering consultant companies, scientific institutes, industry and expert organisations.



// We support operators of wastewater treatment plants in all questions relating to micropollutants in wastewater and their elimination."

DR.-ING. MARIE LAUNAY | DIRECTOR OF KOMS BADEN-WÜRTTEMBERG



Recommendations for action and on-site support

Good planning and optimal operation of the treatment stage that eliminates micropollutants are essential for efficiently protecting the environment. KomS has developed a standard for the appropriate dimensioning of the system and test of the treatment performance. These principles have been collated in the "Recommended course of action for comparative checks and operational monitoring of advanced treatment for micropollutant removal" ("Handlungsempfehlungen für die Vergleichskontrolle und den Betrieb von Verfahrenstechniken zur gezielten Spurenstoffelimination", available in German only). Furthermore, forms are available for recording data of the required measurement campaigns. KomS consider themselves a point of contact for both the operators and expert personnel of wastewater treatment plants as well as engineering consultants and companies that are tasked with the technical extension of wastewater treatment plants. The KomS staff are available for individual on-site consultations as well as for training expert and operating personnel.



Operational exchange of experience

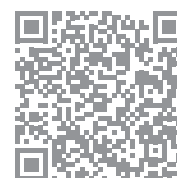
Baden-Württemberg has initiated a special micropollutants community. Similar to the traditional community of wastewater treatment plants organised by the DWA, the micropollutants community are also voluntary associations of wastewater treatment plant operators with the aim of supporting and optimising the protection of waters and the safety of plant operation. However, the goal of this special community is to provide information about current developments regarding the elimination of micropollutants, linking knowledge and sharing experience regarding the new process technology.



Training day held by the special micropollutants neighbourhood in Kressbronn



SPURENSTOFFE
IN DER
AQUATISCHEN
UMWELT



www.koms-bw.de/cms/content/media/KomS_Handlungsempfehlung_2018.pdf



Öhringen wastewater treatment plant, using powdered activated carbon



Lahr wastewater treatment plant, installation of a new pile cloth filter



GROUNDBREAKING PROCESSES

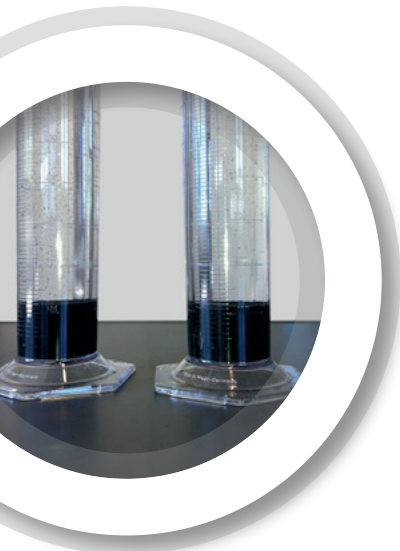
Up until now, especially two operating materials have proven to successfully eliminate micropollutants from wastewater: powdered activated carbon and ozone. At present, the most frequently used process in Baden-Württemberg is the elimination of micropollutants by means of adsorption on powdered activated carbon. However, being a highly reactive oxygen compound, ozone can also be used to remove undesired substances. Furthermore, research is currently being conducted on various combined processes.

One goal, two paths: Powdered activated carbon and ozone

The “powdered activated carbon-based adsorption process” to eliminate micropollutants was developed at the Steinhäule wastewater treatment plant in Ulm/Neu-Ulm. They use powdered activated carbon, which explains the unusual colour of the water inside the contact tank – it is black. They add powdered activated carbon (PAC) to this tank after the third treatment stage. After the PAC has been mixed with the wastewater that has already been extensively treated, the PAC develops its effect: as PAC is porous, this property helps to bind a large number of micropollutants to its considerably large inner surface. Afterwards, it is separated again from the wastewater including the adsorbed micropollutants held inside the sedimentation tank. This process is supported by precipitants and polymers. In the course of filtration, the wastewater also loses its black colour and can be drained into bodies of water. The powdered activated carbon is added to the biological treatment stage in order to be dried together with the sludge and burnt in the end – together with the micropollutants.

In Baden-Württemberg, most systems that have been equipped with an advanced treatment stage are currently using the PAC process. Yet, there are other technologies, such as the elimination of micropollutants by means of granular activated carbon (GAC). However, GAC is used as a fixed-bed filter.

Ozonation, i.e. the other technology that eliminates micropollutants and has already established itself, utilises the high chemical reactivity of ozone, which is a highly active oxygen compound (O_3), in order to degrade compounds of all types. This process has proven in the treatment of drinking water and bathing water from swimming pools, and now in the treatment of wastewater likewise. When using this technology as advanced treatment stage at wastewater treatment plants, it also degrades micropollutants in the same manner. This produces partially unknown transformation products. Therefore, the ozoned wastewater has to be subjected to another biologically active treatment stage, such as sand filtration.



Powdered activated carbon sludge inside a cylindrical stand





Wendlingen wastewater treatment plant, PAC dosing system



Kressbronn wastewater treatment plant, PAC dosing system



Eriskirch wastewater treatment plant, oxygen tank for the ozone system



Westerheim wastewater treatment plant, GAC filter



Are there any other options?

Current experience shows that it is important to adapt the advanced treatment stage for wastewater to the local situation and conditions. Therefore, engineers are testing other approaches to achieve possible improvement potential. One option is to treat wastewater both with ozone and powdered activated carbon. Such a combined process may improve the overall treatment performance, extend the useful life of GAC filters and prevent potentially undesired transformation products in the effluent. In addition, current research projects also explore a potential combination of PAC adsorption and membrane filters, which help achieve potential synergy effects.

