

FLUDICON
FLUID DIGITAL CONTROL

**2009 European Automotive Advanced Suspension Technologies
Excellence in Research Award**



“We accelerate growth”

2009 European Automotive Advanced Suspension Technologies Excellence in Research Award

Award Description

Frost & Sullivan's Excellence in Research Award is bestowed upon a company that has carried out new 'disruptive' research; and has, in general, a strong commitment to research and development. This award recognizes a company's research and development program that has or is expected to bring significant contributions to the industry in terms of adoption, change, and competitive posture. The fruits of this research may already have or will potentially impact certain market sectors. The award also recognizes the company's overall research excellence as well as its commitment toward differentiating itself based on science-backed services or solutions.

Research Methodology

To choose the award recipient, Frost & Sullivan's analyst team tracks research and innovation in key hi-tech markets. The selection process includes primary participant interviews and extensive primary and secondary research via the bottom-up approach. The analyst team shortlists candidates on the basis of a set of qualitative and quantitative measurements. The analysts also consider the pace of research and technology innovation, and the significance or potential relevance of the research to the overall industry. The ultimate award recipient is chosen after a thorough evaluation of this research.

Measurement Criteria

In addition to the methodology described above, there are specific criteria used to determine the final rankings. The recipient of this award has excelled based on one or more of the following criteria:

- Number or type of research projects
- Significance of research in the industry, and across industries (if applicable)
- Absolute R&D expenditures (vis-à-vis industry norm), and % growth (if applicable)
- Calibre/reputation of research staff
- Potential of products of research to become industry standard(s)
- Breadth of intellectual property ownership (patents, scientific publications, papers in peer-reviewed journals, etc.)



Frost & Sullivan presents to Fludicon GmbH the “2009 European Automotive Advanced Suspension Technologies Excellence in Research Award” for its successful research and development efforts in Electrorheology and Electro-Rheological Fluid (ERF) based damping systems. Fludicon was founded in 2001 as a spin-off from the Schenck AG (Dürr Group) in Darmstadt, Germany. The company is presently financed by a group of European investors under the leadership of Munich Venture Partners.

At the forefront of ERF technology and ERF-based applications, Fludicon is a promising upcoming company that exhibits both the technical know-how and manufacturing capability to supply components or complete systems to tier 1 and tier 2 automotive suppliers in the European market as well as to industrial users. The company has made great advances in the development and optimization of ERF that can be used in controllable dampers that have high force authority and fast response, are economical to own and operate, and are highly compatible with a wide range of applications.

Smart Technology – The Competitive Advantage

Fludicon’s ERF-based controllable dampers offer many advantages over dampers controlled by electro-mechanical valves. They are simpler in design and offer manufacturing cost advantages as well as higher reliability. Dynamic response is faster, and tuning is a simple matter of software parameter adjustment.

Also, compared to other technologies which work on a similar principle, e.g. Magneto-Rheological (MR) fluid-based dampers, Fludicon’s ER dampers have superior attributes. The Fludicon ERF (RheOil®) is unique as it contains soft polyurethane plastic particles. These polarizable particles align to form chain-like structures on application of an electric field, resisting the fluid flow and thus producing the required damping. The non-abrasive nature of the fluid (unlike MR fluid) is fully compatible with the materials and manufacturing processes used in standard passive dampers and does not require expensive materials and surface treatments (such as chrome plating of the cylinder/piston sliding surfaces). Furthermore, simple blow-off or one-way valves typically used in passive dampers can be easily integrated into the design for additional flexibility in the tuning of its force characteristics. The use of many standard parts enables a flexible design of comparatively low cost.

Low density is another advantage of the Fludicon ERF. RheOil has a density of 1.04 (kg/L) against magnetic fluids of 2.5 to 4.0 (kg/L). Due to the low fluid density, Fludicon’s ER dampers have a weight advantage of over 3 kilos lighter per car. This reduces the un-sprung mass, thereby improving the ride and handling of the car. The low weight also indirectly improves fuel economy.

Another key advantage of Fludicon ERF is its controllability. The ERF is controlled electro-statically and the response is much faster than other systems available in the market. ER fluids do not use magnetic field and hence do not suffer from the phenomenon of eddy currents, which slow down the response time of the damper. Similarly important, the ER effect is completely reversible, as the fluid particles do not exhibit any electric charge memory phenomena (in contrast, MR fluids exhibit some permanent magnetization effects that cause a stiffening of the damper). The low fluid density and fast electrical field activation and discharge, in combination

with a more rapid fluid reaction, increase speed of response in comparison to MR fluids. Fludicon claims that the dynamic response of its ER damper is three to five times faster than that of competing dampers.

Application Compatibility Across Industry

Fludicon's research on ER fluids and dampers has generated patented designs that are highly compatible with various applications across domains such as automotive, industrial, material handling and transport, rehabilitation and exercise equipment. Fludicon's RheOil can be used in dampers of various designs and dimensions for a broad range of applications where the ability to rapidly and electronically control the damping offers a competitive advantage. For example, in addition to automotive suspensions, Fludicon dampers are used in vibroisolation systems of industrial equipment, drilling and stamping machines, conveyor belts, automation units and robotics. Another primary area of application is physical rehabilitation and fitness machines in which the dampers are currently used to provide consistent and programmable levels of effort based on exercise regimens prescribed by the therapist.

