



BISAF DPF Evaluation

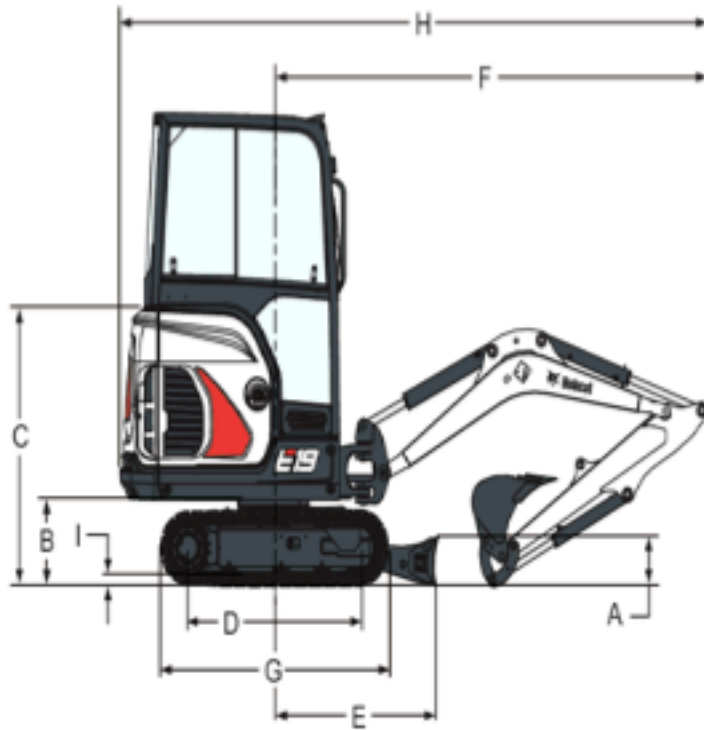
25th May 2018

Background

- BISAF produce a DPF accessory for excavators so that operator exposure to particle emissions can be minimised when they are used in confined spaces:
 - The Particulator.
- The Particulator consists of a cordierite DPF contained in a housing with a control system to allow cleaning (regeneration) of the filter.
 - The regeneration process is carried out in an engine-off condition with heater power supplied through a 110 V power supply.
- This presentation covers results from tests of the Particulator system fitted to a Bobcat excavator under various conditions:
 - A vehicle test cycle under simulated normal operating conditions with a relatively full filter.
 - A filter regeneration cycle (engine-off).
 - A vehicle test cycle under simulated normal operating conditions after the filter regeneration.

Test Vehicle

- Bobcat E19 Excavator



- (A) 235.0 mm
- (B) 419.0 mm
- (C) 1340.0 mm
- (D) 1114.0 mm
- (E) 1045.0 mm
- (F) 2832.0 mm
- (G) 1476.0 mm
- (H) 3831.0 mm

Test Set-up

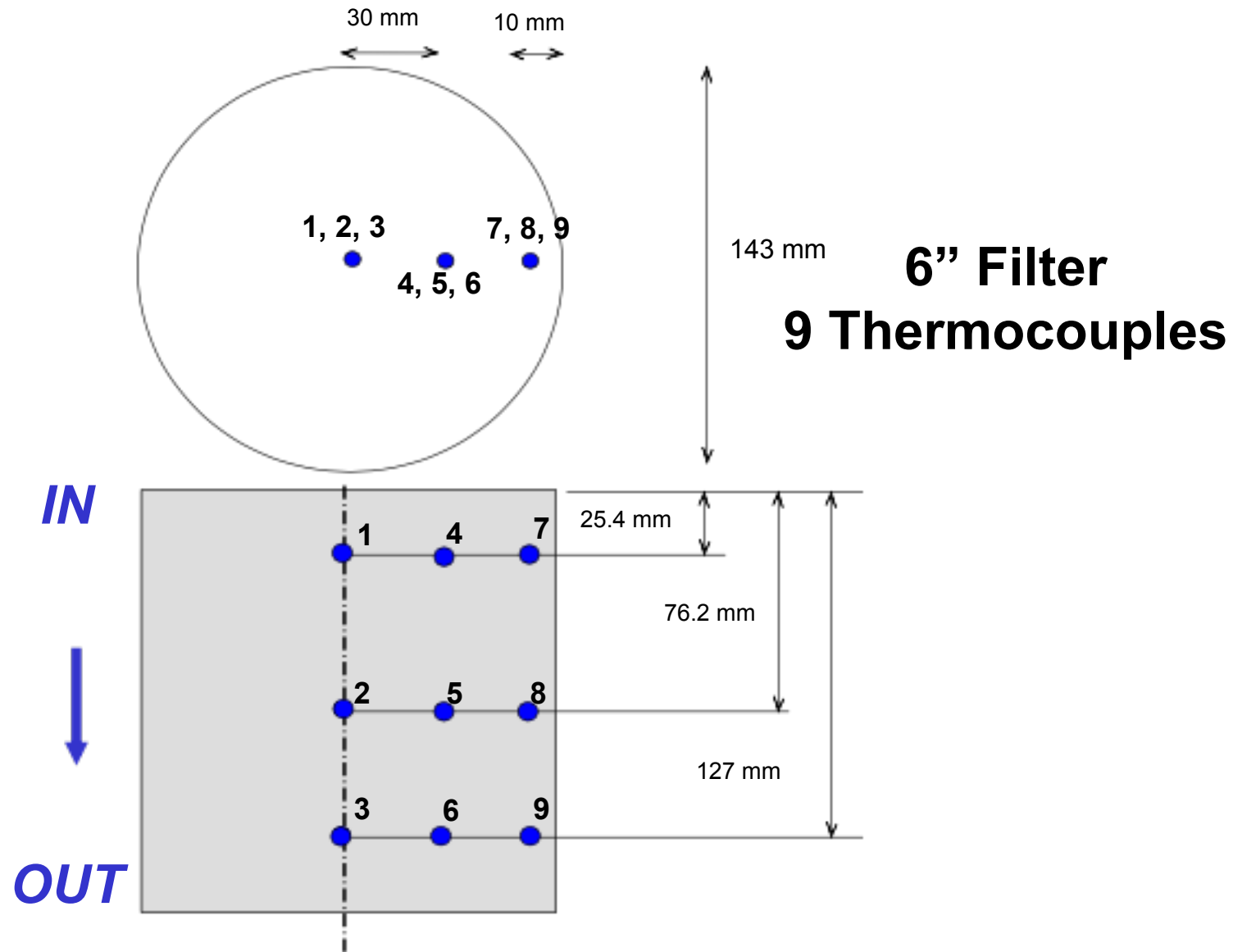
- Bobcat E19 excavator



Test Set-up

- The vehicle used was a Bobcat excavator
 - Fuel used (red diesel as received)
- Primary measurements were emissions in a dilution tunnel.
 - Gaseous Emissions (THC, CO, NO_x, CO₂)
 - Particulate Emissions – Number (PN, using PMP technique), Mass (PM via DMS500) & Size (via DMS500).
- Other measurements were taken:
 - DPF Internal Temperatures, nine internal brick thermocouples
 - DPF Inlet Temperature (between the heater element and the front face of the DPF)
 - ‘DPF Wall’ Temperature (between the filter cartridge and the wall of the filter assembly)

