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Experiencia en California sobre Emisiones y Control de Particulas

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Former Deputy Executive Officer, California Air Resources Board



SACRAMENTO METROPOLITAN



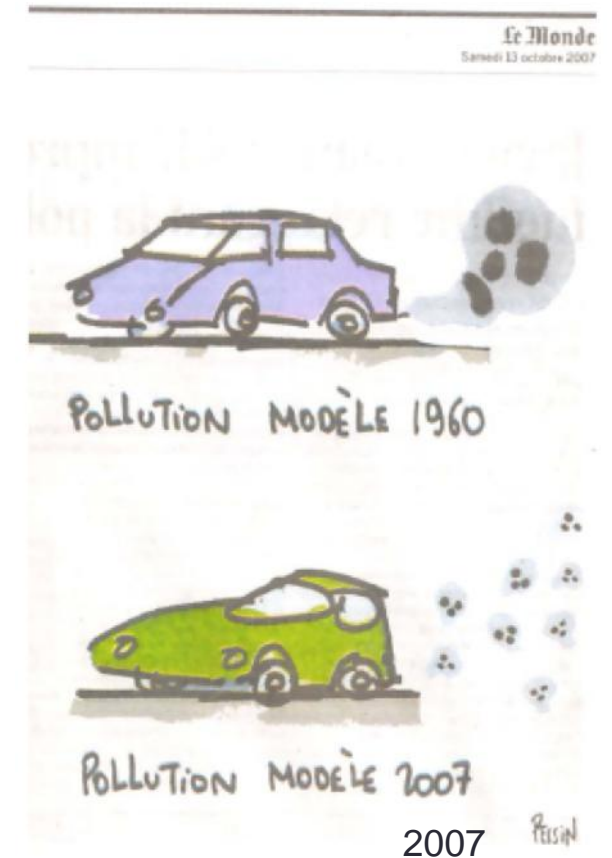
Contexto Historico de la Politica de Control de Emisiones de Particulas en California

Año	Politica y/o Normativa
Early 1980s	Primeras regulaciones de control de particulas a diesel
1996	HEI study by Michigan Technological Univeristy
1998	California identifica formalmente/legalmente a la emision de particulas a diesel como compuesto cancerigeno
2000s	California (informal) participation in UN PMP

HEI

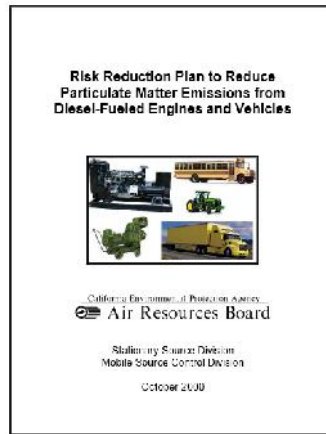
HEI 1996 Study showed higher total number of particles from newer engine (1991) than from older technology engine (1988)

Bagley et al. 1996. Effects of fuel modification and emission control devices on heavy-duty diesel engine emissions. HEI Research Report # 76.
<http://pubs.healtheffects.org/view.php?id=124>



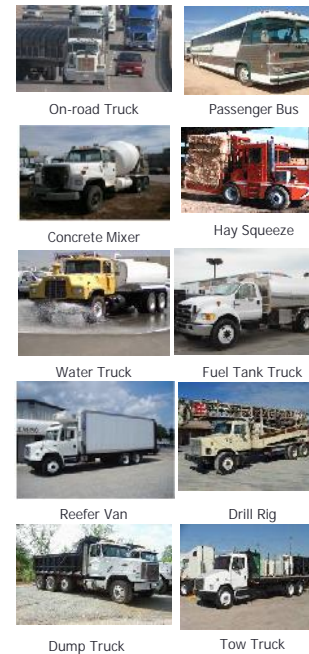
Contexto Historico - continuacion

Año	Politica y/o Normativa
2000	Plan control y reduccion del riesgo de exposicion a particulas a diesel
2000s	Investigacion en California de clean diesel versus gas natural comprimido
2007	New Heavy-duty PM Engine Standards force use of Diesel Particle Filter (DPF)
2010	New Heavy-duty NOx Standards force use of Selective Catalytic Reduction (SCR)
2012	Organizacion Mundial de Salud llega a misma conclusion que California – particulas a diesel son cancerigenas
2000-2015	15 años de investigacion sobre todo aspecto relacionado con emisiones de particulas (incluyendo ultrafinas y nanoparticulas)
2019	Primer EE.UU. programa de “inspeccion y mantenimiento” para heavy-duty diesel
2020	Nueva regulacion NOx a motores pesado (reduccion de 90%)
2023	100% de vehiculos pesados en uso cumplen con estandares 2010 o mejor



- Diesel de 15ppm S
- New engine standards
- In-use requirements
 - Replace, retire, repower, retrofit
- On-road and off-road

