Measurement of burned gas back-flow in the intake port

Introduction

The back-flow (or “spit-back”) of burned gas through the intake valve is an important mechanism for fuel vaporisation and deposit formation. The NDIR500 Fast CO/CO_2 analyser has been developed by Cambustion with a 10-90% response time of approximately 6 milliseconds enabling cycle-by-cycle measurement of CO_2 to be recorded.

The only source of CO_2 in the inlet (with no EGR system) is from the burned cylinder contents and sampling along the centre-line of the inlet port allows a measure of the penetration of this gas into the manifold.

Experimental setup

The NDIR500 sample probe was placed into the intake manifold of a production 1.8litre port fuelled SI gasoline engine at various positions, to measure the penetration of the burned gas from the cylinder back into the intake (by using CO_2 as the tracer). Data was taken at engine idle conditions at the three sample points shown below in Figure 1. Note: the data was taken from one sample point at a time, rather than all three points simultaneously.

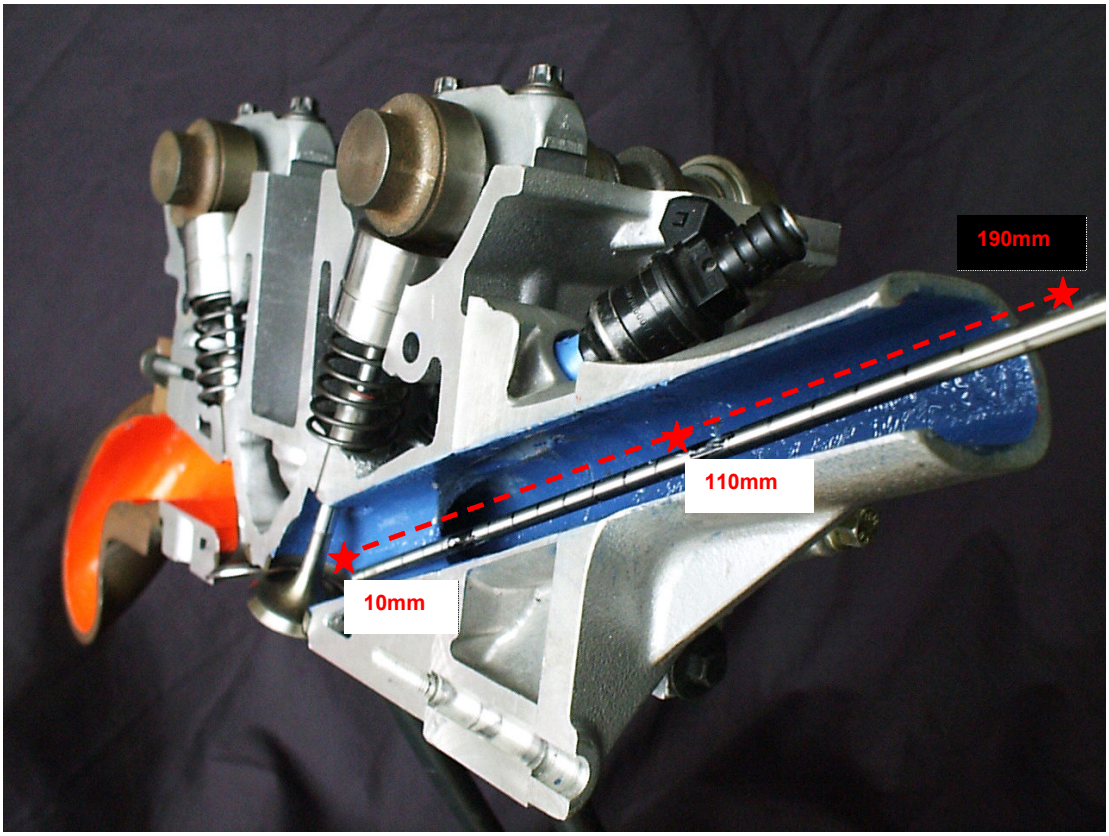

Figure 1: Sample points in the intake of port-fuelled SI gasoline engine

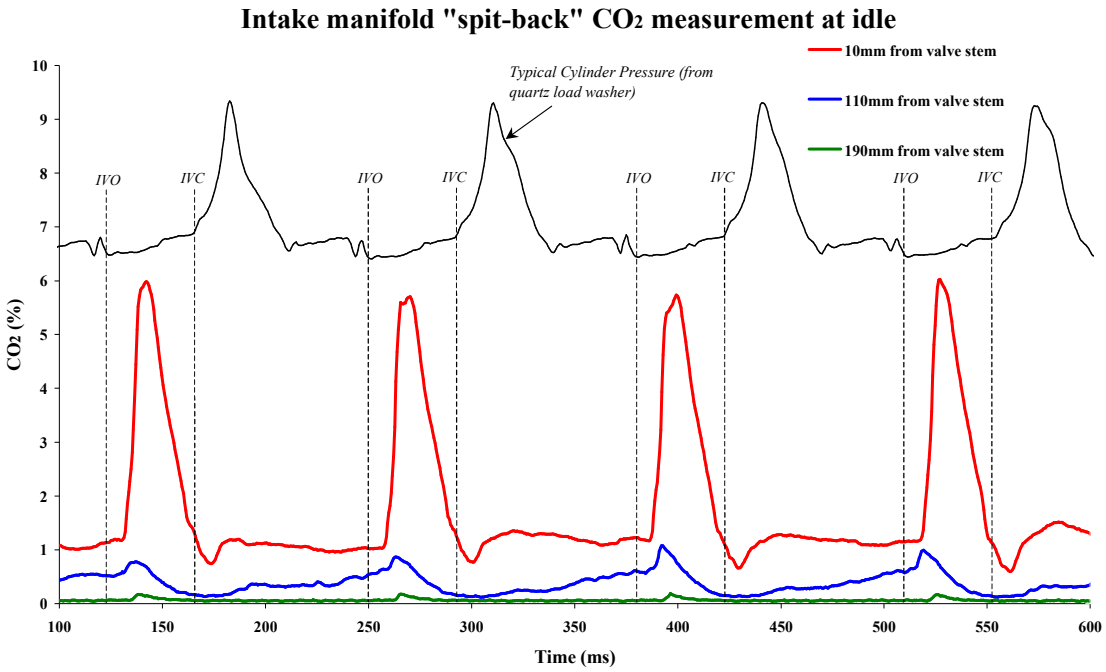

Figure 2: CO_2 penetration into the intake

As can be seen from Figure 2, the penetration into the manifold is still observable at a distance of 190mm from the valve stem.

The flow in the intake shows four distinct periods:

- Quiescent period when the intake valve is shut
- Backflow (due to overlap) at IVO
- A period of forward flow during induction
- A second period of backflow, just before IVC, due to the piston displacing charge back into the intake (most clearly observed at 10mm from valve stem).

Summary

The back-flow (or “spit-back”) of burned gas through the intake valve is an important mechanism for fuel vaporisation and deposit formation. The NDIR500 Fast CO/CO_2 enables cycle-by-cycle measurement of CO_2 in the intake to be recorded.