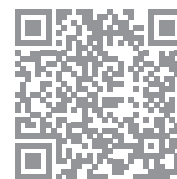
Perfect synergy effects

Advanced treatment aims to eliminate micropollutants; however, it also provides other benefits. The downstream filter is also able to reduce the concentration of phosphorus. This also results in synergy effects for wastewater treatment plants aiming at the extended elimination of phosphorus.

From an operator's perspective, a positive side effect is that powdered activated carbon also further reduces organic pollution in the wastewater-measured as chemical oxygen demand (COD). Wastewater treatment plants that work with PAC are able to reduce the COD value by an average of 30 percent. Another positive effect of ozonation is the reduction of germ contamination. Intensive research is currently being conducted to find ways of reducing the level of multidrug-resistant bacteria.

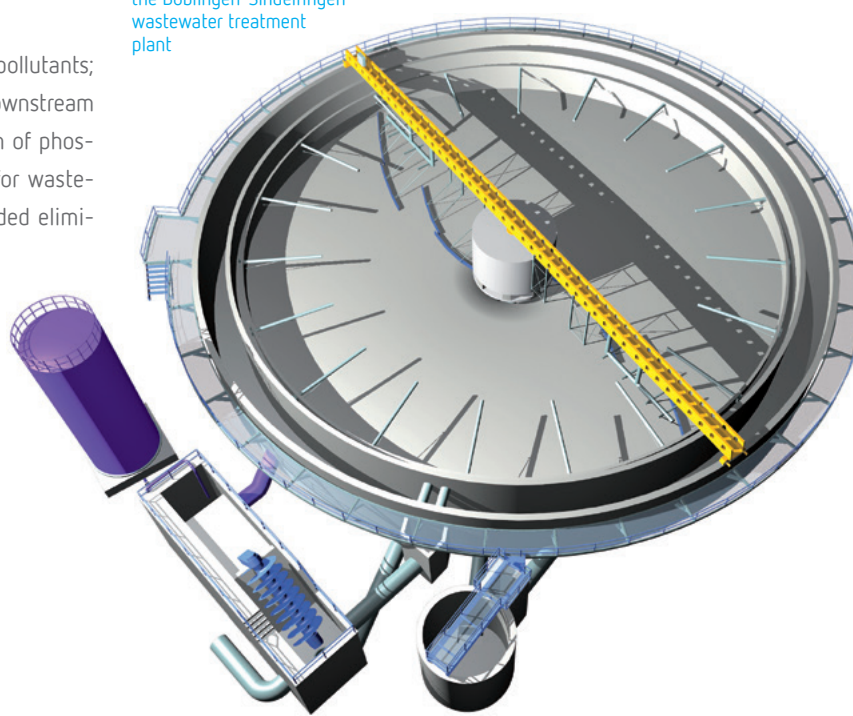


www.koms-bw.de/technologien/oxidative_verfahren/



www.koms-bw.de/technologien/adsorptive_verfahren/

Illustration of the PAC-based adsorption stage at the Böblingen-Sindelfingen wastewater treatment plant





Wastewater treatment plant in Wendlingen am Neckar after completion of the powdered activated carbon-based treatment stage



Mannheim wastewater treatment plant, filter with GAC



Laichingen wastewater treatment plant with activated carbon and downstream cloth filter



EFFECTIVE ACTIVATED CARBON

Activated carbon is an effective means to eliminate micropollutants from wastewater. In this context, there are various options to integrate activated carbon-based processes into wastewater treatment and to use the specific surface of carbon in the most optimal way. In addition, activated carbon can be used in a variety of forms: as powder in multiple process variants and as granules in a fixed-bed filter in most cases.

PAC-based process

Powdered activated carbon (PAC) is ground activated carbon with a grain size that usually ranges between 10 and 50 micrometers (μm). It is directly poured into the wastewater in order for it to reveal its adsorptive effect. In this context, the following rule applies: the longer the period of time during which the PAC is in contact with the water that is to be treated, the higher the amount of micropollutants the PAC is able to adsorb. However, the time is hardly ever long enough for the PAC to be fully "loaded", i.e. in order to achieve an adsorption equilibrium.

Depending on the wastewater and the technical conditions, there are several options to optimise processes. Especially the location at which the PAC is dosed is variable in this case. One option is to install a separate adsorption stage. This comprises a contact reactor where the PAC is added, and a sedimentation tank where it is separated from the wastewater again by means of precipitants. Alternatively, the PAC can be added before the wastewater enters the filter. In this case, the freeboard of the sand filter is also used as the contact chamber for the activated carbon. The PAC is separated in the downstream filter bed. The third option is to directly add the activated carbon to the aeration tank, which also serves as the contact chamber in this case. The PAC is incorporated into the activated sludge and removed from the treatment stage together with the excess sludge.



Information about micropollutant removal at the Langwiese wastewater treatment plant



Activated carbon



// Use of powdered activated carbon is a very well-manageable technology, which does not require a high level of effort in order to integrate it into everyday operation."

DR.-ING. STEFFEN METZGER
SPOKESPERSON OF THE DWA KA-8.6 "ACTIVATED CARBON"



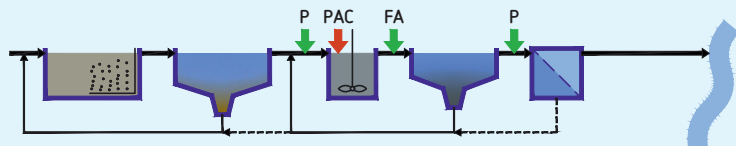
Granular activated carbon in the fixed bed

With a particle size ranging between 0.5 and 4 millimetres, granulated activated carbon (GAC) is much coarser than PAC, which is why it is used in "fixed-bed adsorbers". In this case, the wastewater runs through the heaped up GAC, during which the micropollutants accumulate. In addition, a biological degradation process takes place in these filters. As the GAC remains in the fixed bed, no additional separation stage is required as is the case in the PAC-based process. GAC, on the other hand, only has limited adsorption capacity: if this capacity is exhausted, the granular carbon has to be removed, reactivated and then re-inserted into the fixed bed.

