Soot and NO2 Reduction with a Sintered Metal Filter

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NORTH ROCK RENTALS LTD.

Shell Lubricants

T.F. HUDGINS INCORPORATED
an Allied Reliability brand

Think about tomorrow.

HJS Emission Technology

Mining Provider Client with NO2 exceedance case

Underground Telehandler with Kohler KDI2504 Tier 4F engine 75HP

In current state, Equipment recorded **elevated NO2 levels, 85ppm – 105ppm**

Requirement to find a suitable solution to the Kohler engine.

Engine arrangement includes EGR (cooled) and a DOC only, engine is common rail high pressure injection.

Ontario Mining Reg. 854,

- Reg, stating to have emission sample taken under engine full load ,as practical.
- Current limit of 60ppm for NO2
- Current limit of 750 ppm for NO
- Current limit of 600ppm for CO
- No limit established for Carbon (Soot) at Tailpipe
- (reg.854,sub section 183.2, 0.12 mg/m3 of air exposure limit)

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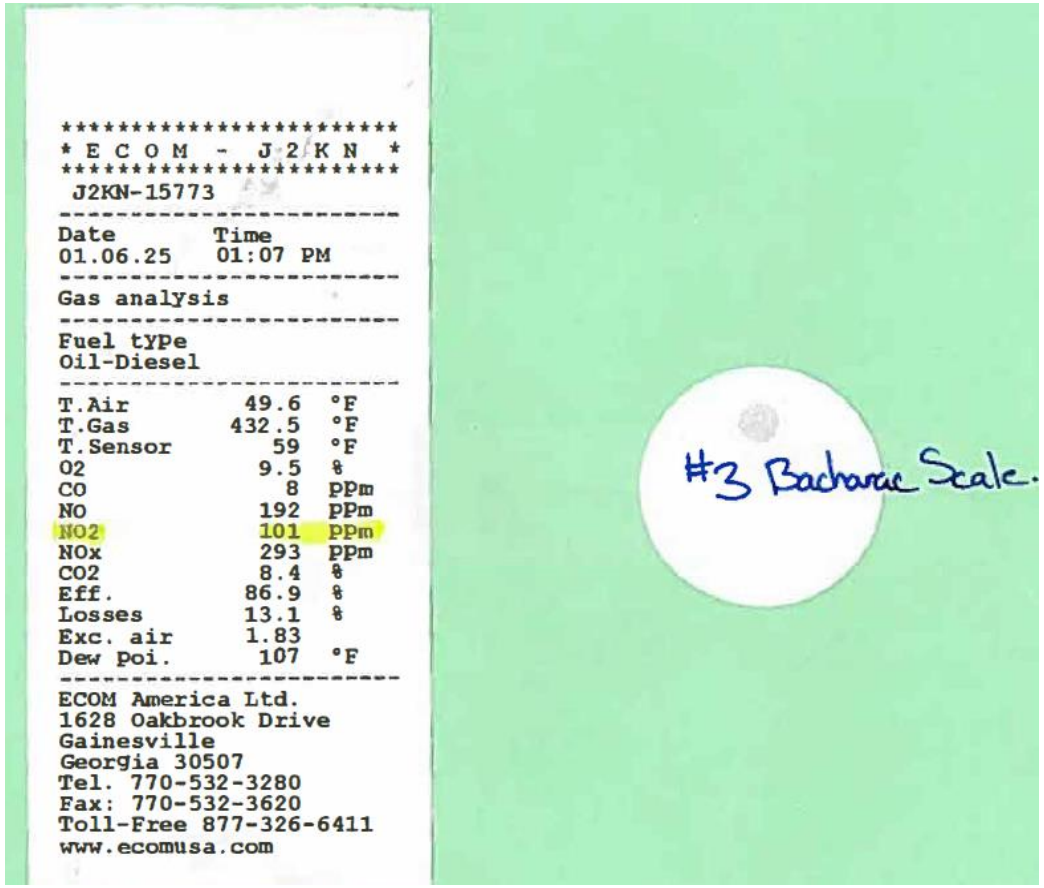
Options:

- Consultation with OEM – Kohler engines of this H.P. class have Tier4F certification and are not subject to NO2 limits for underground**. No adjustment possible.**
- Replace DOC with NO2 neutral or optimized designed. This was reviewed and trialed see results.
- After Market SCR kit to retrofit , Client was not in favor of complicated system and c/w higher cost of purchase & maintenance.
- After Market DPF was trialed, SMF-ER filter was selected for trial, install demonstrated to consume NO2 during regen or soot decomposition.

