



The Impact of Fuel Ethanol and Aromatics on Air Quality

燃料乙醇和芳香烃对空气质量的影响

Jeff Scharping
Wichita, KS, U.S.A.
美国堪萨斯州威奇托



URBAN AIR INITIATIVE

都市清洁空气行动

2016 Chevrolet Colorado
2016年款雪佛兰科罗拉多



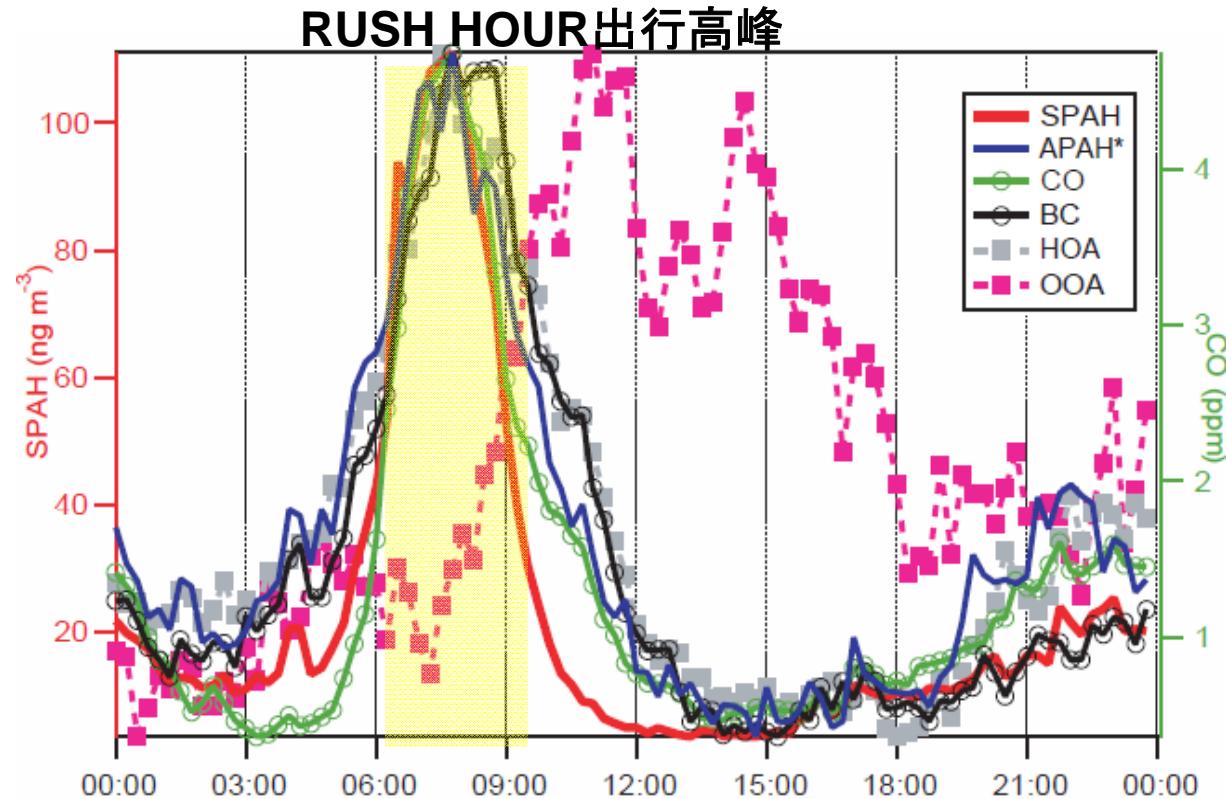
1946 Willys Jeep
1946年款威利斯吉普

What is creating the Pollution? 什么造成了污染？



EPA has a mandatory duty to cut “mobile source air toxics” to “the greatest degree . . . achievable.” -Clean Air Act § 202(l).

“最大程度”减少“移动源有毒空气污染物排放量”是环保署的强制性任务。-清洁空气法案 § 202(l).



“....evidence suggests that motor vehicles are the major source of PAH [Polycyclic Aromatic Hydrocarbons] emissions in Mexico City. Motor vehicles are responsible for 99% of CO emissions in the area.”