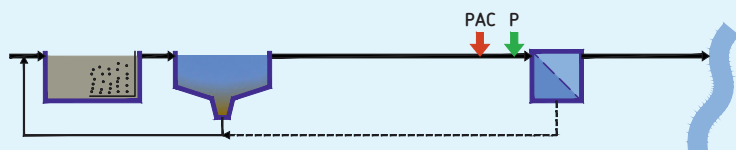
The GAC filter, which is always positioned after the biological treatment stage, can be implemented in two different ways. On the one hand, an existing sand filter can be converted into a GAC fixed-bed filter, i.e. the filter material is replaced with GAC. On the other hand, the GAC fixed bed can be positioned after a filter for filterable substances, thus relieving the load on the granular carbon filters. The filter itself can be designed in different ways: as an open filter through which the wastewater passes from top to bottom or the other way around, as a pressure filter or as a filter that is flushed in parallel to the filtration process.

Process variants with activated carbon

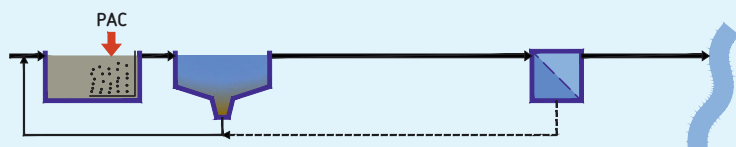
PAC dosing in a separate stage



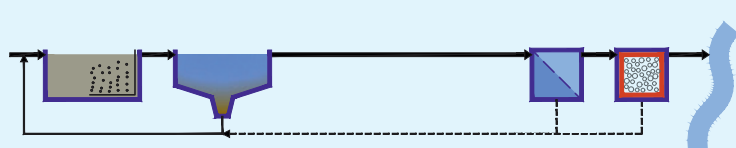
Pre-filter PAC dosing



PAC dosing into the biological treatment stage



GAC filter (with pre-filter)



P: Precipitants
FA: Flocculating agents
PAC: Powdered activated carbon

Which aspects have to be taken into consideration?

The process requires caution, e.g. selection, quality assurance and dosing of the activated carbon used. As multiple activated carbon-based adsorption systems have already been in operation in Baden-Württemberg for many years, a broad spectrum of experience is available. A survey conducted by the working group among operating staff who work at wastewater treatment plants that use activated carbon processes has shown that overall, the processes are "very well-manageable technologies that can be easily integrated into everyday operations."



www.webshop.dwa.de/de/catalogsearch/result/?q=Aktivkohleeinsatz+auf+kommunalen+Kl%C3%A4ranlagen+zur+Spurenstoffentfernung



Westerheim wastewater treatment



Stockacher Aach wastewater treatment plant at Lake Constance



Steinhäule wastewater treatment plant, Neu-Ulm



PRACTICAL EXPERIENCE

With the use of PAC in a separate adsorption stage, Baden-Württemberg has developed a technology for the targeted elimination of micropollutants. In Mannheim, findings from the Ulm pilot project were tested in a large-scale system and brought to production maturity. But other wastewater treatment plants in our state have also taken a pioneering role with regard to activated carbon technology. In addition, significant accompanying studies have been conducted.

Mannheim wastewater treatment plant

Baden-Württemberg has been gaining experience with the use of powdered activated carbon (PAC) for a long time. As early as in the 1990s, PAC was used at municipal wastewater treatment plants in order to remove dye from the wastewater produced by textile processing plants. Between 2003 and 2009, the procedure of eliminating micropollutants by means of PAC was developed at the Ulm wastewater treatment plant. Experience gained with wastewater produced by textile processing plants provided the basis in this case. Afterwards, the technology was installed at the Mannheim wastewater treatment plant – for the first time ever in Europe on a large scale. In 2010, the system was initially put into operation, treating only part of the inlet stream. A sand filter system was already in place in order to separate the activated carbon that was loaded with micropollutants. One of the advantages of the Mannheim wastewater treatment plant is the parallel operation of four treatment lanes, which allowed for supporting the introduction of the new technology and its impacts with extensive accompanying and compa-



Wastewater treatment plant at Mannheim am Rhein

orative studies. In the meantime, the other treatment lanes have been upgraded, so that approximately 90 percent of the annual wastewater volume is treated in a targeted way using PAC.

Today, the Mannheim wastewater treatment plant, which is designed for a population equivalent of 725,000, is taking a pioneering role once again: in future, the biologically treated wastewater, a part of which is led past the PAC system in a bypass, is to be treated using granular activated carbon (GAC) in order to also eliminate the micropollutants from this partial wastewater stream. For this purpose, three filter cells have been equipped with GAC within the scope of large-scale experiments. The success is very promising. In this case, elimination rates of more than 80 percent have been achieved.



// With the extension of the tertiary treatment stage, the performance of the wastewater treatment exceeded the existing minimum requirements. For the first time ever in Germany, we were able to prove that the practice of eliminating micropollutants in a targeted way also works in large wastewater treatment plants."

