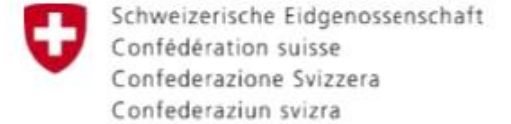




2nd Latin American
Conference on Nanoparticle
Emissions

25 y 26, Noviembre, 2021



Agencia Suiza para el Desarrollo
y la Cooperación COSUDE

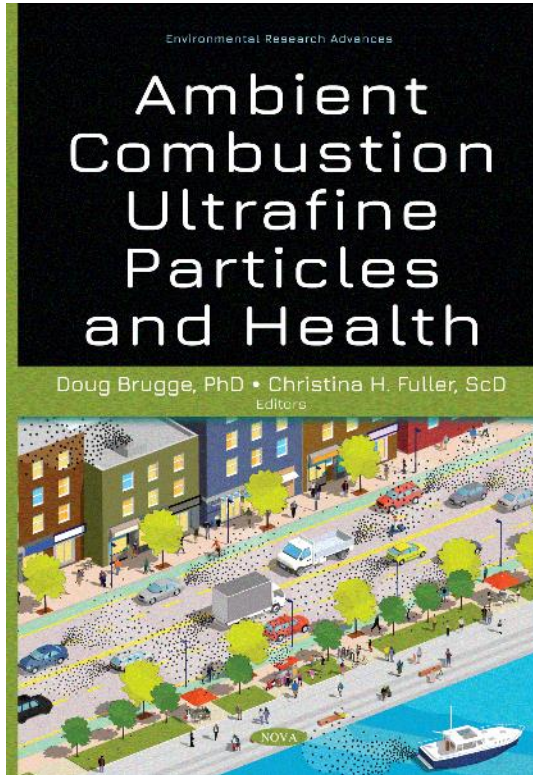
Ultrafine Particle Emissions and US Air Quality Policy

Dr. Alberto Ayala, PhD, MSE

Executive Director, Sacramento Metropolitan Air Quality Management District
Adjunct Professor, Mechanical and Aerospace Engineering, West Virginia University
(former) Deputy Director, California Air Resources Board







ULTRAFINE PARTICLES AND AIR POLLUTION POLICY

*Alberto Ayala, PhD, MSE**
Air Pollution Control Officer and Executive Director,
Sacramento Metropolitan Air Quality Management District;
Professor, Mechanical and Aerospace Engineering, West Virginia University;
Deputy Executive Officer, California Air Resources Board

PREFACE

And an Inch Deep

Discussing the policy landscape in the U.S. related to ultrafine particles (UFP), actions taken by environmental authorities to deal with this problem. After covering some background information, we will use the subject of internal combustion engine emissions of particulate matter (PM) to introduce the policy actions in the U.S. related to UFP. The story will lead us down the path of regulatory standards, other policy instruments, and research spanning the last three decades and conclude with a brief discussion of UFP in ambient air, traffic-related UFP emissions, and near-road air quality.

Any treatment of public policy for environmental protection necessarily will be broad and touch on many interrelated subjects that, threaded together, begin to form the basis for articulation of regulatory and other requirements. Many of those subjects can be highly technical and scientific in nature, requiring specific expertise to be able to draw policy-relevant conclusions. A policy discussion on air pollution and UFP is no exception. While in this chapter we will deal with a broad array of specialized topics such as air pollution, health effects, particle theory, measurements, experimentation, instrumentation, internal combustion, technology, public process, and government bureaucracy; we can do it only superficially. The reader is forewarned to be ready and is highly encouraged, especially if she is a current student, to conduct additional reading and research on these subjects. We will explore the policy landscape in the U.S. and Europe related to UFP pollution and discover that while there may be a lack of

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Today, we are at a classic glass half-full or half-empty stage. The evidence for concern [about ultrafine particle pollution] has grown substantially, but falls short of being convincing to regulators for enacting general policies, especially at the national level

Quantification of Health Benefits of California's Air Quality Regulations, Plans, and Programs

Traditional approach

- ❑ Small subset of morbidity and mortality outcomes
 - ❑ premature cardiopulmonary mortality
 - ❑ hospital admissions for cardiovascular illness
 - ❑ hospital admissions for respiratory illnesses
 - ❑ emergency room visits for asthma attacks

