

Changing : How DSM Engineering Plastics is shaping innovation in oil sumps

A thought paper

Executive summary

A new generation of reinforced engineering thermoplastics is fast becoming the standard for Tier 1 automotive applications - from engines to airbags.

The newest application is a unique hybrid concept for oil pans – and oil sumps –that will enable the industry to reduce weight by up to 30-40% and system costs by up to 20% - whilst at least matching the overall performance of metals, as well as enabling a reduced carbon footprint.

This latest innovation is possible thanks to Akulon®, a revolutionary PA6 thermoplastic that not only outperforms many metals but also enjoys many superior qualities to PA66 (improved processing, long-term heat resistance and improved welding properties).

The coming years will see the introduction of a hybrid oil pan integrated with the structurally loaded bed plate that carries loads from the transmission system. Not only the pan will be made entirely from PA6, but also the main part of the bed plate.

The load of the transmission box will be carried by a small aluminium bracket. The two plastic parts, meaning the pan and two-thirds of the bed plate, are joined together using different kind of welding techniques (vibration, hot air and infra red welding). These two welded parts together form the oil container.

It's been a huge engineering effort, totaling three years of extensive (and expensive) research and development, redesign and now the long-awaited moment of success.

The company behind this innovation is DSM Engineering Plastics. In addition to inventing the Akulon® material, its global team of engineers and technicians has developed the hybrid system itself in partnership on this project with two giants of the automotive industry, MANN + Hummel and Ford Motor Co.

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Akulon PA6, the plastic innovation in oil pan applications

Why Engineering Plastics?

From connectors to components, to interior and exterior trim, engineering plastics now account for 12-14% of the average car. In the next 10 years we conservatively estimate that figure will virtually double to around 20- 24%. Why?

- Leading thermoplastics such as PA6 grades are proven to offer superior price/performance, not just to metals but to other engineering plastics over the lifecycle of the product.
- They perform outstanding at elevated temperatures over long periods (compared with PA66 for example).
- Plastics open the door to future integrations including oil pump, oil cooler dip stick, baffle, etc.
- Plastics are more durable than metals. They don't rust...which makes engines more reliable – and sustainable.
- They offer more flexibility than competitive materials, enabling ease of processing (through injection moulding for example) and streamlining of manufacturing operations, as well as the ability for engineers to widen their scope and be more innovative.
- Polyamides are much lighter than metal, which means lighter engines, less fuel consumption and a reduced carbon footprint. A weight reduction of 100 kg in a vehicle will save as much as 0.4 liters of petrol per 100 km traveled.

Why Akulon® for automotive?

Akulon® - DSM Engineering Plastics' industry leading PA6 material - now has 120 million system installations across 150 vehicle types worldwide.

As this oil sump project has once again proven, Akulon® is matching the bill perfectly: Providing incredible strength under duress (heat, chemical, impact) whilst also being incredibly flexible and pliable from a processing perspective.

Already this material has been used for years in areas such as engine covers and intake manifolds. This is particularly true of the premium grade Akulon® Ultraflow, which offers up to 80% improvement in flow and 25% reduction in injection molding cycle times versus regular PA6 grades.

Furthermore, this same material has the ability to provide a

superior finish to reinforced nylon components like engine covers, improving quality but with fewer processes.

Importantly, for the automotive industry, Akulon® also has a low carbon footprint thanks to its outstanding surface and flow properties. Despite being oil-based products, thermoplastics are more energy efficient than metals and can be recycled in several ways.

The hybrid system: Overcoming barriers

Inventing a wonderful material is one thing. Actually finding viable commercial applications for it...is quite another.

To this end, DSM Engineering Plastics is supported by an outstanding global Knowledge Team with expertise in testing, design, predictive engineering tools (particularly CAE), and other advanced engineering services for customers.

Eventually the team began to think about oil pans and how they could go beyond the norm and develop a hybrid system. The barriers, not surprisingly, were formidable.

Oil pans - and particularly oil sumps - must be able to provide dimensional accuracy and stability as well as strength and stiffness under the very toughest conditions. In particular there were two very simple reasons why plastics were rarely considered for oil pans and sumps:

Heat: These parts are exposed to top temperatures of up to 150°C and need to operate over long periods at 110°C to 140°C. Akulon® has been successfully used in other oil management components, such as cylinder head covers for some years (which have very similar technical considerations).

