



Nano Catalyst Technology

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BAIR RESEARCH & DEVELOPMENT LLC

X PRIZE TEAM PURE CATALYST

Technology

- ▶ Hydrocarbon combustion reimaged in combustion nano catalysis
- ▶ >50% ROI to end-user
- ▶ 0 downtime for install and recharge
- ▶ Intranet for just-in-time delivery logistics, installation and set up video
- ▶ Delivery system hardware and catalyst dropshipped to customer for in-house installation via intranet video instruction
- ▶ Global real-time fault diagnosis
- ▶ 3-phase global implementation
 - ▶ phase 1: hydrocarbon fueled powerplants and oceangoing ships gigaton carbon and megaton other toxic GHG emissions reductions 3 to 5 years
 - ▶ phase 2: freshwater commercial shipping and off-road machinery at least an additional megaton carbon reductions
 - ▶ phase 3: worldwide commercial trucking, due to massive number of units megaton in the short term and gigaton with global implementation

Thomas Bair

- ▶ 40 years mechanical systems analyst, failure analysis, systems repair and reengineering
- ▶ Specialize in electromechanical systems computer interface diagnosis and repair; tool design and fabrication
- ▶ Former ASE certified master technician auto foreign, domestic and heavy-duty truck
- ▶ 20 years experience in combustion catalyst formulation and adaptation
- ▶ 25 years nanotechnology catalyst combustion systems application
- ▶ 15 years exhaust emissions regulations research
- ▶ 18 years nanotechnology hardware design and manufacturing logistics
- ▶ Design manufacturing line to incorporate minimally skilled labor small-scale users
- ▶ Design, locate and incorporate off-the-shelf hardware for large-scale users
- ▶ Designed, tooling, manufacturing and assembly of small-scale dispensing hardware and catalyst formulation
- ▶ Invented new patentable more effective modular catalyst delivery system (minimal additional research for prototype demonstration)

Overview

- ▶ Our Nano Catalyst Injection System (NCIS) injects nano catalysts into the intake or combustion air stream. This truly miraculous technology treats the chemistry of combustion and therefore, is effective on any combustion technology and hydrocarbon. It transforms would-be pollution into power which improves thermal efficiency and reduces emissions.
- ▶ Burn the fuel more completely; increased equipment productivity and longevity, significantly less greenhouse gas (GHG) emissions, more power, smaller carbon footprint, multiple potentially available CO₂ and GHG credits!



NCIS Case Studies

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Small-Intermediate Scale Delivery System Technology

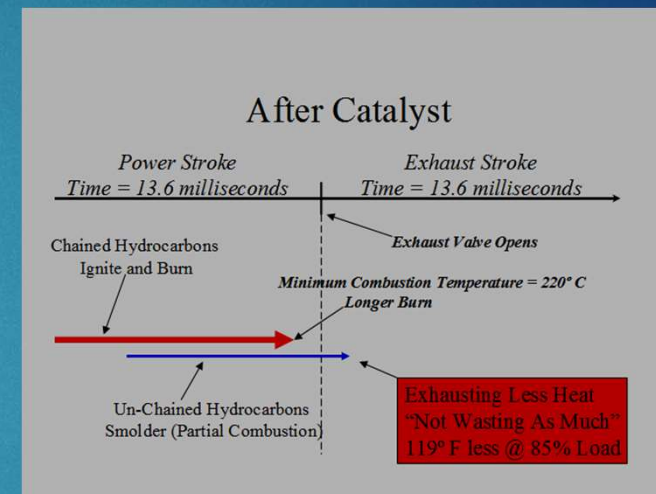
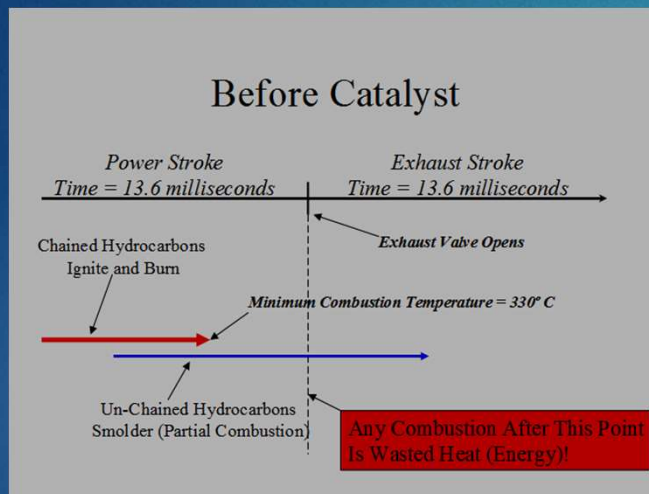
- ▶ Catalyst Formula (3 400 hr. applications)
- ▶ NCIS 20 GPH/2.4 MMBtu Hr.
- ▶ NCIS delivers catalysts at a ratio of parts per billion (ppb) to the weight or heat value of the fuel
- ▶ 20, 40, 60, 80 GPH modular systems available
- ▶ Intermediate consumers may require multiple NCIS dispensers
- ▶ Large-scale may require DI system with multiple redundancy