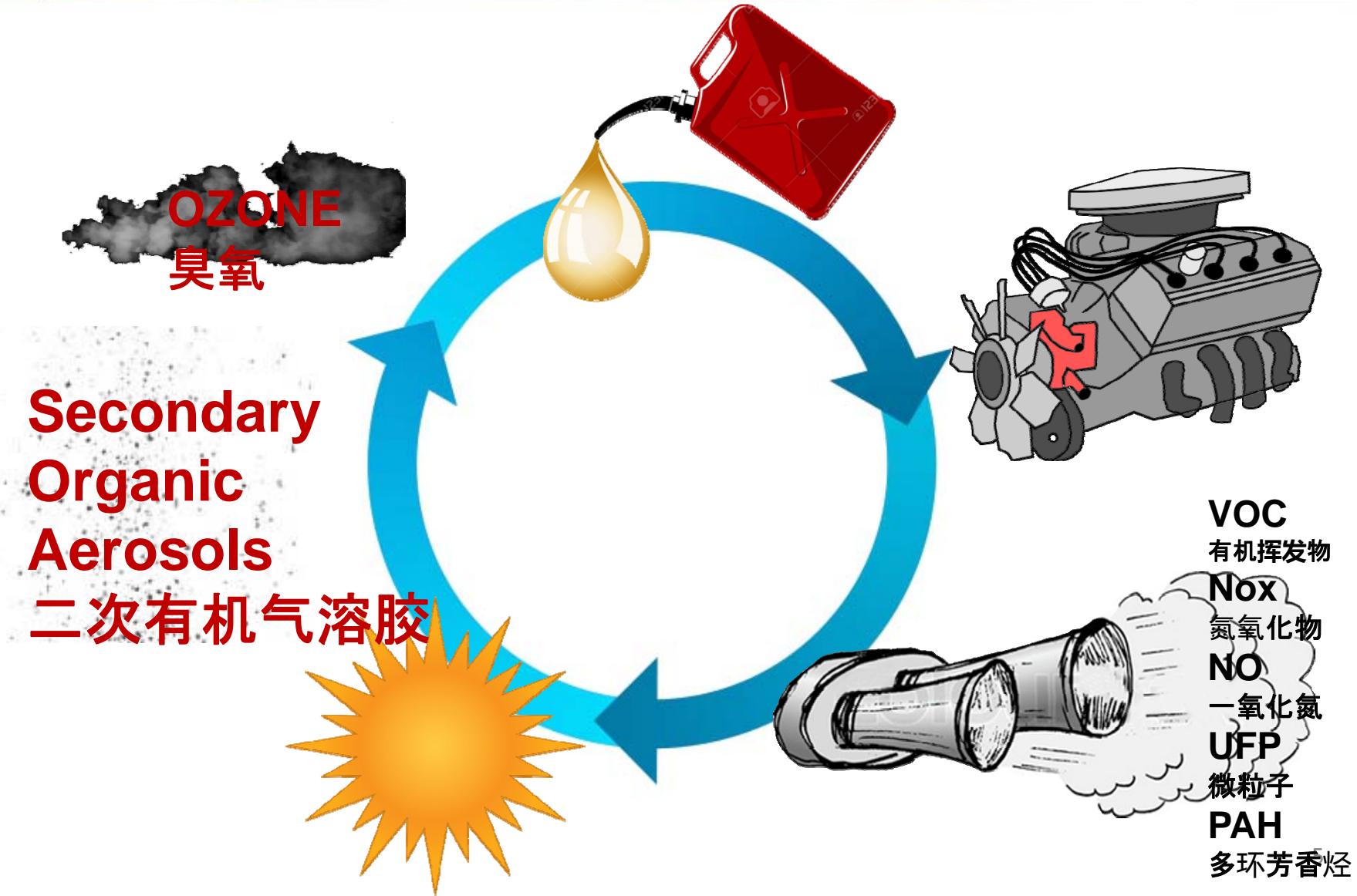
-Secretaria del Medio Ambiente, 2003, Atm. Chem. and Physics, 2006

“有证据显示，PAH[多环芳烃]是墨西哥城主要的污染物来源。该地区99%的一氧化碳排放污染来自于机动车辆。”

-Secretaria del Medio Ambiente, 2003,《大气化学和物理学》, 2006

It Starts with the Fuel

一切从燃料开始



Fire Triangle 火三角



Combustion With High Heat & Pressure 高温高压燃烧



URBAN AIR INITIATIVE

都市清洁空气行动

FUEL & AIR
燃料和空气

EXHAUST 废气



What's in Gasoline? 汽油成分？



URBAN AIR INITIATIVE
都市清洁空气行动



100 的纯汽油，不含乙醇

苯
甲苯
二甲苯

己二烯,
二甲基己烯,
壬烯,辛烷,
萘烷,1,3-戊二烯,
四氟乙烷,
三甲基环己烷,
二苯基乙烷,
三甲基萘,
二甲基环己烷,异苯并呋喃二酮,
戊二烯,二硝基苯,
二甲基菲,藿烷,丁烷,

