Determination of DPF Passive Regeneration Temperatures Using Dynamic Engine Testing

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Common Challenges

Numerous challenges face those working to reduce diesel emissions in mines.

- Active solutions are maintenance intensive, requiring replacement of filter elements, removal from the vehicle for cleaning, or the addition of external heat to burn off soot.
- Passive solutions require less maintenance and operator input, burning (oxidizing) stored soot with only heat supplied by the engine exhaust. Advantages include:
  - Reduced maintenance time and cost
  - Increased vehicle up-time
- Improperly applied passive systems will plug, requiring removal, cleaning, or even replacement. Hoped-for savings are lost!

Passive System Application

1. Matching a passively-regenerating DPF to the application first requires knowledge of the equipment, and the manner in which it's used.

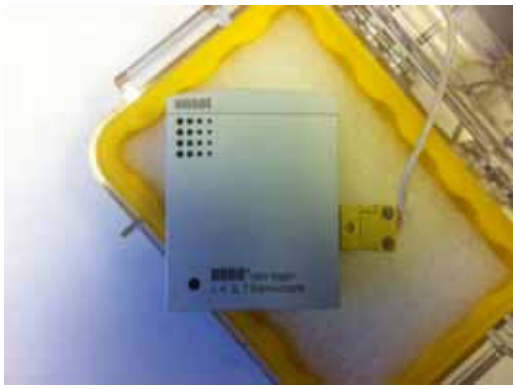
2. The equipment must then be carefully matched to the catalyst system performance.

Passive System Application

- Matching a passively-regenerating DPF to the application first requires knowledge of the equipment, and the manner in which it's used:
  - Engine make, model, size, HP, RPM
    - Backpressure – minimum and maximum backpressure experienced during soot storage and regeneration cycle. Does the maximum exceed engine manufacturer guidelines?
    - Amount of soot storage – how much soot can be stored in the DPF before the maximum permissible backpressure is exceeded.
  - What is the equipment duty cycle? How is it used? It is necessary to know if the exhaust remains hot enough, for a long enough period of time, to regenerate the DPF.

Determine Equipment Duty Cycle

- Measure exhaust gas temperature over a duration of time, ideally several shifts.



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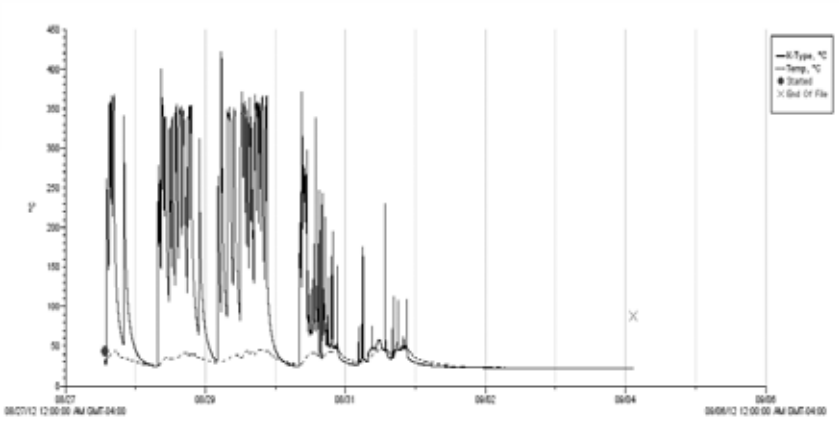
Determine Equipment Duty Cycle

- Data logger collects exhaust gas temperature vs. time



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Determine Equipment Duty Cycle

Bin Temp, 10 deg C intervals, upper value	Count=Num of times exhaust is within T 10-deg "bins"	Percent of time that exhaust is greater than T	Applicable DPF System
100	18		
110	235		
120	230		
130	209	100.0%	
140	224	95.3%	
150	182	90.2%	
160	201	86.1%	Active
170	186	81.6%	Active
180	174	77.4%	Active
190	184	73.5%	Active
200	174	69.4%	Active
210	167	65.5%	Active
220	152	61.7%	Active
230	141	58.3%	Active
240	153	55.1%	Active
250	182	51.6%	Active
260	167	47.5%	Active
270	113	43.8%	Active
280	83	41.2%	Active
290	94	39.4%	Active
300	87	37.3%	Active
310	78	35.3%	Active
320	90	33.5%	Active
330	118	31.5%	Light Catalyzed DPF + Fuel Borne Catalyst
340	237	28.9%	"
350	608	23.5%	"
360	371	9.8%	"