UGUR CAKIR | LEADER OF THE WASTEWATER DEPARTMENT AT MANNHEIM



Stockacher Aach wastewater treatment plant

Stockach is situated at the western shore of Lake Constance. The wastewater treatment plant treats the wastewater of 69,000 population equivalents from various municipalities. As the wastewater treatment plant drains the effluent into Lake Constance, which is particularly worthy of protection as a drinking water reservoir, the plant was equipped with a PAC system as early as in 2011 in order to eliminate micropollutants. The PAC system is positioned between the biological treatment stage and the filter system, while the sand filter, which was already available, provided major benefits. It is important to note that the carbon sludge that settles at the bottom of the sedimentation tank is returned to the contact reactor as "recirculated carbon", where also new PAC is added. Overall, the activated carbon remains in the adsorption stage for several days, which increases the effect. How well the technology works has been intensively explored at this wastewater treatment plant and others by the Micropollutants Competence Centre (KomS). The PAC stage is able to treat a maximum of 21,600 cubic metres per day, while an average of approximately ten milligrams of PAC is added to each litre of wastewater. In the course of a one-year targeted measurement campaign, we found that in dry weather conditions, more than 90 percent of the contained micropollutants were eliminated. This clearly exceeds the minimum performance of 80 percent, which is required in Baden-Württemberg.

Sedimentation at the Stockacher Aach wastewater treatment plant

Westerheim wastewater treatment plant

Westerheim is situated in the Swabian Alb hill range and the wastewater treatment plant there, which is designed for a population equivalent of 5,500, cannot drain its effluent into a flowing water. It is drained into the karst, which is why it enters the groundwater after a relatively short period of time. Thus, the decision was made to equip the small Westerheim wastewater treatment plant with a system that eliminates micropollutants. The technology of choice was granular activated carbon, which made Westerheim the first wastewater treatment plant in Baden-Württemberg to permanently use this technology. In the course of equipping the plant with an advanced treatment stage, a sand filter was installed upstream of the GAC system. Both components are housed in a dedicated filter building. The system is able to treat a maximum of 22 litres of wastewater per second, which allows for the adsorptive treatment of 90 percent of the annual wastewater volume. This means that the vast majority of micropollutants is eliminated.



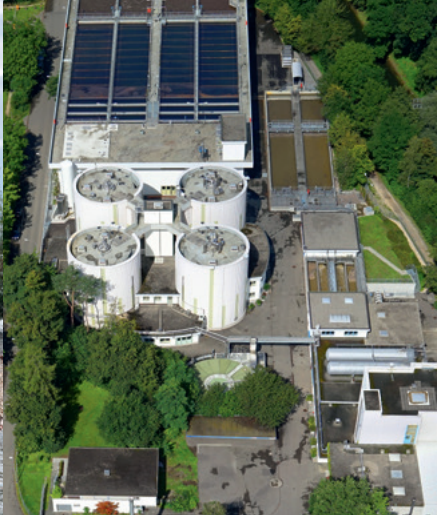
www.koms-bw.de/cms/content/media/KomS-Handlungsempfehlungen_Umsetzung%20am%20Bsp%20AZV%20Stockacher%20Aach_2020.pdf

Ground being broken for the new filter building at the Westerheim wastewater treatment plant





Lake Constance shore near Langenargen



Neugut wastewater treatment plant (Switzerland) that uses ozonation



Eriskirch wastewater treatment plant that uses ozonation



HIGHLY ACTIVE OZONE

Ozone, which is a gas made up of three oxygen atoms, is highly reactive. It also “attacks” micropollutants and chemically modifies them. As a result, they lose their original properties. It is important to post-treat wastewater that has been treated with ozone in order to remove undesired oxidation products, including the remaining ozone. One of the other positive side effects is that the concentration of germs in the wastewater is reduced.

What are the benefits of ozonation?

The example of the Eriskirch wastewater treatment plant shows why it is worthwhile to carefully evaluate the pros and cons of the individual technologies when planning an advanced treatment stage. For this purpose, a feasibility study is conducted to investigate various options and to develop a preferable solution. In this case, the location of the wastewater treatment plant at Lake Constance, which treats the wastewater of a population equivalent of 500,000, plays an important role. “We use ozonation to keep the germ concentration at the lidos located in Eriskirch and Langenargen to a minimum”, explains Klaus Ruff, head of the Friedrichshafen district administration, by giving one of the reasons why it makes sense to use the ozonation process as advanced treatment. Being a very aggressive oxygen compound, ozone in fact not only “attacks” micropollutants, it is also capable of killing germs such as bacteria and viruses. Aside from this, the elimination of micropollutants is of major importance due to the fact that Lake Constance is a drinking water reservoir, into

which the Eriskirch wastewater treatment plant drains its treated effluent. It is important to identify all necessary facts prior to evaluation and decision-making. This also includes testing wastewater for increased bromide concentration, which can be transformed into harmful compounds (bromate) by ozone. In these cases, it is advisable to opt for a different technology to eliminate micropollutants.

The on-site situation is important

As early as between 2012 and 2015, the Eriskirch wastewater treatment plant was involved in the Schussen AktivPlus research project, which was conducted as part of the “Risk management of new pollutants and pathogens in the water cycle” project funded by the Federal German Ministry of Education and Research. Within the scope of the project conducted in the catchment area of the Schussen river, which flows into Lake Constance between Eriskirch and Langenargen, an ozone-based test system was set up in Eriskirch. The test covered different combinations of ozone treatment and filtration. The results showed that the wastewater almost achieved drinking water quality after ozonation.



Ozone pipes



// The overall operational experience made with ozone in operation is stable, robust and safe, the personnel costs are low."

MAX SCHACHTLER | HEAD OF THE NEUGUT/DÜBENDORF/SWITZERLAND WASTEWATER TREATMENT PLANT



In the case of the Eriskirch wastewater treatment plant, another pro argument of using ozone technology was that a sand filter was already available. The filter extracts the transformation products of the micropollutants, which are modified by the ozone, in order to further reduce the risk potential for the environment. After a 15-month construction period, in January 2020, the advanced treatment stage of the Eriskirch wastewater treatment plant started operation as the first ozone system in Baden-Württemberg. Klaus Ruff reports: "The technology is stable."

