GKD: Breaking new ground in the analytics of microplastic

Fractionated filtration with stainless steel mesh

To prevent microplastic loads, research, industry and waste water management are relying ever more heavily on an innovative metal mesh from GKD – Gebr. Kufferath AG (GKD). With their ODW 6 optimized dutch weaves, the leading international technical weavers developed a stainless steel mesh that sets unparalleled standards for flow rate and retention. The company owes its reputation as a proven solution partner in the fight against plastic particles smaller than five millimeters in drinking water and outlet water to its successful project management in the research project OEMP *(Optimized materials and processes for the removal of microplastics from the water cycle)*.

In 2014, Germany's Federal Ministry of Education and Research (BMBF) initiated the program *Materials for a sustainable water industry – MachWas*. As one of the largest research programs in the world in this area, it supports 13 projects for minimizing water consumption, maximizing water availability and developing technologies for water treatment and catchment. The aim is also to research the origin, distribution and effects of microplastics and have sustainable solutions developed to avoid their entry into bodies of water by 2021. The OEMP project (2016 to 2018) focused on identifying the rates of microplastic in the different wastewater streams and developing suitable prevention strategies. Three different paths of ingress for microplastics into the urban water industry were investigated: treated wastewater from a sewage treatment plant, mixed water overflow from the urban sewage system and street runoff water. As there are more than 200 types of plastic, and microplastic particles differ greatly in size, shape and chemical

composition, the investigations were restricted to the most frequently occurring thermoplasts: polyethylene (PE), polypropylene (PP), polystyrene (PS), polyamide (PA) and polyethylene terephthalate (PET). In order to characterize the microparticles, a sampling procedure was developed with fractionated filtration through stainless steel sieves. Here too, the optimized dutch weaves from GKD proved to be the best solution during the course of the project. This mesh type was the basis of the research mandate for GKD within the OEMP. The optimized dutch weaves with a geometric pore size of 10 µm already tried and tested in the water industry needed to be further developed to ensure the retention of microplastics with an absolute filtration rate of 6 µm. Mesh designs with this pore size already available on the market were not suitable for the high volumetric flows of the water industry. Optimized dutch weaves from GKD are characterized by significantly more and finer weft than warp wires. This construction is the reason for the smooth, closed surface and robust mechanical strength of this mesh type. The apertures of the slot-shaped pore geometry are smaller in the mesh surface than within the mesh. This enables them to deliver excellent particle retention and a significantly higher flow rate with the same opening. In addition, the single-ply construction offers a high dirt-holding capacity and good regenerability. Furthermore, the stainless steel mesh does not cause any contamination through process-related plastic abrasion – unlike the plastic media that have mostly been used in wastewater treatment previously.

Challenging development process

Based on the existing mesh design of the ODW 10, GKD developed the design of the weave with the assistance of computers. The required permeability of 6 µm was determined using numeric flow simulation. However, the real challenge began when it came to putting the mesh into production. The first task was to find a supplier to develop and produce the

wire designed specifically for the application. This innovative, extremely clean and particularly ductile stainless steel wire had to exhibit the relevant diameter as well as consistent material properties over the complete length of the wire. In close collaboration with the wire supplier and in intensive test series, it took a year to develop this wire. It took a further year until GKD was able to process this extremely fine wire reliably. Despite possessing the world's leading weaving technology, it proved exceedingly challenging to adapt the machine technology – wire feed and sensor system – to the specific wire properties. Following many setbacks and revisions to the design, it was finally possible to permanently stabilize the production cycle for the new stainless steel dutch weave with a pore size of 6 µm in line with the formula specified by the German Institute of Mechanical Process Engineering (IMVT). GKD also had to break new ground with the measuring technology for inspecting selectivity, as a 6 µm pore is very difficult to measure with the conventional glass bead test. Using a procedure developed in-house, which determines the bubble point with the help of CFD simulations, GKD can determine every pore size quickly and reliably. When using ODW 6, plant operators can therefore rest assured that it removes all spherical particles above the separating limit of 6 µm.