On-road Vehicles

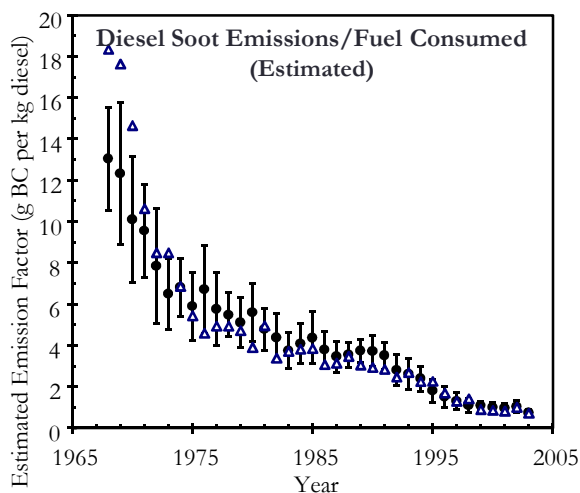


Off-road Vehicles



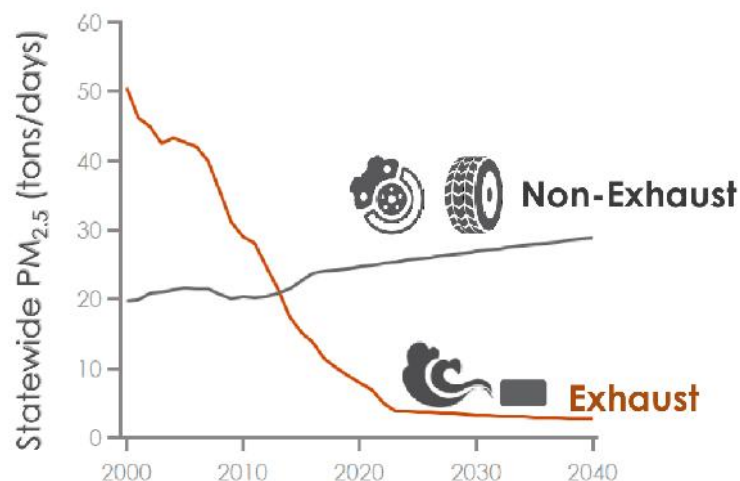
50 Years of Progress Yields New Concerns

50 years of progress on Black Carbon



Kirchstetter, T.W., Aguiar, J., Tonse, S., Fairley, D., and Novakov, T., "Black carbon concentrations and diesel vehicle emission factors derived from coefficient of haze measurements in California: 1967-2003," *Atmospheric Environment*, 42(3): 480-491, 2008

Los frenos y llantas contribuyen mas al PM2.5 ambiental



Source: ARB, EMFAC 2017

El trafico contribuye a las particulas ambientales

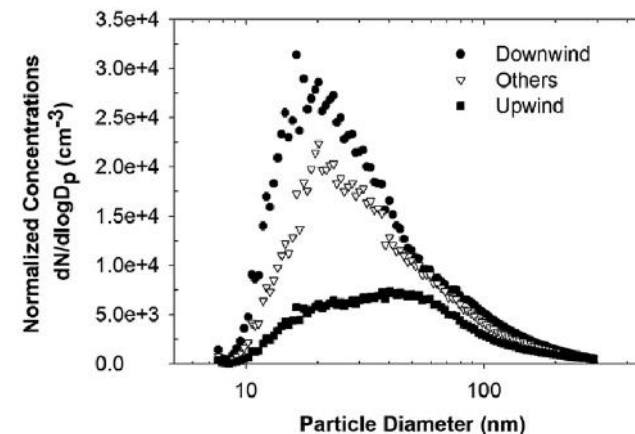
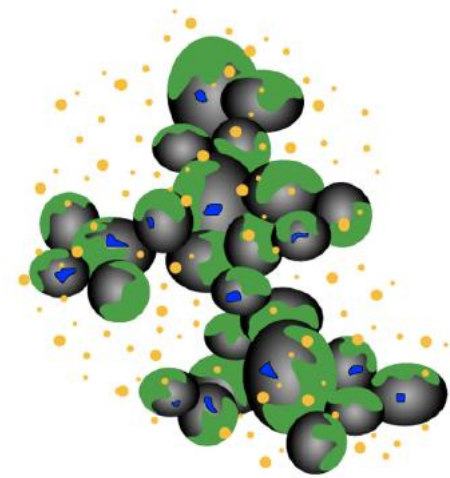


Fig. 4. Comparisons among particle size distributions measured and averaged under different wind directions (i.e., upwind, downwind, and others as depicted in Fig. 1) during the sampling period of one month.

