CAMBUSTION

CLD500 Fast NO_x

Real-time Millisecond Response Nitrogen Monoxide and Nitrogen Dioxide Measurement

Fast response time (2 *milliseconds*)
Continuous two channel sampling
Real-time NO_x emissions analysis

Overview of fast response NO_x measurement

Cambustion have been developing, manufacturing and supplying fast response analyzers since 1987. Following the success of the HFR series fast FIDs (for HC measurement), a fast response chemiluminescence analyzer - the *f* NOx400 - was developed in 1996. This improved design of the fast CLD is computer-controlled with enhanced stability via accurate temperature and pressure feedback control.

Like our other analyzers, the CLD500's fast response time is due to the detector being located in a remote sample head close to the sampling point in the engine. The sample gas is conveyed to the detector through heated capillaries thereby minimising the mixing of the sample gas and yielding a very fast response time.

The analyzer can operate two independent sample heads supported by 10 metre conduits and delivers two channels of data simultaneously. The mobile storage cabinet contains a lockable drawer for tools and manuals. Vacuum pumps and circuit breakers are also located in the cabinet.

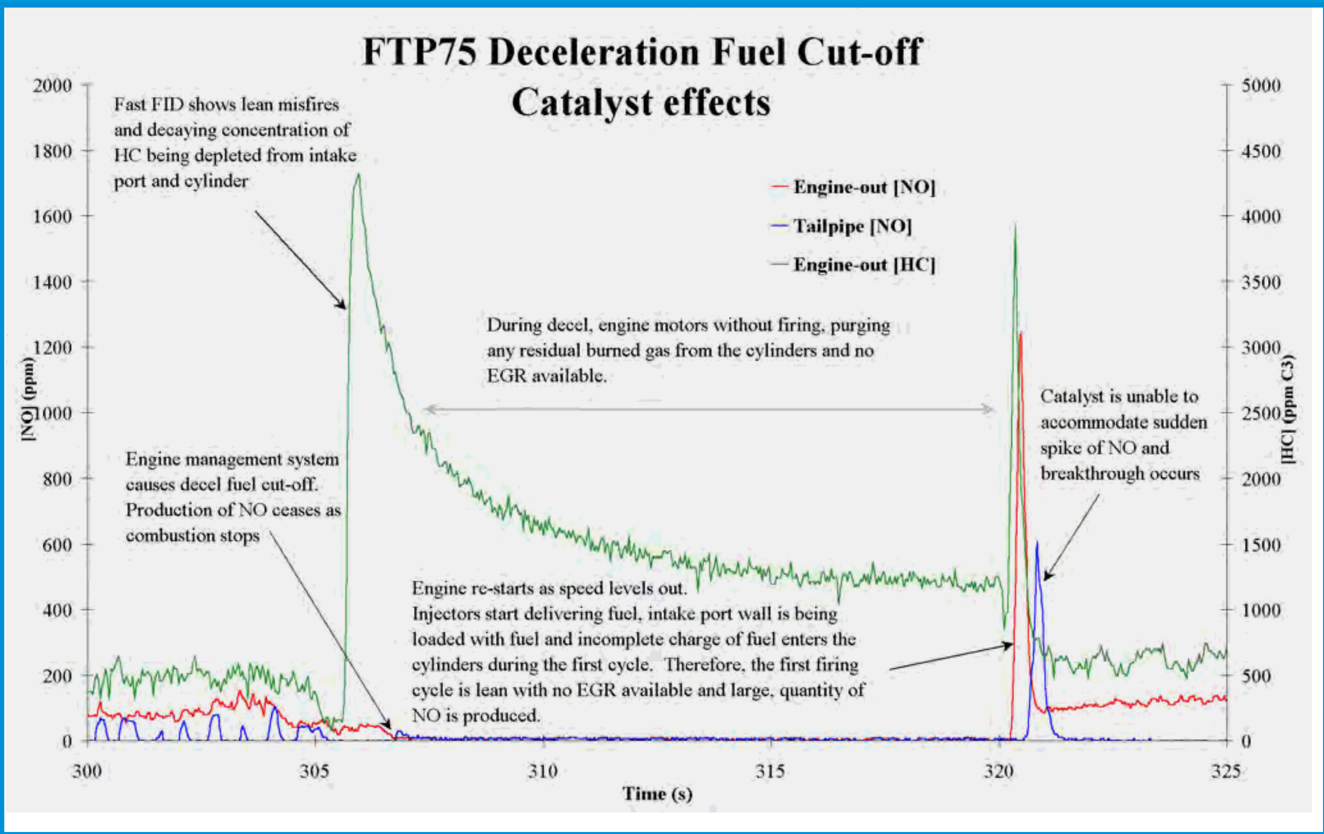
The system is controlled via RS485 serial link from a computer user-interface with remote control as an option. Autocalibration, self testing and fault-finding with on-line help are included as standard.