Temperature vs. time data is used to create a histogram. The temperature that is exceeded 30% of the time is called the T30% temperature, and is a critical piece of information for specifying passively-regenerating catalysts. (NIOSH, May 15, 2003 spreadsheet)

" | Heavily Pt Catalyzed

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Determining Catalyst Performance

- The applications engineer, after performing the previous steps, now has a good idea of the use of the equipment. The next step is to match the equipment type and usage to the appropriate CDPF system.
- Soot-handling performance must be determined by the manufacturer. This includes the amount of soot that can be stored before permissible backpressure limits are exceeded, and the temperatures necessary to cause regeneration.

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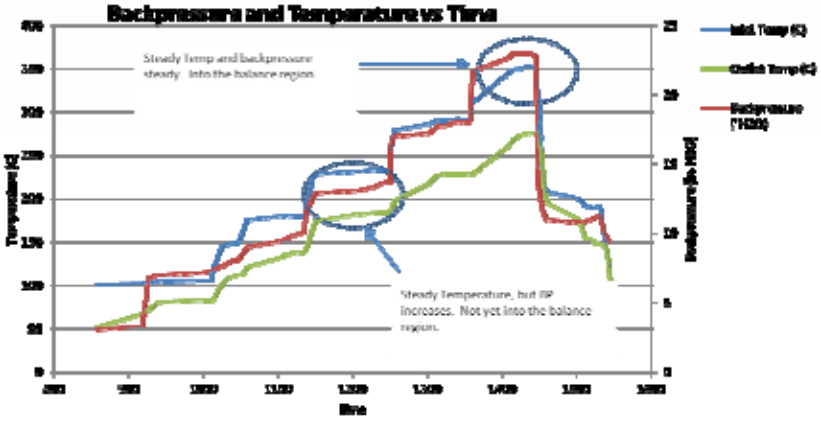
Determining Catalyst Performance

An example of a steady-state test to determine temperature of catalyst regeneration.



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Determining Catalyst Performance

- From the previous graph, balance point is the temperature at which the CDPF is oxidizing soot at the same rate that it is being deposited. This is a unique point that is dependent upon the rate of soot created by the engine and the ability of the catalyst to process the soot.
- The balance point is indicative of performance, but is not sufficient to fully understand catalyst performance or to confidently apply the catalyst to applications.
- A more dynamic test must be performed.

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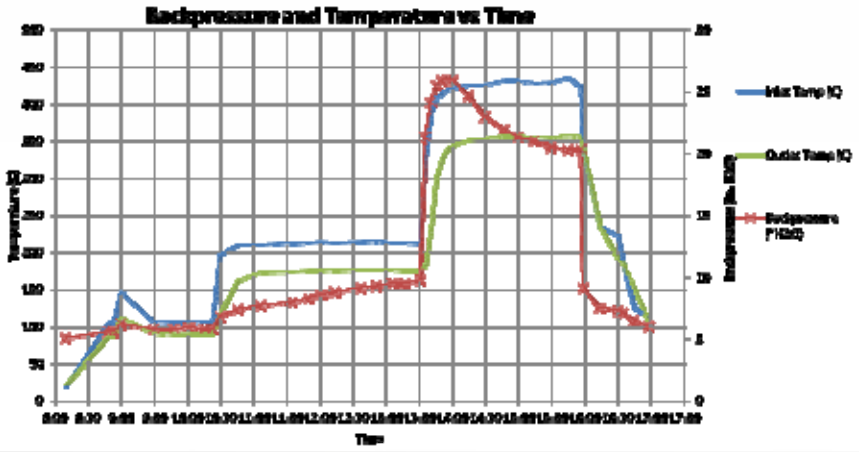
Determining Catalyst Performance

- An example of a dynamic test.