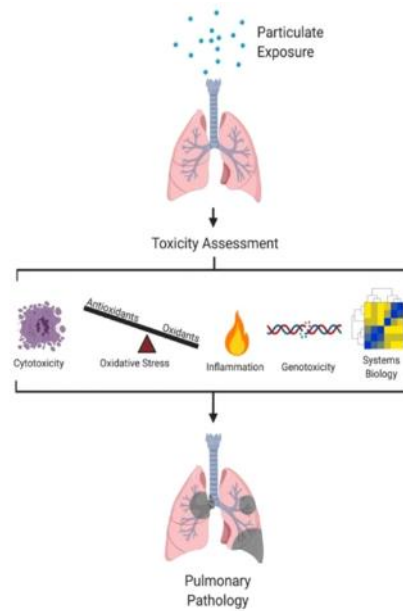
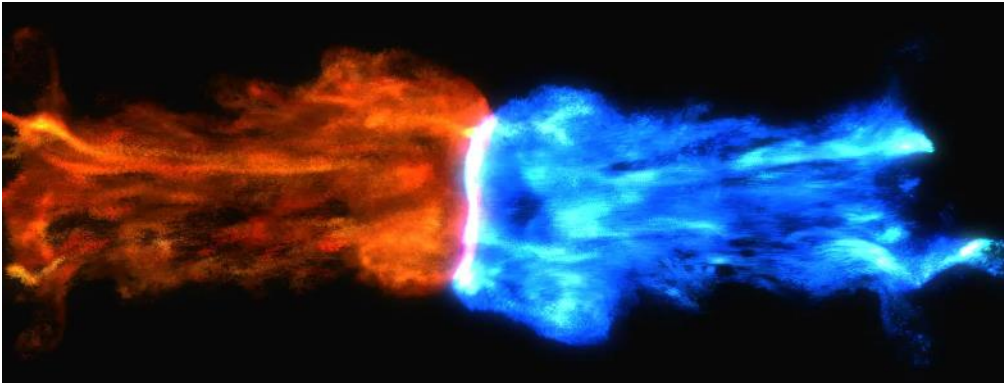


Figure 2. Exposure pathway and potential outcomes of inhaled combustion derived particulate matter.

Update

- ❑ New set of morbidity and mortality outcomes
 - ❑ hospitalizations
 - ❑ emergency room visits
 - ❑ missed work and school days
 - ❑ other burdens

Do ultrafine particles fit in?



Policy Forcers at Play

- Ozone and PM pollution reductions still sorely needed in many parts of the US
- Meeting the National Ambient Air Quality Standards (NAAQS) for Ozone and PM is priority [but no explicit emphasis on ultrafine particles]
- California heavily focused on decarbonization and electrification
 - Not paying enough attention to conventional pollution
- New federal review of O₃ and PM NAAQS underway [unknown if or how ultrafine particles will be treated]
- Extensive research continues [particularly modelling, exposure assessment, and micro-environments]
- The Precautionary Principle

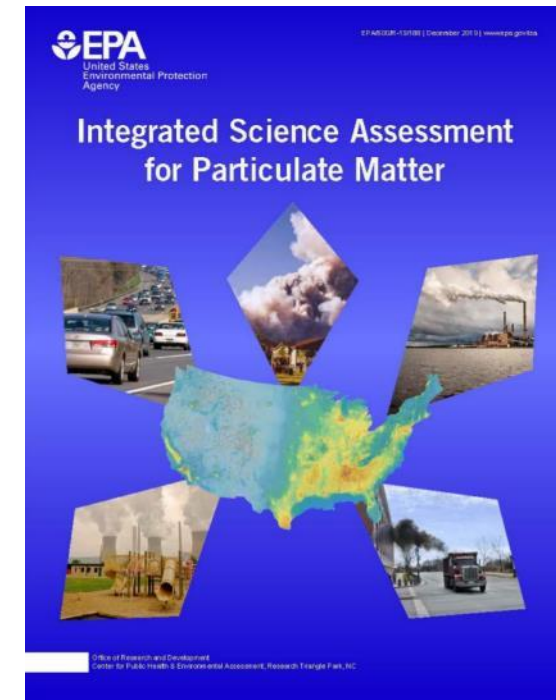


EPA-452/P-21-001
October 2021

Policy Assessment for the Reconsideration of
the National Ambient Air Quality Standards for
Particulate Matter, External Review Draft



