Zoned loading MSL tests on the DPG

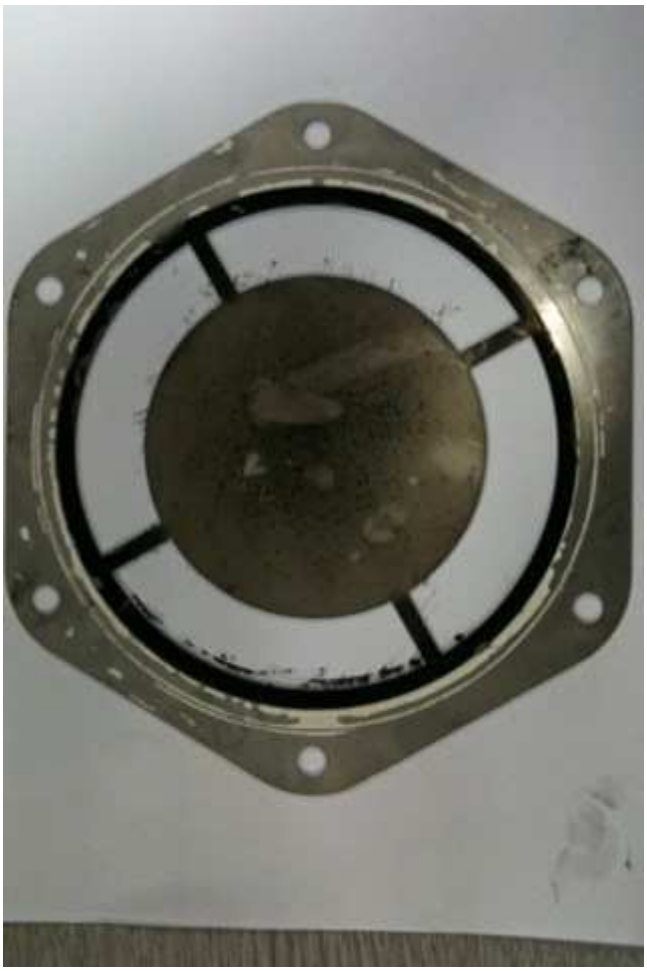
Introduction

General MSL testing on the DPG is discussed in Application note DPG 004. This note describes MSL testing where the initial soot load is non-uniform (which may be more representative of a loaded DPF on a vehicle).

A description of the system hardware, thermocouples and loading schedule may be found in DPG004.

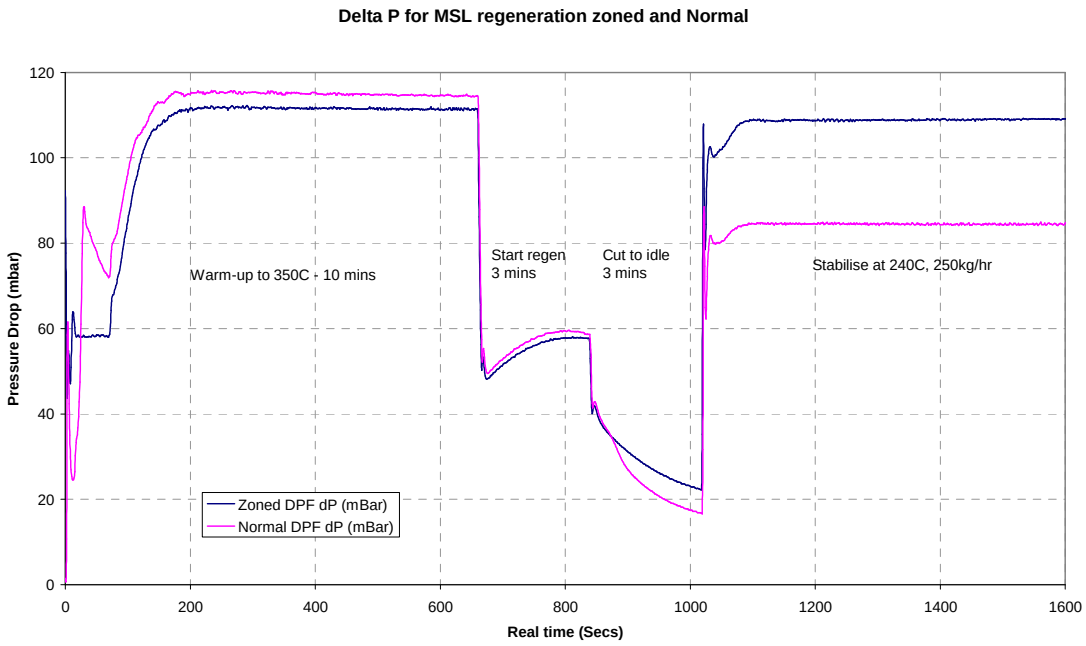
Zoned loading tests

Previous work has shown that MSL regeneration results can depend on the distribution of a given soot load. The part used here was loaded to ~75% of the target load (ie 19.4g of a final load of 26.2g). After this, a mask was fitted to the front of the DPF such that 50% of the frontal area radially from the axis of the DPF was not further loaded. The remainder of the soot was loaded in the remaining 'ring' – nearer to the outside of the DPF. Of course during this final load phase, the pressure drop was increased by the approximate doubling of the space velocity though the remaining open frontal area (shown in the picture below).



