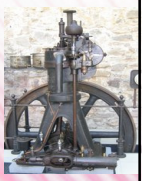
School of
Computing and Engineering

Diagnostic Engineering Research Group

University of HUDDERSFIELD

Fault Detection and Diagnosis in Diesel Engine Using Acoustic Emission (AE)



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Introduction

• Diesel engines are a kind of power source widely used in many fields.

• One of the biggest problems facing machinery today is the high cost of maintenance of diesel engine because the downtime of the engine is expensive.

• Not only does a fault reduce the performance of the engine but also causes secondary damage to other parts of the engine.

• The use of acoustic emission offers non-intrusive tool for engine monitoring

Why AE Monitoring

• AE is sensitive to many physical processes such as friction, impact, cavitations.

• AE has a very high signal to noise ratio and good localization capability .

• Diesel engines are the most complex component and faults sometimes difficult to diagnose using traditional techniques e.g. vibration, acoustics and temperature.

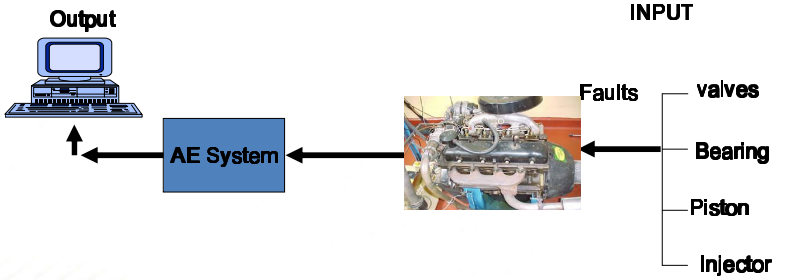
• Early and rapid detection of defects, faults and cracks.

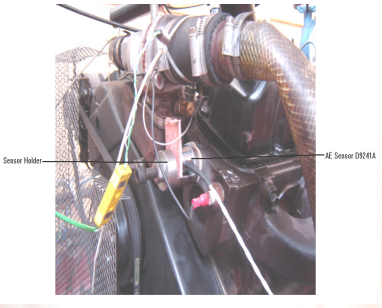
• Entirely non-invasive and more safe to use.

• More attractive option for online condition monitoring

How to detect diesel engine faults using AE

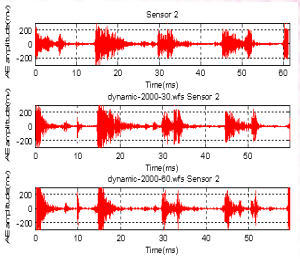
(On-line condition monitoring)

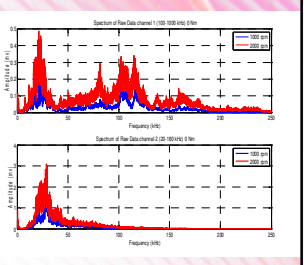




Tests was conducted on a Ford FSD 425 four-cylinder four-stroke, in-line OHV, direct injection diesel engine, rated at 52kW at 2700rpm. AE data is acquired using acoustic emission sensors placed on cylinder head and high speed data acquisition system.

Preliminary Results





• There are four major peaks in the time domain, each peak corresponding to a combustion in each cylinder of the engine.

• It is clear that the amplitude of the signal increased with increase in engine speed, and more harmonics can be seen in the spectrum and the major energy is located in the higher frequency band. This demonstrates that the high frequency band injection frequencies dominate in the engine's AE level.

• Changes in the valve clearance affect the valve lift and the crank angles at which the valve opens and closes. Both the valve lift and the duration of the valve opening period will decrease as the valve clearance increases.

• It is clear that when opening the speed of the valve increases as the clearance decreases and, conversely ,when closing the valve speed decreases as the clearance increases.

Interim Conclusion

. In the time domain, the difference of the AE signals between healthy and faulty has shown to be extremely useful for fault detection and diagnosis. The dominant AE events are associated with the injector and fluid excitation. Valve events (exhaust valve opening), mechanical impacts and gas flow excitation over the valve face are thought to be the main sources in the AE signal.

. In frequency domain analysis is dominated by the firing frequency component and some impact related faults could be obtained from the frequency domain in the form of increasing or decreasing energy level.

. The signals resulting from exhaust valve impacts in frequency domain during valve opening are affected by the valve fault; all show a pattern typical of metal-to-metal impacts.

Future Work

• Optimization of sensor placement.

• Comparison AE with other detection and diagnosis techniques.

• Investigation of AE characteristics of different faults.

• Develop more advanced methods such as Wigner-Ville Distribution and wavelet to analyze AE signals.