- Trump EPA: evidence still inadequate or insufficient to determine causality of morbidity or mortality outcomes and exposure to ultrafine particle pollution
- Biden EPA: PM standards review underway
- What will EPA do about ultrafine particles?
- *“preliminary conclusion to stick with PM_{2.5} mass”*



U.S. EPA. Integrated Science Assessment (ISA)
for Particulate Matter (Final Report, Dec 2019).
U.S. Environmental Protection Agency,
Washington, DC, EPA/600/R-19/188, 2019.

The Knowns

- There is animal toxicological evidence linking long-term ultrafine particle exposure to nervous system effects
- There is evidence of translocation of ultrafine particle outside respiratory tract to the circulatory and brain systems via the olfactory nerve and others pathways
- We have observed neurological effects that are attributable to ultrafine particle pollution exposure



Open Source



Review

Particulate Air Pollution and Risk of Neuropsychiatric Outcomes. What We Breathe, Swallow, and Put on Our Skin Matters

Lilian Calderón-Garcidueñas ^{1,2}, Elijah W. Stommel ³, Ravi Philip Rajkumar ⁴, Partha S. Mukherjee ⁵ and Alberto Ayala ^{6,7,*}

¹ College of Health, The University of Montana, Missoula, MT 59812, USA; lilian.calderon-garcidueñas@umontana.edu

² Universidad del Valle de México, Mexico City 14370, Mexico

³ Department of Neurology, Geisel School of Medicine at Dartmouth, Hanover, NH 03755, USA; Elijah.W.Stommel@hitchcock.org

⁴ Department of Psychiatry, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry 605006, India; ravi.psych@gmail.com

⁵ Interdisciplinary Statistical Research Unit, Indian Statistical Institute, Kolkata 700108, India; psmukherjee.statistics@gmail.com

⁶ Sacramento Metropolitan Air Quality Management District, Sacramento, CA 95814, USA


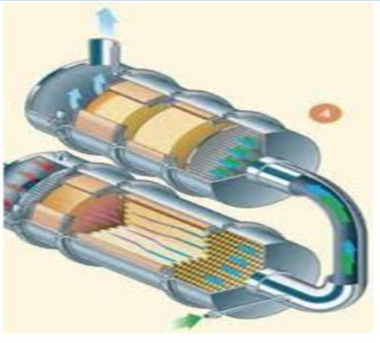



⁷ Department of Mechanical and Aerospace Engineering, West Virginia University, Morgantown, WV 26506, USA

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Int. J. Environ. Res. Public Health **2021**, *18*, 11568. <https://doi.org/10.3390/ijerph182111568>

<https://www.mdpi.com/journal/ijerph>

We can “check the box” on PM and NO_x emissions thanks to high-efficiency post-combustion devices

PM and NO _x Emissions	DOC + DPF +SCR + Better Systems Coming	Oxidation, Filtration, and Reductions	99.9% reductions in PM emissions possible	PM Control from ICEs
				