BISAF DPF Thermocouple Map



Test Set-up



Standard Test Cycle (STC)

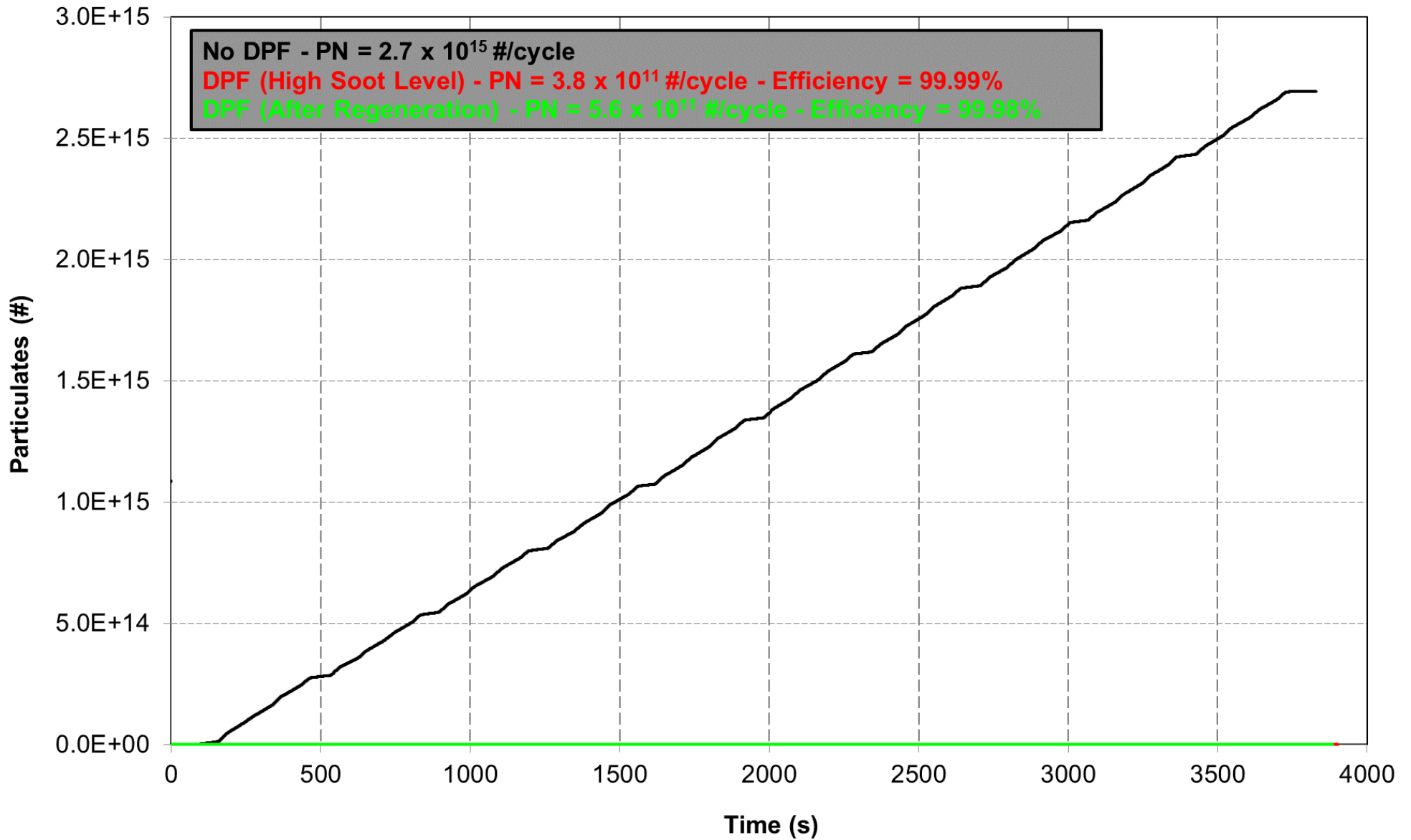
- Idle for 60s.
- Increase engine speed to maximum revs 2650 rpm and lift arm to maximum height (approx 2,000mm) fully extended (approx 3,000mm over a period of about 30s lifting a test weight of 300kgs.
- Hold for 60s.
- Return arm to ground position 30s.
- Hold at high idle for 60s.
- Raise arm to maximum height 30s.
- Hold for 60s.
- Return arm to ground position and decrease revs to idle 30s.

Test Programme

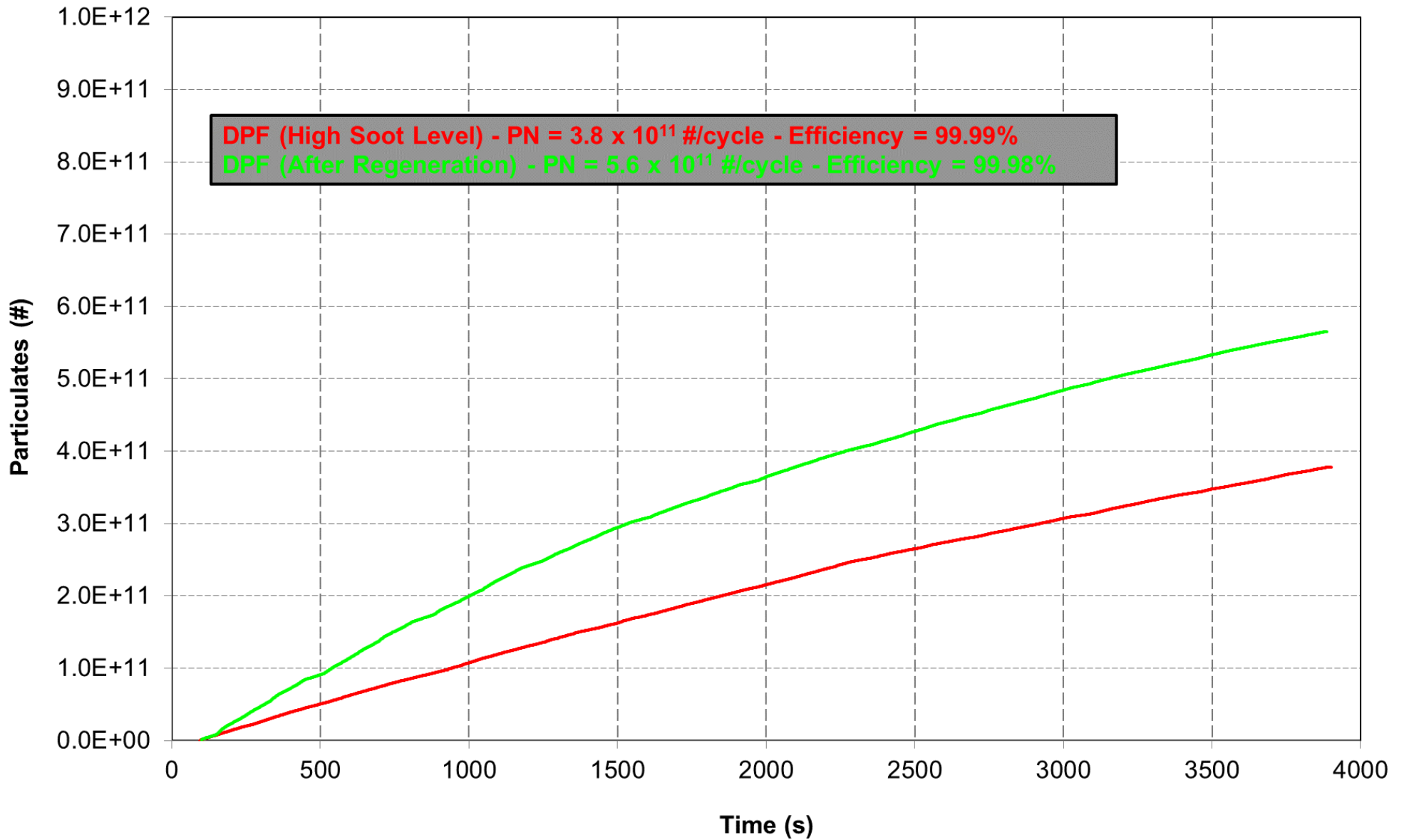
- Warm-up – 4 x STC
- Baseline test with no DPF fitted – 10 x STC.
- Fit DPF Assembly followed by Warm-up – 4 x STC
- Evaluate conditioned DPF – 10 x STC.
- Regenerate DPF followed by Warm-up – 4 x STC
- Evaluate regenerated DPF – 10 x STC.