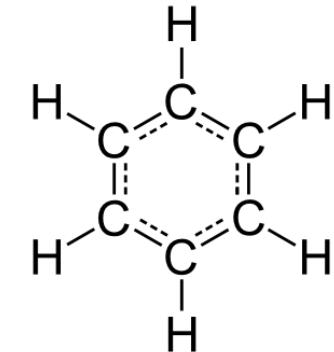
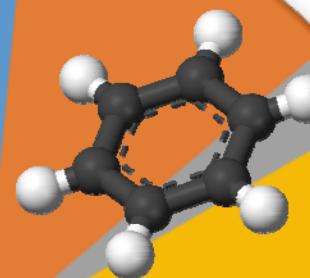
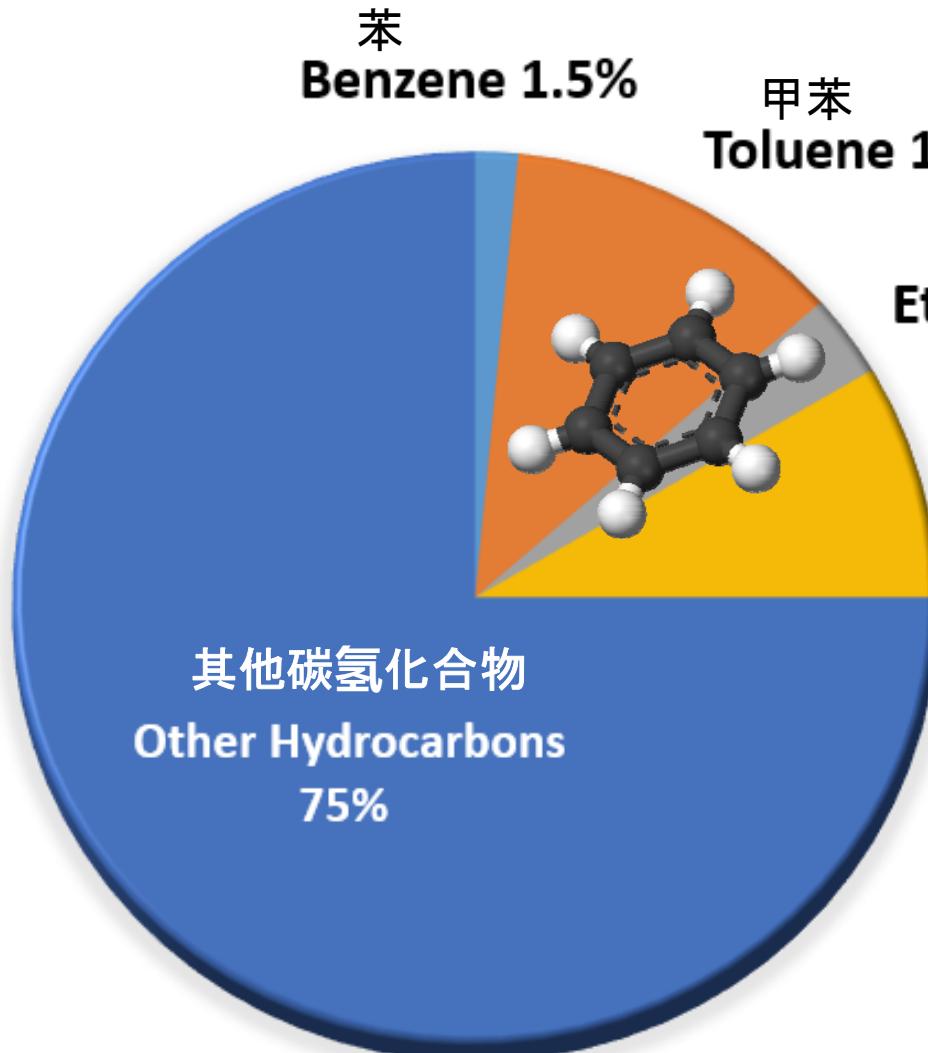
异丁烯,甲基茚,苯并呋喃,
二甲基-1-己烯,三甲基己烷,二硝基苯酚,
乙基环戊烷,三甲基十三烷,二硝基芴,
乙基丁烯,己酮,甲基-苯-基丙烯,
乙基辛烷,乙基庚烷,松香酸,乙酸,
苯乙酮,氨,壬二酸,甾烷,萜烷,
顺式十氢化萘,顺-蒎酸,癸醛,癸酸,
Decyclohexane,邻苯二甲酸二乙酯,二甲基十二烷,二十二烷,
反油酸,乙基对二甲苯,四氯化碳,铈,
乙基己醇,丁子香酚,氟化物,甲酸,糠醛,戊二酸,
愈创木酚,二十一烷,庚醛,庚二酸,庚基环己烷,
十六烷酸,十六烷,己酸,二十碳烷,茚酮,
异戊基苯,异丁子香酚,月桂酸,柠檬烯,马来酸,丙二酸,
氯甲烷,甲基十二烷,辛醛,辛二酸,正辛基环己烷,

