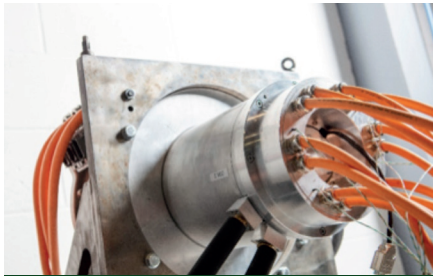


Case Study

Passenger Cars



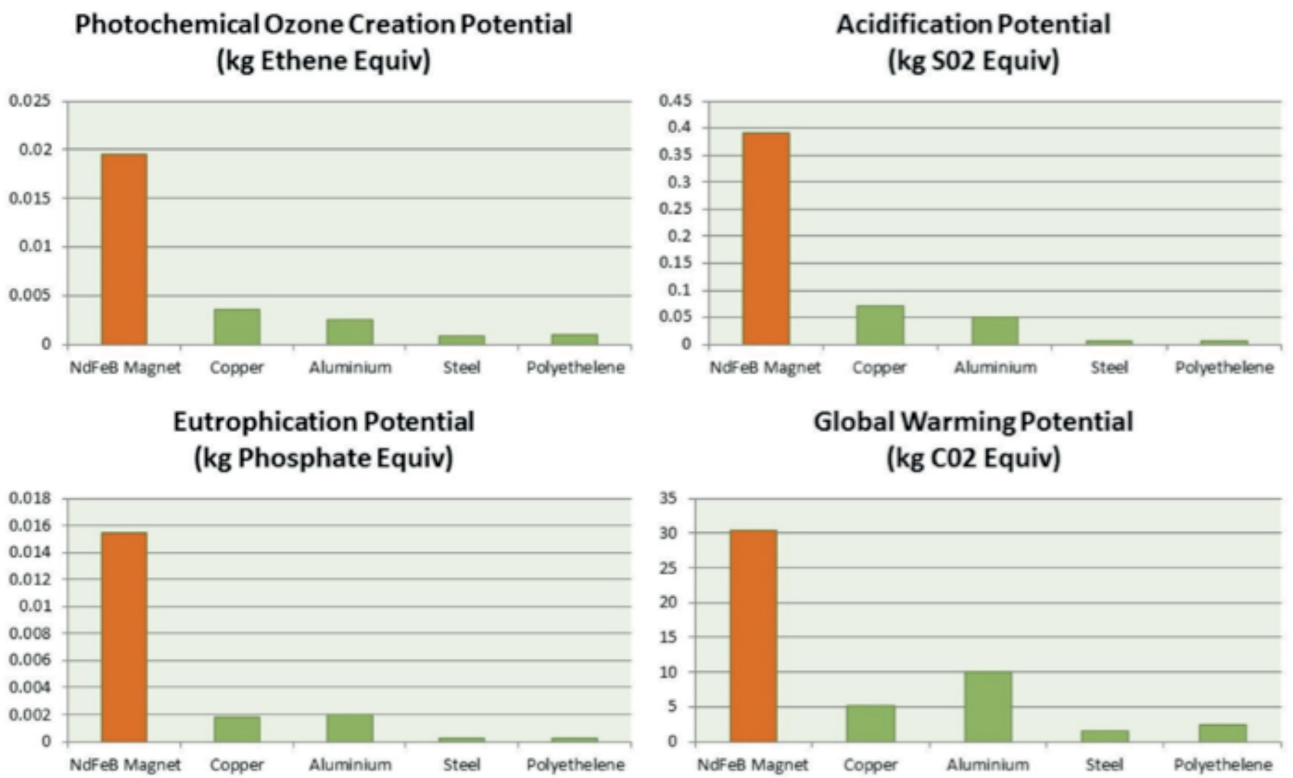
SSRD motor and power electronics

THE CHALLENGE

As electrification accelerates in the passenger car sector there are significant sustainability challenges regarding the materials required to deliver the volumes of both batteries and motors. Rare earth magnetic materials are becoming widely recognised as a key issue in future motor designs with several approaches being developed to mitigate their use. Toyota for example, announced that they had developed a 'neodymium reduced heat resistant magnet' which reduces the amount of neodymium by up to 50% while removing both dysprosium and terbium. Toyota have a plan to utilise the magnets in small motors in the first half of the 2020's with a drive towards high performance motors by the end of the decade.