KOHLER KDI TIER4F ENGINE,

Original system (OEM)

elevated NO2 under full stall.



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**********************
* E C O M  -  J 2 K N *
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 J2KN-15773
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Date        Time
01.06.25    01:07 PM
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Gas analysis
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Fuel tYPe
Oil-Diesel
----------------------
T.Air        49.6   °F
T.Gas       432.5   °F
T.Sensor       59   °F
O2            9.5   %
CO              8   ppm
NO            192   ppm
NO2           101   ppm
NOx           293   ppm
CO2           8.4   %
Eff.         86.9   %
Losses       13.1   %
Exc. air     1.83
Dew poi.      107   °F
----------------------
ECOM America Ltd.
1628 Oakbrook Drive
Gainesville
Georgia 30507
Tel. 770-532-3280
Fax: 770-532-3620
Toll-Free 877-326-6411
www.ecomusa.com
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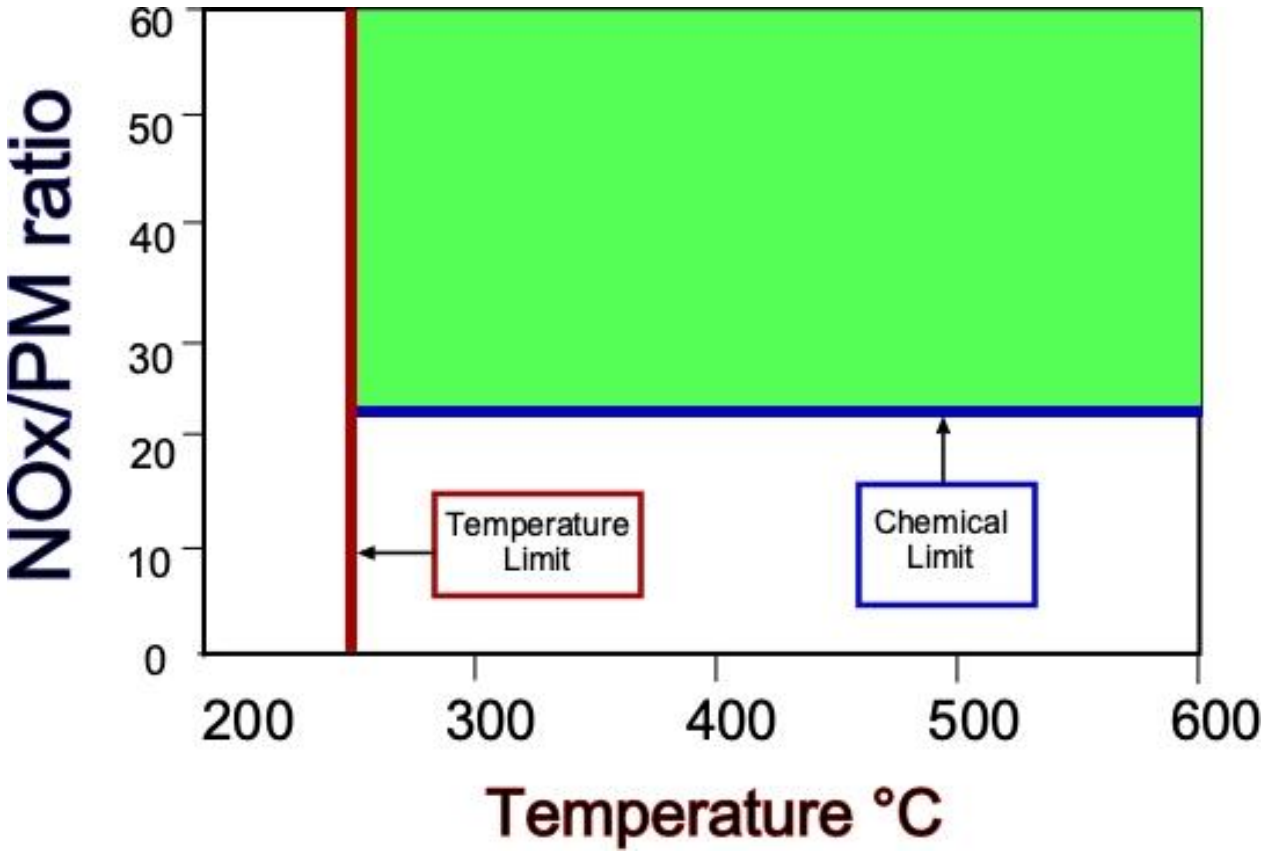
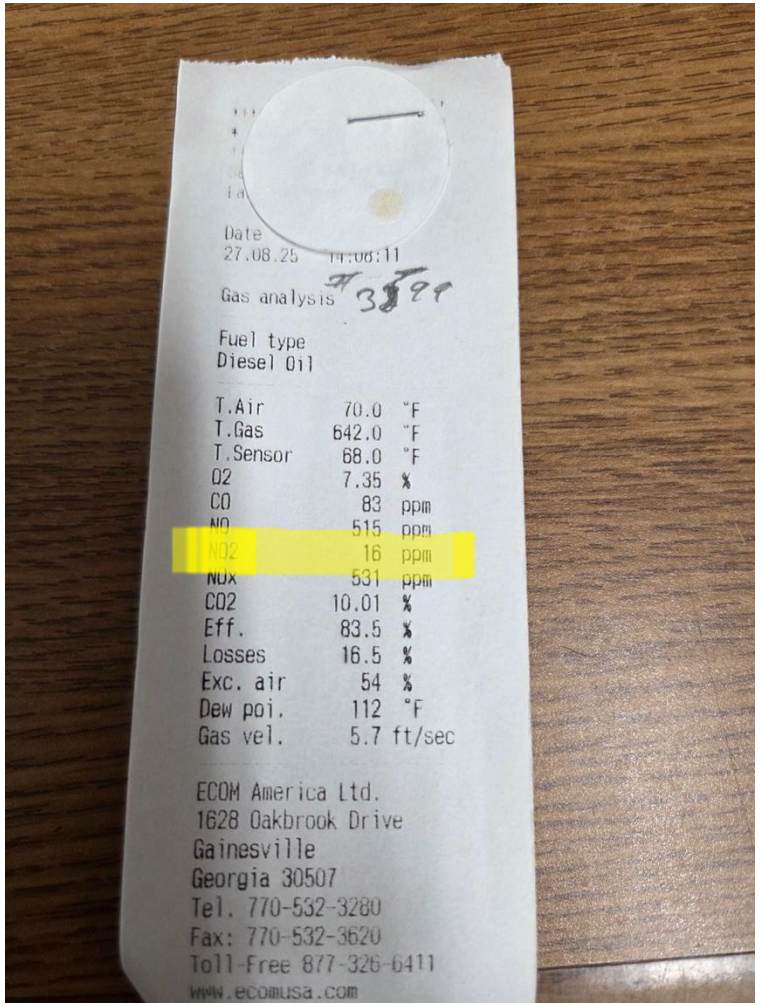
#3 Bacharach Scale.

