



Catalyzed Particulate Traps: Technology Assessment



DEER Workshop
August 5-9, 2001
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Outline



- Background - Particulate Traps
- Test Procedures
- Test Results
- Modeling
- Concluding remarks

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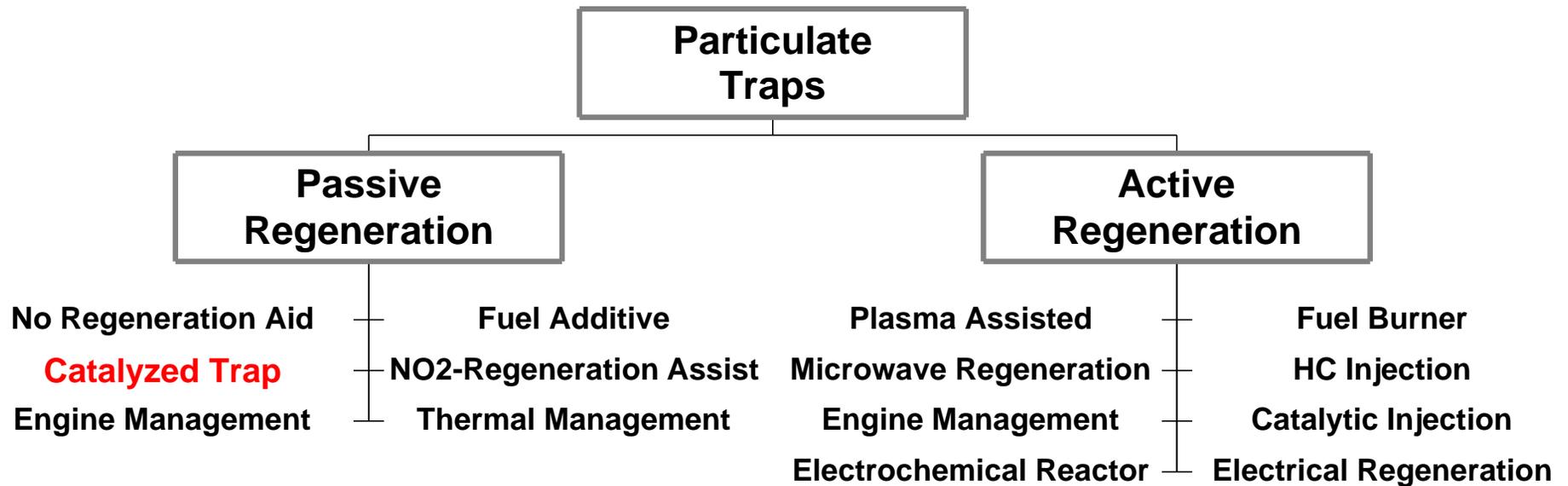


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Diesel Particulate Traps



“Technological” Classification



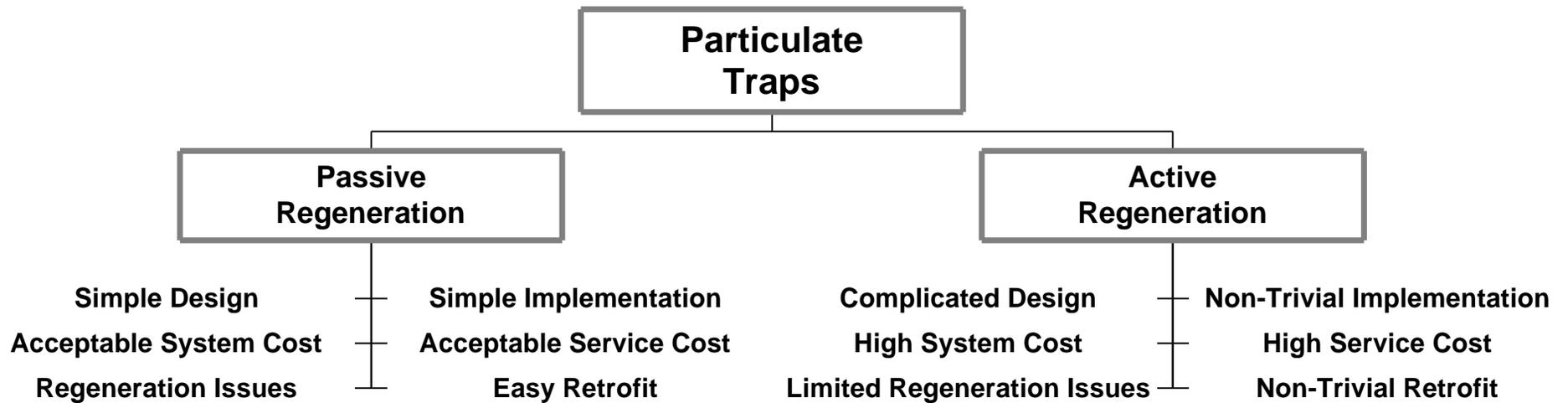
“Preferred”

Alternative

Diesel Particulate Traps



“Acceptance” Classification



“Preferred”

Alternative

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Test Equipment



- Engine: Cat 3126B, HEUI, 190hp
- Oil Consumption: 0.00023 lb/bhp hr (ultra low)
- Oil Spec: 15W-40 CH4 (highest grade)
- Test Cell: Steady-State
- Fuel: <15 ppm S
- Particulate Traps: Trap A, Trap B, (catalyzed)
- Measurements: System Performance
 - » Engine: Speed, Load, BSFC, Emissions
 - » Trap: Δp , T, Emissions, η_{filter} , η_{regen} , Ash

Trap Test Procedures



Test Type

Test Method

-
- | | |
|------------------|--------------------------|
| • Loading: | Gravimetric, Calculation |
| • Balance Point: | Mass Balance |
| • Regeneration: | Controlled, Uncontrolled |
| • Ash: | Gravimetric, Calculation |