La medicion y conteo de las nanoparticulas – solidas versus solidas + volatiles



- = soot
- = nucleation mode
- = condensed HC/SO₄
- = imbedded metallic ash

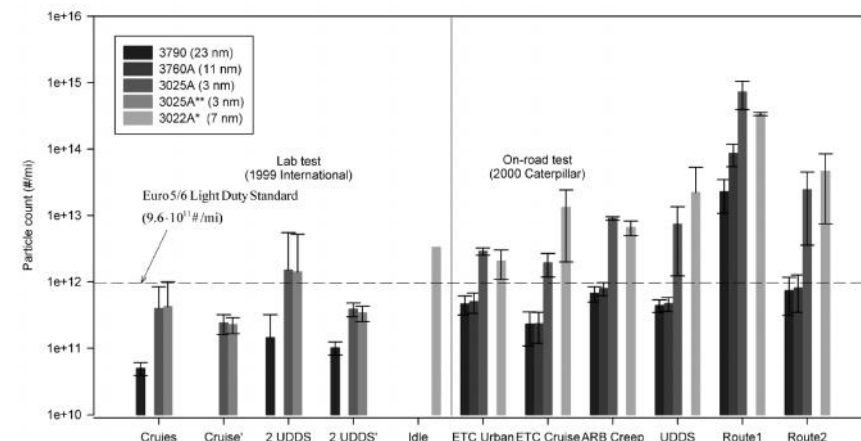
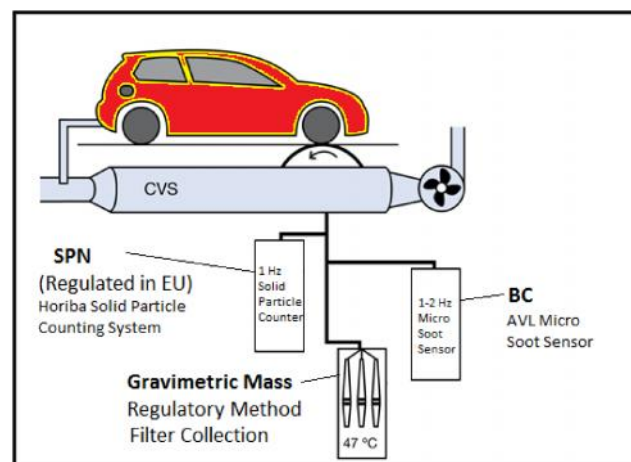


FIG. 4. Particle Number Counts per mile for lab and on-road tests for HD trucks. Note: * Without outliers. Route 2 is a transient driving which is composed of flat road driving with 5 stops in a 10 min stretch). For Route 1, the 3025A and 3022A concentrations were both saturated and hence the values represent absolute lower bounds. Also, the 3760 concentrations were above the maximum stated range for the instruments. **3022A sampled at CVS while other CPCs sampled under PMP dilution system. **This 3025A is a duplicate 3025A CPC for the laboratory testing. The laboratory idle test was integrated over the entire test period, and as such does not have an error bar.



Available online at www.sciencedirect.com

ScienceDirect

Aerosol Science 38 (2009) 1079–1118

Review

Chemical characterization of particulate emissions from diesel engines: A review

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Evaluation of the European PMP Methodologies during On-Road and Chassis Dynamometer Testing for DPF Equipped Heavy-Duty Diesel Vehicles

Kent C. Johnson^a, Thomas D. Durbin^b, Heejung Jung^b, Ajay Chaudhary^b, David R. Cocker III^b, Jorn D. Herner^b, William H. Robertson^b, Tao Hua^c, Alberto Ayala^b & David Kittelson^c

^a University of California, College of Engineering, Center for Environ. Res. Technol. (CE-CERT), Riverside, California, USA

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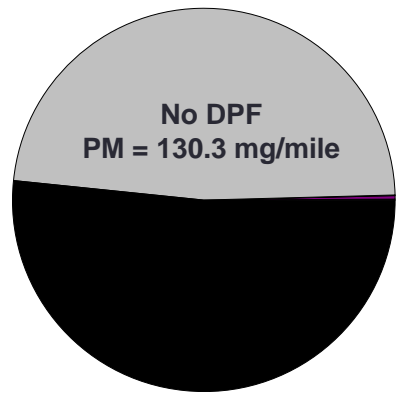
^c University of Minnesota, Department of Mechanical Engineering, Minneapolis, Minnesota, USA

Published online: 07 Jul 2009.