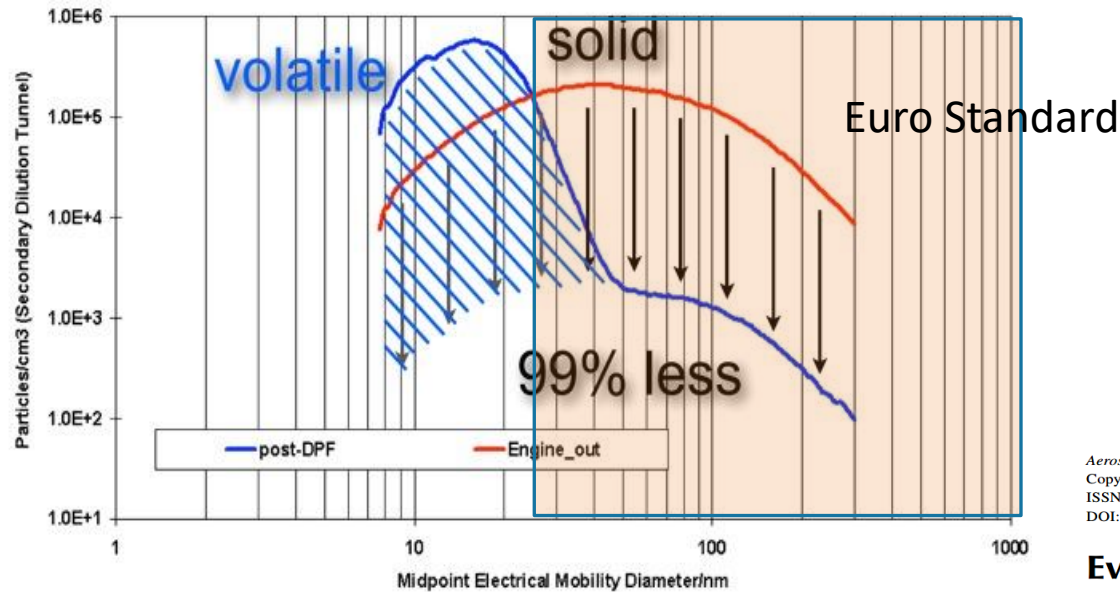
.....as long as they work as intended in the real world through useful life and there no more cheating....

State going after malfunctioning HD diesel trucks

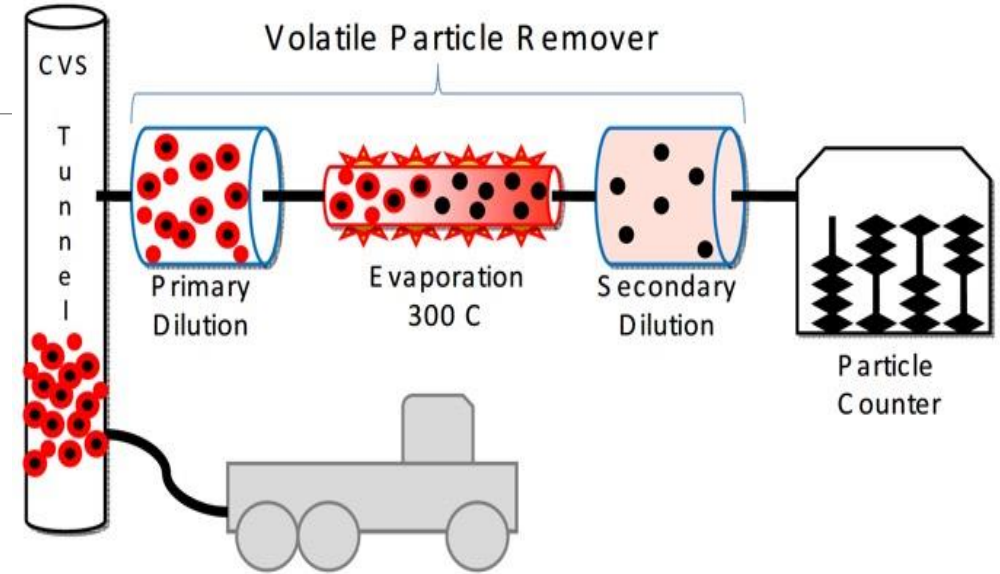
- New heavy-duty inspection and maintenance program (1/1/23)
 - Remote OBD and opacity for non-OBD trucks
 - Roadside monitoring
- Malfunctioning trucks responsible for majority of PM and NOx emissions (7% of HD Trucks emit 56% of statewide emissions)
- Screen a large number of trucks
- Quickly identify vehicles producing excess emissions
- Portable Emissions Acquisition System (PEAQS) – CO2, NOx, BC
- Other systems available (i.e., RSD, UC Berkeley Overpass, U of Denver “tent”)
- PEAQS installed on mobile trailer or existing fixtures
- *Does ultrafine particle counter have role?*



Why did California abandon Euro UFP standards?



...Because of exclusion of toxicologically-relevant volatile fraction of particle emissions, and...