Trap Test Procedures



Screening Methodology for Trap Technology

Filtration Characteristics
Regeneration Characteristics
Ash Accumulation



Range of Applications

Trap Loading Strategy

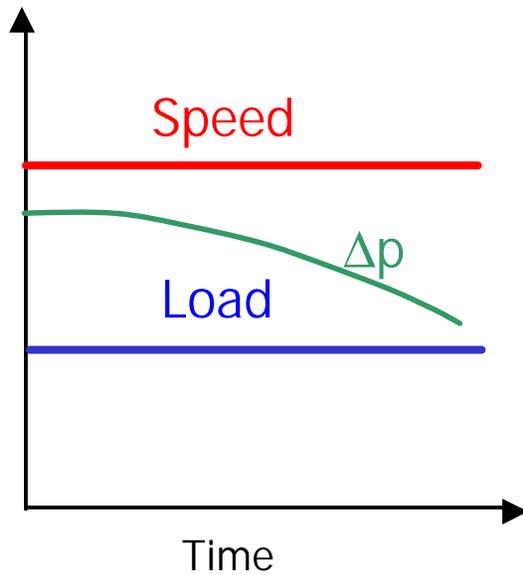


- EPA Mode 11: 45 kW, 2187 RPM
- Exhaust Temperature: ~280 deg C
- Loading Time: 22hrs, 88 hrs
- Loading Levels: 3g/liter, 12 g/liter

Regeneration Strategies

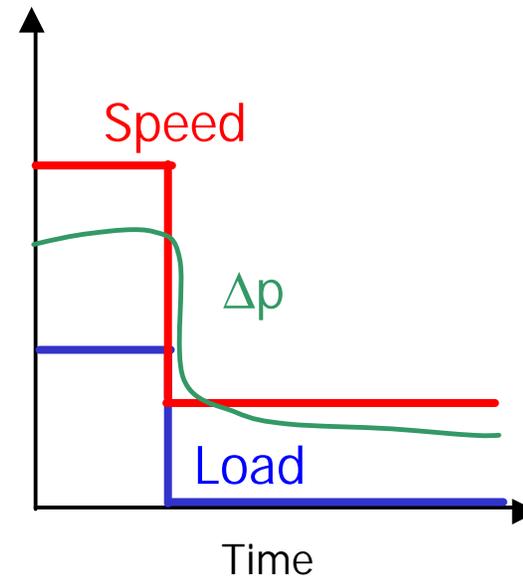


Controlled Regeneration



Exhaust Gas Temperature ~ 450 C

Uncontrolled Regeneration



190 C < Exhaust Gas Temperature < 450 C

Test Matrix



Loading	22 hrs (3g/l)	88 hrs (12g/l)
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Regeneration	Controlled	Uncontrolled	Controlled	Uncontrolled
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Trap A				
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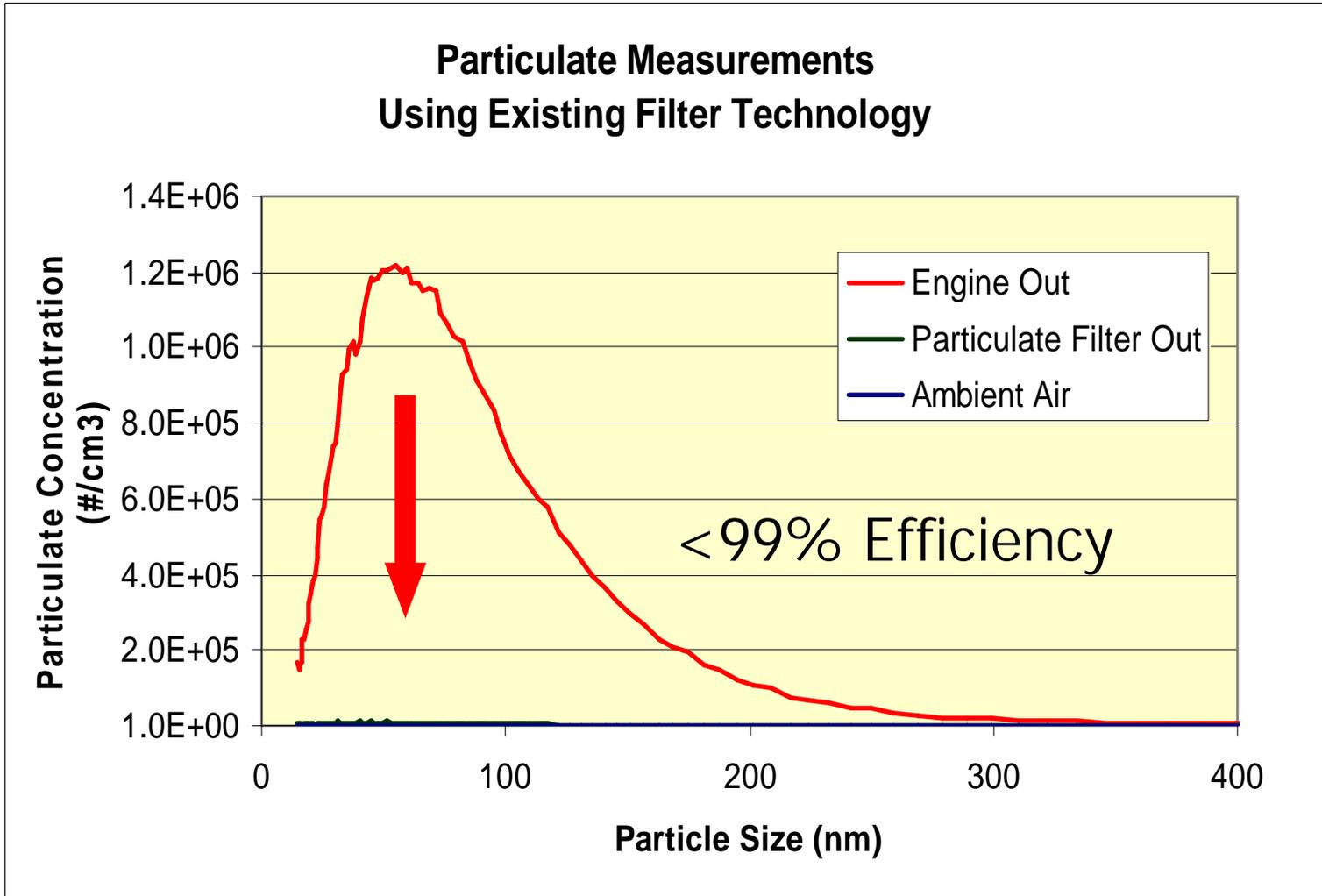
Trap B				
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Outline