Strong Research Workforce

Fludicon has a highly dedicated workforce of 26 persons, contributing to the lean and healthy structure of the organisation with strong fundamentals and high-quality human resources. The critical fluid development area comprises a team of five personnel of which two are PhD holders, two are chemical engineers and one is a support technician. With regard to fluid development, Fludicon's research in continuously refining the fluid has resulted in the development of RheOil, which consists of polyurethane particles (micro spheres with a mean diameter of approximately 5 micrometers) dispersed in silicone oil. RheOil combines the outstanding long-term properties of homogeneous ERF's together with the much better ER performance (faster response and larger yield stress) of particle-based ERF's. Fludicon achieved this unique combination of the best properties of homogenous and inhomogeneous classes of fluids through the development of a chemically attached emulsifier which equalises the surface energy of the particles (hydrophilic) as well as the surrounding fluid (hydrophobic). In developing RheOil, Fludicon concentrated on a very low base viscosity (30 mPa.s) of dispersion together with a reasonably good yield stress to get a good turn up ratio (approximately 20) over a broad range of temperatures. The low base viscosity also allows for a compact design of fast moving devices like car or industrial dampers.

On the application side, the company has about 15 engineers and technicians who strive to introduce new applications in industry, fitness and rehabilitation, and automotive (passenger cars, light commercial vehicles, military vehicles, motorcycles, bicycles, etc.) sectors.

Fludicon engineers the control electronics in-house and has developed a family of controllers which can be combined with the ER dampers for any given application requirement. Miniaturization of the electronics is well under way, as is conformity with all relevant application specifications.

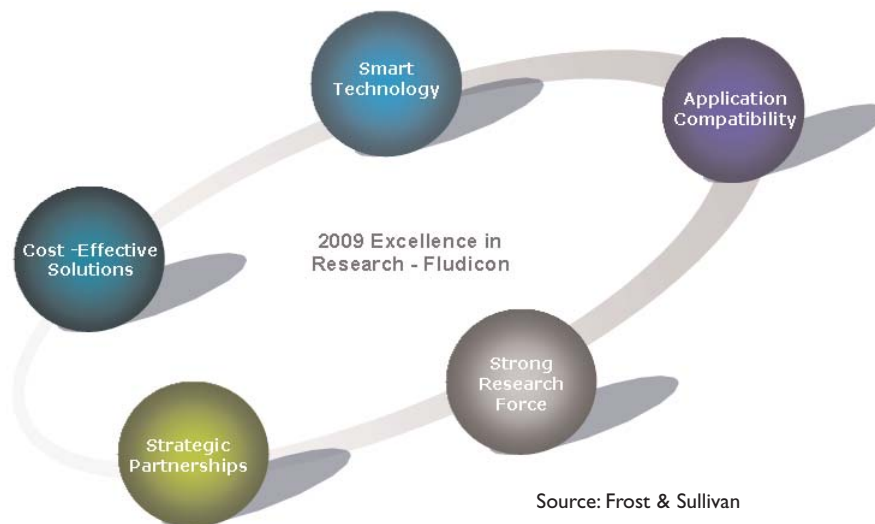
As a system provider, Fludicon has also developed and continues to nurture its own expertise in the field of control strategies and algorithms – thus covering all aspects of the ERF-based systems technology to provide customers with ready-to-run solutions. Fludicon possesses over 65 patents in the areas of ER fluid and its manufacturing process, damper design, control strategies, high-voltage power supplies as well as many applications where controllable damping is required.

New Market Penetrations through Strategic Partnerships

Fludicon is set to commercialise its ER fluid and ER dampers for production vehicles in 2010 with the introduction of its eRRide® semi-active suspension system. Initially, eRRide will be available in emergency vehicles (ambulances) and will from there spread throughout the light commercial vehicle market due to its obvious ride and handling benefits. The company expects to have an early-entry advantage as not many participants are in this segment. Another new area of application that Fludicon intends to penetrate is the motorcycles segment. Fludicon's ER dampers will help mitigate the dangerous "highsider" manoeuvre whereby a rider loses control after the rear suspension is suddenly compressed and then rebounds, throwing the rider off the bike. The company is studying ways to mitigate this suspension behaviour through its dampers by controlling suspension compression and rebound in these cases. Furthermore, Fludicon initiated work on a Military Vehicle Controlled Suspension Program for the German federal armed forces in 2004 and successfully concluded the project on military 5-ton off-road trucks in the first quarter of 2008. In the passenger car segment, the company is currently exploring opportunities with luxury car manufacturers that offer semi-active suspension systems. Fludicon fully expects its eRRide system to equal or outperform present suspension systems and is presently conducting a benchmarking study. These activities will reduce the time-to-market when the automotive industry recovers from the current economic crisis. Chart 1.1 shows the Fludicon- Excellence in Research for the Automotive Advanced Suspension Technologies Market in Europe for 2009.

Chart 1.1

Automotive Advanced Suspension Technologies Market: Fludicon--Excellence in Research (Europe), 2009



Conclusion

With numerous benefits offered by Fludicon in terms of smart technology, cost-effective solution and wide application compatibility, its damper systems are expected to be well accepted in Europe. By venturing into the automotive application in the near future, Fludicon's ERF dampers are expected to be a worthy alternative to the already available semi-active dampers based on alternate technologies. Fludicon expects the demand for its fluid to grow over ten times by 2012 and aims to be the local technical centre of expertise for the European region with a production capability of damper systems for industrial, physical rehabilitation and automotive applications. Presently, Fludicon is poised to introduce its automotive products by forming strategic partnerships with tier 1 and tier 2 suppliers that cater to the automotive industry.

Considering the aforementioned factors, Fludicon is the worthy recipient of the "2009 European Automotive Advanced Suspension Technologies Excellence in Research Award."

About Best Practices

Frost & Sullivan Best Practices Awards recognize companies in a variety of regional and global markets for demonstrating outstanding achievement and superior performance in areas such as leadership, technological innovation, customer service, and strategic product development. Industry analysts compare market participants and measure performance through in-depth interviews, analysis, and extensive secondary research in order to identify best practices in the industry.



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