Aerosol Science and Technology, 43:962–969, 2009
 Copyright © American Association for Aerosol Research
 ISSN: 0278-6826 print / 1521-7388 online
 DOI: 10.1080/02786820903074810

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

Kent C. Johnson,¹ Thomas D. Durbin,¹ Heejung Jung,¹ Ajay Chaudhary,¹ David R. Cocker III,¹ Jorn D. Herner,² William H. Robertson,² Tao Huai,² Alberto Ayala,² and David Kittelson³

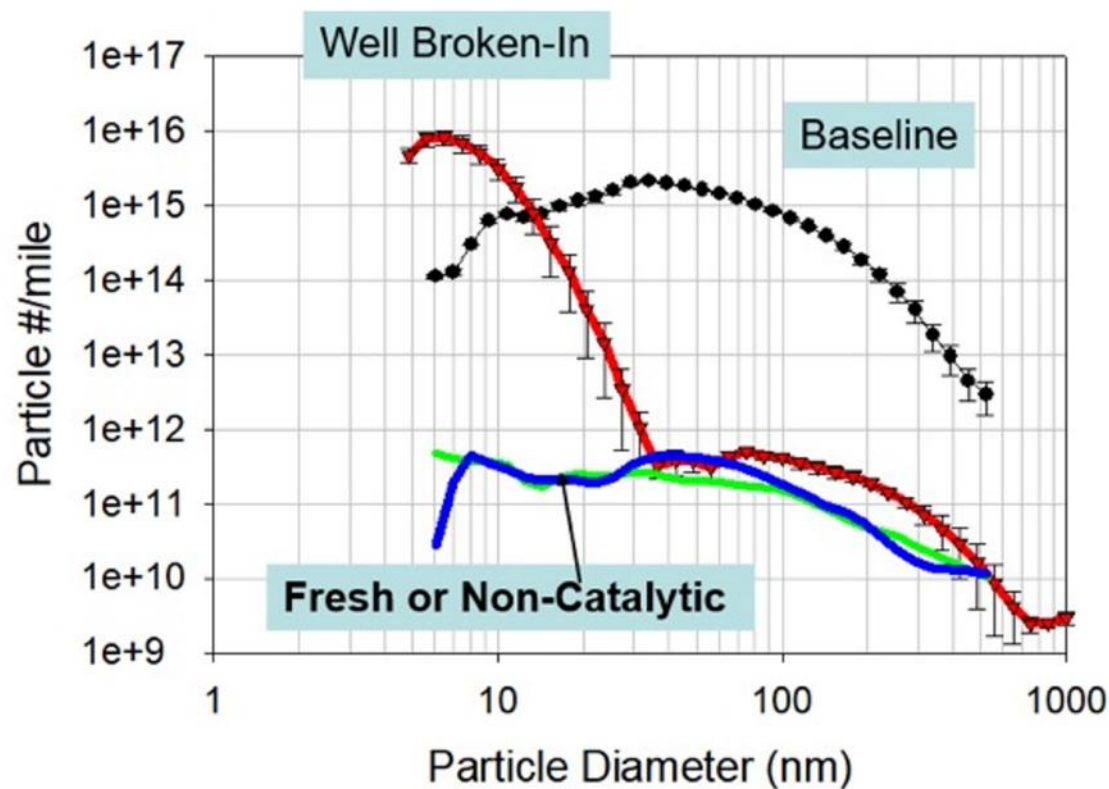
¹University of California, College of Engineering, Center for Environ. Res. Technol. (CE-CERT), Riverside, California, USA

²California Air Resources Board (CARB), Sacramento, California, USA

³University of Minnesota, Department of Mechanical Engineering, Minneapolis, Minnesota, USA



DPF has demonstrated PM and total PN (volatile and solid) control?



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

Conceptual model of formation of UFP emissions in catalyzed aftertreatment devices