Aromatics
BTEX
芳香烃

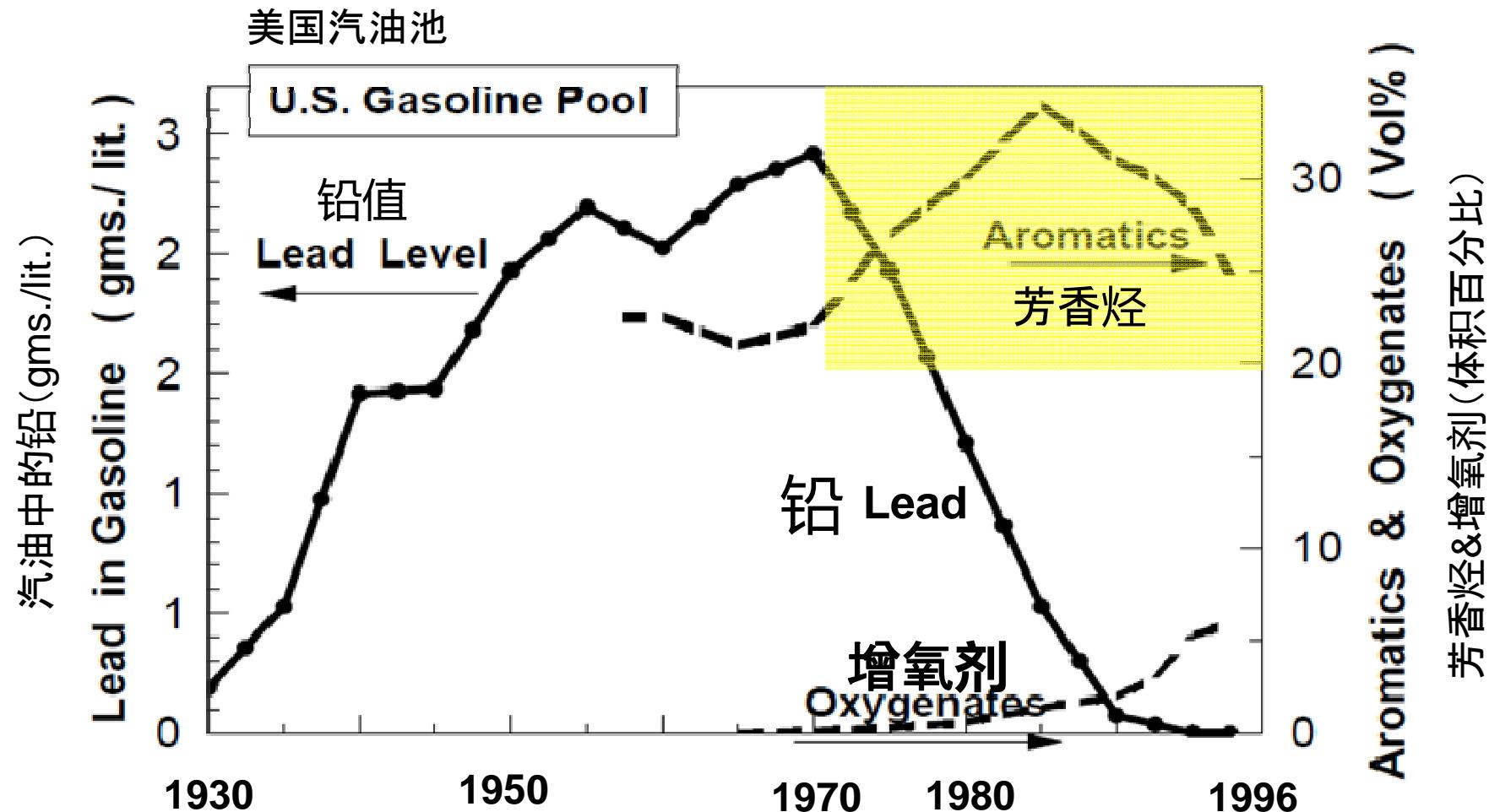


Aromatics in Gasoline

汽油中的芳香烃



Aromatics and Octane 芳香烃和辛烷



-William J. Piel, Lyondell Chemical Company, 1999
-William J. Piel, 莱昂德尔化学公司, 1999

PM – Particulate Matter
芳香烃使颗粒物增加



ETHANOL乙醇

GASOLINE汽油



PM – Particulate Matter

芳香烃使颗粒物增加



- PM classified as a class 1 carcinogen. -International Cancer Agency 2013
颗粒物被归为一类致癌物质。-国际癌症研究机构2013
- Long-term exposure to PM has been associated with an increased risk of developing cardiovascular and respiratory disease and irritation, infection and discomfort. -World Health Organization
- 长期暴露于颗粒物会导致心血管和呼吸道疾病, 过敏,, 感染和身体不适的风险----世界卫生组织

