An Overview of the Turbopump Development Programme in the University of KwaZulu-Natal's Aerospace Systems Research Group

Jonathan Smyth, Luke Philogene, Jeffery Bindon, Michael Brooks and Graham Smith
School of Mechanical Engineering, University of KwaZulu-Natal, Durban, 4041, South Africa

Glen Snedden
Council for Scientific and Industrial Research, PO Box 395, Pretoria, 0001, South Africa

Abstract

Space technologies are becoming increasingly important to economic development in Africa. Despite this, the continent lacks a satellite launch capability and its reliance on foreign launch service providers may be seen as both limiting development and compromising economic independence. South Africa, with its well developed space infrastructure, is in a uniquely favourable position to lead the way to an African launch capacity.

Although South Africa previously acquired launch experience through solid-propellant technology, the commercial booster market is dominated by liquid-propellant engine technology. For this reason a turbopump design capability would be vital to any future South African commercial launch initiative.

In this context, the University of KwaZulu-Natal's Aerospace Systems Research Group, located in the School of Engineering, has initiated a turbopump development programme to identify the key challenges in high-performance turbopump design. This programme currently consists of two projects; the preliminary design of a kerosene turbopump and the development of a pump test facility.

The kerosene turbopump is designed for use in a commercial booster engine of a vehicle capable of lifting 50-500 kg payloads into a 500 km circular, sun synchronous orbit from a South African launch site. This application necessitates a small, light weight pump capable of reliably meeting the engine's flow requirements while utilising a relatively simple and low cost design. The impeller is designed to operate at 14500 rpm while providing a flow rate of 103 kg/s and a head-rise of 890 m of kerosene. This presentation will describe the design methodology being used, focusing on the impeller geometry and its predicted performance.

The presentation will also address the development of a pump test facility for use in improving the design process and validating impeller performance. The closed loop test rig will run scaled down impellers derived according to the pump affinity laws. The facility will enable an experimental investigation of the impeller's head-rise, capacity, power consumption, efficiency and net positive suction head requirements. Pressure distributions in the impeller will investigated to improve understanding of the through-blade flow characteristics and assist in design optimisation. Data will provide a reference for future CFD work. The test rig will use a 65 kW hydraulic motor coupled to a 6:1 gearbox to drive the impeller up to speeds of 5000 rpm.

Presenter: To be determined.