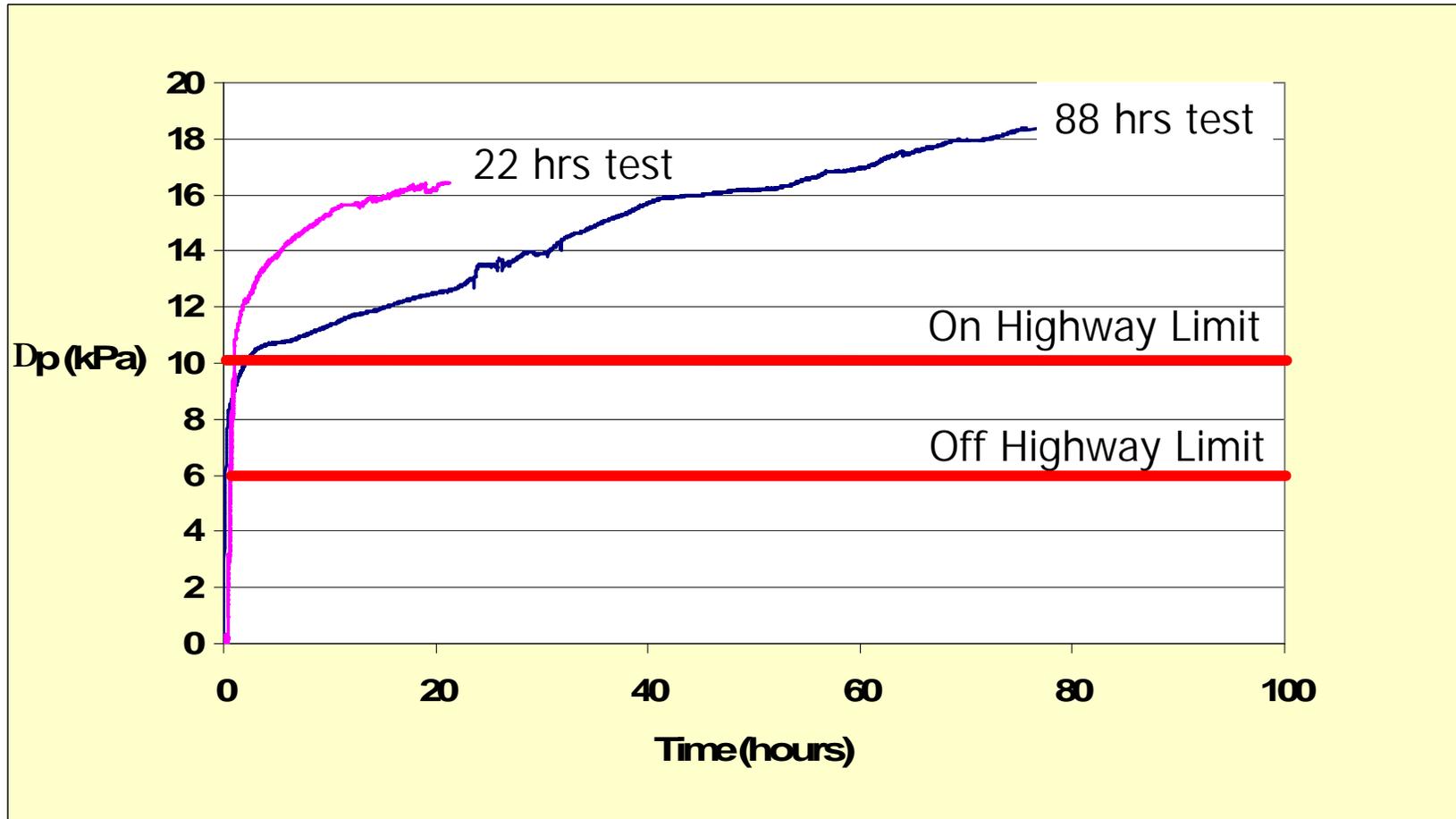
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Filtration Efficiency