Ozone – Experience from Switzerland

Since March 2014, the Neugut wastewater treatment plant in Dübendorf, Switzerland has been eliminating micropollutants at a stable rate of 82 percent – plus/minus two percent. This is reported by Max Schachtler, manager of the wastewater treatment plant and he adds: "The overall operational experience made with ozone is positive. Operation is stable, robust and safe, the personnel costs are low." Up until now, there have not been any incidents.

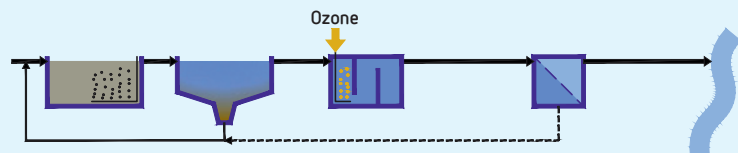
The ozone used at the Neugut wastewater treatment plant is generated in an ozone generator, which transforms oxygen (O₂), which is stored in a tank that only holds oxygen, into ozone (O₃). In the ozone reactor, which is located downstream from secondary sedimentation, the micropollutants are attacked by the highly reactive ozone. Mr Schachtler explains that it has proven

very efficient to add ozone to multiple chambers. The ozone offgas, which almost completely consists of pure oxygen, is added to one of the biological treatment tanks via injector nozzles. This increases economic efficiency. The remaining ozone is released into the air as oxygen in the residual ozone destructor (ROD). Ozonation also reduces the concentration of dissolved organic carbon (DOC) by up to 20 percent and the chemical oxygen demand (COD) by up to 30 percent. In addition, Mr Schachtler points out that the quality of the biological treatment has a direct impact on the elimination performance of ozonation and the consumption of resources. He recommends: plan the ozone system with sufficient reserves in order to be able to flexibly respond to different requirements.



www.koms-bw.de/cms/content/media/SchussenAktivplus%20Abwasserreinigung_20170404.pdf

Schematic view of a wastewater treatment plant with an ozonation stage



it has proven



WHAT IS POSSIBLE – AND WHAT ARE THE LIMITS?

The advanced treatment stage is capable of removing a multitude of micropollutants from the wastewater, which significantly reduces the risk potential for the aquatic environment. In this context, the treatment performance is measured based on the elimination rate of specific indicator substances. However, also the advanced treatment stage, which eliminates micropollutants, has its limits: not all compounds can be eliminated equally well. And the effort involved also depends on the condition of the wastewater to be treated.

Impressive performance

The overall performance of a wastewater treatment plant with an advanced treatment stage that eliminates micropollutants is measured based on the elimination rates of "indicator substances". The wastewater of municipal wastewater treatment plants usually contains these compounds in such high concentrations that an elimination rate of 80 percent can be proven. Other criteria for the selection of indicator substances were well-functioning elimination processes using both activated carbon and ozone, as well as reliable and most cost-effective analytics. Please refer to the "Recommended courses of action" published by the Micropollutants Competence Centre Baden-Württemberg (KomS) for a detailed description of how to proceed in order to prove elimination performance. At least six samples are to be taken from the inlet and outlet of the wastewater treatment plant as 48-hour, flow-dependent mixed samples, which are then analysed in a special laboratory. For operators of wastewater treatment plants, it is almost

impossible to measure the concentration of micropollutants in their own laboratories. The necessary analytics are too complex. However, continuous on-site monitoring can be achieved with optical measuring probes, which are already used to measure the concentration of COD in the effluent of wastewater treatment plants today. Up until now, however, a spectral absorption coefficient with a wavelength of 254 nanometres (SAC_{254}) has proven to be a suitable parameter to analyse the elimination of micropollutants when using activated carbon and ozone. The decrease in SAC_{254} in percent is related to the reduction of individual micropollutants. SAC_{254} can be measured using samples from the inlet and outlet of the advanced treatment stage, either on-line or in the laboratory. In both cases, special devices that are able to take measurements in the UV range are used. They enable operators of wastewater treatment plants to monitor the treatment process independently and give them the opportunity to react in due time if the treatment performance is not optimal.



Diclofenac is often used for pain relief and as an antiinflammatory drug.



// Baden-Württemberg considers the elimination of micropollutants successful, if the elimination rate is at least 80 percent. The requirements to be met by the relevant measurements are defined precisely."

DR URSULA MAIER | BADEN-WÜRTTEMBERG MINISTRY OF THE ENVIRONMENT



SEVEN REPRESENTATIVE MICROPOLLUTANTS:

Carbamazepine – Pharmaceutical substance used to treat epilepsy, for example.

Diclofenac – Pharmaceutical substance used to relieve pain and treat inflammation.

Hydrochlorothiazide – Pharmaceutical substance used to treat hypertension and cardiac insufficiency, for example.

Irbesartan – Pharmaceutical substance used to treat hypertension.

Metoprolol – Pharmaceutical substance, acts as a beta blocker, used to treat cardiac diseases.

Benzotriazole – Complexing agent that acts as corrosion inhibitor and prevents silver from tarnishing.

Σ 4- and 5-Methylbenzotriazole – Similar to Benzotriazole, as anti-freeze agent, for example.

The advanced treatment stage not only eliminates indicator substances from wastewater, but a multitude of micropollutants. As a result, the overall risk potential for the aquatic environment is reduced significantly. The overall analysis of the wastewater treatment plants in Baden-Württemberg that have already been equipped with the treatment stage that eliminates micropollutants shows that the emission of various micropollutants is reduced by approximately 90 percent.

When does the technology reach its limits?