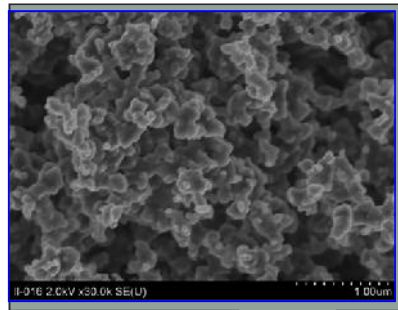
Diesel particle emission control



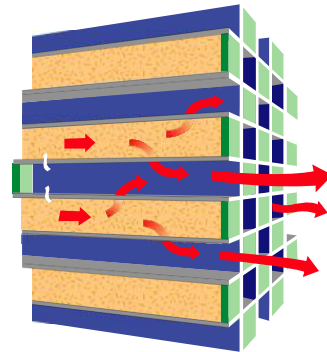
DPF was a game changer on PM



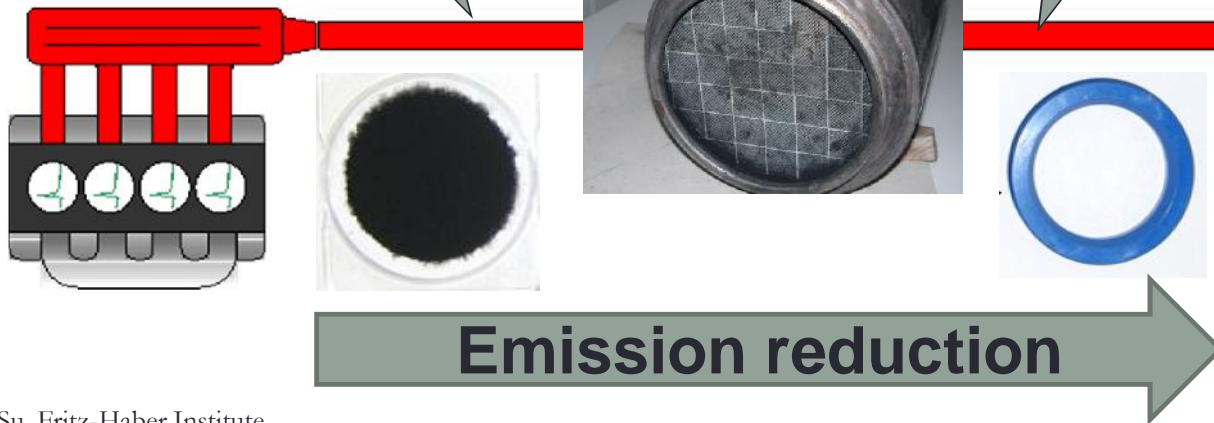
OC
EC



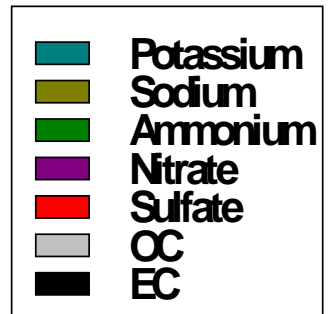
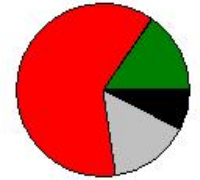
Pre-DPF soot