Air pollution causes cancer, World Health Organization agency declares

世界卫生组织公告, 空气
污染物会导致癌症

POOR AIR QUALITY
TRAVEL WISE
空气质量较差
明智出行

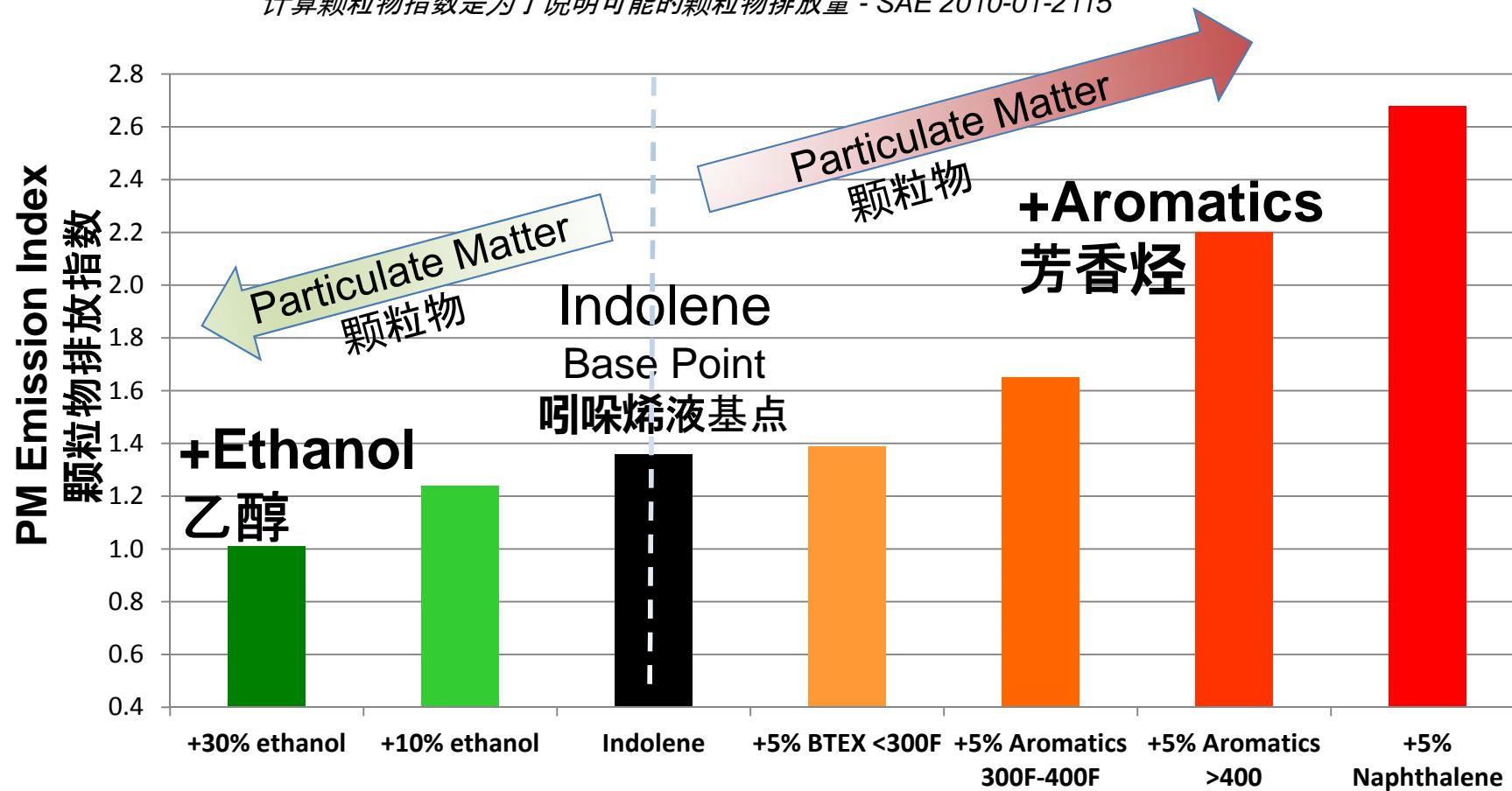


PM – Aromatics Increase Particulate Matter 芳香烃使颗粒物增加



Honda's Predictive Model Index 本田预测模型指数

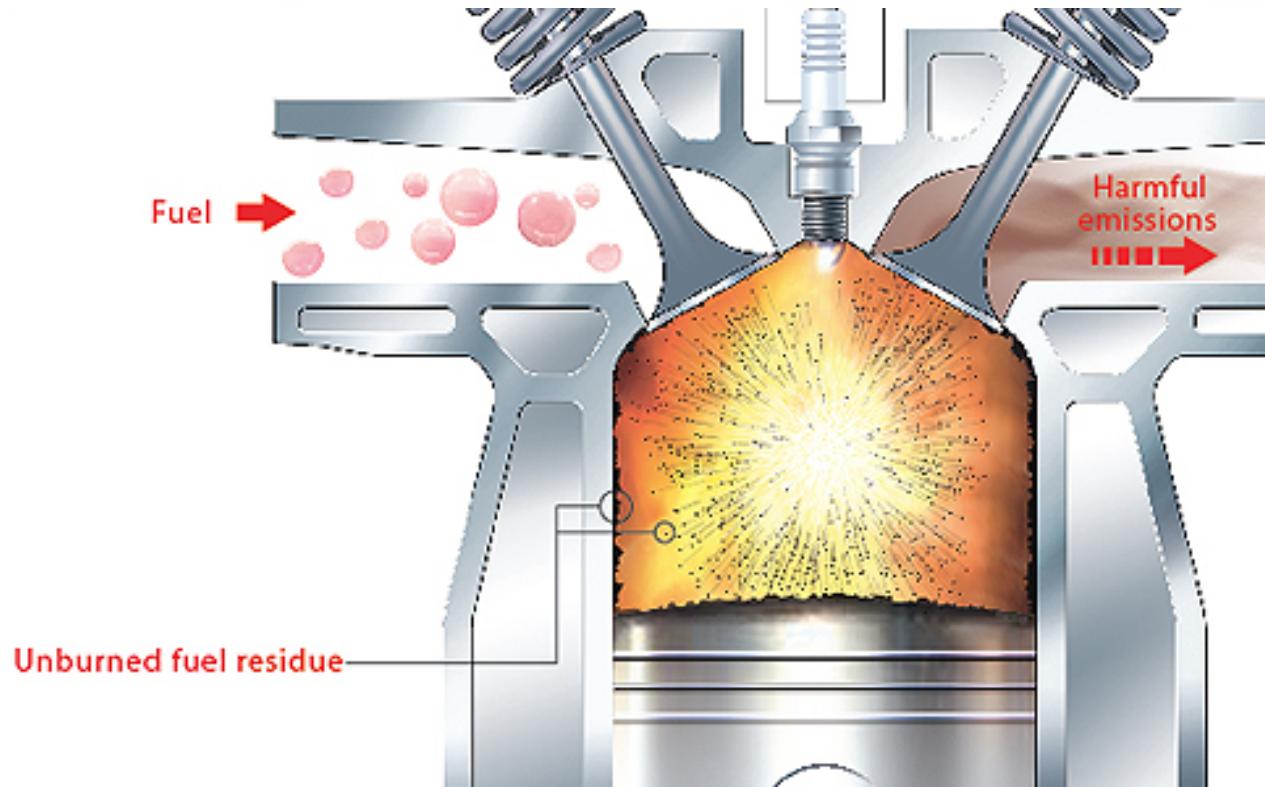
A PM index was developed which indicates the potential of PM emissions - SAE 2010-01-2115
计算颗粒物指数是为了说明可能的颗粒物排放量 - SAE 2010-01-2115



PM – Aromatics Increase Particulate Matter 芳香烃使颗粒物增加



URBAN AIR INITIATIVE



- “**Limiting distillation** temperatures and **aromatic** content are the most important parameters for **controlling** emissions...and build up of Combustion Chamber **Deposits.**”

