Composite suction filter with a laser-welded suction tube and the newly developed V-Pore97 filter media

Smart filtration for automatics

Innovative high-performance filtration systems, designed using exclusive flow simulation software, can remove small to ultra-small particles, thus ensuring the long-term reliability of automatics

The ability of automatic transmissions to operate reliably over many years is critically dependent upon the purity levels of the transmission fluid that is employed. To ensure such purity, integrated filters that remove small to ultra-small particles from the oil flow in a closed loop have become a vital necessity. The Filtran group (SPX and IBS Filtran) has evolved into an established producer of such high-performance filtration systems because of the company's determination to actively address transmission manufacturers' growing demands, and to respond with innovative research developments. Current examples demonstrating this commitment include the new CombiMedia filters, and the use of exclusive and advanced flow simulation software aimed at determining design-related filtration performance.

Demands for enhanced transmission performance, superior shifting convenience and improved environmental compatibility are the core challenges faced by the makers of automatic and semi-automatic transmissions today. Transmission developers respond to these needs by introducing new and easily recyclable materials, more efficiently sized designs, increasingly sophisticated control systems, and innovative transmission solutions. Examples of the latter include continuously variable transmissions (such as Audi's Multitronic) or dual clutch transmissions (such as VW's DSG). In addition, a continuous increase in the number of speeds of stepped automatic transmissions can be observed in the market (such as Daimler's 7G-Tronic and ZF's 8HP system).

Unlike manual-shift gearboxes, automatic transmissions possess an oil circuit that not only lubricates and cools the various components, but also supplies the fluid medium for the specific hydraulic transmission control system. The latter comprises highly sensitive parts that need to be protected from contamination by foreign matter and other impurities. This is ensured by means of filter systems designed to maintain the transmission in its proper operating state throughout its service life.

Filter system manufacturers have to adapt their product development to altered boundary conditions. Their products must not only withstand higher operating temperatures and more aggressive oil types, they should use minimum space when performing their functions. The system should cause less differential pressure, provide enhanced dirt hold capacity, and deliver maximum filtration efficiency. Filtran has managed to devise new filter concepts that offer advantages in terms of all three of these parameters.

In the past, filtration relied exclusively on the use of suction oil filters operating as a full-flow filter in the oil circuit, upstream of the pump. This design requires the use of a fairly open-pored filter material to ensure an adequate oil supply even at very low temperatures. Today, additional pressure oil filters are employed to achieve higher oil cleanliness levels. Such filters are arranged in a partial flow in the oil circuit, typically in the cooler line, and are commonly equipped with a bypass valve. Since the differential pressure across the filter is of secondary importance, a high-efficiency filter medium can be selected.

As space is at a premium at the filter mounting site, which is specifically below the automatic transmission's control valve housing, suction oil filters must be of a flat design. The filter medium, which is typically a needle-punched non-woven fabric, will usually be a single-layer type, configured into a bag-shaped or planar-pleated element. As a depth filtration material, needle-punched non-wovens offer service life gains over mere surface filtration media such as woven fabrics. Pressure oil filters, on the other hand, are usually designed as a round filter element comprising the filter medium in the form of a zigzag-folded, pleated strip.

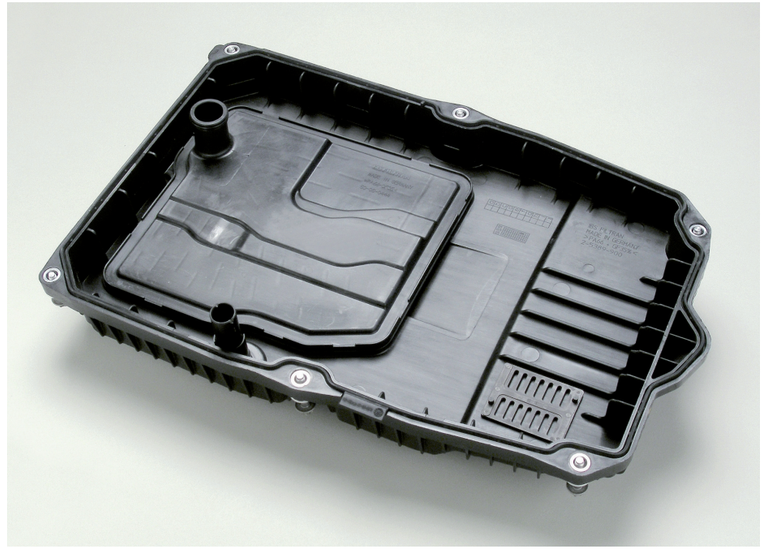
New developments by Filtran include the CombiMedia suction filter that combines different filter media in one housing. In comparison to conventional suction oil filters, the oil cleanliness levels achievable with this product are markedly higher so that in some applications, there is no need for an additional pressure oil filter. This saves mounting space, and reduces the number of parts and therefore the overall cost as well.