Regeneration Window





TEST EQUIPMENT CREDIT;

- **ECOM EN3** MULTI GAS ANALYZER
- **CAPELEC P3090** – PARTICLE COUNTER

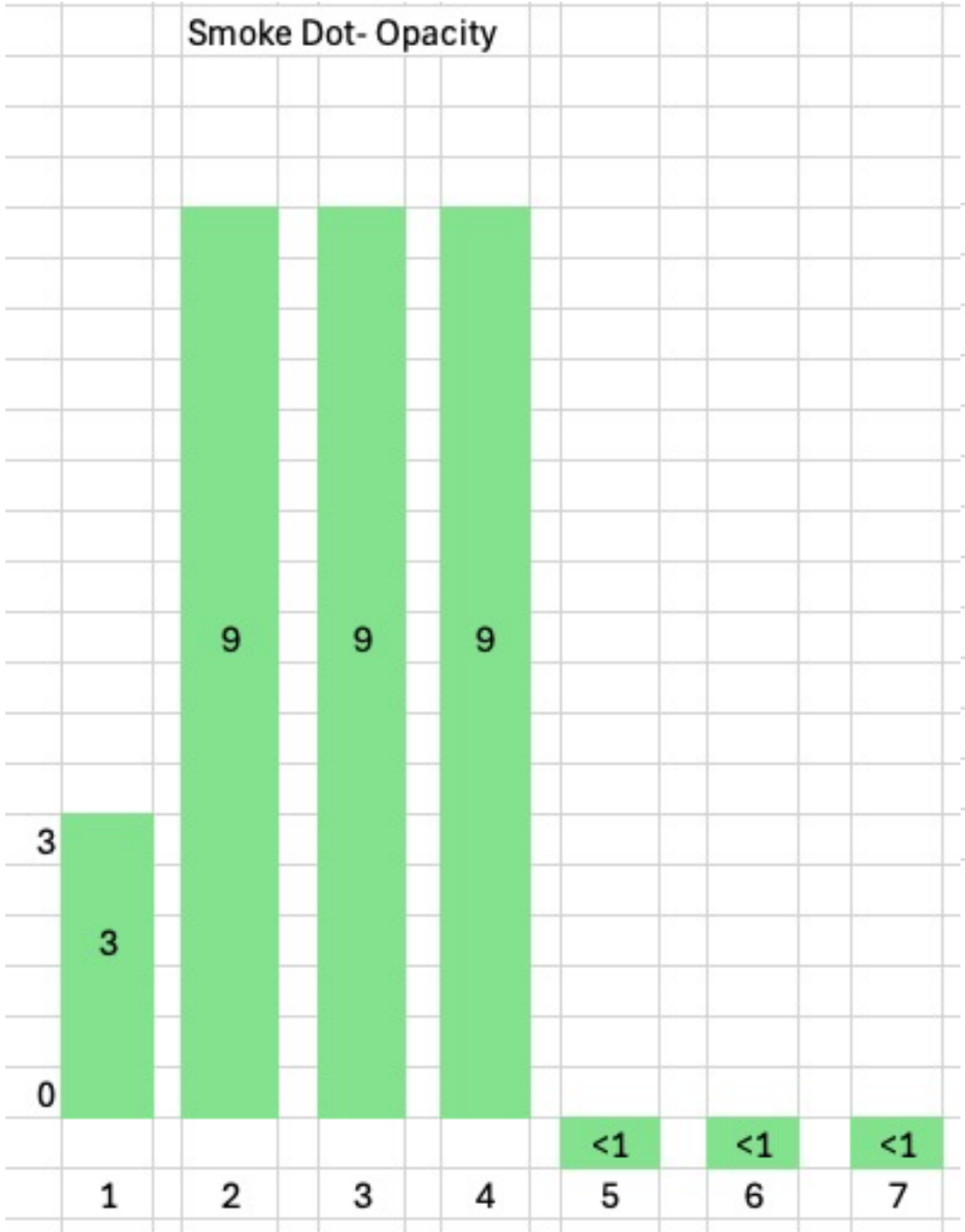
Underground Telehandler with Kohler KDI2504 Tier 4F engine 75HP

