Balance point testing

Introduction

The temperatures required for oxidation of soot stored on a diesel particulate filter can be reduced using a catalyst, either via a coating applied to the filter or blended with the fuel, a fuel borne catalyst. Conventional DPF catalytic activity testing is conducted by holding a pre-loaded filter at increasing temperature steps and measuring, by weight, the soot loss between each sequence.

Soot load filter (DPG or engine)
Precondition @300ºC (removes VOF)
Stabilise temp @ 250ºC and weigh
20 minutes @ 350ºC
Stabilise temp @ 250ºC and weigh
20 minutes @ 370ºC
Stabilise temp @ 250ºC and weigh
20 minutes @ 410ºC
Stabilise temp @ 250ºC and weigh
20 minutes @ 440ºC
Stabilise temp @ 250ºC and weigh

Figure 1 - example of catalytic activity test sequence

Compared with Thermogravimetric analysis of the filter catalytic activity testing has the advantage of including the effects of catalyst to soot contact area and diffusion limitation within the soot structure. However, the many stages of weighing involved, and the inherent errors associated with weighing a hot DPF, make this type of catalytic activity testing labour intensive. With recent upgrades to the Cambustion Diesel Particulate Generator it is now possible to operate loading conditions, where soot is generated, at temperatures which will lead to soot oxidation. This has the advantage of allowing uninterrupted testing to determine the filters balance point, the temperature at which more soot is oxidised than is being loaded.

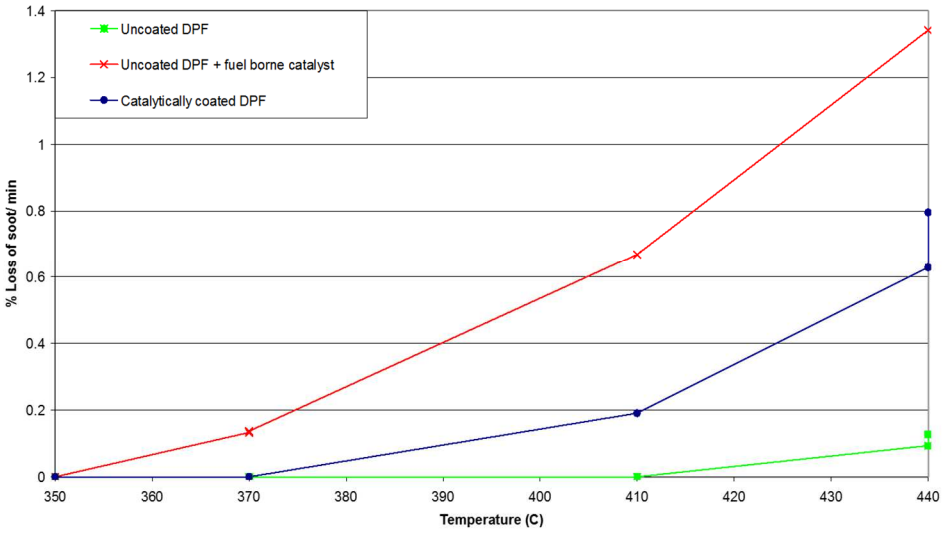

Figure 2 - example of catalytic activity test results

DPG Configuration

In order to conduct balance point testing a DPG with medium duty capabilities is required so that loading can be carried out at sufficiently high temperatures to promote soot oxidation. The possible area of operation during loading is shown in green on the graph below.

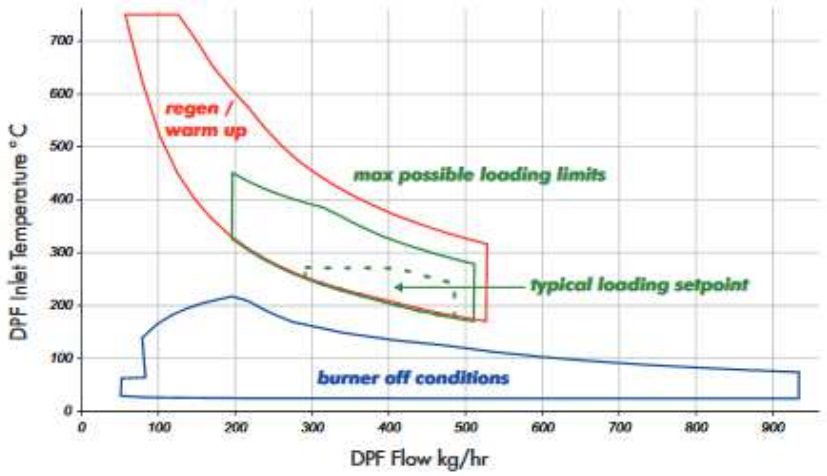

Figure 3 - medium duty DPG operating map

Results

The results shown below compare the balance point for a coated and uncoated filter. The DPG was set to load with 10g/h of soot at a series of temperature steps, each with the same flow. The filter was held at each temperature for a set amount of time to allow the backpressure change associated with the temperature increase to stabilise.

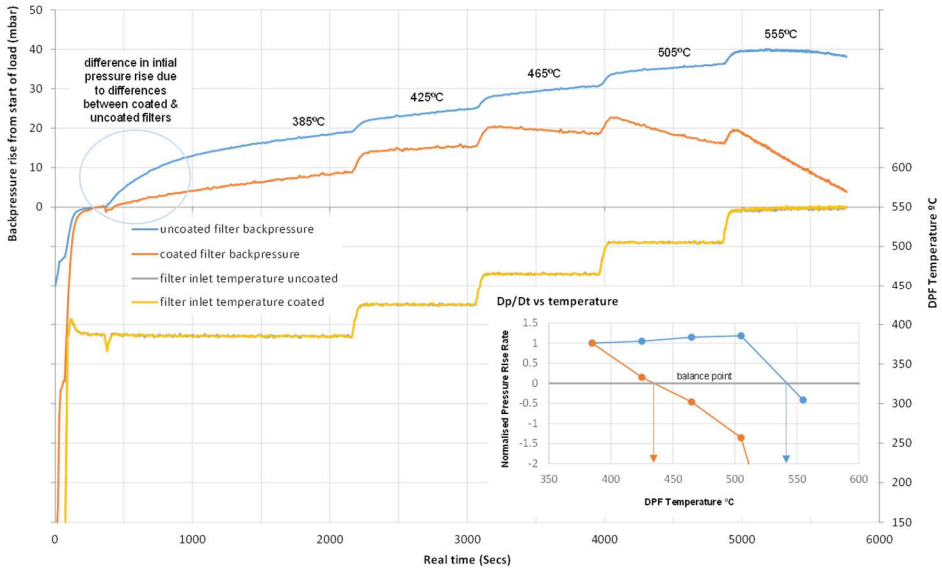

Figure 4 - balance point testing results

The blue dP rise which corresponds to the uncoated filter shows that no significant soot oxidation occurs until above 500ºC, indicated by a reduction in the normalised pressure rise rate. Once the rate of oxidation exceeds the 10g/h loading rate the dP gradient becomes negative, the temperature at which this happens is the balance point. For the uncoated filter this happens at close to 550 ºC whereas for the catalytically coated filter, orange trace, the temperature required for soot oxidation is much lower, with the balance point at less than 450 ºC.