Standard Test Cycle Evaluations

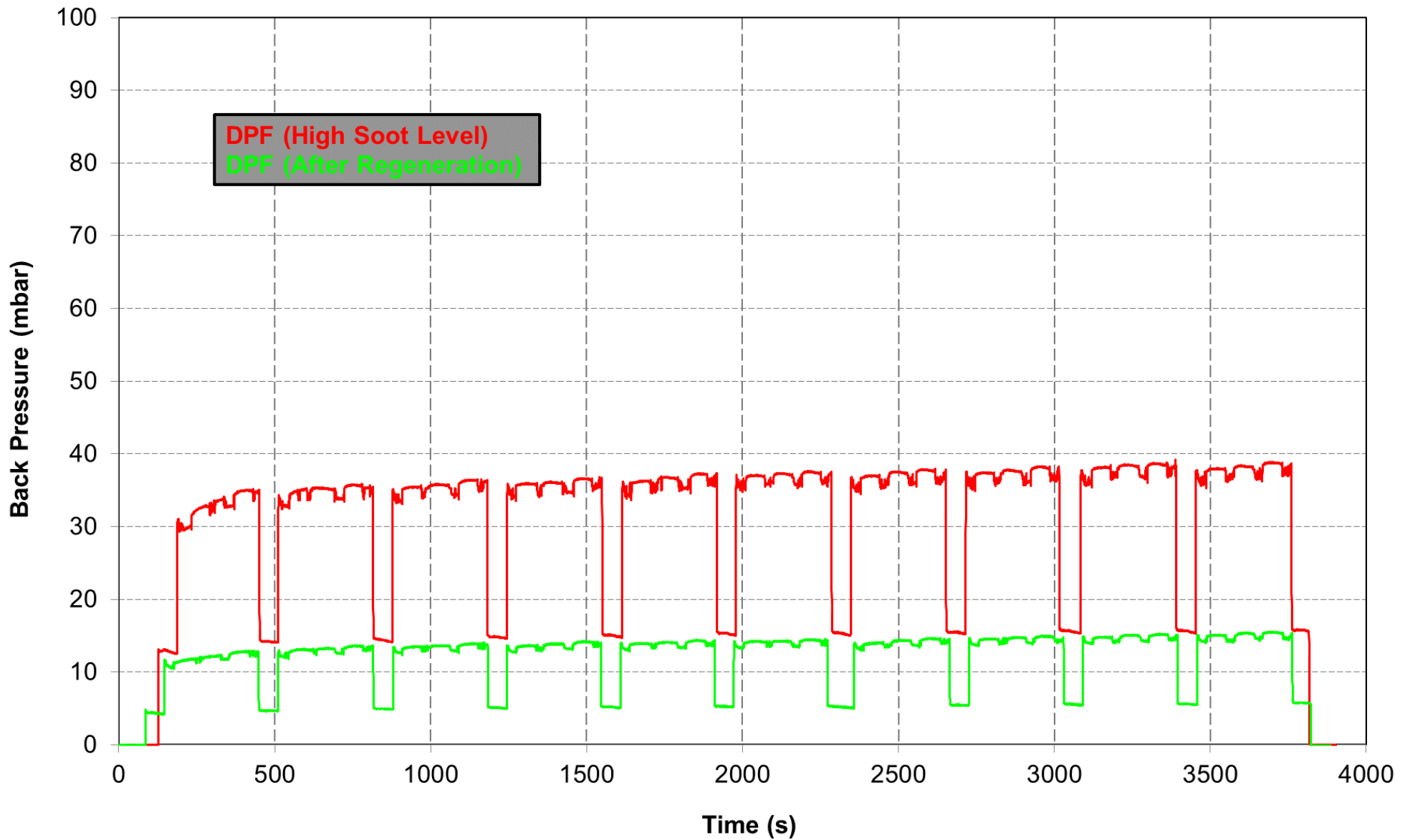
Particulate Number



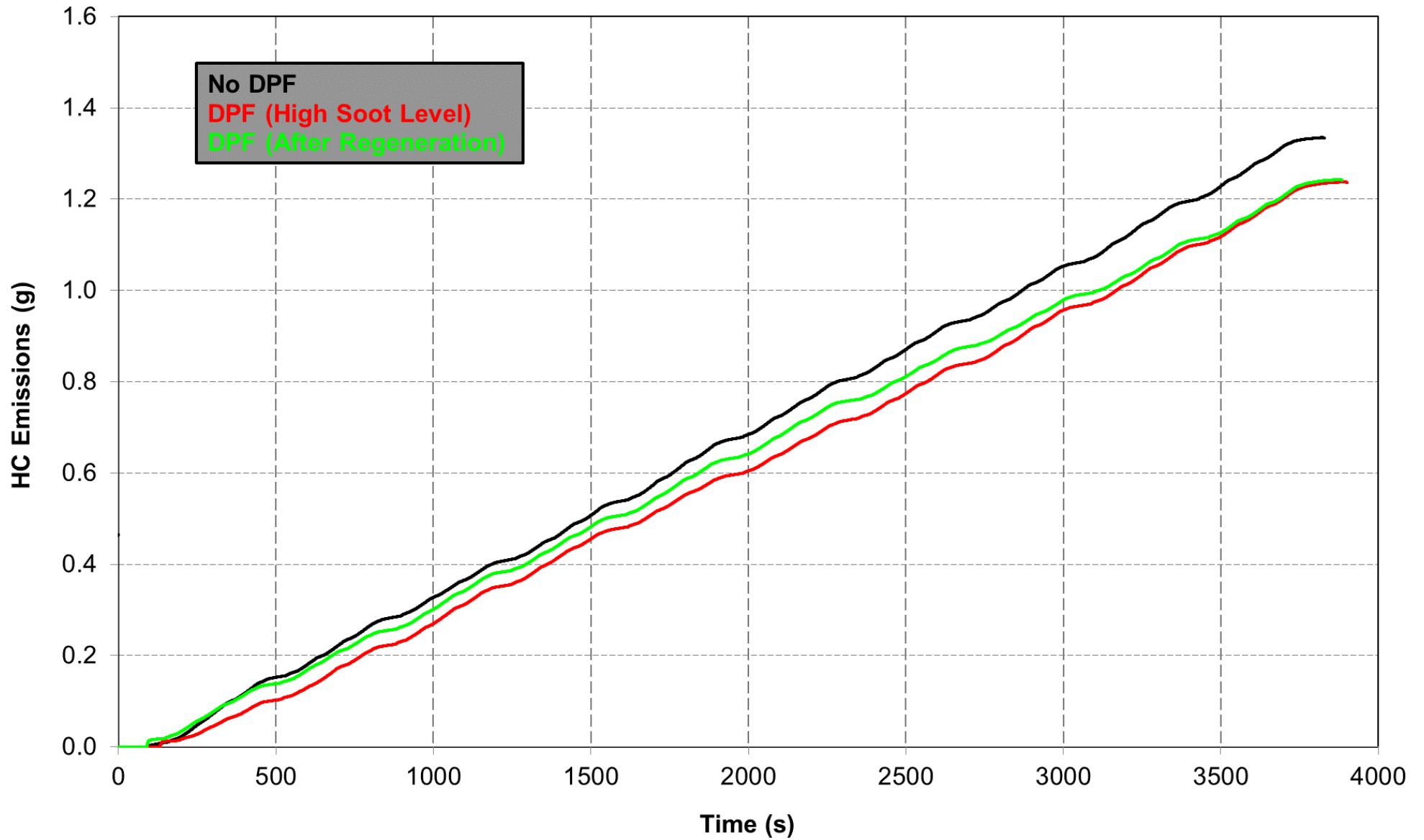
Particulate Number



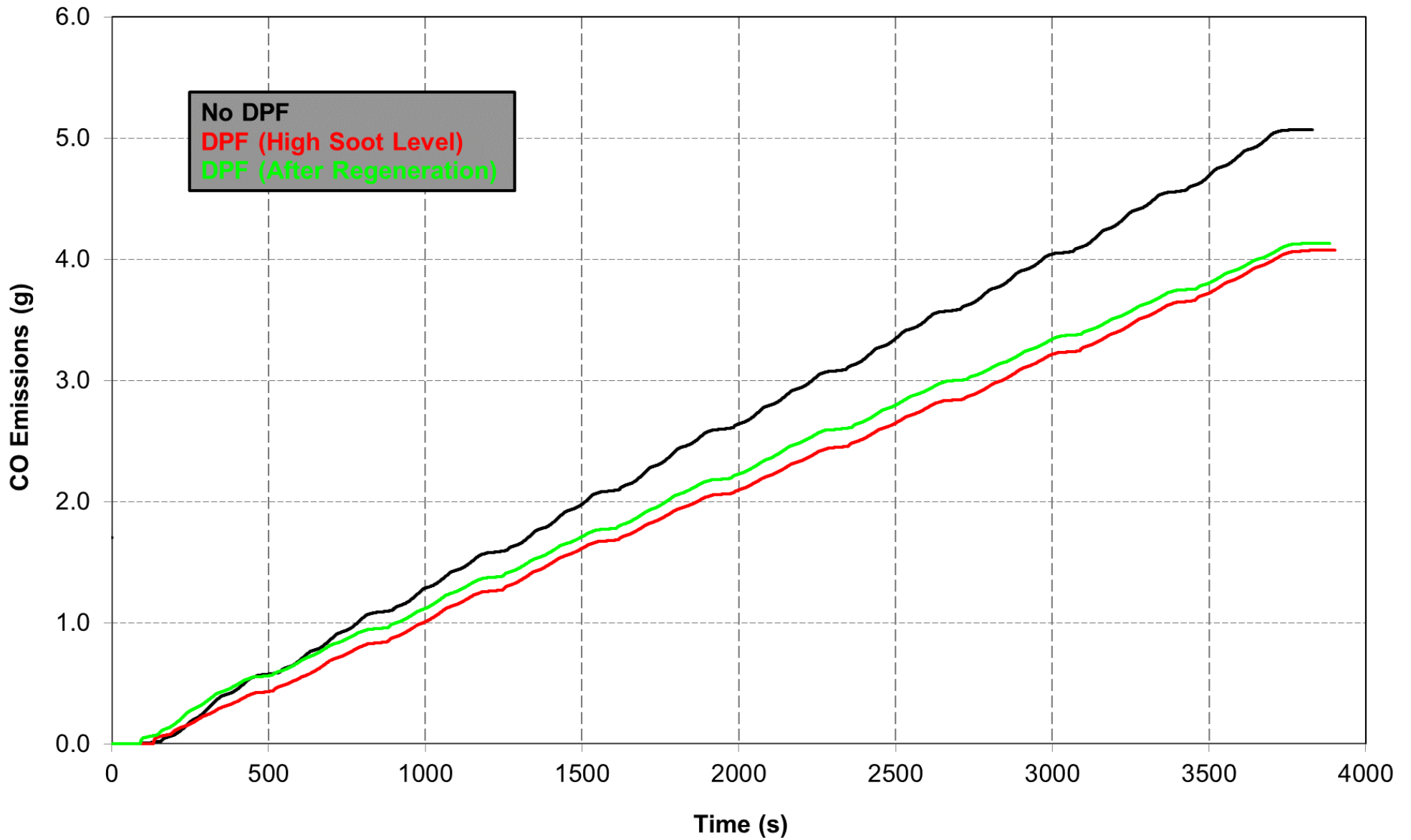
DPF Back Pressure