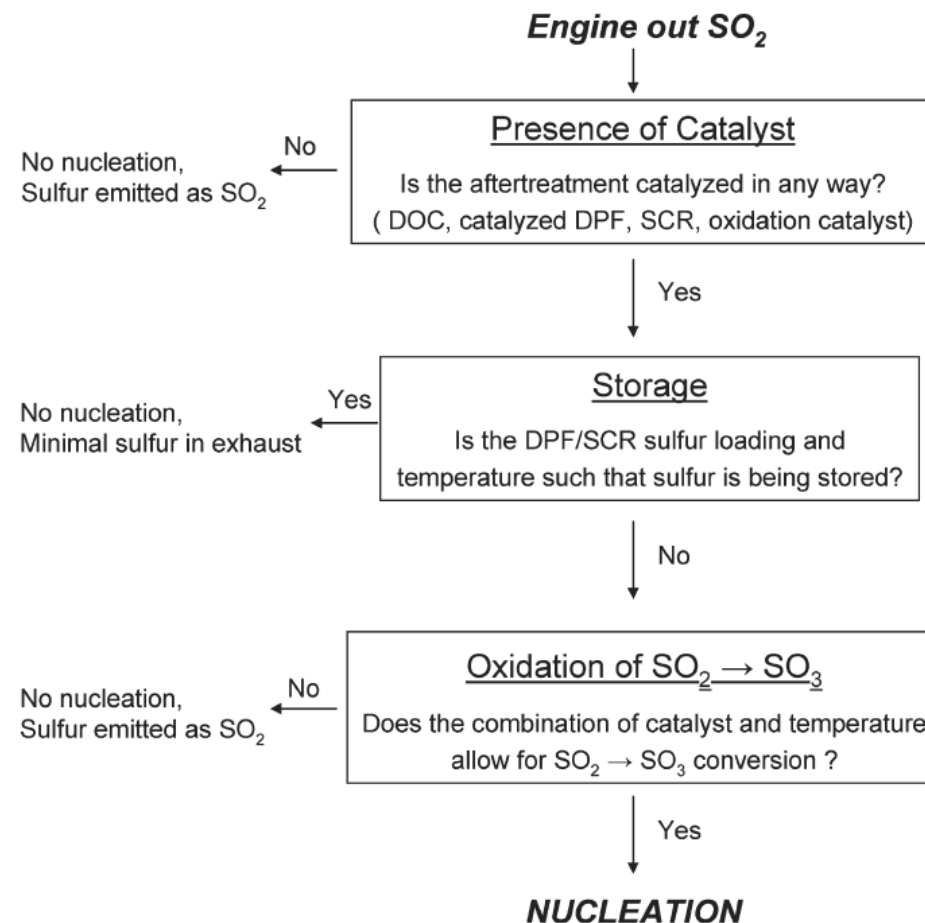
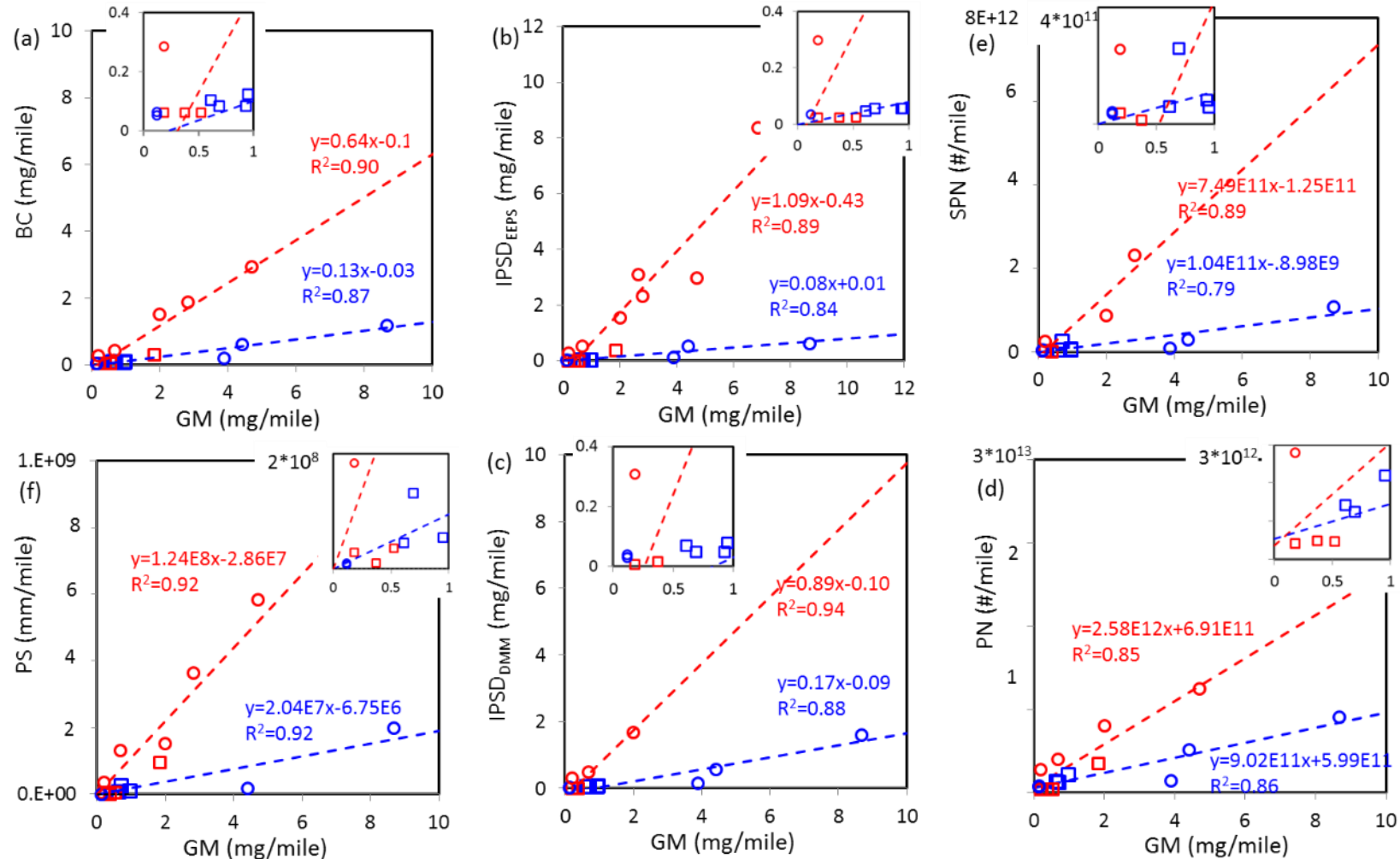