The triple demands for high separation efficiency (to achieve high oil purity and a small critical particle size), high dirt absorption capacity (to extend the maintenance intervals and filter service life) and high functional reliability at low differential pressures, play a key role in filter rating and design. Although separation efficiency and absorption capacity are dependent mainly on the choice of filter medium, the differential pressure produced by a given filter is directly contingent on the design of the filter housing. This makes it mandatory to optimize the fluid dynamic properties of the housing.

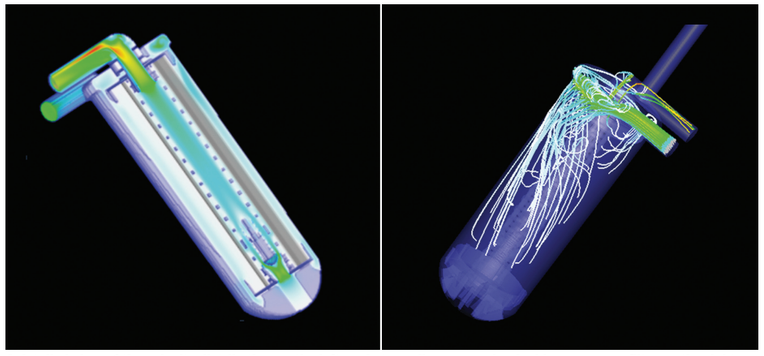
Using the SuFiS computational fluid dynamics (CFD) software developed by Filtran in cooperation with the Fraunhofer Institut Techno und Wirtschaftsmathematik (ITWM), the company is able to generate a meshed 3D model of each filter that can then be used to render internal flow conditions quickly and easily visible as a function of diverse parameters. The design and rating of the filter can therefore be optimized at a very early stage in the engineering process, resulting in a shortened development cycle for a new filtration system.

Such PC-based modeling not only provides a visualization of flow conditions, but also enables the user to calculate the differential pressure drop as a function of the volumetric flow rate. As a result, the modeling allows engineers to optimize the effectiveness of the filter. Together with ITWM, Filtran is already working on a refined and upgraded version of the SuFiS software that will enable simulation and monitoring of the filter efficiency and dirt-hold capacity performance parameters.

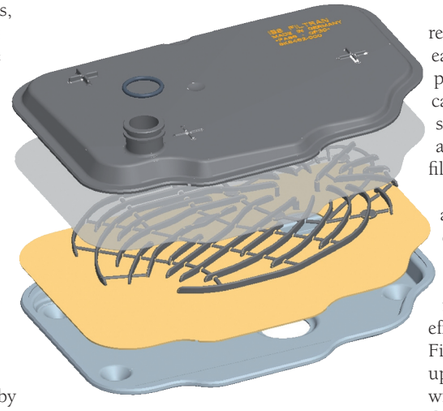
Although CFD simulations will not be able to replace practical filter testing altogether, they provide Filtran with an exceedingly useful development tool that facilitates cost-efficient design and the rating of advanced filter systems for automatic transmissions of all design sizes and performance categories, and reduces development time. TTI



The full plastic oil pan for a typical automotive application with an integrated suction filter and a filling system



A detailed view of the velocity distribution on the left, and streamlines occurring inside a pressure filter on the right



Structure of a CombiMedia suction filter: filter housing upper cover, full-flow screen mesh, rib tray as spacer, partial-flow fine filter medium, filter housing bottom pan