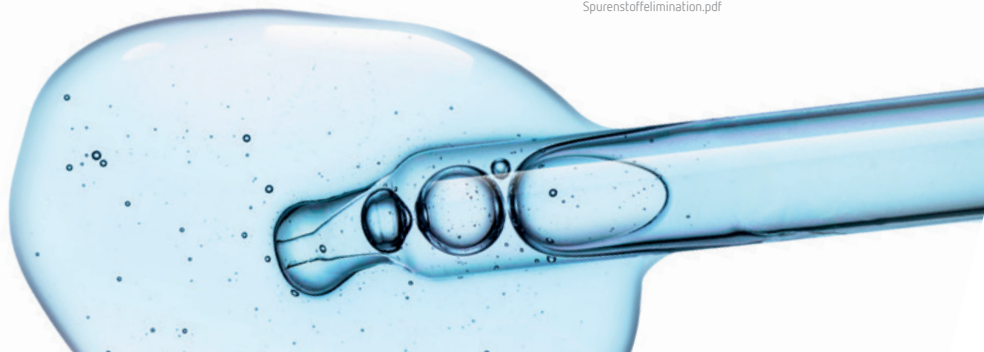
The term "micropollutants" summarises a multitude of substances with different chemical properties and from different areas of application. Research has shown that wastewater contains very constant concentrations levels of a variety of pharmaceutical substances or Benzotriazoles, which can be eliminated very well by means of the advanced treatment stage. However, the concentration of other micropollutants in municipal wastewater, such as biocides or X-ray contrast media, tends to fluctuate. As the overall composition of the wastewater also depends on the specific catchment area, the dosage rates of ozone or activated carbon have to be calculated for each wastewater treatment plant individually in order to achieve the optimum elimination performance.

In this case, the elimination rate of individual micropollutants may not only depend on the adsorption processes on the activated carbon or on how well the molecular structure of the substance can be attacked by ozone. It also depends on the biological elimination of the micropollutants. After all, microorganisms in the biological treatment stage are also able to contribute to the degradation of micropollutants. However, a variety of factors play a role in this context, such as the type of biological process, the age of the sludge as well as the temperature.

Some substances, however, can only be eliminated to a very small degree or not at all even by means of an advanced treatment stage. This includes the X-ray contrast medium diatrizoic acid or the industrial chemical melamine, which is used for a variety of purposes, such as break-proof tableware. Even if the plant is equipped with a treatment stage that eliminates micropollutants, please do not neglect the importance of any efforts made to reduce the intake of micropollutants into municipal wastewater in the first place. This also includes informing people about the proper disposal of expired pharmaceuticals.



www.koms-bw.de/cms/content/media/2019_07_Abschlussbericht%20Koms_Vergleichsmessungen%20zur%20Spurenstoffelimination.pdf





// A cost analysis conducted over several years confirms minimally raising the citizens fees, major positive effects can be achieved for the environment."

DR.-ING. MARIE LAUNAY | DIRECTOR OF KOMS BADEN-WÜRTTEMBERG



WHAT ARE THE COSTS?

The advanced treatment stage is able to effectively eliminate micropollutants from wastewater, which is a major benefit for bodies of water. There is no doubt about that. But at which cost? A cost analysis, which is based on current experience, has shown that the additional costs for citizens can be kept within limits: they range between an additional four and ten percent of the annual fee.

What are the factors that impact the costs?

Powdered activated carbon is able to eliminate a multitude of micropollutants from wastewater to a very high degree. The costs incurred by that have been calculated by the Micropollutants Competence Centre Baden-Württemberg (KomS) in cooperation with the Hamburg-based company Aquabench as part of a long-term study. For this purpose, six wastewater treatment plants were selected which had been operating a system that eliminates micropollutants for several years and had documented the operating experience they had made and the costs they had spent in detail over the last years. The analysis showed that the costs were influenced by multiple factors: differences in the volumes of the wastewater treated with powder activated carbon played a major role, especially with regard to the specific capital costs. Yet, larger plants are at an advantage also with regard to personnel and maintenance costs. The cost-intensive extent of the investments made to build the PAC stage significantly depend on the wastewater volume that can be treated in the stage, i.e. whether the total wastewater flow or only a part of the conventionally treated wastewater is led into the advanced treat-

ment stage, thus, whether the system is designed for the total or partial flow. The option to use existing system components, such as sand filters, to extend the system by an advanced treatment stage also provides clear savings. And last but not least, the composition of the wastewater influences the amount of PAC or ozone that has to be added. In this case, especially large volumes of industrial wastewater can boost the costs.

Heavy fluctuation in individual cost items

A detailed analysis of the costs that are to be expected is of great interest for all operators who are planning to build a system that eliminates micropollutants. Especially the capital costs show large differences depending on the system – which is comprehensible in view of the different local and framework conditions. In this case, four systems could be used for a standardised cost analysis: the Ulm-based Steinhäule plant and the wastewater treatment plants in Mannheim, Böblingen-Sindelfingen and Lahr. In these four cases, the capital costs range between 4.9 and 20.6 cent per cubic metre of wastewater. Especially in the case of smaller plants, the capital costs have an overproportionate effect. The operating





Stuttgart-Mühlhausen wastewater treatment plant



Breisgauer Bucht wastewater treatment plant
Pipe system of the sand filtration stage



Lahr wastewater treatment plant, silo containing powdered activated carbon



costs, however, are way more uniform. The calculation of the operating costs also includes the Stockacher Aach and Kressbronn-Langanargen wastewater treatment plants in addition to the four plants mentioned above. The calculation showed a range between 5.7 and 13.5 cent per cubic metre of wastewater. This includes both personnel costs and operating material, such as activated carbon and flocculants, as well as costs for power, disposal, wastewater analyses and maintenance. In this case, individual conditions also play an important role. As a result, between six and eleven grams of activated carbon have to be added per cubic metre depending on the composition of the wastewater, while the costs for activated carbon are subject to strong fluctuation. When using the wastewater volume that is actually treated in the PAC stage as a basis, the cost range is even smaller (between 3.9 and 7.0 cent/cubic metre).