Post-DPF clean sample

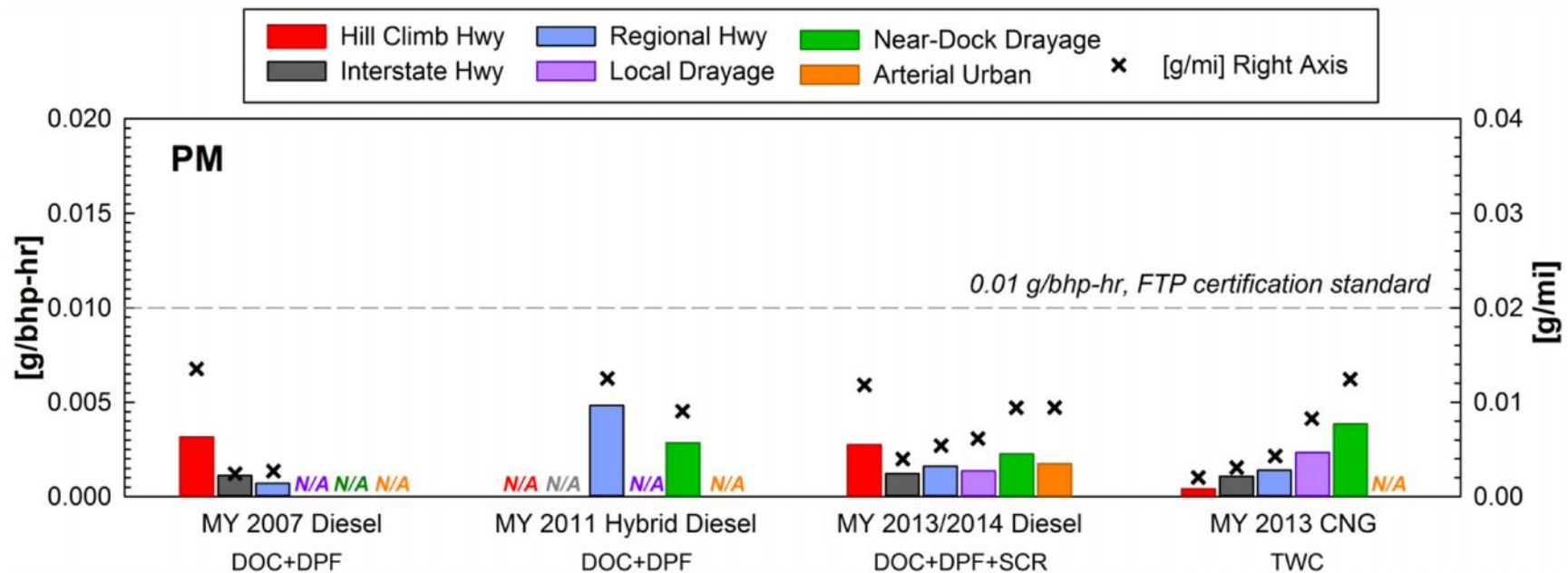


DPF+SCR
PM = 17.4 mg/mile



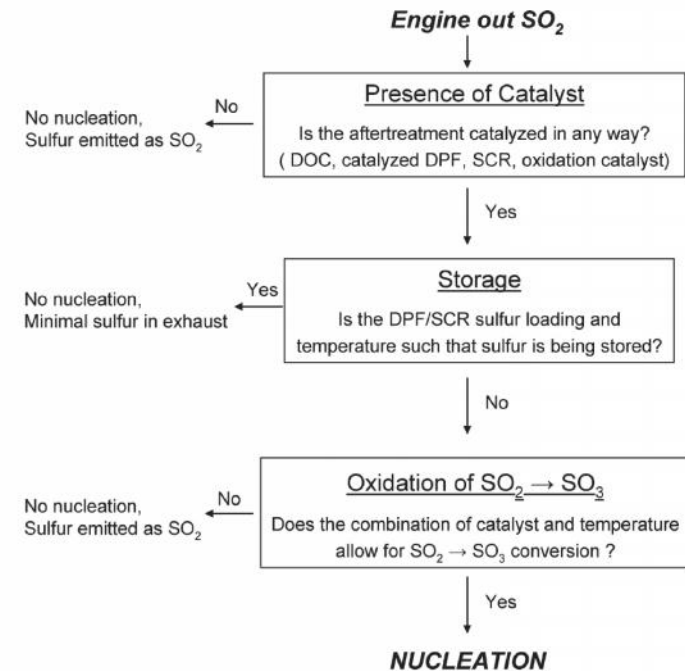
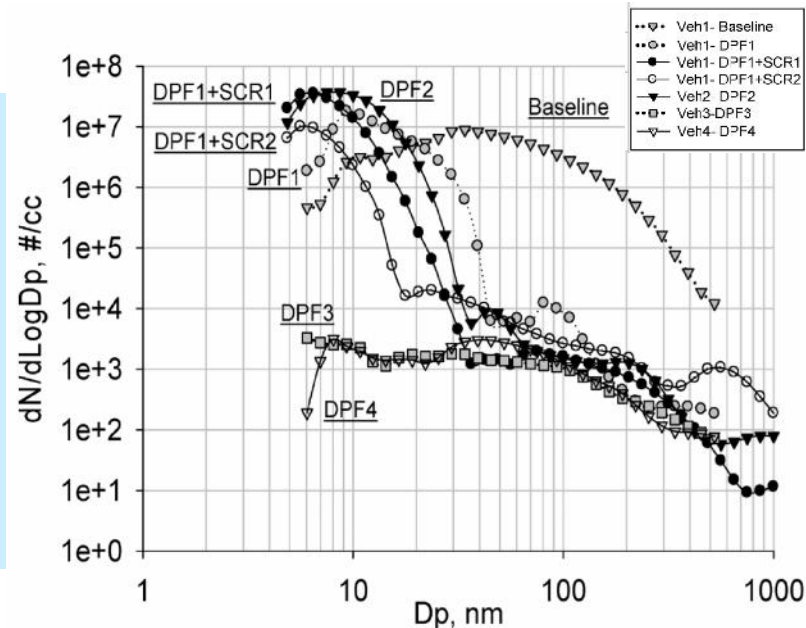
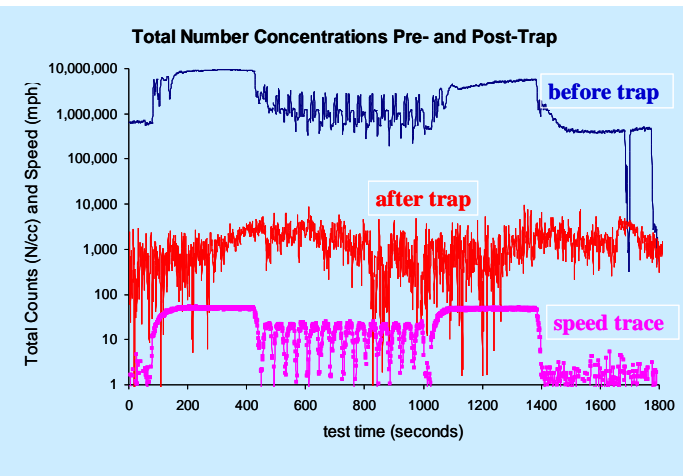
Efectividad del DPF esta bien Documentada

Vehiculos Pesados a Diesel y GNC Cumplen Ampliamente con Normativa de FTP PM



Quiros, et al. - Submitted to Emission Control Science & Technology for publication in April 2016.

DPFs pueden generar o reprimir formación de nanopartículas dependiendo de cantidad de material particulado en el DPF, edad del catalizador, y condiciones de operación



Ayala, A. and J. Herner, "Transient Ultrafine Particle Emission Measurements with a New Fast Aerosol Sizer for a Trap Equipped Diesel Truck," SAE Tech. Paper, 2005-01-3800



ARTICLE
pubs.acs.org/est

Effect of Advanced Aftertreatment for PM and NO_x Reduction on Heavy-Duty Diesel Engine Ultrafine Particle Emissions

Jorn Dinh Herner,* Shaohua Hu, William H. Robertson, Tao Huai, M.-C. Oliver Chang, Paul Rieger, and Alberto Ayala

California Air Resources Board, 1001 "I" Street, P.O. Box 2815, Sacramento, California 95812, United States

Figure 3. A basic model depicting when nucleation occurs in HDDE with aftertreatment. The important factors are catalyst, storage, and SO₂ to SO₃ conversion.