The reason rare earth materials are such a focus of concern is both the supply chain for the material which drives >90% through a single country, China, and the energy and process routes required to first separate, and then to refine them. Often the elements are found entwined with radioactive materials and require acid leeching to separate them from the surrounding materials presenting a potentially significant environmental challenge even before the material is ready to be turned into a magnet:

Lifecycle data for the production of the different materials used in electric motors



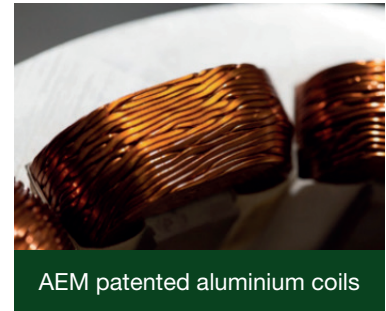
AEM SOLUTION

AEM is able to offer a passenger car focused traction motor solution that can address all of these issues while delivering higher levels of performance than the market leading permanent magnet motors at a lower cost – SSRD.

Utilising design, manufacturing and material innovations, SSRD removes both the rare earth magnets and copper windings while offering system (motor and converter) level power density of over 20kW/litre and 6.5kw/kilogramme and achieving peak efficiencies around 96%.

Advantages

Because permanent magnets are no longer required the system level improvements continue to deliver real world benefits when integrating the motor into a vehicle platform. Permanent magnets will demagnetise at high temperatures meaning they need significant cooling to ensure they continue to work. SSRD has no such requirement requiring a much simpler cooling loop. SSRD delivers its performance by operating at high speed, in order to maintain the efficiency at a system level AEM has internationally recognised transmission design capability supported by a patented gear manufacturing process which ensures we can deliver the performance you need as a lightweight, cost effective and efficient system.



As well as removing the magnets the team at AEM have developed a patented manufacturing process which allows SSRD to use aluminium windings in place of copper. Copper is an expensive material and dense material which increases the difficulty of recycling the overall motor. The removal of both the magnets and the copper from the system means that SSRD has the potential to save over 60% on the Bill of Materials cost, will be lighter and the whole motor can be upcycled by melting down through an electric arc furnace into high grade steels without the need for any disassembly.

A key feature of permanent magnet motors is that they are never 'off'. The motor will always generate either current or torque while rotating meaning a level of control and safety electronics always need to be in operation. When SSRD is not being driven it is truly 'off', acting as a freely rotating mass which does not generate current or torque. Using this feature the team at AEM have patented a multi-motor design approach which allows one or more motors to be turned on or off depending on the performance requirements of the vehicle at the time. In turn this means that the multi-motor system can be operated at peak efficiency across a much broader part of the vehicle drive cycle – offering the electric vehicle equivalent of cylinder deactivation. These efficiencies translate into a real-world increase in range or battery size reduction.

Collaboration

Collaboration is at the heart of the development of SSRD, driving and focusing its design and accelerating its route to market. The development process has seen the concept handed from partnership to partnership coordinated by the AEM team throughout. The collaborative product development programme which AEM is leading brings together world class experts in passenger car and electrical system design as well as UK supply chain partners and internationally recognised powertrain academics to deliver a proof of concept E-Axle showing the potential which magnet free motors can deliver to the passenger car sector.

Today

SSRD has been designed and tested at a prototype level. We are keen to discuss product development programmes targeting Start of Production in 2022-23 to demonstrate how SSRD can deliver real world cost and performance benefits to your platforms.

Collaborative development work we have previously completed was recognised by The Engineer magazine as a leading example of collaborative innovation, winning both the automotive and overall 'Collaborate to Innovate' award in 2019. If you are interested in working with us to deliver our market leading recycled magnet technologies into your product then please drop one of our commercial team a line at:

mike.woodcock@advancedelectricmachines.com

or

andrew.woods@advancedelectricmachines.com