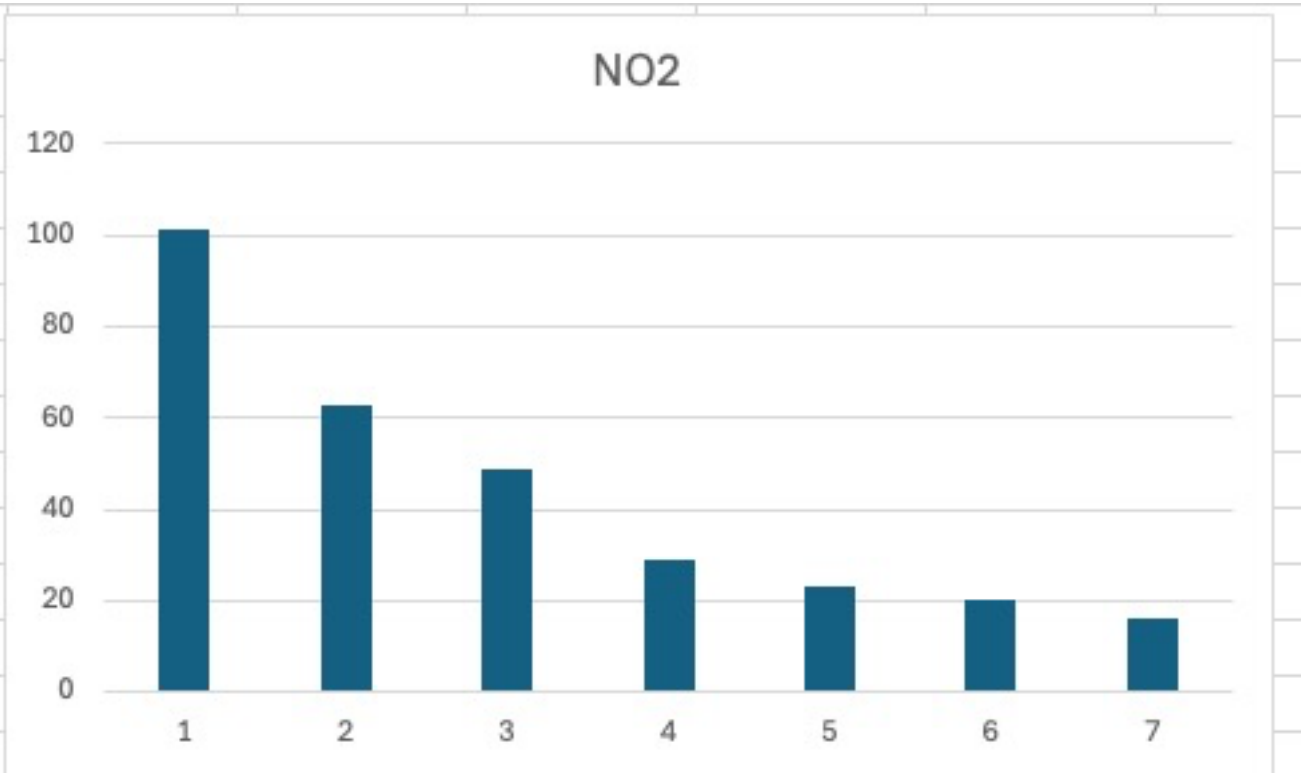
Kohler KDI2504 Tier 4F test with improved DOC(HJS)

RESULTS USING NEW DOC, PROVED TO HAVE INSUFFICIENT CHANGE TO NO2

	Kohler KDI-2504 TIER 4 FINAL		1	2	3	4	5	6	7
	E-COM Data	Date	1/6/25	5/13/25	8/19/25	8/19/25	8/19/25	8/20/25	8/27/25
		Time	1:07	14:47	12:27	12:30	14:54	7:21	14:06
°F.	T. Air	T. Air	49.6	78.6	71.1	71.6	75.6	66.2	70
°F.	T. Gas	T. Gas	432.5	700	382.3	771.8	677.1	698.2	642
°F.	T. Sensor	T. Sensor	59	79.5	70.2	70.9	82.4	67.5	68
%	O2	O2	9.5	6.96	14.48	8.05	7.66	7.74	7.35
ppm	CO	CO	8	2	156	79	83	81	83
ppm	NO	NO	192	399	289	445	465	488	515
ppm	NO2	NO2	101	63	49	29	23	20	16
ppm	Nox	Nox	293	462	318	484	488	488	531
%	CO2	CO2	8.4	10.3	4.8	9.5	9.78	9.72	10.01
%	Efficiency	Eff.	86.9	82.5	81.2	78.7	82.2	81.2	83.5
%	Losses	Losses	13.1	17.5	18.8	21.3	17.8	18.8	16.5
%	Exc. Air	Exc. Air	1.83	50	223	63	58	58	54
°F.	Dew Point	Dew point	107	112	92	110	111	111	112
ft/sec	Gas Velocity	Gas velocity		0.6	4.7	6.3	8.7	6	5.7
	Smoke Dot- Opacity	Opacity	3	9	9	9	<1	<1	<1
		Opacity	3	9	9	9	-1	-1	-1