Gas natural comprimido y gasolina



Emisiones de nanoparticulas por motores a gas natural comprimido (GNC or CNG) es similar a los diesel con DPF

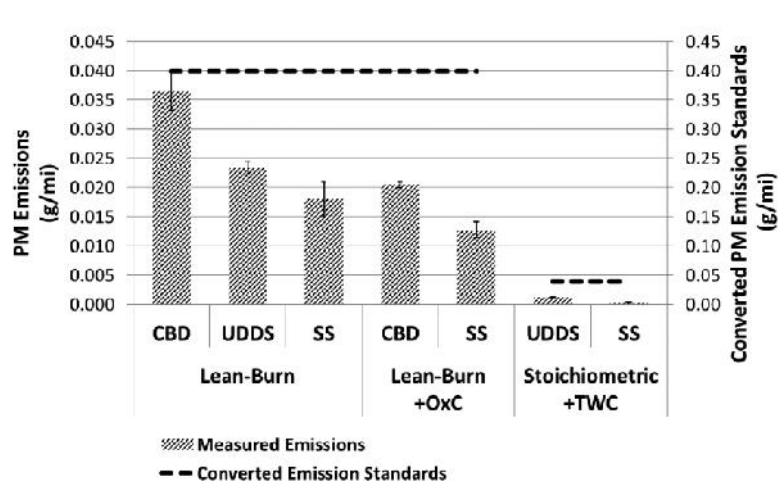
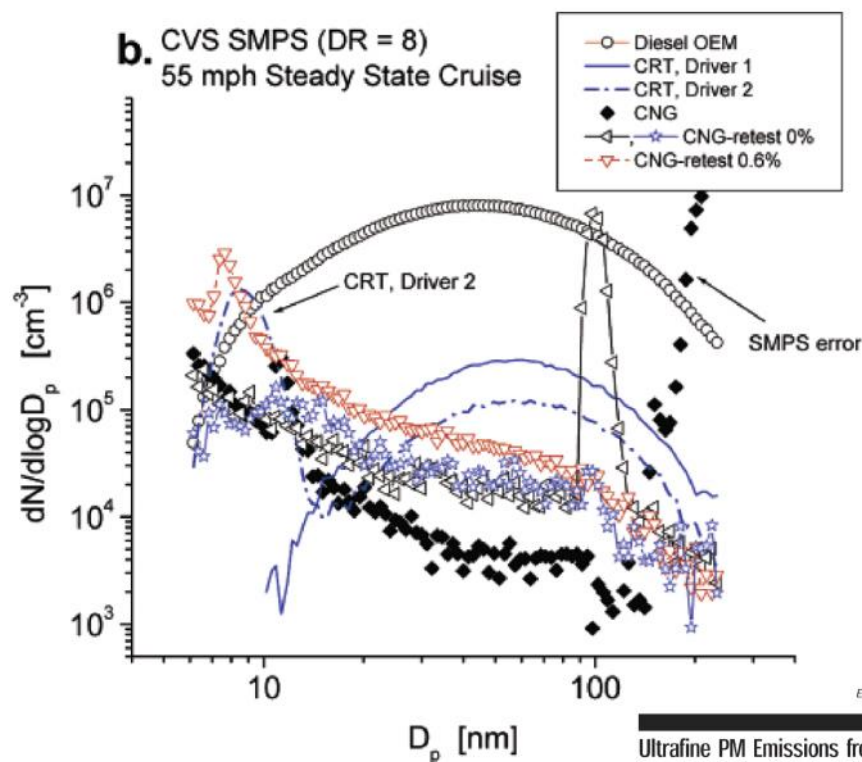


Figure 4. Particulate matter emissions by engine and exhaust control technology over the CBD, UDDS, and SS cruise cycles. Converted PM emissions standards are based on a conversion factor of 4 bhp-hr/mile (California Air Resources Board, 2012b) that converts certification emission standards from g/bhp-hr to emissions in g/mile.



Environ. Sci. Technol. 2002, 36, 5041-5050



Journal of the Air & Waste Management Association

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Criteria pollutant and greenhouse gas emissions from CNG transit buses equipped with three-way catalysts compared to lean-burn engines and oxidation catalyst technologies

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^b West Virginia University, Center for Alternative Fuels, Engines and Emissions, Morgantown, West Virginia, USA

Accepted author version posted online: 13 May 2013. Published online: 01 Aug 2013.

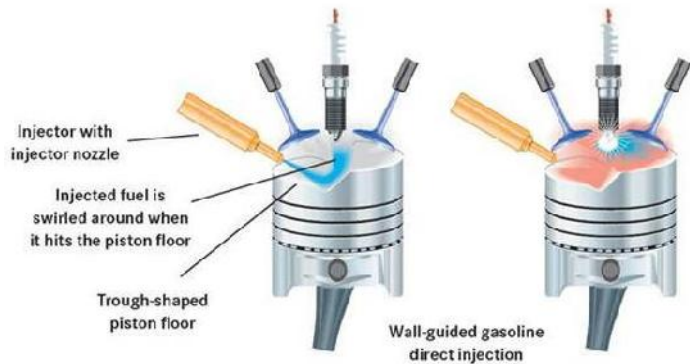
Ultrafine PM Emissions from Natural Gas, Oxidation-Catalyst Diesel, and Particle-Trap Diesel Heavy-Duty Transit Buses