-William J. Piel - Lyondell Chemical Company 1999

“限制蒸馏温度和芳香烃含量是控制排放量最有效的手段....以及燃烧室沉积物的增加。”

-William J. Piel - 莱昂德尔化学公司1999

Polycyclic Aromatic HydroCarbon Nucleate then Accumulate



- “PAHs are widespread contaminants formed during **incomplete combustion...**”

- *Pol. J. Environ. Stud.* Vol. 22, No. 2 (2013), 553-560

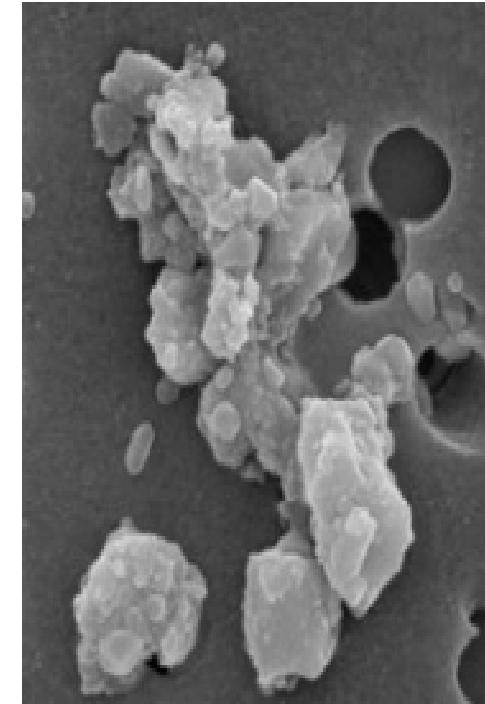
“PHA(多环芳香烃)是不完全燃烧过程中形成的常见污染物....” - 《波兰环境研究杂志》卷22, 第2期(2013), 553-560

- “...as PAHs promote aggregation and nucleation. The **bioethanol** fraction on the other hand, **is virtually devoid of PAHs...**” 多环芳烃促进了累积和成核作用。生物乙醇的加入, 另一方面, 实际上避免了多环芳烃—应用能源杂志2016

- *Applied Energy Nov 2016 A molecular dynamics*

study of...