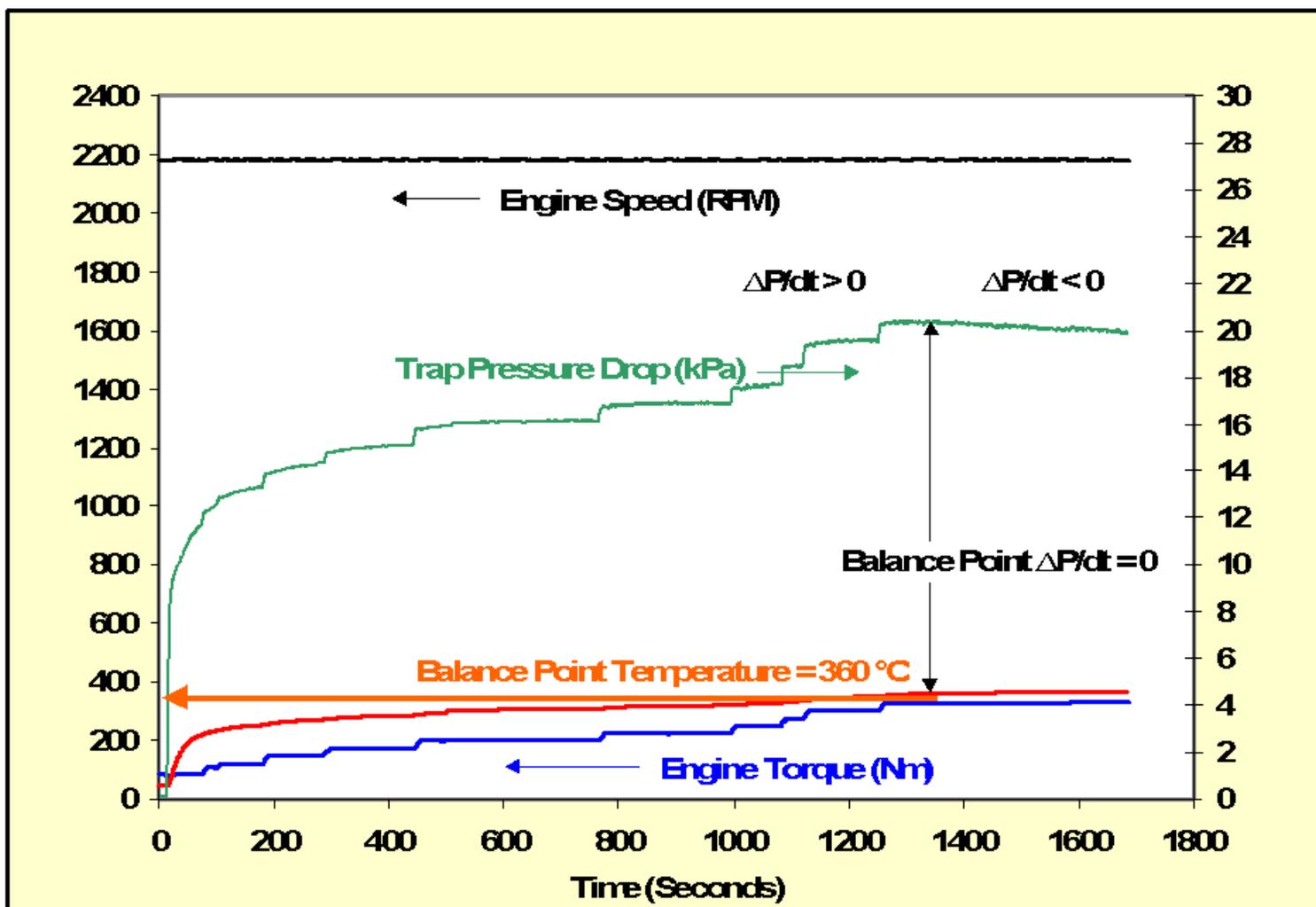


Example of Trap Loading

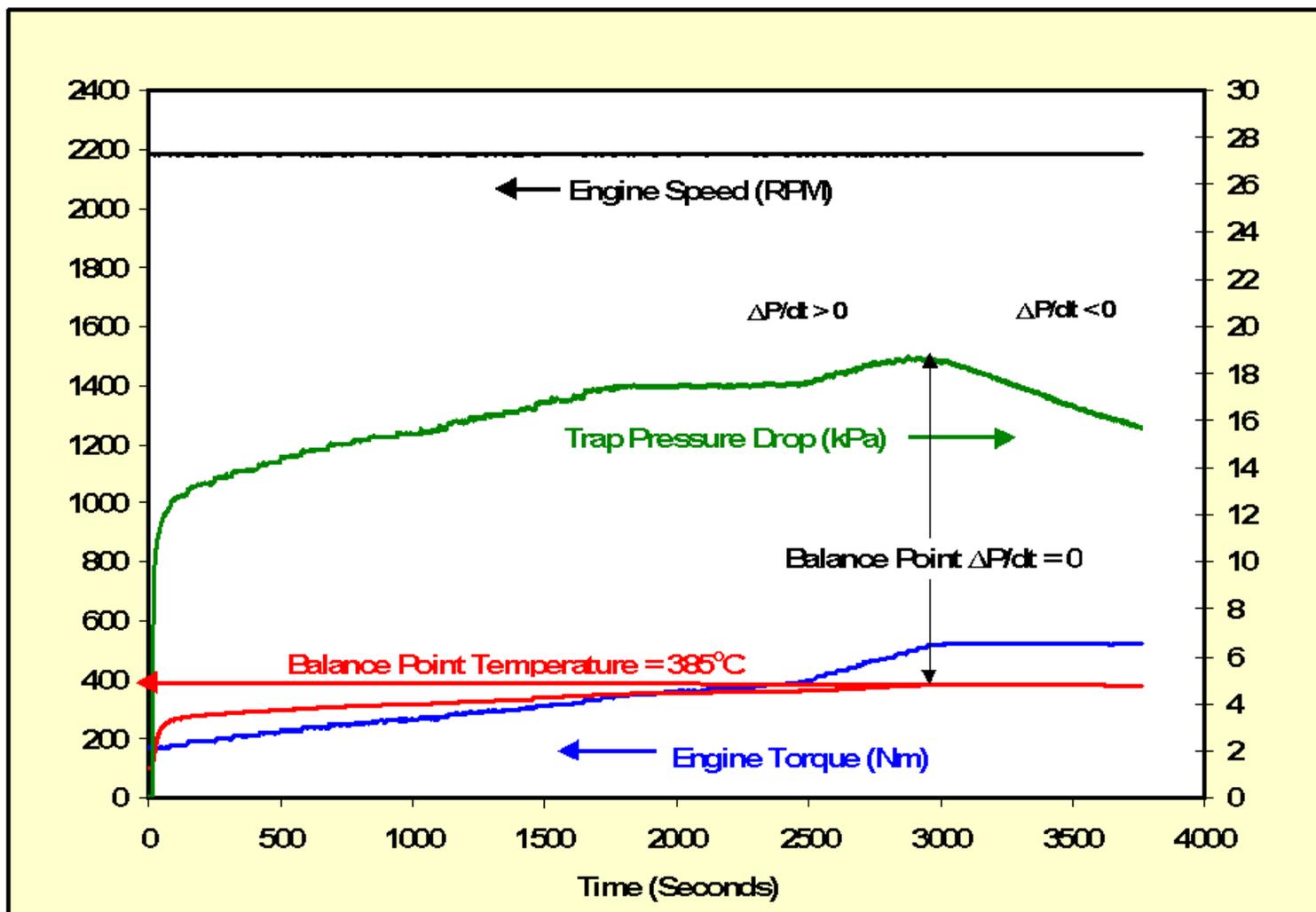
25% Load, Rated Speed, 190 Hp, 7.2 L Engine, 17 Liter Trap