Transient 3-way catalyst & NO_x trap performance

The need to understand the behaviour of aftertreatment systems during speed, load, temperature and purge transients is of vital importance for reducing tail-pipe emissions. Short duration spikes in tailpipe emissions can be undetectable using conventional, slow analyzers and when these transients occur at times of high exhaust mass flow, the resulting mass of emissions can contribute significantly to final mass emissions quantities.

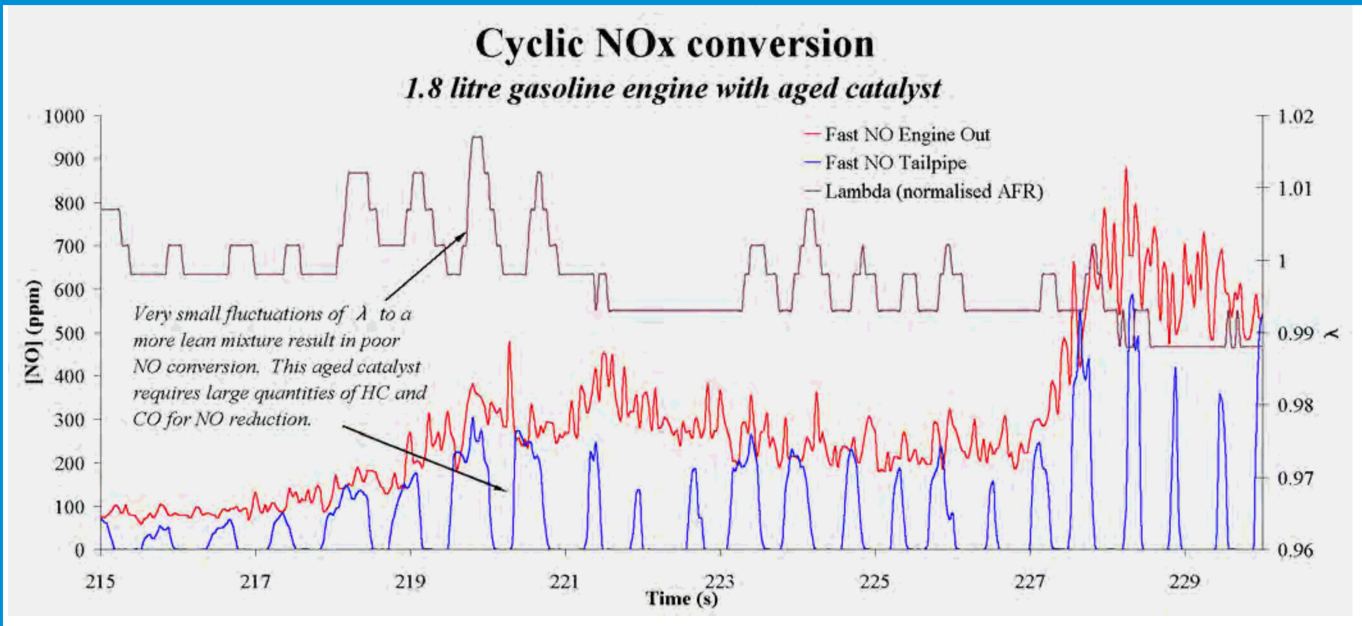
The example shown below is from a 1.8 litre gasoline engine with an aged catalyst during Bag 1 of the FTP75 drive cycle. This engine had a strategy of fuel shut-off during hard decelerations which resulted in no available EGR to control NO_x and lean combustion on restart. Some data which was taken simultaneously with a Cambustion fast FID shows the hydrocarbons being presented to the catalyst in the engine-out gas.