BRITT A. HOLMÉN^{a,†} AND ALBERTO AYALA^a

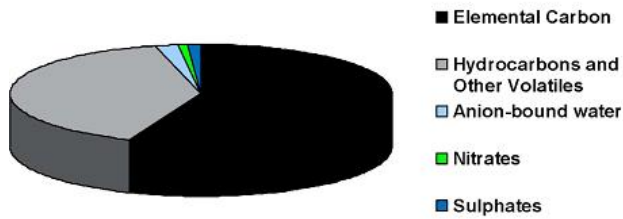
^a Civil and Environmental Engineering, University of Connecticut, Storrs, Connecticut 06269-2037, and California Environmental Protection Agency, Air Resources Board, Sacramento, California 95812

prescribed for taking it to obtain meaningful results. Of critical importance is the temperature difference sampling compare in numbers. Total particle number sampling for the two alternative steady-state cycle data collected from 0.5 to 9 × 10⁴ with the CRT filter, and the CNG bus.

GDI PM/ PN > PFI PM/PN > DPF and GPF PM/PN

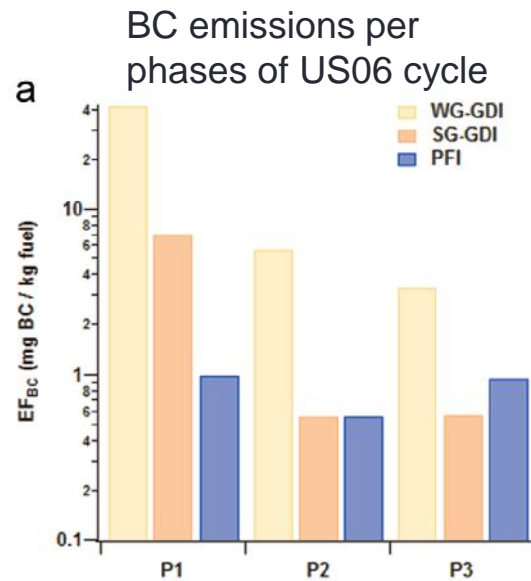


Chemical Analysis of PM Euro 4 VW FSI



GDI

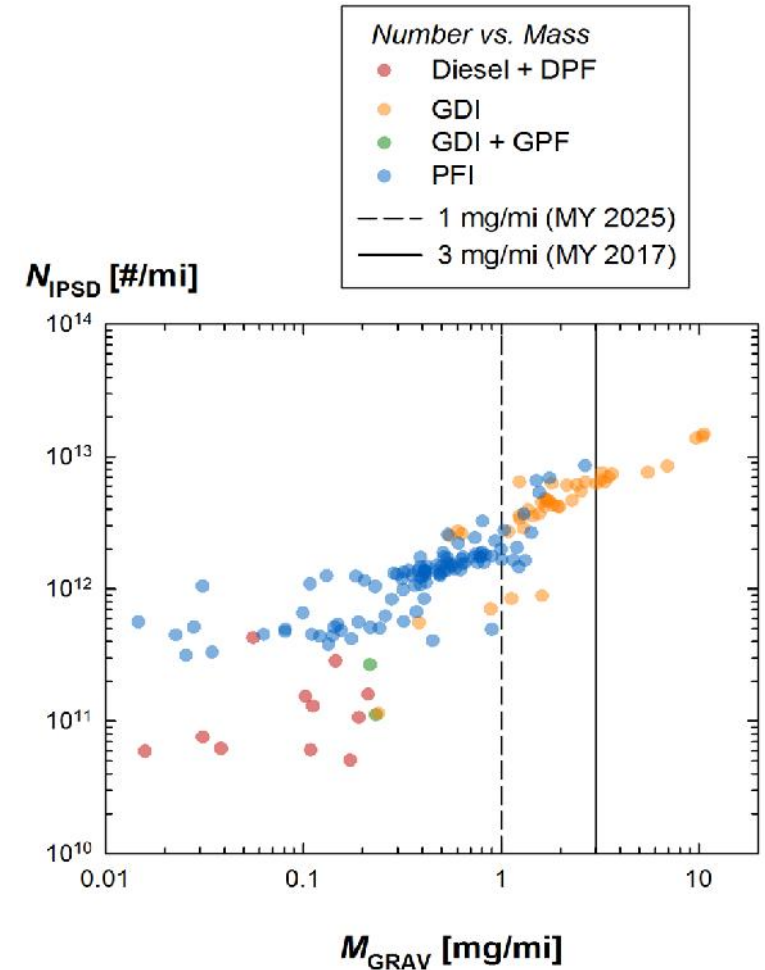
http://www.greencarcongress.com/2006/02/mercedesbenz_pr.html



Characterizing emissions and optical properties of particulate matter from PFI and GDI light-duty gasoline vehicles

R. Bahreini^{a,*}, J. Xue^{b,c,d}, K. Johnson^b, T. Durbin^b, D. Quiros^e, S. Hu^d, T. Hual^e, A. Ayala^f, H. Jung^g

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^e California Air Resources Board, 1001 J Street, Sacramento, CA 95834, USA



What is next?....