Pioneering comparative tests of filter media

In parallel with the complex development work for this precision mesh, GKD supported OEMP project partner TU Berlin with the in-situ tests for comparing two filter systems with different filter media. The object of the investigation was the runoff water from the Ruhleben sewage plant in Berlin. This sewage plant treats the wastewater from up to 1.6 million population equivalents, working according to the activated sludge process with denitrification and biological phosphorous elimination. In dry weather, the daily cleaning capacity is 247,500 cubic meters and when it rains, 600,000 cubic meters. For the comparative tests by TU Berlin, a Mecana drum filter

system and the prototype of a new disk filter system from Invent were used. While the 16 filter frames of the disk filters were screened with optimized plain dutch weaves from GKD, the drum filter used pile fabric and microfiber filter media. In order to create valid comparative values for the plain dutch weave, the disk filter was fitted successively with ODW 20, ODW 8 and ODW 6. With the ODW 20, the dirt load of the water taken from the outlet of the sewage treatment plant was reduced from six to two milligrams per liter. At the same flow rate, the ODW 6 reduced the dirt load of the outlet water by a further 50 percent to a content of one milligram per liter. The ODW 6 reached these excellent filtration rates in the micro-filtration range with a maximum throughput of 110 cubic meters per hour. In regular operation, they processed 50 cubic meters of water per hour. Altogether, 79,000 cubic meters of sewage treatment plant outlet water were treated with this precision mesh. Although the cloth filters on the drum filter system delivered marginally better separation performance than the disk filters, the ODW 6 made a better overall impression on the researchers. What convinced them was the sharp separating limit of the GKD sieves with the geometric pore size of 6 µm. As cloth filters are made of a tangle of fibers, they do not have a defined pore size and therefore do not allow reliably reproducible statements to be made. With a view to achieving as broad a spectrum of application in practice as possible, the ODW 6 also impressed with its universal usability: All disk filter systems – including those already available in sewage plants – can be fitted with this filter medium.

Use in research and practice

The ODW 6 also proved what their extraordinary range of properties could do as a laboratory material in the OEMP project: Both the German Federal Environmental Agency and TU Berlin selected them for their laboratory applications. A higher federal authority, namely the German Federal Institute for Materials Research and Testing (BAM), also employed this mesh type for

investigations into microplastics. Which is why GKD was involved in two other collaborative research projects – RAU *(Tire abrasion in the environment)* and RUSEKU *(Representative investigation strategies for an integrative understanding of systems used for specific entry of plastics into the environment)* – as a development partner in the context of microplastic analytics. During the RAU project, GKD developed a sampling basket that is used in conventional street drains instead of the usual leaf collecting baskets. Using an integrated filter cascade, it can specifically fractionate the particulate material in street runoff water. This property makes it a key element of the analysis instruments used to sample the entire flow of matter from a rain shower for the first time during the RAU project. This was not possible with the established sampling procedures in place at the time.

Looking back, GKD sees its project participation in research programs of this size as an important experience that opened up new prospects for the company. Its active collaboration in new areas of development for mesh and the interdisciplinary exchange in the project consortium resulted in various other impulses for interesting innovations. Plus, the attention that the projects received in the scientific arena justified GKD's reputation as an expert research partner and solution developer in the field of microplastics. This expertise is confirmed by numerous inquiries from research institutes, colleges and industry representatives on the subject of analyzing the retention of microplastic particles.

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GKD – WORLD WIDE WEAVE

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WORLD WIDE WEAVE

Industrial Mesh (woven metal mesh and filter solutions), Process Belts (belts made of mesh and spirals), Architectural meshes (façades, safety and interior design made of metal fabrics) and Mediamesh® (Transparent media façades). With its headquarter in Germany and five other facilities in the US, South Africa, China, India and Chile – as well as its branches in France, Spain, Dubai and worldwide representatives, GKD is close to markets anywhere in the world.

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