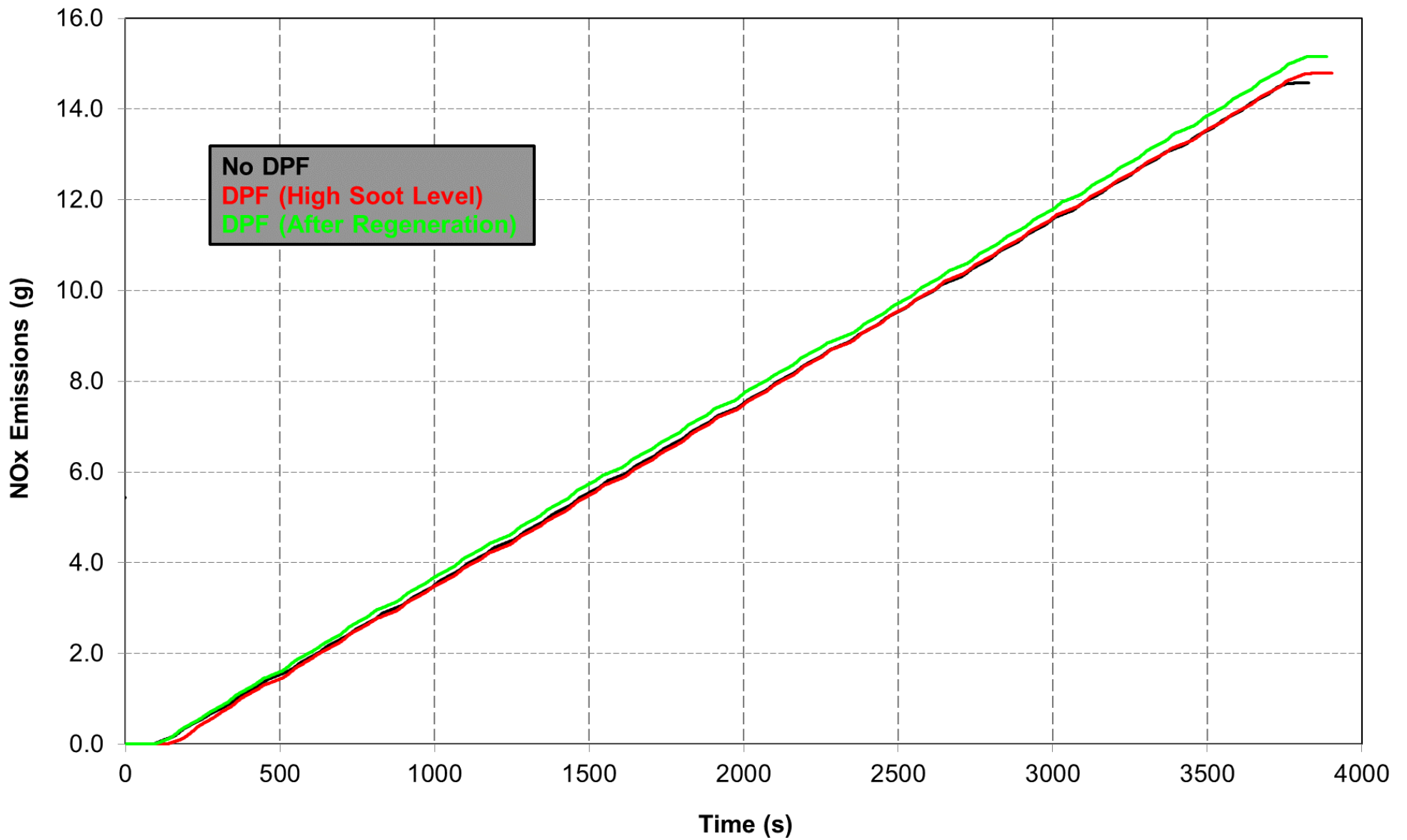
HC Emissions



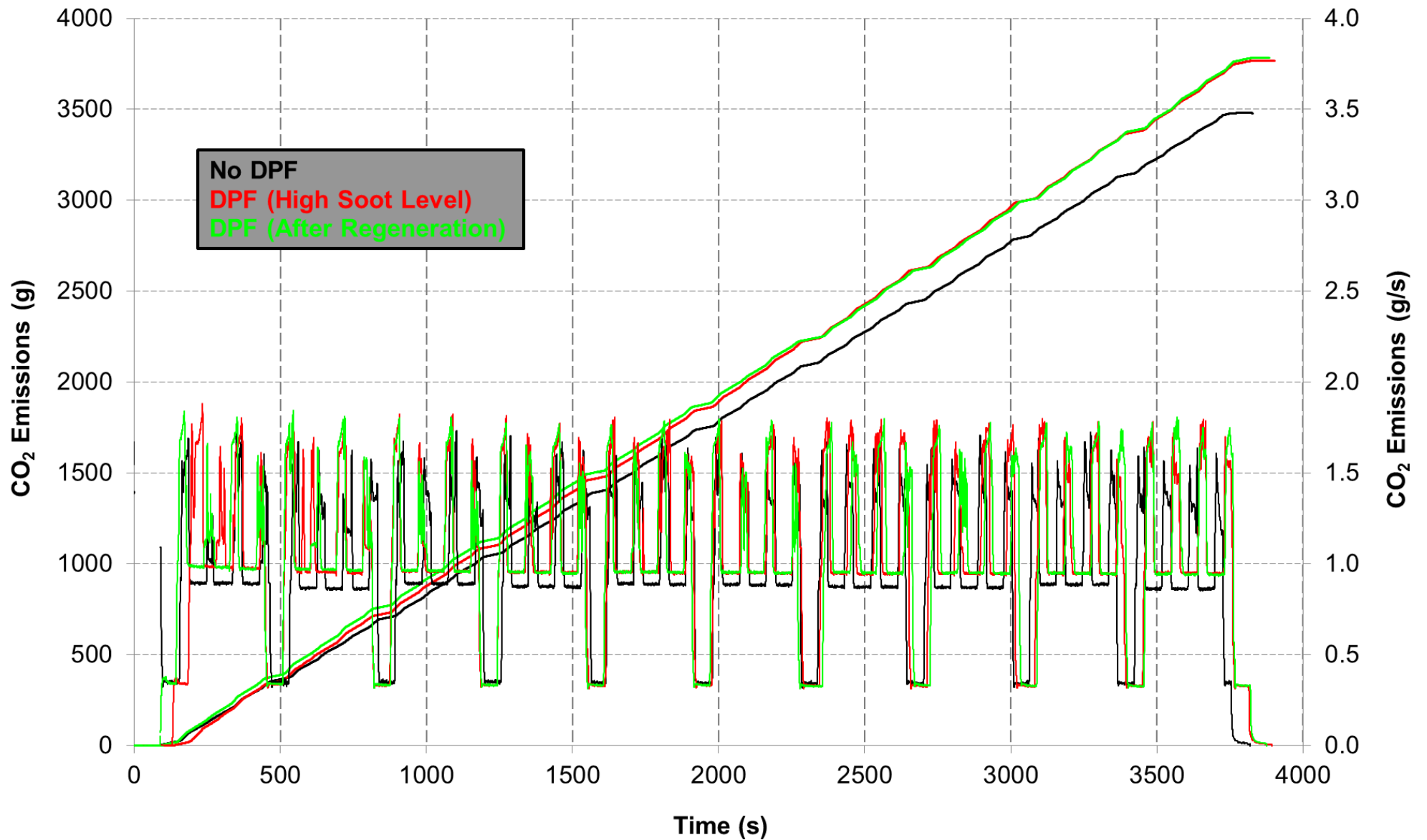
CO Emissions



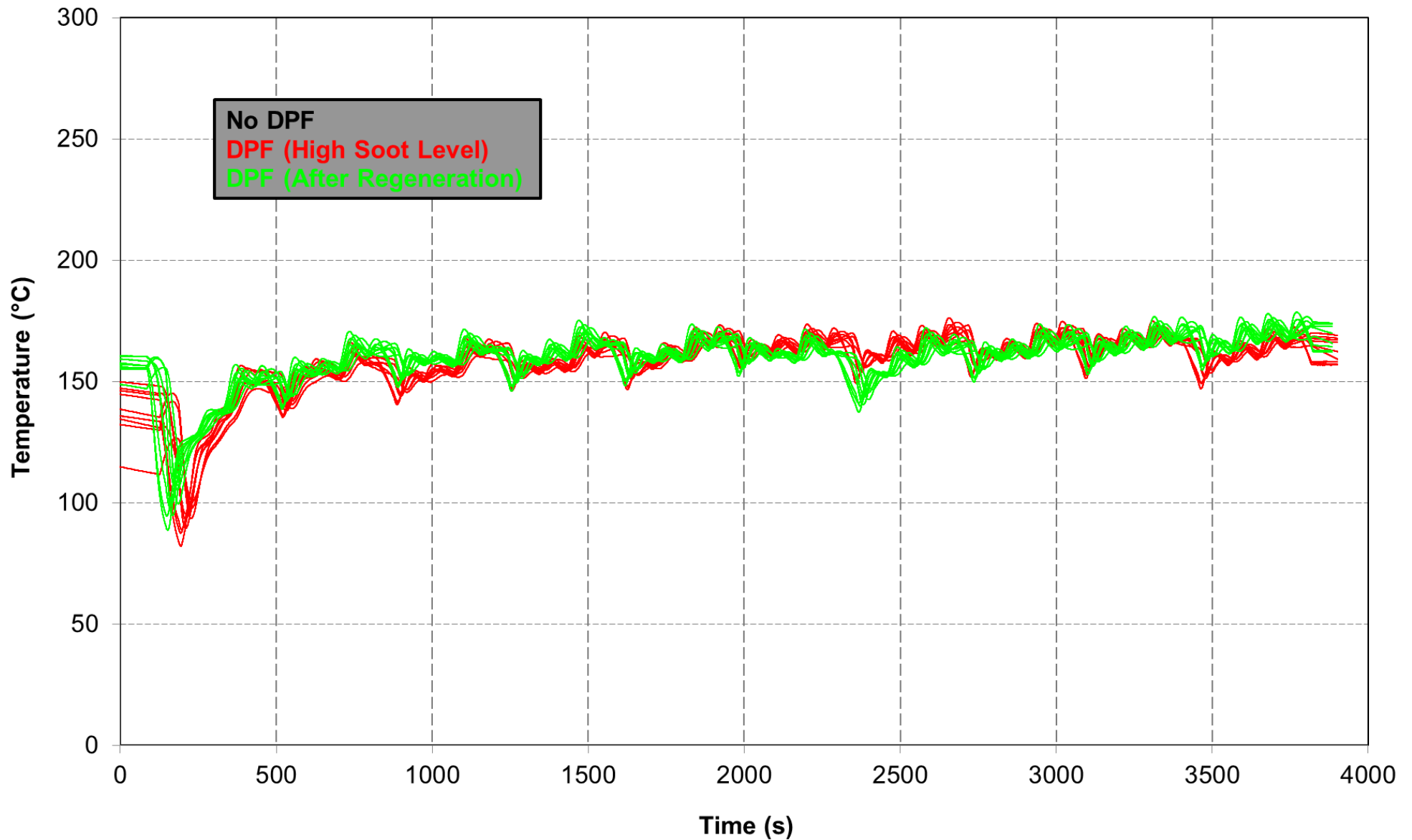
NOx Emissions



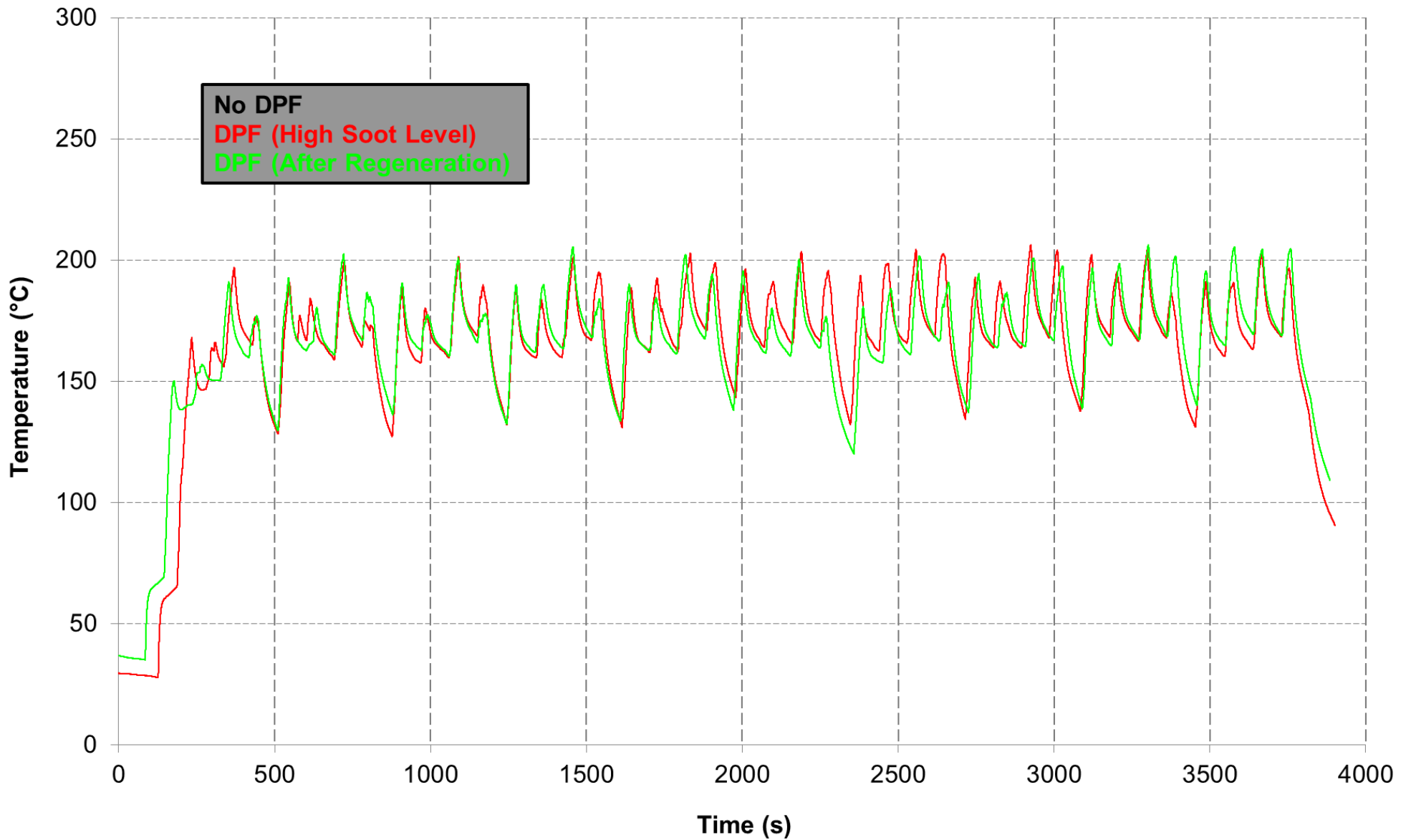
CO₂ Emissions



DPF Internal Temperatures – T1 to T9