Project Details

- ▶ Carbon reduction system
- ▶ Same principle as a catalytic converter but in the most effective location
- ▶ Catalyst injected nearly molecular into intake air stream of engine
- ▶ Splits oxygen molecules into usable radical oxygen atoms
- ▶ Lowers the burning temperature of hydrocarbons allowing for a longer, more powerful, smoother burn
- ▶ Converts pollution into power, improves fuel economy and reduces greenhouse gases
- ▶ Combustion catalyst cannot fail if it is properly introduced
- ▶ Treats chemically the inefficiencies of combustion at the source prior to formation providing substantial additional energy release

Combustion Cycle Before and After NCIS



- ▶ More intense, smoother, longer burn
- ▶ More energy to work expressed by lower exhaust temperature (EGT)

Benefits

- ▶ Fuel savings alone \geq 50% ROI
- ▶ Cleaner longer-lasting engine oil
- ▶ Longer engine life by diminished carbon deposits and harmonic vibration
- ▶ Longer burn time results in more complete combustion
- ▶ Soot and unburned hydrocarbons now aid combustion
- ▶ GHG formation robbed energy, with NCIS energy released saves fuel, reducing: cost, CO₂ and all GHGs

Installation and Maintenance

- ▶ Installation in less than 30 minutes and in most cases while in operation
- ▶ Small footprint
- ▶ Heat, weather, and vibration resistant
- ▶ Moving parts mounted on a removable control chassis
- ▶ All moving parts can be replaced while in operation in mere seconds
- ▶ End users will have spare control boards for uninterrupted delivery
- ▶ The NCIS hardware remains the property of the company therefore, unlimited warranty (replacement parts and upgrades will be provided free of charge) with continual purchase of catalyst
- ▶ 750 KW Cat generator required 2 NCIS 20 GPH dispensers



Performance Data

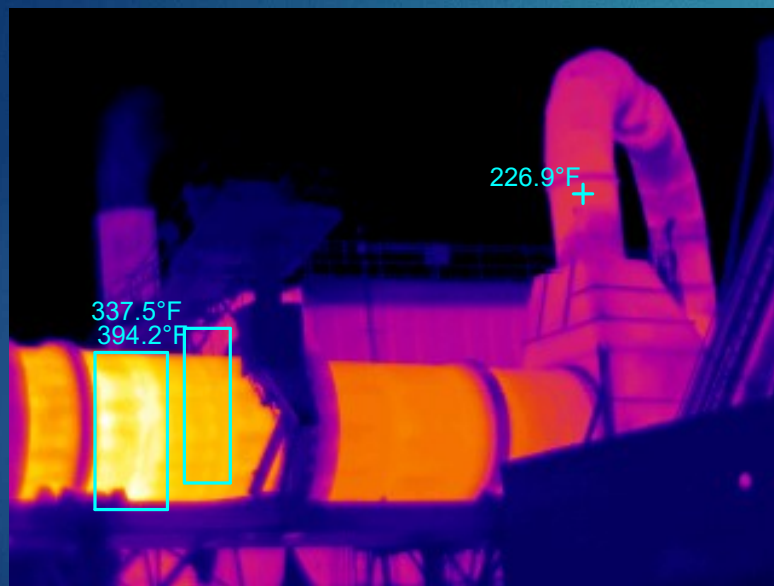
Engine/ Application	Engine Age (Hours)	Test Duration	Fuel Usage W/O CVI	Fuel Usage W/ CVI	% Change
Caterpillar 988 - Front Loader	10887	111 Hours	16 GPH	13.7 GPH	14
Caterpillar D-9 Dozer	8923	124 Hours	22 GPH	18 GPH	17
Caterpillar 922 Loader	5375	526 Hours	18 GPH	16 GPH	12
Caterpillar 988 Loader	7463	390 Hours	18 GPH	14 GPH	23
Caterpillar 773 Haul Truck	8100	242 Hours	23 GPH	12.5 GPH	46
Caterpillar V-12 Generator Set	4382	278 Hours	24 GPH	21 GPH	11
Cummins ISM 425HP	24293	2570 Miles	7.8 MPG	6.6 MPG	19
				Average	20
				Median	17



