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VOLVO TECHNOLOGY PRIZE 2001: FILM COOLING OF ROCKET NOZZLES

Worth a total of SEK200,000, the Volvo Technology Prize was awarded, at the Volvo Group AGM, to a group of engineers who have developed a highly advanced method of cooling rocket nozzles for space applications. The new technique is known as film cooling.

Volvo Aero has been an active partner in the European space programme for many years. The company's main products in this area are the turbines for the rocket fuel supply system and the nozzles for the main propulsion unit.

The products are developed and manufactured by Volvo Aero using especially advanced technologies. The products concerned are required to perform without problems under extraordinarily severe conditions.

The competition in the market is extremely tough and the demands for continued development high. For example, the demand for improved nozzle cooling performance and strength – both at lower cost - is a recurring one.

A team from Volvo Aero consisting of **Jan Häggander, Lars-Erik Eriksson** and **Arne Boman**, together with **Lars-Olof Pekkari, now with** Volvo Buses and **Mikael Bigert** who has moved to Volvo Cars, has developed a completely new form of nozzle cooling - known as film cooling - for the next generation of the Vulcain propulsion unit for the Ariane rockets.

Film cooling means that gases are sprayed at supersonic velocity along the inside wall of the nozzle to cool the wall and improve its strength. In the Vulcain 2 nozzle, the upper half is cooled by liquid hydrogen pumped through the tubes which comprise the wall. The lower half is film-cooled using the exhaust gases from the two turbines which drive the fuel and oxygen pumps, together with the hydrogen already used to cool the upper half of the nozzle. The film follows the entire wall as far as the nozzle outlet, protecting it from the extremely high flame temperature of 3,100˚C.

Film cooling enables the wall in the lower half of the nozzle to be made of sheet metal rather than an assembly of welded tubes, thereby reducing the cost.

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It is not easy to describe the complex behaviour which occurs during the 10 minutes or so which represents the life of a rocket nozzle. Nevertheless, it is clear that the Volvo development team solved a series of tough problems along the way.

Among other problems, the team successfully reduced the production cost. Which means that the total cost for a 40% bigger, more robust nozzle, that delivers more thrust is unchanged.

"Film cooling really stretches the envelope," comments Senior Design Engineer Jan Häggander. "The new nozzle is so much more efficient that it contributes to the capability of launching a 150 kg higher payload.

"This might not sound much. However, considering that every additional kilogramme sold means a bonus of USD10,000 – 20,000 per launch, it is easier to understand the customer benefits of film cooling.

The first launch of an Ariane rocket with the new nozzle is scheduled for May 2002.

The team's achievement in developing film cooling has been recognised by the award of the Volvo Technology Prize for 2001 – the 14th year of the award. In keeping with tradition, the prize was presented to the winners by Volvo CEO Leif Johansson as a prelude to the Volvo Group's AGM, before an attendance of 2,000 shareholders.

The Volvo Technology Prize was instituted in 1988 to recognise particularly outstanding technological achievements within the Volvo Group, which contribute to raising the company's technological image and stimulating initiatives designed to promote the Group's technological expertise in the years ahead. Over the years, world-renowned innovations which have received the award have included the Duoprop marine propulsion system, the Cityfilter, the transport information system Dynafleet and the Volvo side-impact airbag (SIPSbag).

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