Cathode air purification in fuel cell systems

Talamon has developed advanced adsorptive media for cathode air filters

Fuel cell technology is widely considered as a key enabler of zero-emission mobility, in both the automotive and aerospace industries. Especially in applications requiring long ranges and short refueling times, hydrogen fuel cells offer significant advantages over battery-electric drives. However, large-scale adoption still faces considerable technical challenges.

INTENDED LIFETIME

One of the most critical requirements is the intended lifetime: for automotive use, a lifetime of at least 25,000 operating hours is expected, while aerospace systems often demand even higher endurance. To achieve these targets, the fuel cell must be not only mechanically robust and thermally efficient but also reliably protected against external influences. The quality of the supply air is particularly important.

Even traces of airborne contaminants in the ppb range can cause irreversible performance degradation and permanent damage to the sensitive cathode catalysts and membrane. Effective air filtration is therefore essential to ensure the long-term operation and lifetime of the fuel cell. The development of special filter media that reliably retain molecular impurities under real operating conditions is therefore a key issue for the successful use of this technology in the mobility sector.

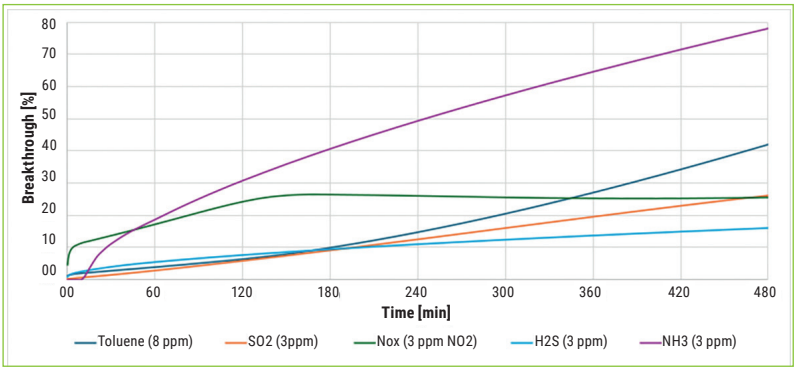
ADSORPTIVE FILTER MEDIA

In order to effectively protect the sensitive components of the fuel cell from pollutants, Talamon GmbH has developed two adsorptive filter media, specifically tailored to the requirements of cathode air filters.

The filter media are based on specially modified activated carbon engineered in multilayer structure with optimized functionality. Targeted chemical modifications of the surface have significantly improved the adsorption properties against critical pollutants such as sulphur dioxide (SO_2), hydrogen sulphide (H_2S) and nitrogen oxides (NOx).

PERFORMANCE EVALUATION

The performance evaluation was carried out under realistic conditions: 8-hour exposure at 23°C, 50% relative humidity, and low ppm-level contaminant concentrations. These test scenarios are designed to reflect real-world exposure patterns in the ppb range.



Left: *(Figure 1) Breakthrough behavior over time of various airborne pollutants at 23°C, 50% RH and an inflow velocity of 0.1 m/s with Δp of 8 Pa on medium 109888*

Above: *Example of a complex media structure*

The breakthrough behavior over time for various pollutants is shown in Figure 1 below. Due to the catalytic conversion of NO2 to NO, both components are summarised under NOx.

The second-generation material, Product 109888, was designed to improve removal efficiency for highly critical sulfur compounds and toluene. This performance enhancement was achieved alongside a reduced pressure drop. However, this medium exhibited lower capacity for ammonia and higher breakthrough levels of nitrogen oxides, primarily due to increased formation of nitrogen monoxide within the filter medium.

The next stage of development will focus on the targeted combination and further development of the existing material systems. The aim is to integrate high loading capacity, low pressure drop, and highly selective pollutant binding into a new generation of filter media.

COMPLEX MEDIA CONFIGURATIONS

Thanks to flexible manufacturing, Talamon can economically produce even small batch sizes. This allows for the realization of complex media configurations (see above) tailored to specific customer requirements.

ABOUT THE AUTHOR

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