Strength: Oil pans and sumps need to be able to withstand sudden, violent impacts at high speed – as well as show extreme resistance to chemicals and other potentially damaging fluids like ice and oil. There needed to be 100% certainty that the material would perform when it really matters.

Even materials with seemingly identical mechanical property profiles can perform very differently when subjected to the most extreme conditions. Therefore to prove beyond all doubt the performance and safety credentials of Akulon® for oil pans and sumps,

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DSM Engineering Plastics made a major decision: To embark on a three-year research and development project that combined its material and engineering expertise with outside validation from leading industry partners.

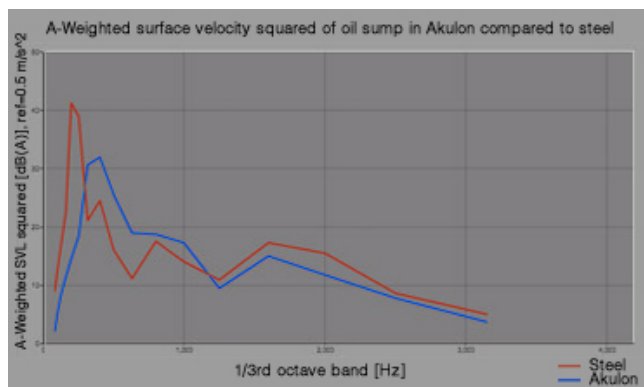
Testing & validation

Before a prototype Akulon® oil sump could be built, the material first needed to be exhaustively tested.

Expertise in Computer Aided Design (CAE) was instrumental in designing a series of innovative tests on the hybrid system - impact, noise and structural –to prove its performance at all levels.

The engine 'drop' test: How would an Akulon oil sump stand up to unexpected impact, like an engine drop. This test was formulated to find out.

The noise (NVH) test: To measure the radiated noise levels.



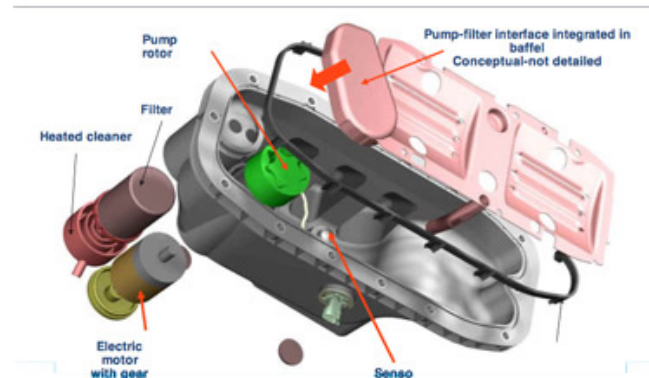
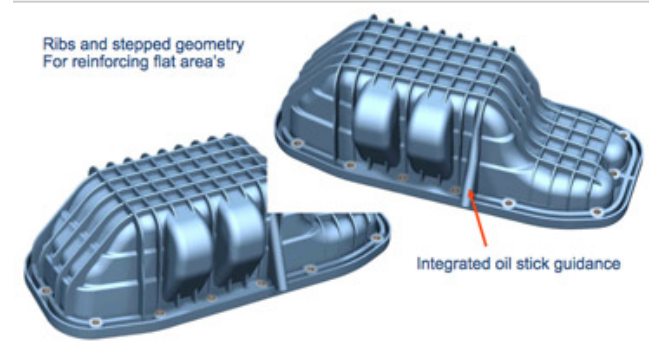
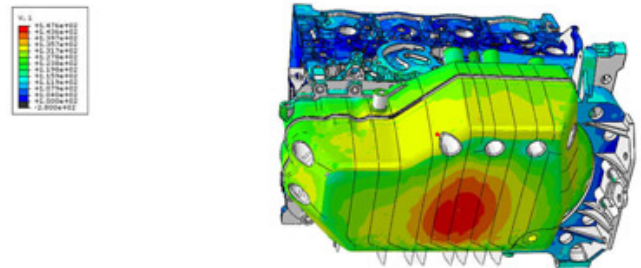
The stone impact test: A functional test that simulates stones and other hard objects striking the oil sump -using a ball-bearing fired at high-speeds, up to 230m/s.