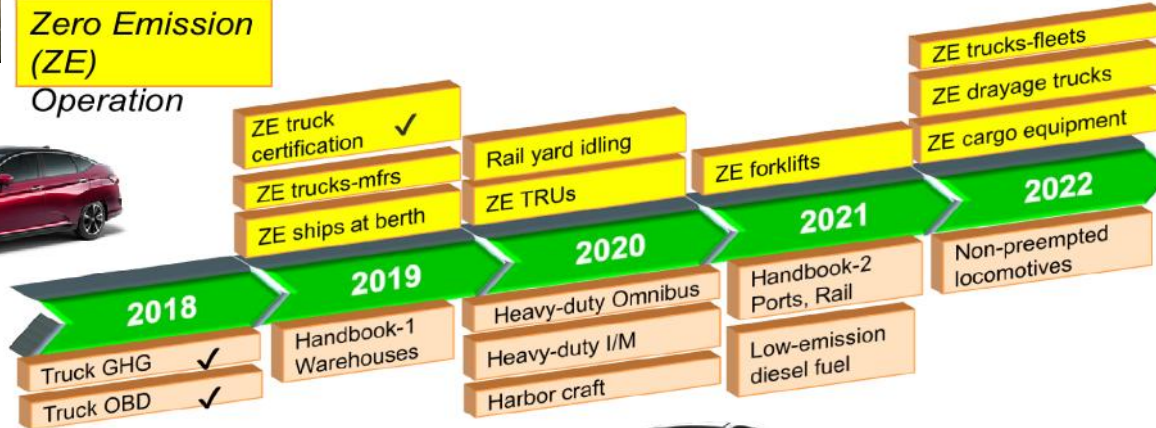
....a lot of electrification



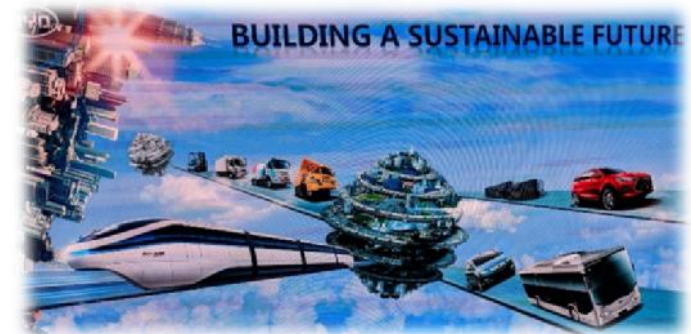
Plan de regulacion para vehiculos pesados en California



Zero Emission (ZE) Operation

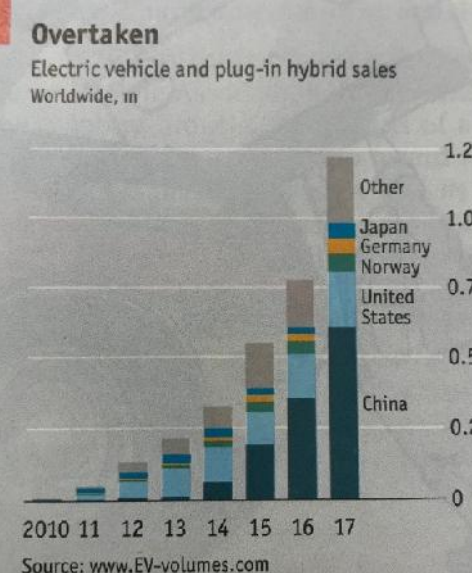


Lower Emissions



VW scandal was good for electrification

California ZEV targets: 1.5m/2025, 5m/2030, ?/2040, ?/2050



"sooner or later the country will have to ban diesel cars" Angela Merkel, German Chancellor



Diesel trucks would be nearly eliminated in California under proposed law

Peter Fimrite | 9/18/19 | www.chronicle.com



Peter Fimrite, San Francisco Chronicle, 3/8/19



Protesters in front of the Transport Ministry in Berlin, Germany, on March 14, 2018. A German court ruled that cities may impose bans on diesel cars in order to bring down air pollution. Larsen Koall / Images

How air pollution contributes to 8 million deaths each year

By Richard E. Petter The Conversation | May 7, 2018, 11:30 AM

Reference: The Economist, 3/3/18



California lawmaker wants to ban gas car sales after 2040

By ALEXE KOSEFF | 9/12/17 | www.sacbee.com

France and the United Kingdom are doing it. So is India. And now one lawmaker would like California to follow their lead in phasing out gasoline- and diesel-powered vehicles.

When the Legislature returns in January, Assemblyman Phil Ting plans to introduce a bill that would ban the sale of new cars fueled by internal combustion engines after 2040. The San Francisco Democrat said it's essential to get California drivers into an electric fleet if the state is going to meet its greenhouse gas reduction targets, since the transportation sector accounts for more than a third of all emissions.

"The market is moving this way. The entire world is moving this way," Ting said. "At some point you need to set a goal and put a line in the sand."



How Volkswagen turned from diesel pariah into electric gorilla

David Ferris | E&E News reporter Published: Thursday, January 3, 2019