Fibre balls in the fight against micropollutants

Festo is automating the world’s first plant featuring Fuzzy Filters® for removing microplastics and medication.

Each year, 8,000 tons of pharmaceutical products and 10 tons of microplastics alone end up in Germany’s largest river, the Rhine. Conventional wastewater treatment plants will always struggle to deal with such large quantities of micropollutants. That is why the town of Barntrup in the German state of North Rhine-Westphalia added a purification stage for micropollutants to its wastewater treatment plant – a world first using Fuzzy Filters® from Bosman and automated with pneumatics from Festo.
These micropolllutants or trace substances have been shown to have significant consequences for the environment. For example, certain beta blockers, anti-epileptic drugs and contraceptives cause damage and changes to the organs, sexual characteristics and behaviour of fish if they get into the water. Scientists are currently studying how they damage the human organism.

**Activated carbon as a basis**

For the most part, microplastics measuring five micrometres to five millimetres and trace substances can only be removed in a fourth purification stage. This is achieved by adding activated carbon powder to the water in a contact tank. The activated carbon with its porous and crumbly structure has a large internal surface area. In physical terms, one teaspoon of activated carbon powder has the same surface area as a football pitch. This surface area provides lots of room for the trace substances to accumulate. The activated carbon-enriched water is therefore kept in the contact tank for 15 to 20 minutes.

In conventional plants a further tank, called a sedimentation tank, is required to remove the activated carbon from the water after this purification process. The activated carbon falls to the bottom of the tank and, together with the attached trace substances, is later separated with the sewage sludge and burned. Apart from the contact tank for activated carbon treatment, a bigger investment in a large sedimentation tank that takes up a disproportionately large amount of space is also required. Measurements have revealed that this method removes 80 per cent of the pharmaceutical residues and X-ray contrast agents from the wastewater. Wastewater treatment plants without this fourth purification stage only hold back around 30 per cent of the trace substances collected.
Elimination of 95 per cent
Removing 80 per cent of the micropollutants was still not enough for the town of Barntrup, especially since the purified water can get into a drinking water catchment area via a river network. “That’s why Barntrup opted for the world’s first purification system with Fuzzy Filters® from Bosman Watermanagement,” explains Frank Waermer, Managing Director and consulting engineer of the Detmold-based engineering office Danjes. “With this filter system we can eliminate as much as 95 per cent of all trace substances and also remove microplastics and phosphorus from the wastewater.” Danjes planned the entire system and coordinated its implementation.

“The core of the filter system is the Fuzzy Filter® balls,” says Dr Kathrin Gantner, Office Manager at Bosman Watermanagement GmbH in Berlin. Bosman is the manufacturer that makes the filters and flocculators. The Fuzzy Filter® balls are made from synthetic fibres and shaped into a sphere with a diameter of around 33 millimetres using a clip. The high porosity and low density of the medium ensure that a Fuzzy Filter® system can absorb at least two to three times the amount of filtratable solids as sand or cloth filters – a true wonder fibre in the fight against micropollutants.

Around and through
Unlike conventional filter systems, the liquid to be filtered flows both around and through the filter material and not along the medium, as with sand filters. The suspension to be filtered flows into the distribution chamber under the filter bed. In the distribution chamber, the inflowing water is evenly distributed over the filter surface before it flows through the lower fixed perforated plate and into the filter bed. The micropollutants absorbed by the activated carbon as well as the

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phosphorus and microplastics that fell to the bottom of the tank are collected in the filter bed and the filtered water flows back out the top of the Fuzzy Filter®.

As soon as a specified turbidity value or predefined maximum pressure is reached in the filter bed, a backwash cycle is started. Backwashing involves pumping raw water into the filter while an external fan blows in purge air to set the filter medium in motion. The filter balls, which move freely between the perforated plates, are set into motion by the air flow as if in a dance; contamination particles adhering to and stored in the filter are thus loosened and flushed out.

The activated carbon is pumped back into the aeration tank with the backwash water and a further purification process is started, since the activated carbon may still be holding micropollutants after the first flushing cycle. After one purification cycle, the amount of trace substances is reduced to a fraction. “This process can be repeated several times, which means that the Fuzzy Filter® method from Bosman can render many more micropollutants harmless than the single-step activated carbon method. With this method, the activated carbon is combined with the sewage sludge in the sedimentation tank after just one purification cycle and removed,” explains Gantner.

**Automation made easy**

The butterfly valves and gate valves, which allow the wastewater containing the micropollutants to flow in and the purified water to flow out, are automatically opened and closed using the quarter turn actuators type DAPS as well as linear actuators DLP – all pneumatic. Other butterfly valves and gate valves in combination with the pneumatic actuators mentioned supply the purge air and close the sludge outlet. Automated gate valves are also used in the small pumping station that pumps water from the biological clarification stage into the fourth purification stage.

The torque for the quarter turn actuator DAPS is generated via a scotch yoke mechanism to overcome the high breakaway torques of the process valve. The sturdiness and torque graduation add a level of safety to process valves with a rotation angle limited to 90° such as ball valves and butterfly valves. The pneumatic linear actuators DLP act directly on the slide plate and enable the butterfly valves and gate valves to be reliably opened/closed and precise positions to be achieved too.
Pneumatics in wastewater technology
The modular valve terminals MPA with multi-pin control the actuators. These valve terminals as well as the service units from the MS6 series are securely protected in ready-to-install control cabinets supplied by Festo. “As we have seen in many of our projects, pneumatic components from Festo are characterised by a high level of sturdiness and reliability,” says Waermer. “Pneumatics is always our first choice over electric solutions for our water and wastewater projects, because pneumatic components are much less expensive and much more compact than electric ones. On top of that, they have built-in explosion protection and can be operated for a certain amount of time using their compressed air reservoir even in the case of a power failure.”

“Festo expert Winfried Plaßmann gave us a lot of support when planning and executing the project, and was very generous with his expertise and time,” adds Hermann Klippenstein, manager of Barntrup’s wastewater plant. “It wasn’t just the reliability and integrated nature of the pneumatic systems, including connection to the process control system, that impressed us, but also the dependability of the advice we received,” says Waermer.

Fuzzy Filter® balls in use: the high porosity and low density of the medium ensure that a Fuzzy Filter® system can absorb at least two to three times the amount of filtratable solids as sand or cloth filters.

Fibre balls in the fight against micropollutants: the Fuzzy Filter® balls are made from synthetic fibres and shaped into a sphere with a diameter of around 33 millimetres using a clip.

Activated carbon in the contact tank: with its porous and crumbly structure, it has a large internal surface area. This is where the micropollutants accumulate.
About Festo:
Festo SE & Co. KG is a global player and an independent family-owned company with headquarters in Esslingen am Neckar, Germany. The company supplies pneumatic and electrical automation technology to 300,000 customers of factory and process automation in over 35 industries. The products and services are available in 176 countries.

With about 21,200 employees in over 250 branch offices in 61 countries worldwide, Festo achieved a turnover of around €3.2 billion in 2018. Each year around 8% of this turnover is invested in research and development. In this learning company, 1.5% of turnover is invested in basic and further training. Yet training services are not only provided for Festo’s own staff – Festo Didactic SE also supplies basic and further training programmes in the field of automation technology for customers, students and trainees.