1	Post OEM supplied DOC Full Stall
2	Post HJS DOC Full Stall
3	Pre-DOC No Load- Full RPM
4	Pre-DOC Full Stall
5	Post Full Stall with SMF-ER 2.7
6	Post Full RPM (2500) with SMF-ER 2.7
7	Post Full Stall with SMF-ER 2.7





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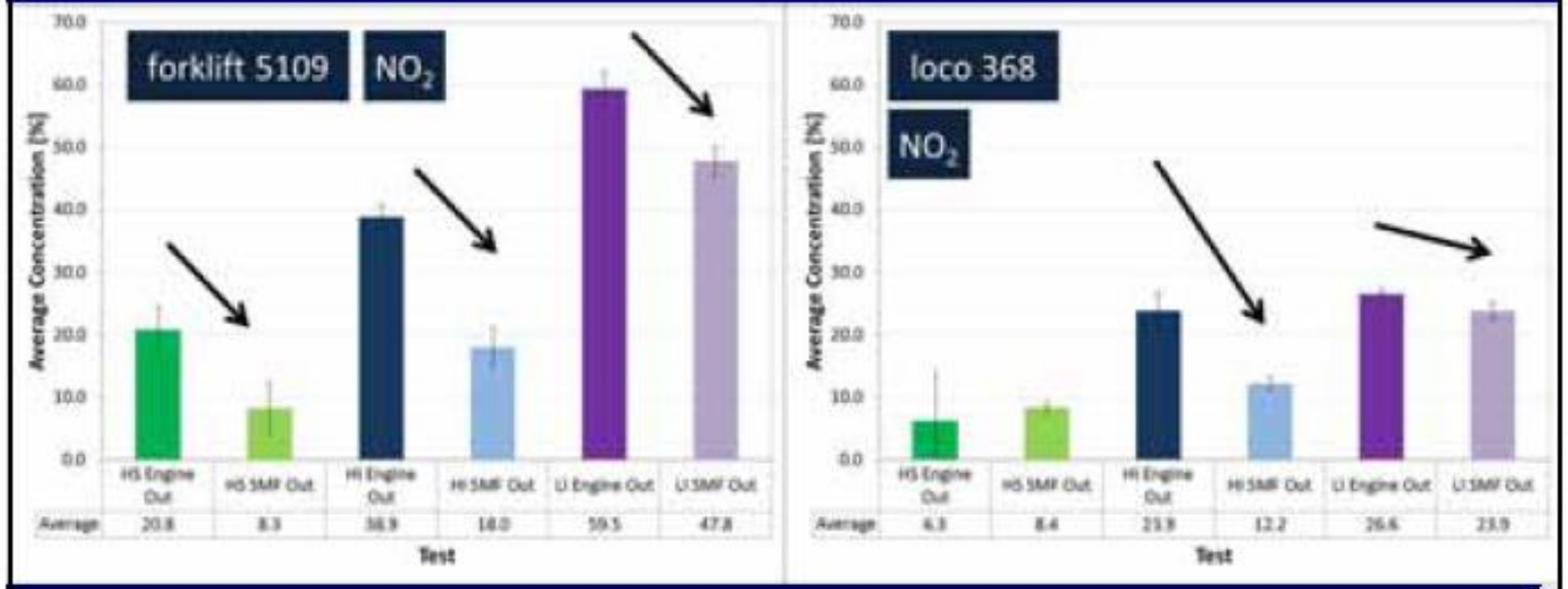
The analysis of NO_2 results indicates the following:

- It appears that the substantial fraction of NO□ was consumed in reaction with soot stored in SMF element;
- That fraction was probably a function of amount of soot trapped in the element.



