Observing EGR valve leakage using the NDIR500

Introduction

Exhaust Gas Recirculation (EGR) is employed to reduce NOx production rates by diluting the oxygen content of the intake charge and reducing combustion temperature. However, the rate of EGR needs to be carefully controlled, as too much EGR results in excessive particulate emissions and a reduction in engine efficiency, and too little EGR results in excess NOx (which is not treated by oxidation based after-treatment systems).

EGR is controlled by using a valve which allows a prescribed amount of the exhaust gas back into the intake. However, the requirements of production (reduced cost, ease of manufacture) can result in reduced performance of the EGR system, and in some cases this may compromise the EGR control.

This application note describes the use of the Cambustion NDIR500 Fast CO/CO_2 analyzer to measure the delivery of EGR during transient engine operation.

Experiment

In this experiment the NDIR500 was used to measure CO_2 in a modern, turbocharged, Euro Stage 3 compliant diesel passenger car, during the New European Drive Cycle (NEDC). The fast CO_2 analyzer outputs and the EGR drive pressure were logged on the fast data acquisition system. The vehicle speed was also logged. The CO_2 was sampled in the EGR pipe (immediately after the EGR valve) and the intake port of cylinder #1.

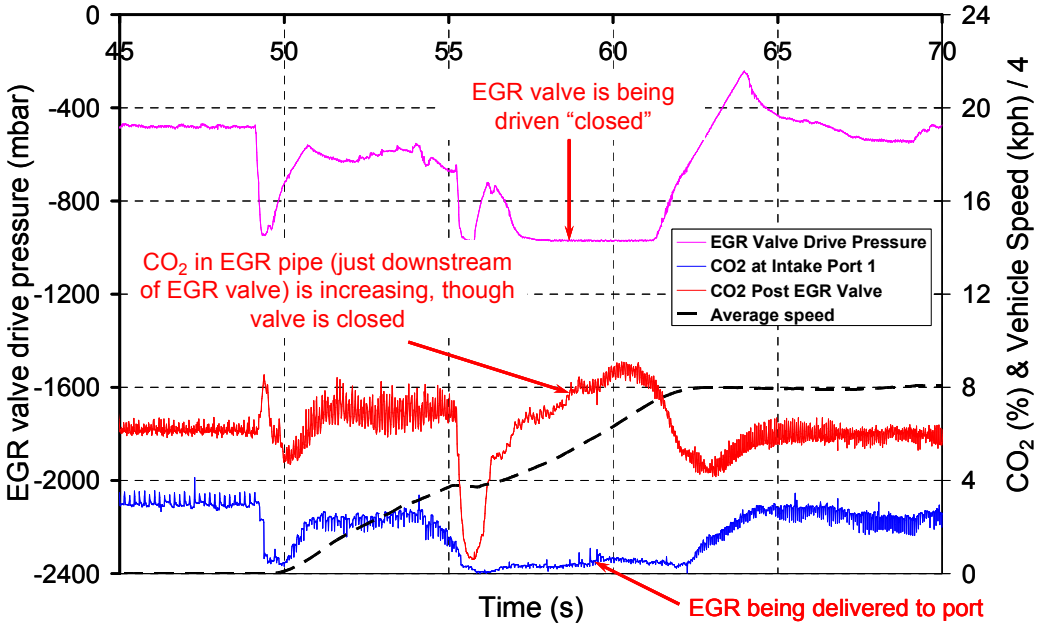

Chart 1 - EGR valve leakage

Results

The CO_2 sampling point being just downstream of the (closed) EGR valve, one might expect that trapped EGR within this closed-end pipe should remain relatively stable, or even reduce as the NDIR continues to sample its contents. However, the post-EGR CO_2 level indicated in Chart 1 above shows the CO_2 level increasing, indicating that the EGR valve is not closing properly, presumably due to deposits.

While we have no method of measuring the flow rate through the valve, there is a significant enough quantity of EGR flowing through this nominally closed valve to be detectable at the intake port of cylinder 1 (yielding about 0.5% CO_2)

Conclusions

The effects of deposits or other factors affecting the reliability of EGR valves can exhibit themselves in a rather “hit-and-miss” manner. By measuring the EGR using fast response CO_2 analyzers, it is possible to view such effects in real time and evaluate their impact.

Such unmanaged EGR control can have consequential effects on NOx and particulate emissions which can also be measured in real time using Cambustion analyzers.