However, the conclusion of the study is what actually matters to the fee payers: they can anticipate extra costs of 8.6 and 20.6 cent/cubic metre per payable wastewater volume. This results in amounts between 2.90 and 7.80 Euro per population equivalent, which equals to approximately four to ten percent of the total annual fees charged. Depending on the framework conditions, future amounts may be higher. However, this comparably small percentage of the current burden of charges on citizens means a significant contribution to the elimination of micropollutants, achieving benefits for the environment:

The conclusion of the study reads: "With these costs, all plants involved achieve an average elimination performance of the monitored substances that exceeds the required 80 percent by far."

Funding: subsidies help

The Ministry of the Environment in Baden-Württemberg funds 50 percent of the costs incurred by feasibility studies and comparable pre-studies related to the elimination. A 20 percent bonus, which is capped at a maximum of 80 percent, is granted for each individual measure taken to eliminate micropollutants, whereas the amount of the funding depends on the applicable water fee.



https://koms-bw.de/cms/content/media/Broschuere%20Langzeitbetrachtung%20Pulveraktivkohlebehandlung_Druck.pdf



Handover of the funding confirmation for the construction of an advanced treatment stage at the Stuttgart-Mühlhausen wastewater treatment plant. From left to right: Fritz Kuhn (former head mayor of the city of Stuttgart) Wolfgang Schanz (retired city director), Franz Untersteller Member of the State Parliament (former Minister of the Environment, Climate Protection and the Energy Sector in Baden-Württemberg), Boris Diehm (Head of the department for wastewater treatment plants and sewer operation, SES)



WHAT DOES THE FUTURE HOLD?

Baden-Württemberg is aiming to further promote the extension of wastewater treatment plants by an advanced treatment stage to eliminate micropollutants. In this context, the focus is on the consensus that the measures taken are of a preventive nature. The aim is to extend wastewater treatment plants especially in locations where this is particularly sensible in favour of protecting water bodies and in close consultation with operators.

Outlook: What are the plans in Baden-Württemberg?

Out of a sense of responsibility towards the environment and future generations, Baden-Württemberg is planning to improve wastewater treatment especially near sensitive water bodies and contamination hotspots. To ensure a targeted extension in accordance with technical aspects, the Ministry of the Environment in collaboration with KomS have defined criteria to be met by extensions of municipal wastewater treatment plants that were equipped with a treatment stage that eliminates micropollutants.

The list of criteria takes the specific situation in Baden-Württemberg into consideration and is consistent with the "Organisational framework for wastewater treatment plants" developed in the Stakeholder Dialogue of the German government. This concept helps achieve a 30 to 50 percent extension rate in the treatment of the federal state's wastewater volume.

Which wastewater treatment plants take priority with regard to an extension?

Wastewater treatment plants that drain their effluent into the following water bodies:

- Lake Constance and its inlets
- groundwater
- a body of water that seeps into the ground temporarily or over the entire year in the case of unfavourable ground conditions such as karst
- water bodies with a wastewater proportion of more than 50 percent of the total flow after drainage in the case of low water level. Small plants – size classes one to three – are usually excluded for reasons of efficiency for the time being.

Regardless of the region and the drainage situation, the future plan is to generally extend large and major plants with a treatment performance of 500,000 population equivalents or more. Thus, autumn 2019 saw the start of the extension of the Stuttgart main wastewater treatment plant, which now includes a treatment stage to eliminate micropollutants.



// Water bodies are highly important as a habitat for a variety of organisms and for ecological balance. By taking prevention into account, we have developed a target in Baden-Württemberg as to which wastewater treatment plants will take priority with regard to extension in future.”

DR ANDRE BAUMANN
FORMER STATE SECRETARY AT THE BADEN-WÜRTTEMBERG MINISTRY FOR THE ENVIRONMENT



Liaison with the water authority

According to current, preliminary results, approximately 125 municipal wastewater treatment plants meet the clear criteria for extension by a system that eliminates micropollutants. Further criteria can be applied in order to review individual cases.

The question which and how many wastewater treatment plants will be extended in the end also depends on other framework conditions. Any other planned construction works on wastewater treatment plants can be used as a reason to review or consider the option of building a system that eliminates micropollutants. In the case of smaller wastewater treatment plants, structural measures are to be primarily reviewed. Synergy effects can be achieved in the course of all potential measures that may be required to further eliminate the concentration of phosphorus. If a wastewater treatment plant meets one of the criteria for the construction of a system that eliminates micropollutants, it makes sense to contact the responsible water authorities and jointly clarify objectives. The actual application forms for funding can also be submitted through the responsible water authorities.

A feasibility study is carried out as a first specific step. The study investigates different technical variants and defines the budget necessary for converting the system. The federal state funds 50 percent of the costs.

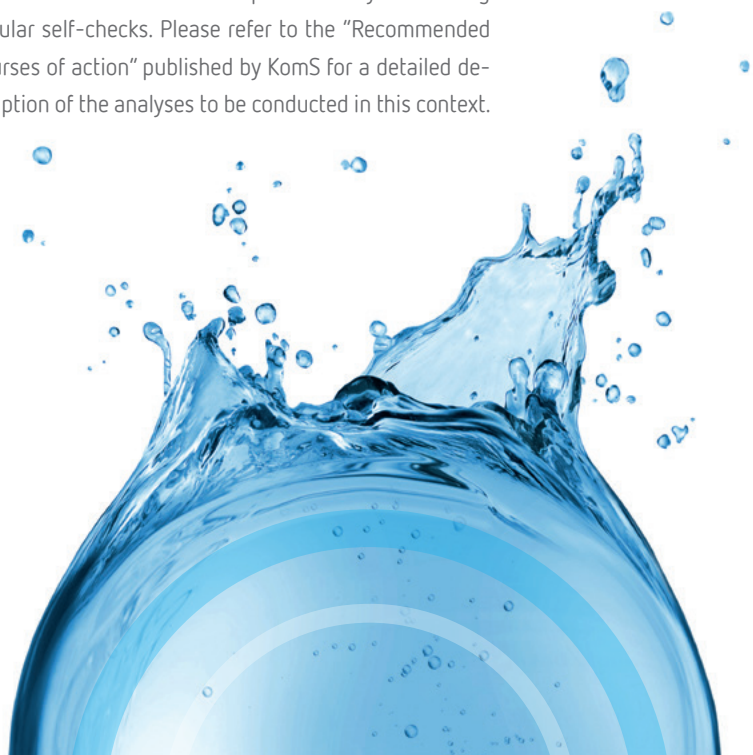
The Ministry for the Environment and KomS have jointly developed a guideline describing the minimum requirements to be met by such studies. The guideline is intended as assistance for engineering consultants when being tasked with conducting such studies.



