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HYBRID STIRLING ENGINE-ADSORPTION CHILLER FOR TRUCK AUXILIARY POWER UNIT APPLICATIONS

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Highlights

- Free-piston Stirling engine for truck APU.
- Waste heat driven zeolite-water adsorption chiller for cab air conditioning.
- Experimental test data from prototype test rig.

ABSTRACT

This paper presents preliminary experimental test results for a novel truck auxiliary power unit (APU) design consisting of a 1 kW_e free-piston Stirling engine and 2 kW_t zeolite-water adsorption chiller that is powered via waste heat from the engine's cooling jacket. A prototype system was built and tested to study the interaction dynamics between the Stirling engine and adsorption chiller and to determine the performance of the chiller in extreme ambient temperature conditions. The results show that pulsed thermal loading from the chiller on the engine results in engine power spikes to 110-115% of rated power. An average COP of 0.42±0.06 was achieved for the adsorption chiller. An investigation into mitigating the negative effects of low buffering was also conducted and estimates that a buffer volume of 50 litres is sufficient to minimize the effects. This volume can potentially be achieved through integration with the main truck engine eliminating the need for a supplementary tank. The proposed system has many benefits over existing technologies such as low noise, high reliability and clean emissions without any need for additional exhaust treatment.

Keywords: Adsorption Cooling, Zeolite-Water, Stirling Engine, Truck Auxiliary Power Unit

Nomenclature

Nomenclature		Subscripts	
Abbreviations		<i>amb</i>	ambient
APU	auxiliary power unit	<i>cab</i>	truck cab
COP	coefficient of performance	<i>c</i>	chiller flow
DEV	Diesel engine-vapour compression	<i>ci</i>	chiller inlet
FPSE	Free-piston Stirling engine	<i>co</i>	chiller outlet
HX	Heat Exchanger	<i>cool</i>	cooling capacity
NTC	negative temperature coefficient	<i>d</i>	drive flow
SAS	Stirling-adsorption system	<i>di</i>	drive inlet
		<i>do</i>	drive outlet
		<i>input</i>	heat input

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