CELLULOSE FILTER MEDIA MODIFIED BY AEROGEL APPLIED FOR REMOVAL OF DISPERSED WATER FROM DIESEL FUEL

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In order to reach high-quality requirements for diesel fuel, new filtration techniques and separation materials are continuously being developed. The diesel filtration problems observed in recent years result from a change of fuel composition due to environmental concerns. In addition, parameters defined in standards for fuels are adjusted to meet requirements of common rail injection systems, which means that diesel completely free of water and solids is expected.

The common filtration method is a single stage separation filter having a hydrophobic material which is a barrier for dispersed water droplets and at the same time enables the oil to pass through its pores. Due to a simple design, compact size and relatively low cost, cellulose based filters are widely applied in vehicles to protect the engine.

Presented work is focused on modification of cellulose filters surface in order to make more hydrophobic material and decrease water drop adhesion to its surface. Proposed modification method includes direct deposition of gelating aerogel solution on filter surface by spray coating. The aerogels synthesized using methyltrimetoxysilane (MTMS) precursor show promising properties such as large specific area, strongly hydrophobic and at the same time oleophilic properties. The modification parameters such as volume ratio of MTMS/solvent, gelation grade and volume of the modifying solution on the obtained structure and surface properties was taken into account. The original unmodified material was used as a reference material to verify effects of modification.

To characterize the properties of separation materials, measurements of static contact angle (CA) and sliding angle for water droplets were carried out using the goniometer equipped with a tilting base. Moreover, the structure of modified material surface was verified using Scanning Electron Microscopy (SEM).

The materials characterized with high contact angle and low sliding angle were selected for full-scale modification. The separation performance was verified in water separation experiment in the test rig of diesel filters. For this purpose, the cellulose based pleated separator was constructed. During the tests commercially available, low sulfur diesel fuel was used. Testing procedure was based on the SAE J1488 standard test method, however not all parameters defined in this standard were followed. Pressure drop, flow rate and total water concentration on the inlet and outlet (measured by coulometric Karl Fischer method) were determined and recorded during the test time.

The conducted research shows the influence of aerogel deposition parameters on aerogel structure and final surface properties of cellulose separation material. Due to strongly oleophilic properties of aerogel, the separation mechanism relay on water droplets and oil film interaction instead of interactions with material surface. It means that capillary force is determined by oil/water interfacial tension. Additionally, obtained results indicate difficulties in surface coalescence of water droplets because of surfactants presence. As a consequence, water drainage from separator surface seems to be slower than water droplets deposition causing increase of pressure drop during separation process.

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