Figure 3. A basic model depicting when nucleation occurs in HDDE with aftertreatment. The important factors are catalyst, storage, and SO₂ to SO₃ conversion.

Strong inter-correlations among six alternative metrics, suggesting that adopting strategies to control one parameter may incidentally reduce the signal from any other metric of suspended PM



Xue, J., Li, Y., Quiros, D., Hu, S., Huai, T., Ayala, A. Investigation of Alternative Metrics to Quantify PM Mass Emissions from Light-duty Vehicles. CRC Real World Emission Workshop. 2017

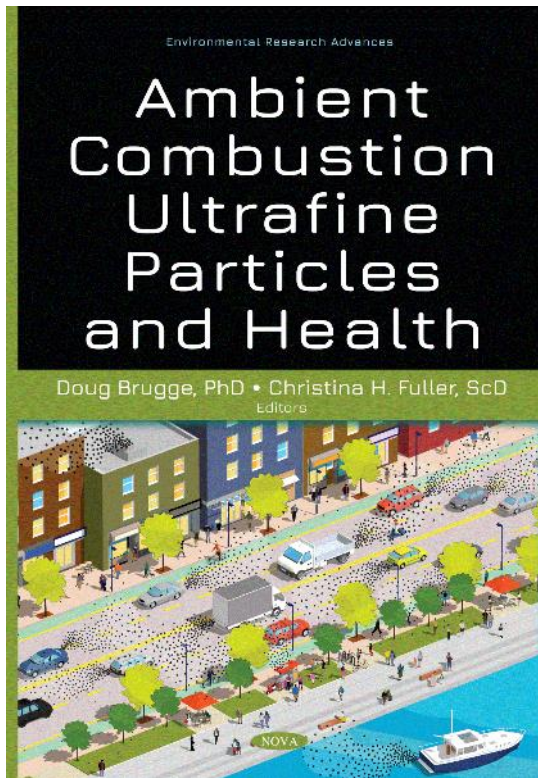
Red markers represent FTP tests ○ GDI
 Blue markers represent US06 tests □ PFI

Euro 7/VII Developments



- “safeguard measures against non-compliant vehicles”
- Commission with teeth: “compliance and conformity checks in laboratories or on the road” [looking for defeat devices and] “Comission can order recalls and impose sanctions”
- RDE and ultrafine particle monitoring and control?

Final Remarks



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Mil Gracias!

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