To give the project added gravitas and credibility DSM Engineering Plastic then took a further major step – inviting Ford Motor Co to validate testing of the engine at its labs, complete with detailed technical reports and product files.

Akulon passed all tests with flying colours.

The prototype

Having successfully put Akulon through its paces, Ford suggested that DSM should enlist the help of MANN + Hummel in designing an actual working prototype of the hybrid oil sump. The offer was made and accepted – and three initial designs were produced joining oil pan and bed to together using vibration welding techniques.



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Bottom line: Benefits to tier 1 & OEM suppliers

What does a hybrid system in a re-engineered engine mean to the OEM/tier 1?

Akulon PA6 for oil sumps provides superior price/performance over a wide range of competitive materials, including steel, aluminium, metal-elastomer laminates, and indeed PA66.

Specifically, the Akulon-based hybrid system:

- Provides a cost reduction ranging from 20% for an aluminium oil sump to as high as 50% for silent steel, ie Bondal® metal oil pan. The component is quicker and more efficient to produce and more flexible to process from an engineering standpoint.
- Reduces weight by 20% compared to a traditional aluminium oil pan, rising to 40% in comparison to an aluminium bed plate and Bondal® oil pan. It results directly in lighter vehicles, reduced fuel consumption and lower carbon footprint.
- Enables innovation. For example, further simplification of engine design and production could be achieved through integration of the oil sump with various engine parts – from dipstick and oil pump to filter and suction pipe.
- Performs with high mechanicals at a temperature range between -30c degrees and -150c degrees. Akulon, a PA6, is able to perform in extreme heat for far longer than lesser PA66 grade plastics.
- It's sustainable: The clock is ticking not just for the automotive industry but for the entire planet. An Akulon® oil sump could be recycled either conventionally (into garden furniture, for example) or through innovative sustainability methods like feedstock recovery, which involves the shredding and separation of complex plastics.

Next steps: Tomorrow and today

After three very busy years, DSM Engineering Plastics has proven that a fully integrated hybrid oil sump made from PA6 is not just possible, but commercially viable.

Longer term: In the coming years the organisation will commit even greater time, budgets and resources to bringing the hybrid oil sump to market: We expect it to be commercially available by 2013.

Short term: Akulon® oil pans will go into production later this year in a variety of grades including Akulon Ultraflow K-FHG7 and K-FHG6, which deliver a significant improvement in flowability, without losing strength.

Thinking outside the box

And what of the day after tomorrow? Beyond oil sumps, DSM Engineering Plastics is already thinking about new applications – such as a plastic gearbox and even major parts of the car body structure. In fact, we believe that the amount of plastic used in the average automobile will double over the next 10 years.

Akulon is only part of the puzzle. Already we are using engineering plastics in bold new areas such as the steering wheel (in the case of Arnitel® a sister material to Akulon).

Meanwhile, a new generation of materials is being developed that tap into the growing, critical need for the automotive industry to take sustainability to the next level. Ecopaxx is a bio-based, high-performance engineering plastic for high-tech applications that is 100% carbon neutral from cradle to grace and is already being tested in several pilot projects.

The future has begun.

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About DSM Engineering Plastics

DSM Engineering Plastics is one of the world's leading suppliers of quality engineering thermoplastics providing customer value through sustainable solutions that reflect the DSM People, Planet and Profit strategy.

DSM Engineering Plastics delivers innovative opportunities for customers who design or produce electrical applications, electronic equipment, cars, barrier packaging films as well as many mechanical and extrusion applications. These markets are served with a broad portfolio of high performance materials including Akulon® 6 and 66 polyamides, Arnitel® TPC, Arnite® PBT and PET polyesters, Xantar® polycarbonate, Yparex® extrudable adhesive resins, and Stanyl® high heat 46 polyamides.

Most recently, DSM Engineering Plastics has introduced the first new polymer of the 21st century: Stanyl® ForTii™ and EcoPaXX™, a bio-based, high performance engineering plastic. DSM Engineering Plastics had sales in 2009 of EUR 648 million and employs some 1600 people worldwide

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