www.koms-bw.de/cms/content/media/2018-11-20%20Arbeitspapier%20Spurenstoffe.pdf

Functional check during operation

The rule that the environment can only be sustainably protected if the technology works properly also applies to the advanced treatment stage. Thus, funding the conversion also requires monitoring of success and proof of the defined elimination rate. Also during regular operation, it is important to ensure proper operation of the system that eliminates micropollutants by conducting regular self-checks. Please refer to the “Recommended courses of action” published by KomS for a detailed description of the analyses to be conducted in this context.



ELIMINATING MICROPOLLUTANTS

GUIDE ON THE UPGRADING OF WASTEWATER TREATMENT PLANTS

EXTENSION PROCEDURE OF
WASTEWATER TREATMENT PLANTS

CONTACTS

FURTHER
DOCUMENTS

FUNDING IN
ACCORDANCE WITH
GUIDELINES WATER
ECONOMY 2015

1

INFORMATION EVENTS/SHARING OF EXPERIENCE

CONGRESS

1.1 CONSULTATION

- General information → KomS
- Individual consultation regarding the extension of wastewater treatment plant → Engineering company



2

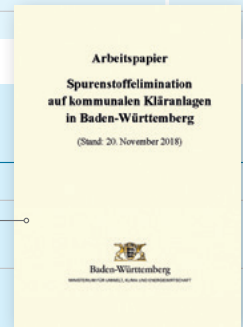
MICROPOLLUTANTS KOMS TECHNOLOGY FORUM

2.1 IDENTIFY MOTIVE

- Voluntary prevention
- To be achieved due to local framework conditions → BW CATALOGUE OF CRITERIA

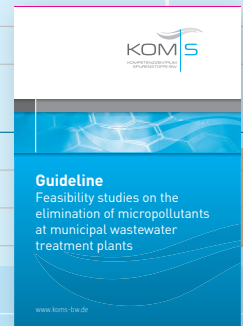
2.2 DISCUSS FUTURE CONCEPT

- Additional treatment requirements (e.g. elimination of phosphorus) → Water authority
- Connection of additional wastewater treatment plants



2.3 FEASIBILITY STUDY

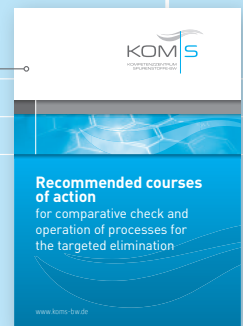
1. Obtain quote
2. Apply for funding
3. Order study



50%

- Results → Engineering company
- Description of the motive
 - Occurrence of micropollutants at the wastewater treatment plant and comparison with survey
 - Review the feasibility of suitable processes
 - Estimation of costs

ADVICE APPROACH
MICROPOLLUTANTS
MEASUREMENT





EXTENSION PROCEDURE OF
WASTEWATER TREATMENT PLANTS

CONTACTS

FURTHER
DOCUMENTS

FUNDING IN
ACCORDANCE WITH
GUIDELINES WATER
ECONOMY 2015

3

INFORMATION EVENTS/SHARING OF EXPERIENCE

CONGRESS

MICROPOLLUTANTS KOMS TECHNOLOGY FORUM

SPECIAL MICROPOLLUTANTS NEIGHBOURHOOD



3.1 PLANNING RESOLUTION

3.2 CONTRACT AWARD FOR PLANNING

1. Commissioning of engineering office to handle a procedure according to the German Regulation for the Award of Public Contracts (VgV)
2. Tender the planning service
3. VgV process
4. Award the planning service

3.3 PLANNING SI 1 – 4

- Identify fundamentals
- Pre-planning
 - Select process
 - Estimate costs
- Draft planning
 - Cost calculation
- Approval planning

Engineering company



3.4 APPLY FOR FUNDING

- Water Economy Funding Guidelines 2015:
 - Submit by 1st October of the year before the project is to start

Water authority

Guideline by the
Ministry of the
Environment on the
funding of water
economy projects

(Water Economy Funding
Guidelines 2015 –
WEFG 2015)

Of 21 July 2015 –
Ref. 5-8907.00/5

Funding
20 %
max. up to 80 %

3.5 RECEIPT OF FUNDING CONFIRMATION

3.6 IMPLEMENTATION SI 5 – 8

- Construction planning
- Prepare award process
- Involvement in the award process
- Object monitoring

Water authority

Engineering company



MEASUREMENT OF MICROPOLLUTANTS PRIOR TO THE EXTENSION



4

4.1 STARTING OPERATION 1

- Optimisation phase 1 Test
- phase "Regular operation"

MEASUREMENT OF MICROPOLLUTANTS
OPERATION DOCUMENTATION



Recommended courses
of action for comparative check
and operation of processes for
the targeted elimination of
micropollutants

www.binnw.de

