PRESS RELEASE

16 June 2015

Significant fuel savings and rapid payback shown for rail flywheel hybrid technology

- Research and development conducted by Ricardo, Artemis Intelligent Power and Bombardier Transportation
- Innovative high-speed flywheel-based brake energy recovery system concept developed for Diesel Multiple Unit (DMU) rolling stock
- Double-digit percentage fuel savings and sub-five year investment payback demonstrated
- Discussions on potential applications now being pursued with key rail industry stakeholders

The DDFlyTrain project has projected a fuel saving of around 10 percent based on the use of high speed flywheel brake recovery technology retrofitted to DMU rolling stock. This order of saving means that the technology has a potential return on investment of inside five years. The project has also produced a proof of concept test rig used to demonstrate the technology to rail industry stakeholders and a concept for integration onto a Bombardier Turbostar DMU.

The project set out to demonstrate through rigorous simulation and rig testing, the practical feasibility, operational fuel and energy savings, and the economic investment case for the use of high speed flywheel energy storage technology on DMU trains. The hybrid solution is based on Ricardo’s TorqStor high-speed flywheel energy storage technology and the high efficiency Artemis Digital Displacement® hydraulic pump-motor transmission.
The research project, which started in 2013 and was led by Artemis, was co-funded by Innovate UK and the Rail Safety and Standards Board. It included extensive simulation work based on field service data, which was used in the optimal sizing and design of a practical installation high speed flywheel brake energy system for rail-based application, and the construction and commissioning of a test rig for demonstration purposes. The project has also completed an initial integration exercise to incorporate the hardware and software onto a Turbostar DMU. Significant effort has been focused on identification and management of the key operational concerns of such a solution.

Even before the project completion and delivery of the results announced today, the project and its constituent technologies had been widely recognized. In late 2014 the DDFlyTrain project received a Rail Exec award in the safety and sustainability category and the Ricardo TorqStor flywheel technology on which it is based received the 2014 SAE Tech Award, as one of the top five technologies to be on display at the SAE World Congress.

Why brake energy recovery and re-use is attractive for rail applications

Although it has previously been used exclusively on electric rolling stock, regenerative braking represents a particularly attractive fuel-saving proposition for DMUs. The launch phase efficiency of conventional diesel rail vehicle transmissions, which typically use a torque converter on starting from rest, can be as low as 30 percent. By capturing and storing energy otherwise dissipated during braking, a significant improvement in fuel consumption is possible if this energy is subsequently reused to augment acceleration from rest during the period of poor transmission efficiency. Other associated benefits can also be realized: improved longevity of braking system components as retardation is applied through absorbing energy into the flywheel, less noise and vibration from the engine during launch, and reduced exhaust emissions produced in the vicinity of stations.

In addition to its very promising application on DMU rolling stock, the high speed flywheel technology demonstrated in the DDFlyTrain project is also extremely attractive.
for electric multiple units operating on DC conductor rail networks such as the London DC electrified lines region. Network power capacity issues can place a significant restriction on the number of trains allowed to operate in some sectors, given the high current demand during launch. By applying high speed flywheel technology a significant element of this launch requirement can be eliminated, thus increasing effective capacity.

**How the DDFlyTrain hybrid system works**
Ricardo’s TorqStor is connected to the DMU driveline via Artemis Digital Displacement® hydraulic pump-motors in which computer-controlled solenoid valves coordinate the responses of individual pistons to the overall power and torque requirements. Compared with conventional hydraulics, Digital Displacement® pump-motors have inherently high part-load efficiencies and controllability and this makes it economically feasible to use hydraulics in energy sensitive applications such as DMU regenerative braking.

Ricardo’s TorqStor differentiates itself from other flywheel designs with its unique permanent vacuum. This is made possible by its advanced magnetic gear system that enables the transmission of torque across a vacuum without the limitation of rotating seals or necessity for vacuum pumps. It provides an industrial design for deployment in real-world applications where durability and ease of serviceability are of paramount importance. It is also highly scalable depending on the requirements of each application. With the value attaching to this potentially disruptive technology, the key aspects of Ricardo’s TorqStor are understandably the subject of protection by a family of patents.

In the DDFlyTrain project, the optimal configuration for a DMU was found to be two 4.5MJ capacity TorqStor units with a maximum speed of 45,000 rev/min. The proof of concept demonstration test rig was a scaled-down version of the DMU architecture, based on a single 220kJ TorqStor.
“Ricardo’s TorqStor high speed flywheel technology linked to the Artemis Digital Displacement high efficiency transmission provides a technically feasible and commercially attractive means of enabling regenerative braking on DMUs – so providing a pathway to reduce the carbon footprint of this form of rail travel,” commented Ricardo VP of Innovation David Rollafson. “The double-digit percentage fuel savings and short commercial payback demonstrated for this technology make it attractive both as a retrofit solution for existing fleets as well as for application on new-build rolling stock.”

“Digital Displacement® technology is ideally suited to railway driveline applications requiring highly efficient fluid power, as demonstrated in the DDFlyTrain project where we have used this high efficiency variable transmission as the powertrain interface for the TorqStor high speed flywheel,” added Dr Niall Caldwell, Artemis’s Managing Director. “With the DDFlyTrain test rig commissioned in our Edinburgh lab we are now in a position to demonstrate this very promising application to rail industry customers.”

“Bombardier Transportation is committed to providing the latest energy efficiency technologies and innovations in our products and services,” commented Rob Cowling, Head of Value Added Services. “The DDFlyTrain project has demonstrated impressive fuel savings from a cost-effective solution for the recovery and re-use of energy normally lost through braking on diesel trains. This is a rail industry first, and we are actively discussing the potential application of this technology as a means of improving the environmental performance and operational viability of legacy diesel fleets.”

Ends
NOTES TO EDITORS:

Ricardo plc is a global, world-class, multi-industry consultancy for engineering, technology, project innovation and strategy. Our people are committed to providing outstanding value through quality engineering solutions focused on high efficiency, low emission, class-leading product innovation and robust strategic implementation. With almost a century of delivering value through technology, our client list includes the world’s major transportation original equipment manufacturers, supply chain organizations, energy companies, financial institutions and governments. Guided by our corporate values of respect, integrity, creativity & innovation and passion, we enable our customers to achieve sustainable growth and commercial success. For more information, visit www.ricardo.com.

Bombardier Transportation is a global leader in rail technology, offers the broadest portfolio in the rail industry and delivers innovative products and services that set new standards in sustainable mobility. BOMBARDIER ECO4 technologies – built on the four cornerstones of energy, efficiency, economy and ecology – conserve energy, protect the environment and help to improve total train performance for operators and passengers. Bombardier Transportation is headquartered in Berlin, Germany, and has a very diverse customer base with products or services in more than 60 countries. It has an installed base of over 100,000 vehicles worldwide.

Artemis Intelligent Power Ltd performs research, development, and technology licensing associated with Digital Displacement® hydraulic power technology, and other innovations in the control and transmission of fluid power. The company’s mission is to lead hydraulic power into the digital age. Artemis was spun out from research at the University of Edinburgh and is wholly owned by Mitsubishi Heavy Industries of Japan. It works closely with leading global companies to develop Digital Displacement® solutions for a wide range of power transmission applications, many of which were previously out of bounds due to the low part-load efficiencies and limited controllability of traditional hydraulics.

Media contact:

Anthony Smith
Ricardo Media Office
Tel: +44 (0)1273 382710
E-mail: media@ricardo.com