Catalyzed Trap A Balance Point Test, 3 g/liter



Catalyzed Trap B Balance Point Test, 3 g/liter



Regeneration Efficiency



	22 hours (3 g/liter)		88 hours (12 g/liter)	
	Controlled	Uncontrolled	Controlled	Uncontrolled
Trap A	50%	23%	6%	6%
Trap B	75%	13%	15%	*41%

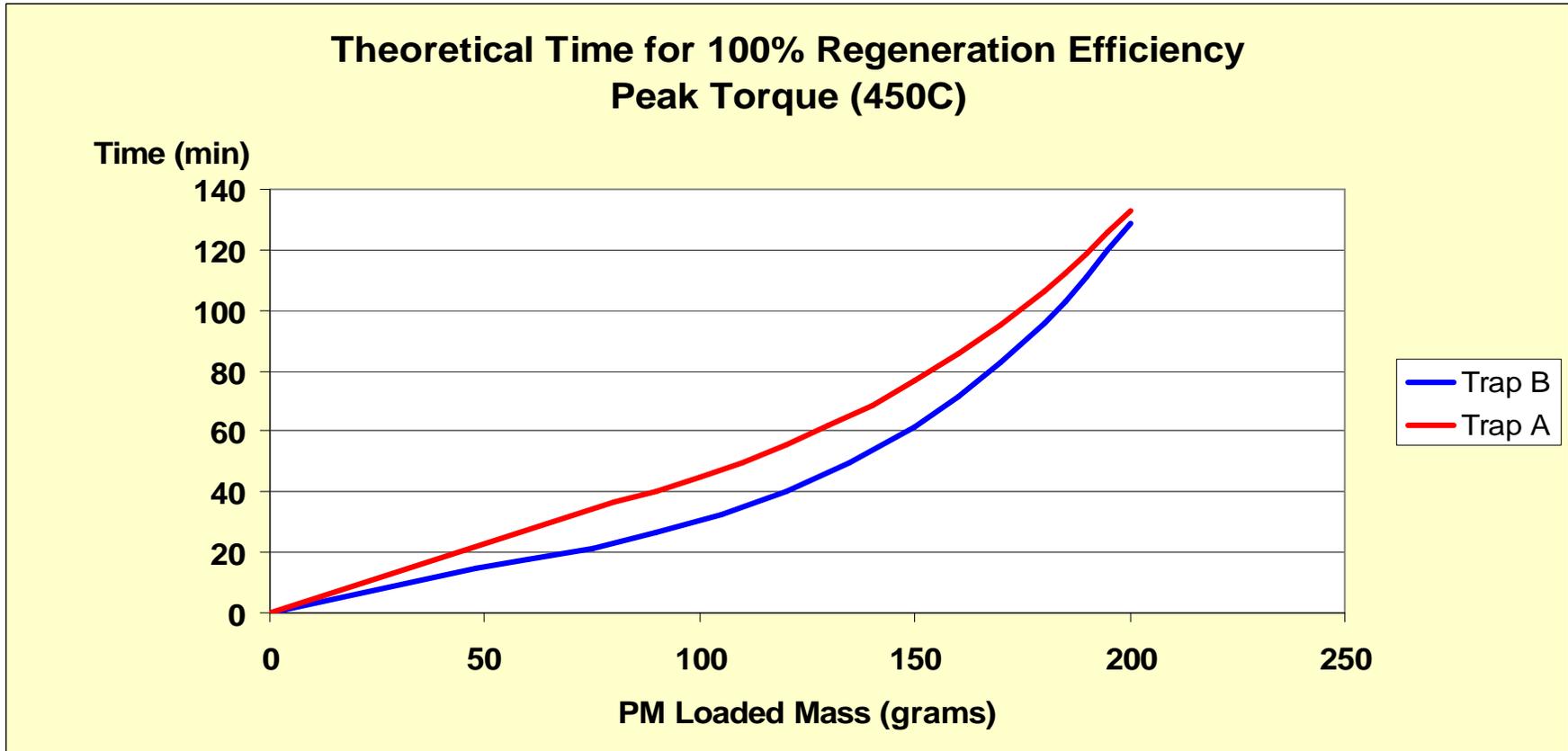
* Outlier - Data Measurement Problem

Outline

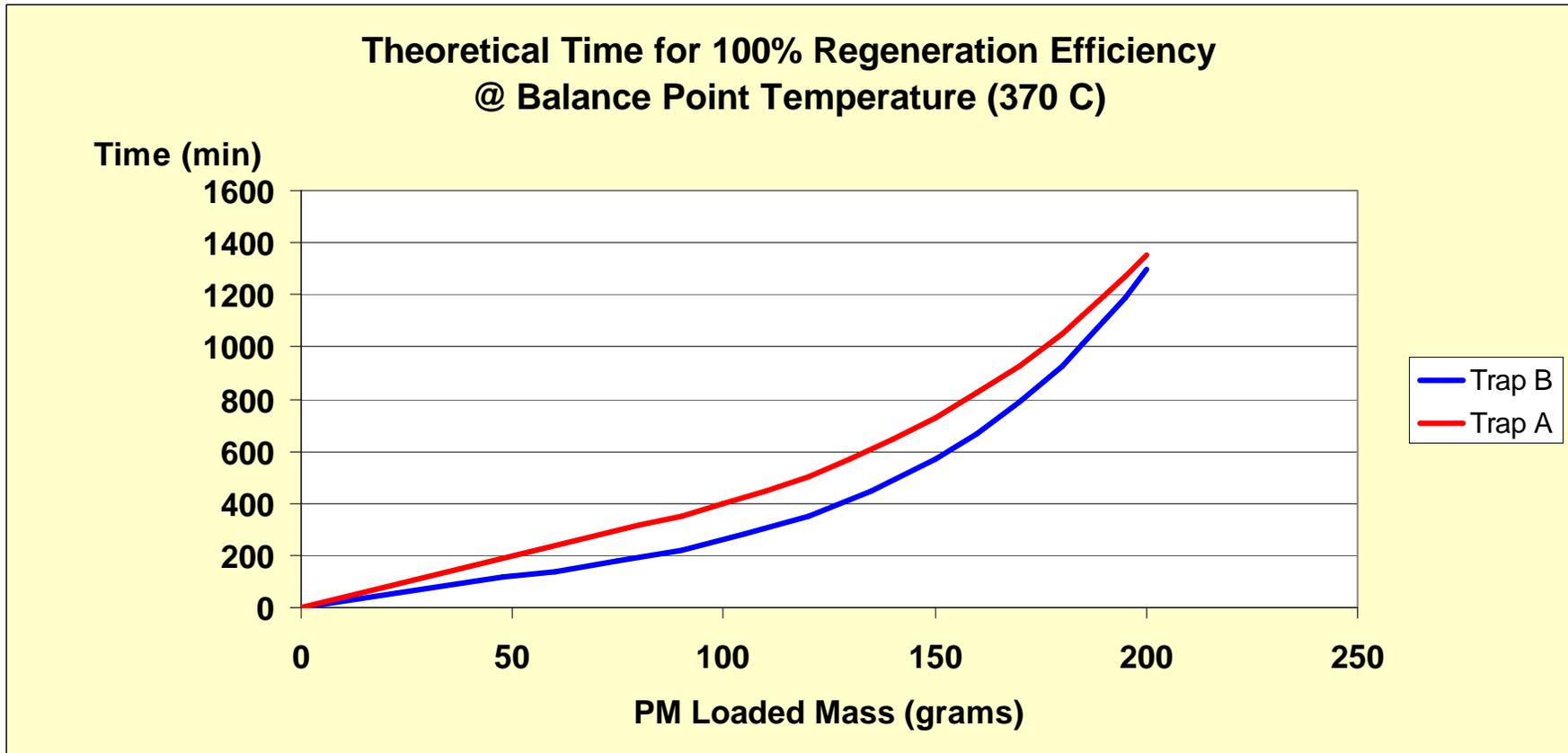


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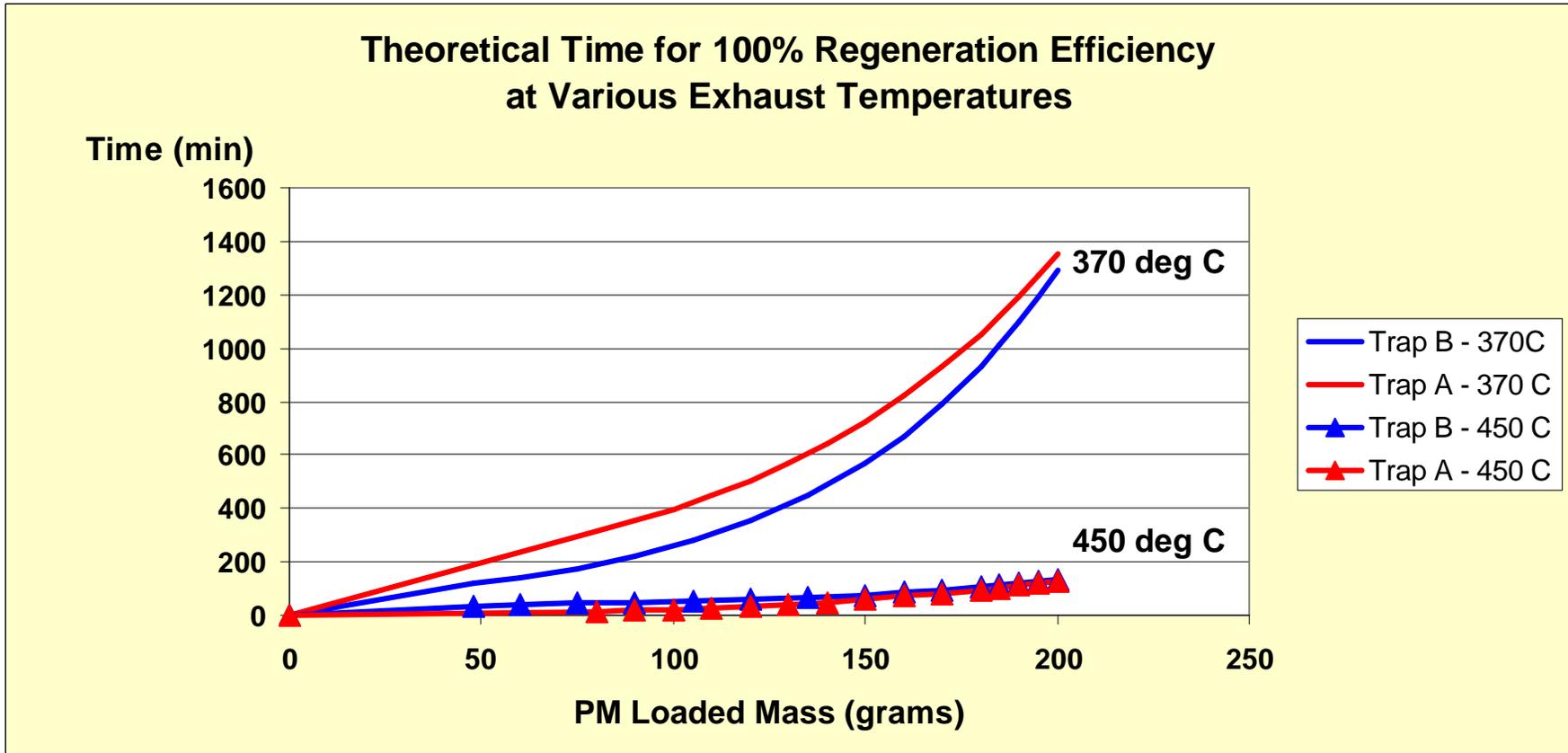
Regeneration Characteristics



