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Unsteady Interaction Of Turbocharger Compressor With IC Engine

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INTRODUCTION

Growing global concern pertaining to climate change has meant that engine development has become more focused on engine emissions. A method of reducing the emissions of an internal combustion (IC) engine is to use smaller engines but recover power lost due to reduction in size by using a turbocharger or supercharger.

To ensure that a turbocharger is appropriate for a given engine it has to be matched correctly. This process is called turbocharger matching. Turbocharger matching ensures that the compressor is providing sufficient air to the engine over a wide range of operating conditions.

Currently compressors are mapped by carrying out controlled experiments which put limits on its applicability to real world situations.

EXPERIMENTAL SETUP

The operating conditions of the compressor were analysed on a state of the art test bed. This test bed uses a 4 cylinder 4.4L diesel engine and is equipped with a high speed data acquisition system to examine the flow characteristics. A sampling frequency of 69444Hz was used to ensure that all time dependant phenomena could be analysed.

The mass flow of air was measured using a hot film mass flow meter was placed in the flow upstream of the compressor.

Pressure measurement across the compressor is an essential parameter when determining the operating conditions of compressor and engine. The setup is equipped with highly sensitive pressure transducers were used with an accuracy of 0.04%.

Nine steady engine states were measured. The engine speed and torque were set to ensure that three operating points were measured at three different pressure ratios.

RESULTS

The points are averages over several cycles of the pressure ratio and corrected mass flow measured on the engine test rig described below.

Left: Typical points of compressor performance. Red line is the surge line, to the left of this line the compressor goes into surge. Surge is an unstable operating condition observed at low mass flows and can cause severe damage and hence is undesirable.

The flows were shown to have large fluctuations which were caused by the unsteady interaction of a roto-dynamic machine (Turbocharger Compressor) and with a reciprocating machine (IC engine).

The Relationship between pressure fluctuation and mass flow have shown that the pressure fluctuations are minimum at a give mass flow rate. This minimum has been observed in the heart region of the compressor map, but near to the surge line. This indicates a possibility of using pressure ratio fluctuations as a measure to determine the onset of compressor surge.

CONCLUSION

Unsteady interaction with compressor and IC engine has been investigated.

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The mass flow of air was measured using a hot film mass flow meter placed in the flow upstream of the compressor.

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Below: Pressure transducers were mounted on the compressor outlet (6).