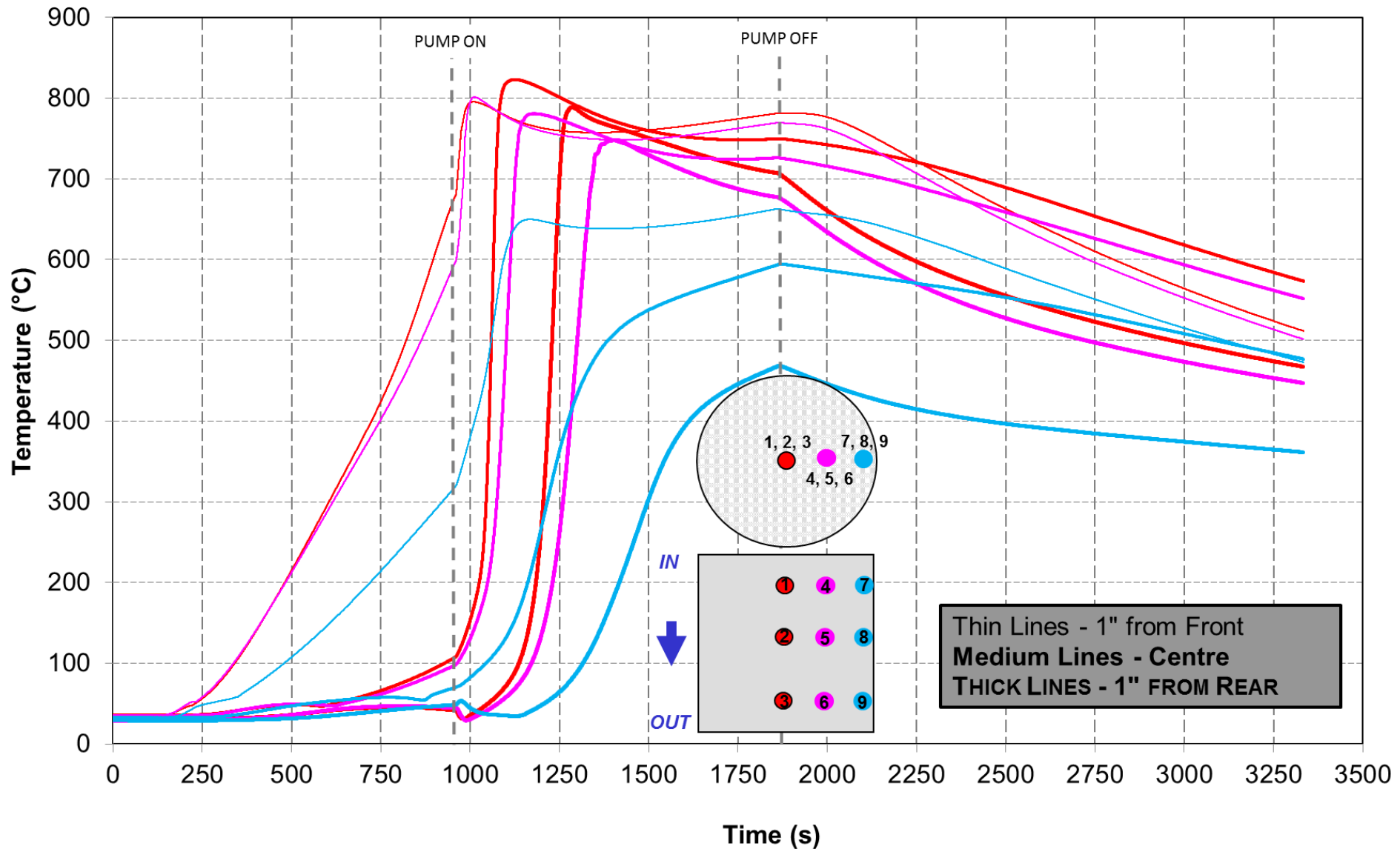


DPF Inlet Temperature

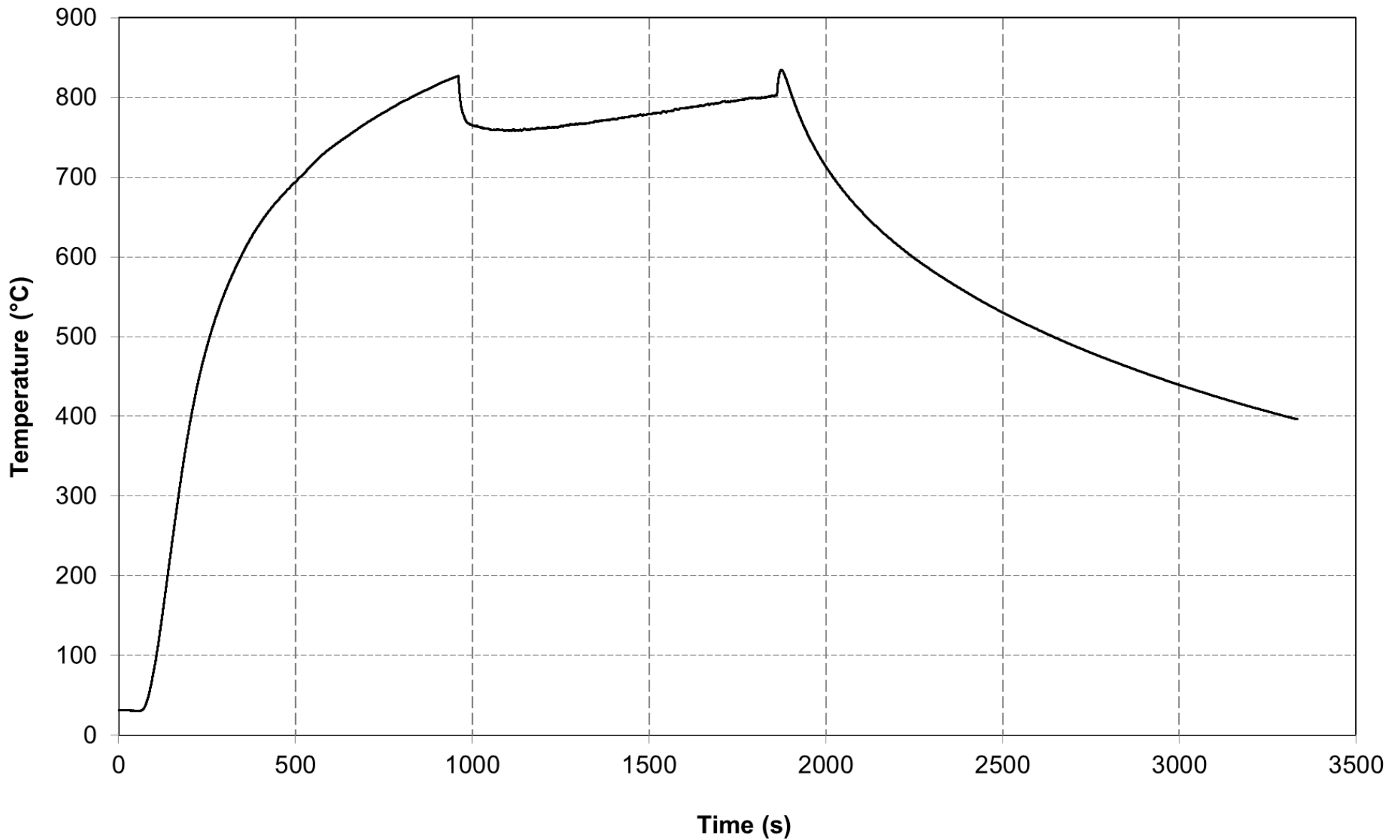


DPF Temperatures During Regeneration

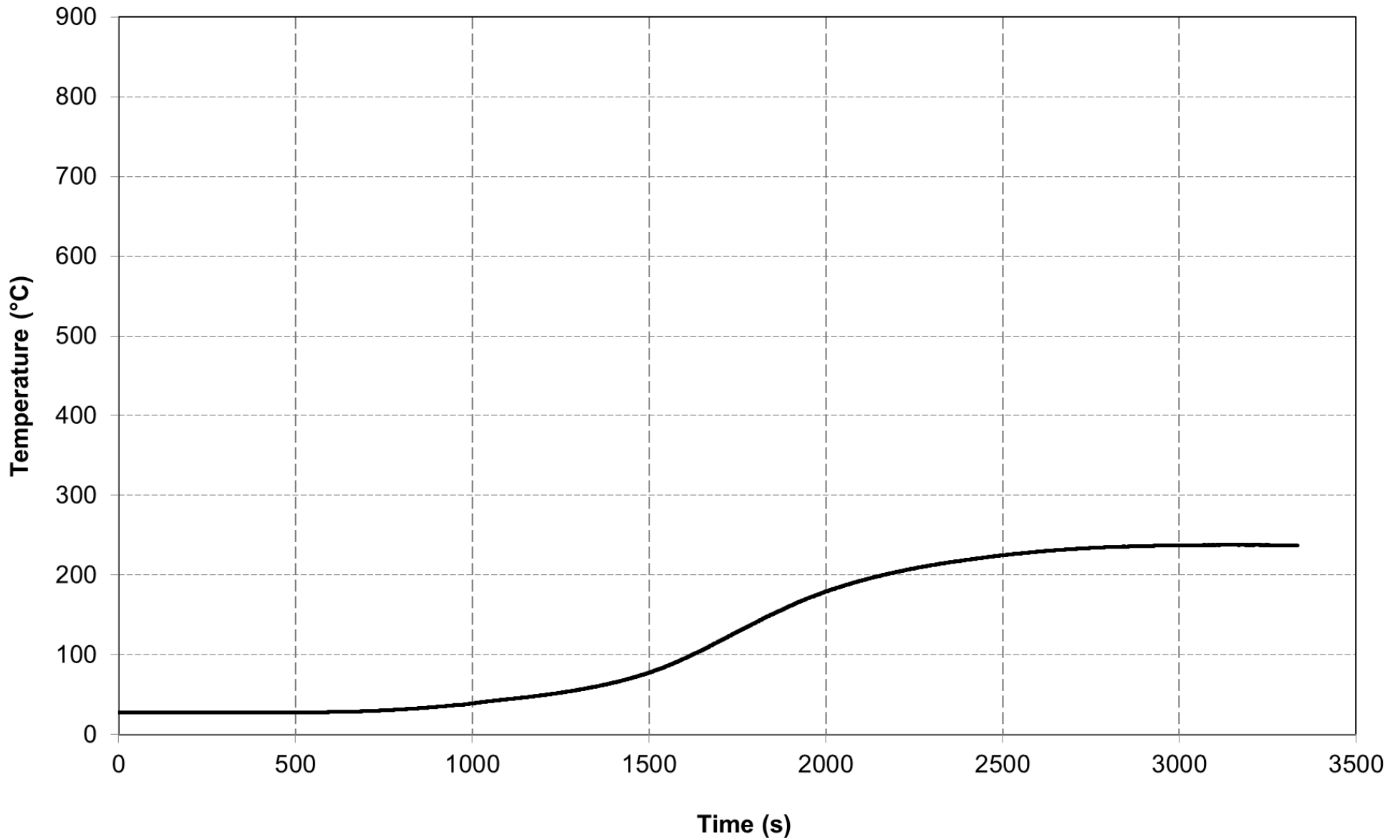
DPF Temperatures T1 to T9 During Regeneration



DPF Inlet Temperature During Regeneration



DPF Wall Temperature During Regeneration



Summary

- The DPF system fitted to the Bobcat excavator in this case was very effective at removing particles from the exhaust stream:
 - Well over 99.9% efficiency of particle removal.
- The regeneration of the filter appeared to be effective:
 - DPF backpressure was substantially lower after the regeneration.
 - Temperatures within the DPF during the regeneration cycle were sufficiently high to oxidise soot on the DPF.
- Gaseous emissions were largely unaffected by the DPF – as expected:
 - Operator exposure to both NO_x emissions and CO emissions would be a concern in a confined space.