The results of a subsequent MSL regeneration (with the mask removed) are shown in the figures below. Figure 1 shows the pressure drop for the two tests. The pressure drop during warm-up and the start of regeneration are similar (the normal load pressure drop is slightly higher). The similarity in this pressure drop may be due to the broadly linear relationship between pressure drop and sootload when the part is in the 'cake' mode. This means that, to a first order, the reduced pressure drop in the central area (where the soot cake is thinner) is balanced by the increased pressure drop around the outside (where the soot cake is thicker).

Figure 1 Dp for MSL regen on normal and zoned load



The lower pressure drop at the end of the ‘cut to idle’ phase indicates that more soot is removed in the test where the sootload was normal (although, the average part temperature may be different between the 2 tests). This is also indicated by the lower pressure drop during the stabilise period after the cut to idle regen, where the flow and temperature are changed to allow a repeatable weight measurement to be made. The soot removed in the zone loaded MSL test was 7.6g compared with 8.1g for the uniform load (The initial load for each test is ~26.2g).

Figure 2 shows the response of the thermocouple measuring the gas temperature entering the DPF (close to the axis) and those 15mm from the front face of the DPF.

It is noted that the thermocouples near to the centre of the DPF (1 and 4) rise faster for the zoned load – since the flow is generally higher where the soot cake is less thick. The TCs near the edge of the DPF at the front have a generally slower response for the zoned loading – since the flow here is correspondingly reduced.

Figure 3 shows the response of TCs near to the rear of the brick. Similar to above the TCs near to the brick axis show a faster response for the zoned load and those nearer to the edge a slower response. There is a striking difference in the maximum temperatures and temperature gradients between the zoned and normal loads. The zoned load being significantly cooler.

In each case, the ‘cut to idle’ phase occurs after 3 minutes of ‘start regen’. This is optimised for the uniform case. This means that the maximum temperatures for the zone loaded case may be higher if this time is adjusted for the zone-loaded case.

Figure 2 DPF temperatures near to front of brick

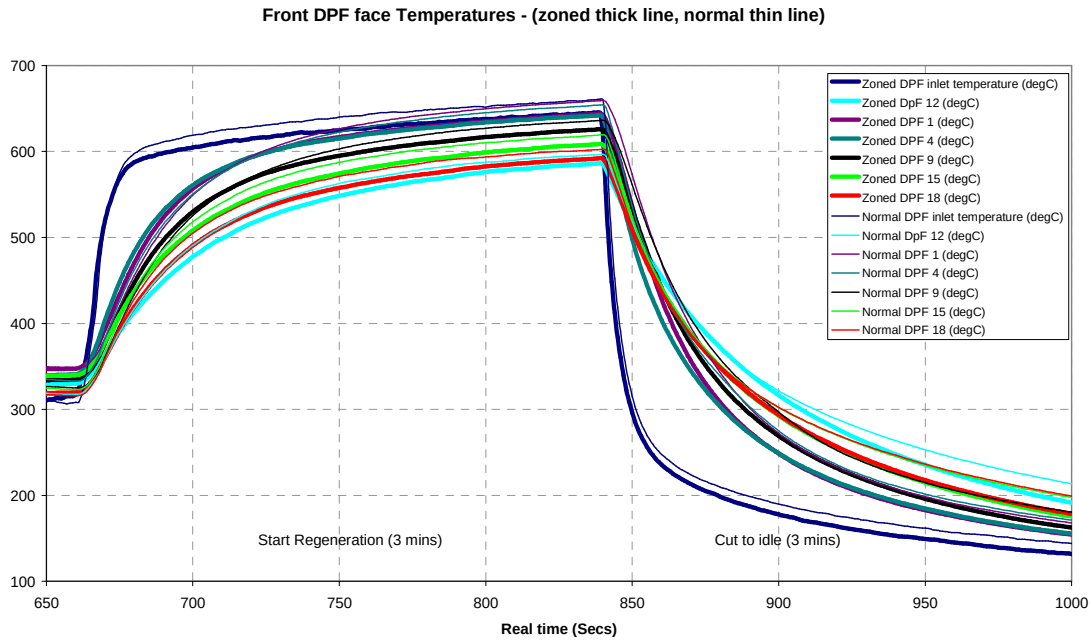


Figure 3 DPF temperatures near to the rear of the brick