San Antonio Axial Flow Southern California Counter Flow Asphalt Plant Case Study

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Infrared Thermography Axial Flow Asphalt Plant



Catalyst demonstrates dramatically improved thermal efficiency. Increased firebox and lower exhaust temperature. Plant is now capable of higher output and fuel savings. Higher output increases tons per hour and delivery radius.

Southern California Asphalt Plant Annual Compliance Test

- ▶ 26% less air
- ▶ 41% less fuel
- ▶ 47% NOx corrected (mass flow lbm/HR)
- ▶ 44% reduced CO (mass flow lbm/HR)
- ▶ All reductions accomplished while maintaining production levels
- ▶ In accordance with US and California EPA rules Heat Rate here is heat value of fuel utilized

Type:	Without Catalyst	With Catalyst
Date:	2/19/2003	2/20/2003
Run:	21	25
Time:	1:00 PM	2/20/2003 12:51
Control Parameters	FGR Man 40ppm	FGR Man 38ppm
FCI Fuel Gas Flow (SCFH):	87,483	51,405
Combustion Air Temp (°F):	305	208
Flue Gas Flow (SCFH):	132,058	96,603
FGR Temp (°F):	305	208
Burner Draft ("Hg):	0.30	0.30
Sand Fraction:	26%	26%
Rock Throughput (ton/hour):	304	296
Moisture content:	1%	1%
FGR/Fuel Flow (SCF/SCF):	1.5095	1.8793
Heat Rate (MMBTU/hr):	80	47
Air Flow (SCFM):	2,169,147	1,599,387
Bulk F/A Equiv Ratio:	0.388	0.309
Therms	1.528	2.621
RM/CEMS Emissions Data		
RM/CEMS NOx (ppm):	18.2	12.7
RM/CEMS CO (ppm):	108.228	81.729
RM/CEMS O2 (%):	13.36%	14.95%
Method 19 EXHAUST FLOW (DSCFH):	2,216,822	1,651,408
NOx MASS FLOW (lbm/HR):	4.82	2.51
CO MASS FLOW (lbm/HR):	17.5	9.8
RM NOx @3% O2 (ppm):	43.1	38.2



Oceangoing Ships Fuel Ignition Analyzer (FIA) Case Study

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FIA Test Results

- ▶ Test was run on fuel grade 380, test number F06048532
- ▶ Baseline indicates a fuel cetane number at lowest instrument limit so may be lower than measured 19.4
- ▶ With addition of catalyst cetane is 22.6
- ▶ Catalyst raised cetane to usable level
- ▶ User would avoid blending with costly high-grade diesel oil
- ▶ Technician astonished in 20 years no difference but with catalyst junk fuel to usable quality
- ▶ Technician intrigued and requested test with high grade fuel
- ▶ Fuel grade 180 pre-cat cetane was 39.9 which increased to 46.0 with the addition of the catalyst, test number F060484819
- ▶ Technician convinced absolutely and remarked that the system performance was astounding

Conclusions

- ▶ **Scalable:** technology is sized to individual sources and applied by in house on board personal
- ▶ **Available:** all applications are designed to incorporate off-the-shelf hardware and chemistry in any quantity is available with minimal lead time
- ▶ **Achievable:** phase 1 implementation could achieve gigaton carbon emissions reduction within 3 to 5 years
- ▶ All test results indicate the catalyst is remarkably effective
- ▶ ROI for both manufacturer and end-user is exceptional
- ▶ Increases fuel and thermal efficiency, increases power and energy performance, while minimizing carbon and all GHG emissions
- ▶ Truly miraculous technology ahead of its time
- ▶ Nanotechnology was struggling for relevance in the 80s, revived in the 90s but is phenomenally timely now
- ▶ It makes combustion cleaner and things last longer
- ▶ Altered fuel and computer control strategies have exhausted efficacy, nano combustion catalysis is the timely, viable, available interim and complementary technology for GHG and carbon reduction