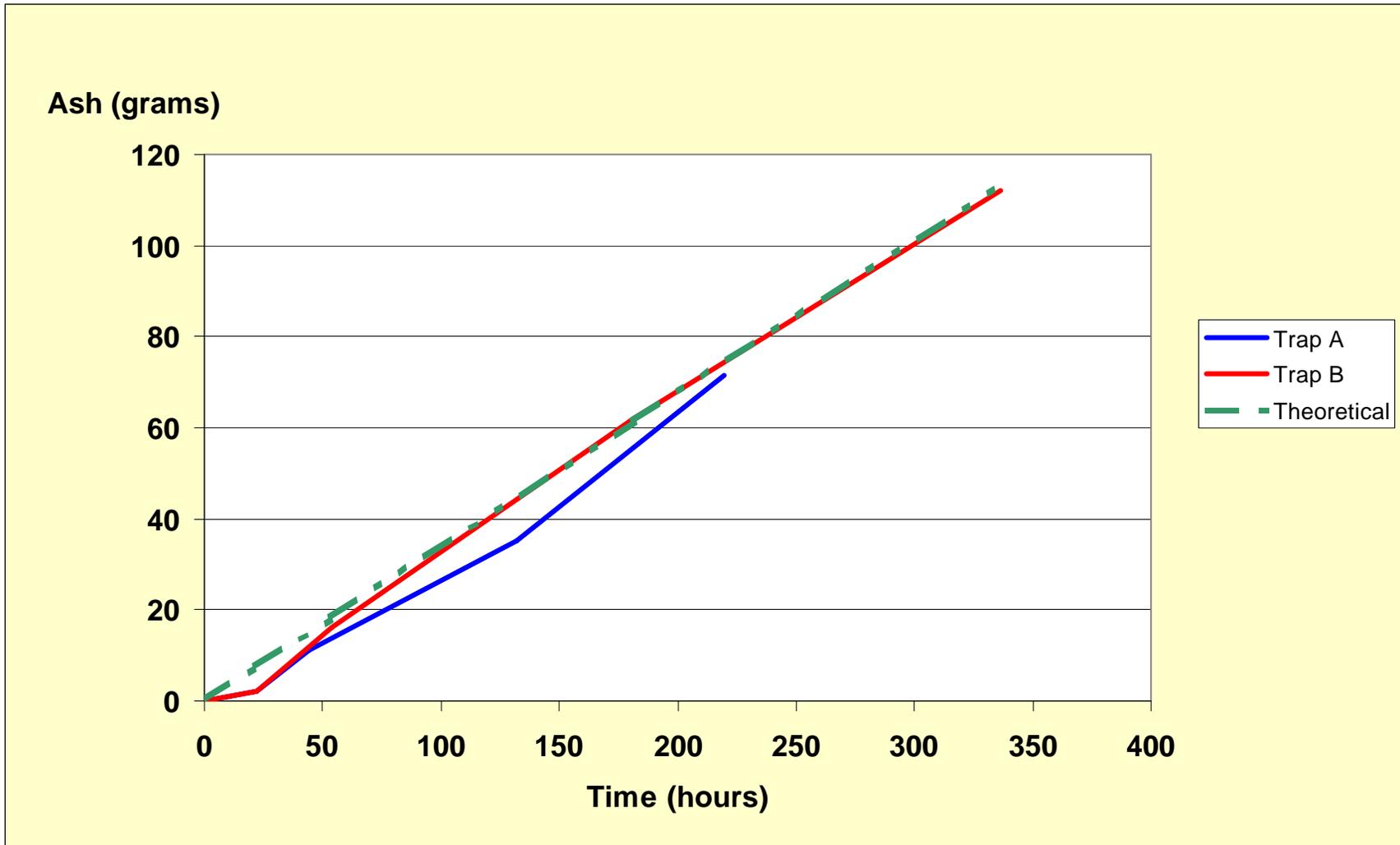
Regeneration Characteristics



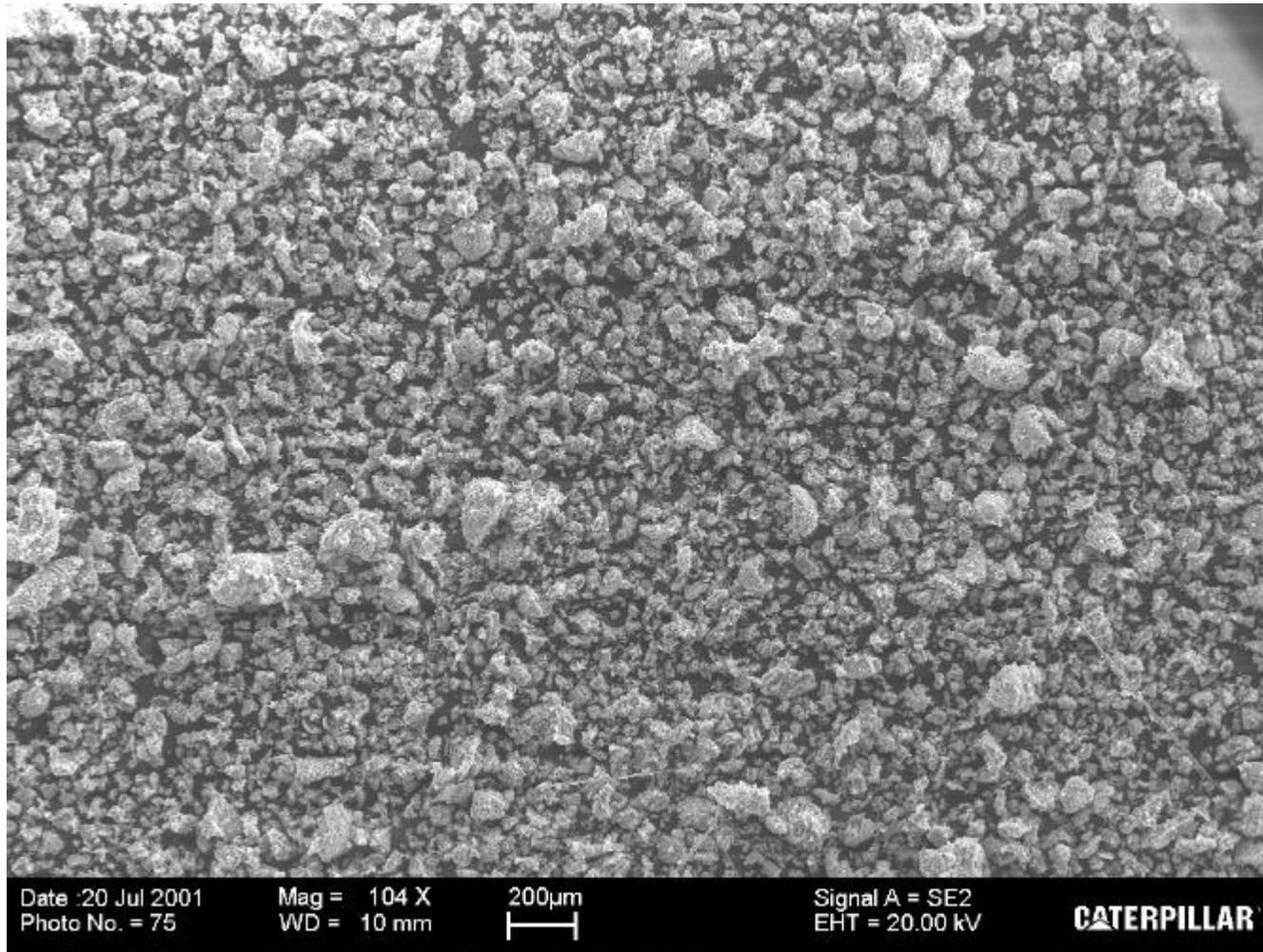
Regeneration Characteristics



Ash Accumulation



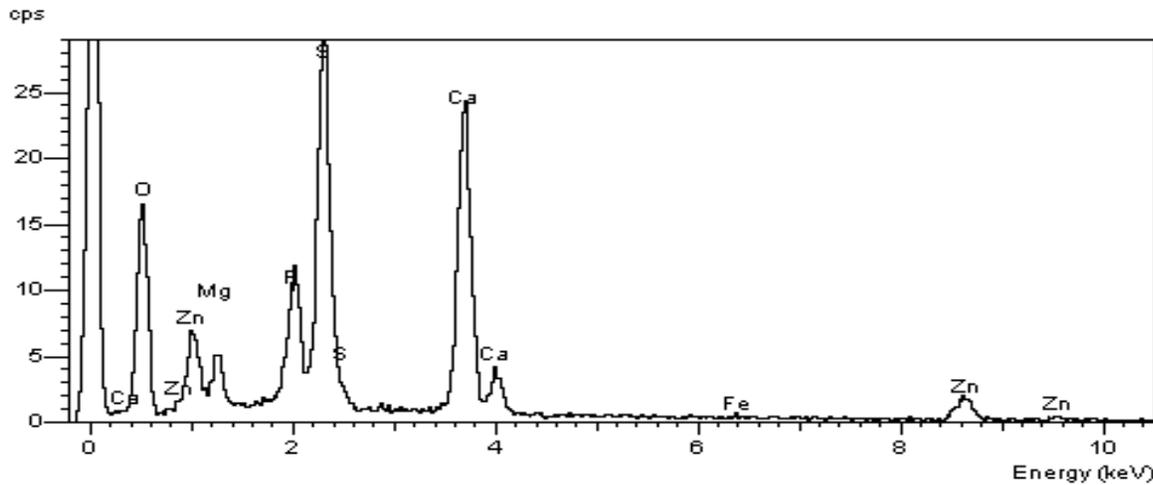
Ash Analysis



Ash Analysis



Trap B 200X Particle 2 – 100 Micron



Elmt	Spect. Type	Element %	Atomic %
O K	ED	54.45	73.35
Mg K	ED	2.57	2.28
P K	ED	5.12	3.56
S K	ED	14.31	9.62
Ca K	ED	16.41	8.82
Fe K	ED	0.19*	0.07*
Zn K	ED	6.95	2.29
Total		100.00	100.00

Analysis Consistent with Lube Oil Ash

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Concluding Remarks



- Balance Point Temperature - Misleading
 - For catalyzed traps, this temperature is dependent on accumulated mass in the trap
- Regeneration Issues
 - Should not rely solely on operating at or above Balance Point Temperature for some period of time
- Ash Accumulation Issues
 - Significant Ash Accumulation was measured even with very low lube oil consumption