- “...Raising total aromatics content from **15% to 25%** raises BTEX emissions by about **52% to 103%**. -Karavalakis et al., *supra* note 238, at 7027. See also Stein et al., *supra* note 148.
- 芳烃的含量从15%增加到25%增加了苯, 甲苯, 乙苯, 二甲苯等芳烃类的排放, 可增加52%到103%。



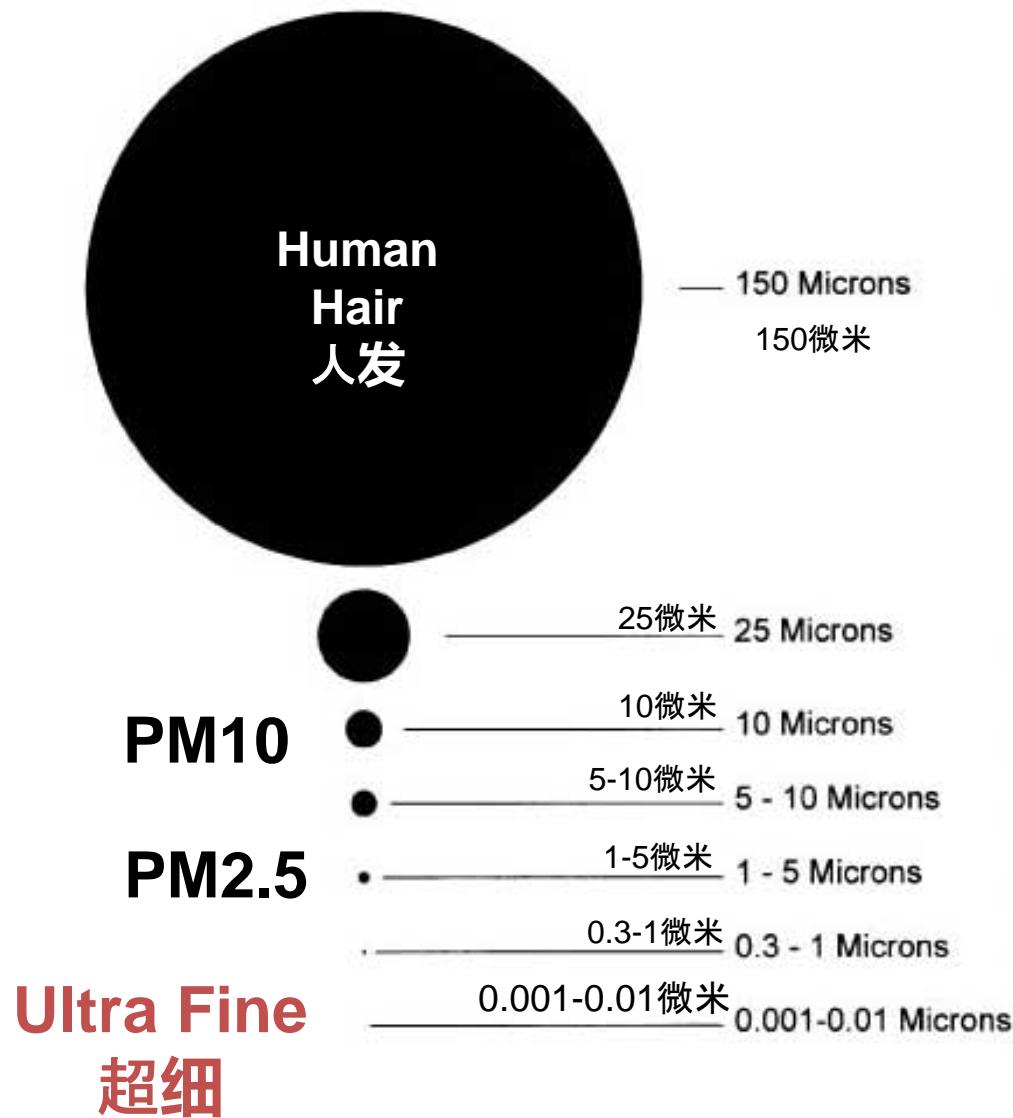
UFP < PM 0.15

Ultra Fine Particles from Aromatics

芳香烃使超细颗粒增加



URBAN AIR INITIATIVE
都市清洁空气行动



UFPs come from high-distillate aromatics that fail to combust, and are nucleated on a PAH.