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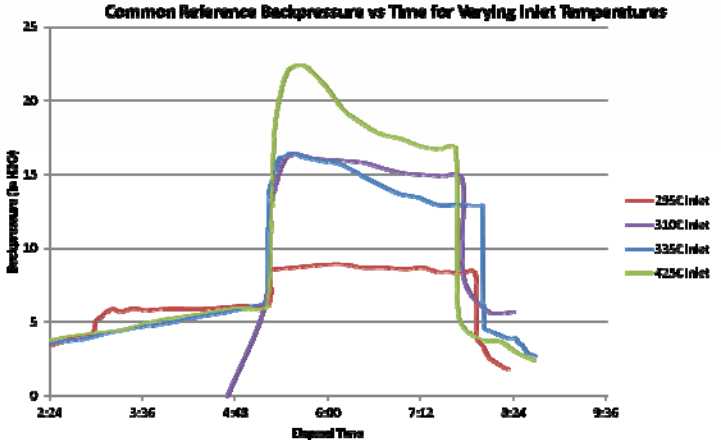
Determining Catalyst Performance

- Different regeneration rates are evident with varying inlet temperature.



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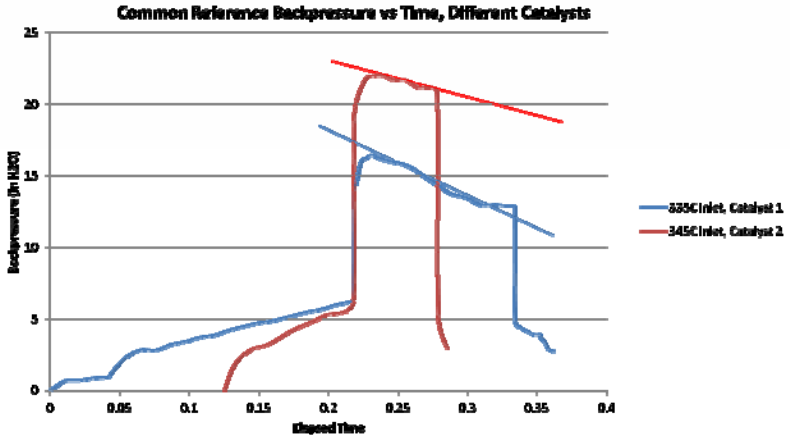
Determining Catalyst Performance

- Different regeneration rates are also evident with different catalysts.



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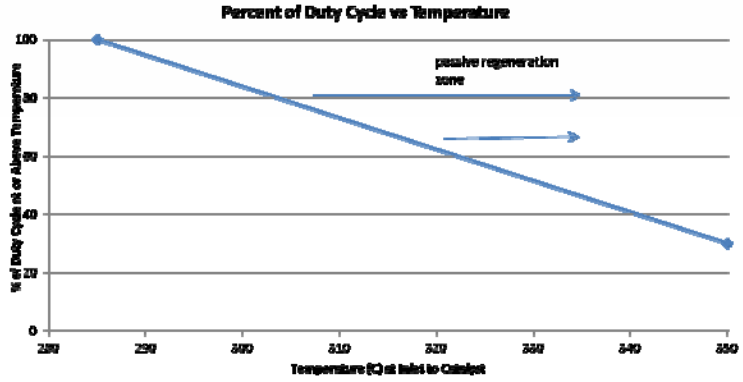
Applied Performance Information

- With this information, the equipment duty cycle can now be compared to CDPF performance, and the correct system can be selected.



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Summary

- Passively-regenerating CDPFs can offer significant time and money savings, but they must be applied properly. To do so, the applications person must have:
  - Knowledge of the engine, and the manner in which it's used.
  - Knowledge of catalyst performance, based upon testing that closely simulates real-world performance.
- Unfortunately, there's still more to the problem. Often, soot-burning performance is accompanied by increased levels of NO_2. By carefully matching equipment usage with catalyst performance data, a reasonable balance can often be found.
- Any restriction, whether flame arrestor, muffler, or uncatalyzed particulate trap can change emissions, particularly NO_2, coming from the engine. Monitoring is important.