The NO spike occuring on engine restart indicates an area which potentially causes concern for calibrators but which would not be obvious from a conventional NO_x analyzer.



Instantaneous catalyst breakthrough

Other short-duration spikes of tailpipe NO_x can be detected even during steady state engine operation. Here, an Exhaust Gas Oxygen sensor reveals that the normal control fluctuations of the AFR (normalised as "λ") can cause NO_x breakthrough on an aged catalyst.

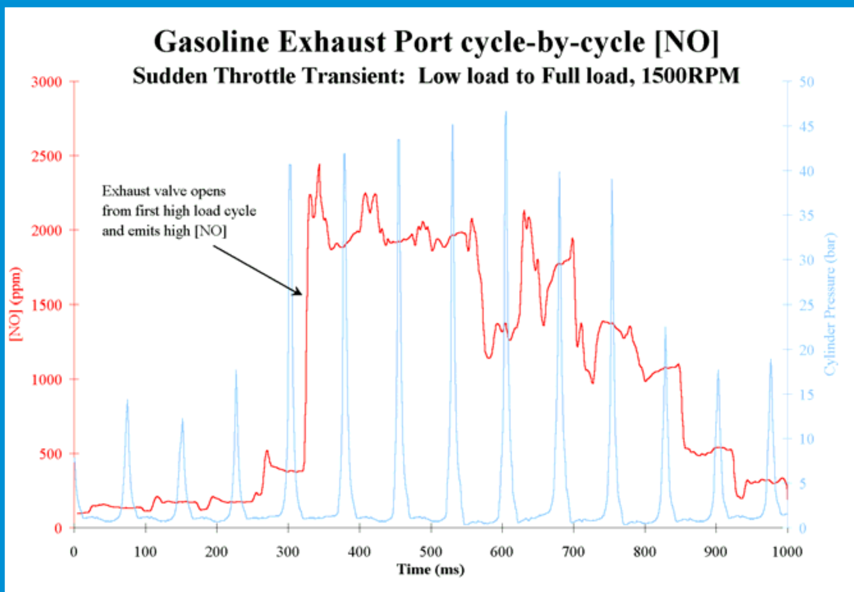


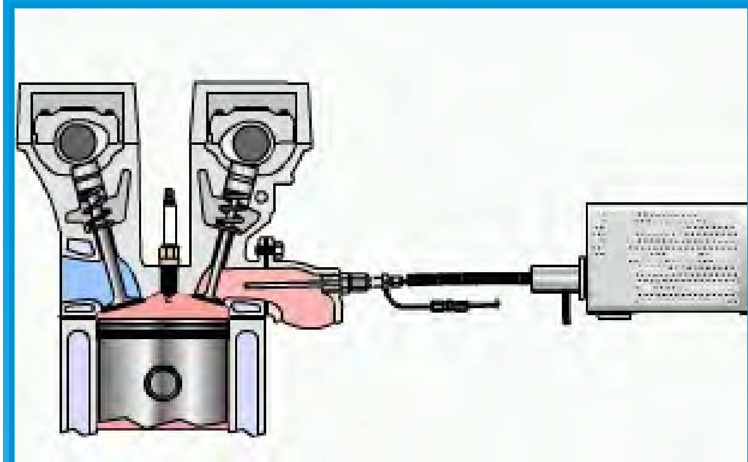
Cycle-by-cycle exhaust port measurement

The fast response time of the CLD500 allows analysis of NO emissions within single exhaust strokes.

By sampling from the exhaust port of engines, the cycle-by-cycle NO_x can be measured and the effects of EGR, spark timing, variable valve timing, fuel control and other phenomena can be studied.

In this example, a 4-cylinder, 1.8-litre production gasoline engine was subjected to a sudden load increase by operating the throttle "closed-open-closed".





When sampling close to the exhaust valve, the instantaneous [NO] can be measured and compared with the cylinder pressure for that cylinder.

The graph shows that when the exhaust valve opens following the first of the higher load cycles, the exhausted gas contains increased concentration of NO (as expected from high load conditions). The subsequent cycles show the [NO] which is emitted on a cycle-by-cycle basis and reveals the cyclic variability.