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https://mdec.ca/2012/S2P3-Bugarski.pdf

https://mdec.ca/2009/S2P1_hensel.pdf

https://mdec.ca/2010/S2P1_stachulak.pdf

PREVIOUS REPORT AND MATERIAL DEMONSTRATE THAT DPF CAN HAVE EFFECTS ON NO2 REDUCTION


27.6
HJS
BOOSTER LUGS

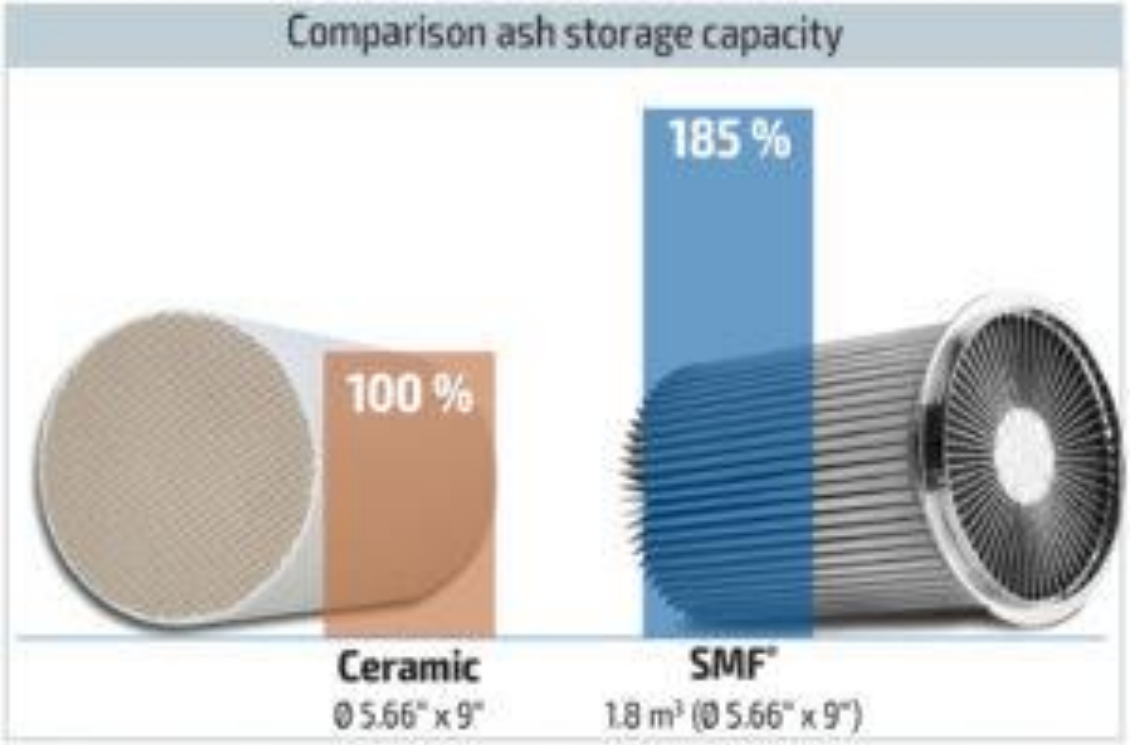
Install in one Hour

No Additive
No Reset

Clean with Water or Air in 10 minutes

Operating Characteristics

- Simple handling - short changeover times via quick-release clamps
- Pressure monitored for easy inspection
- Easily cleanable with water or air
- Metallic construction - Highly durable design
- High Ash storage capacity - Longer time between services

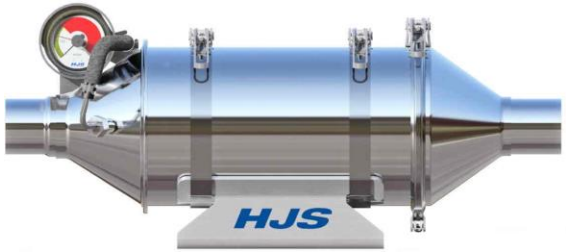


CONCLUSION

THE RESULTS ARE ONGOING AND WILL BE FURTHER MONITORED DURING NORMAL OPERATION OF EQUIPMENT AT VARIOUS MINE SITES.

1. The installation of the DPF without the DOC has effectively reduced NO2 at operating temperatures (<750F).
2. The CO production was not affected.
3. The soot level was reduced at < 98% efficacy from the original, secondary benefit from installation, and most importantly, on the Safety & Health effects.

SMF-ER
Soot capture for low exhaust temperatures



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