UFP从高蒸馏温度芳香烃中产生，无法燃烧，并成为PAH的核心成分。

UFP < PM 0.15

Ultra Fine Particles from Aromatics

芳香烃使超细颗粒增加



URBAN AIR INITIATIVE

- “.... The Particulate Number (PN) reduction ranges between 60% and 90% [when using ethanol blends]....” 颗粒物数量的降低幅度在 60%-90% 之间(如果添加乙醇的话)

—M.A. Costagliola et al., Combustion Efficiency and Engine Out Emissions of a S.I. Engine Fueled with Alcohol/Gasoline Blends, Applied Energy



- U.S. EPA currently **does not account** for UFPs, because it measures particles by **mass** rather than particle number. 美国环保署目前并不管理超细微粒物，因为它只测量颗粒物的质量而不是数量
- “...ultrafine particles...penetrate deeper into the airways of the respiratory tract...in which **50% are retained in the lung** [and] particle toxicity tend to be stronger for the fine and ultrafine PM size fractions.”

“....由于细颗粒和超细颗粒可以渗透到呼吸道深处，并可到达肺泡，其中50%会停留在 肺部，因而这些作用在细颗粒和超细颗粒上表现得更为明显.... 细和超细PM组分往往 具有更强的颗粒物毒性。车辆排放的颗粒被认为是导致都市区域出现在空气中传播的 小尺寸颗粒污染物的最大原因。”

-《环境科学与健康杂志》, Valavanidis, Fiotakis, Vlachogianni, 2008 年7月

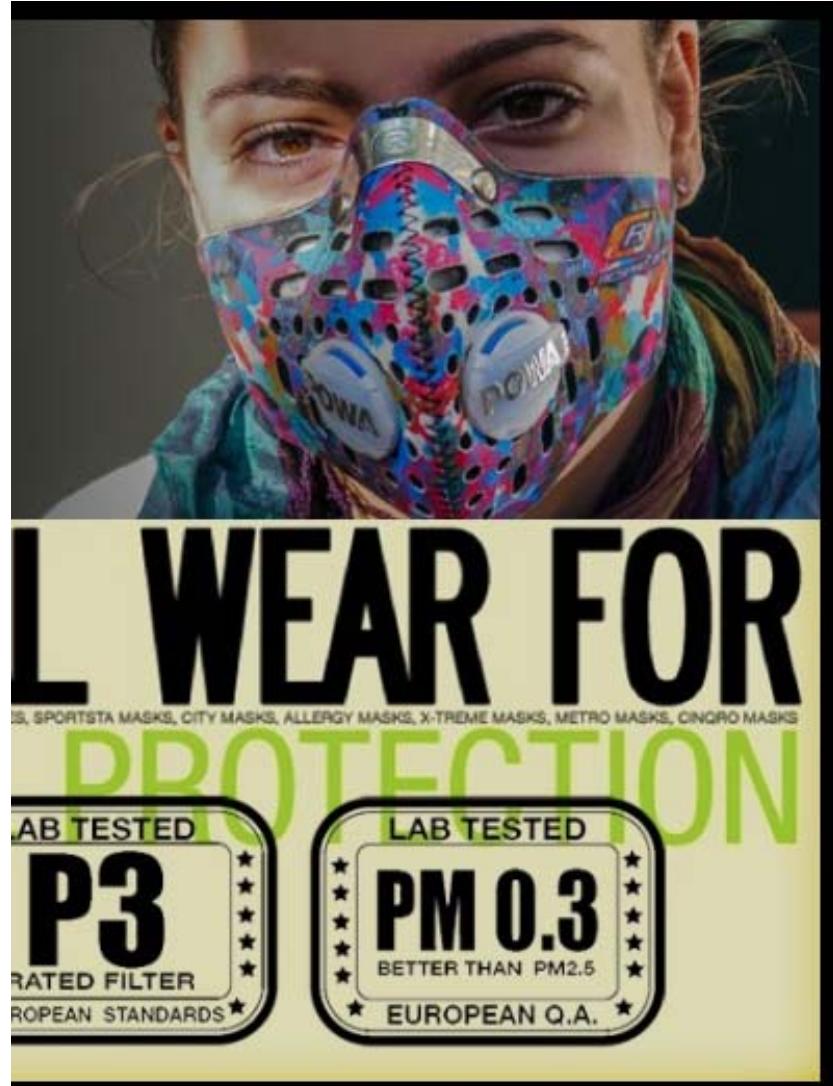
UFP < PM 0.15

Ultra Fine Particles from Aromatics

芳香烃使超细颗粒增加



URBAN AIR INITIATIVE

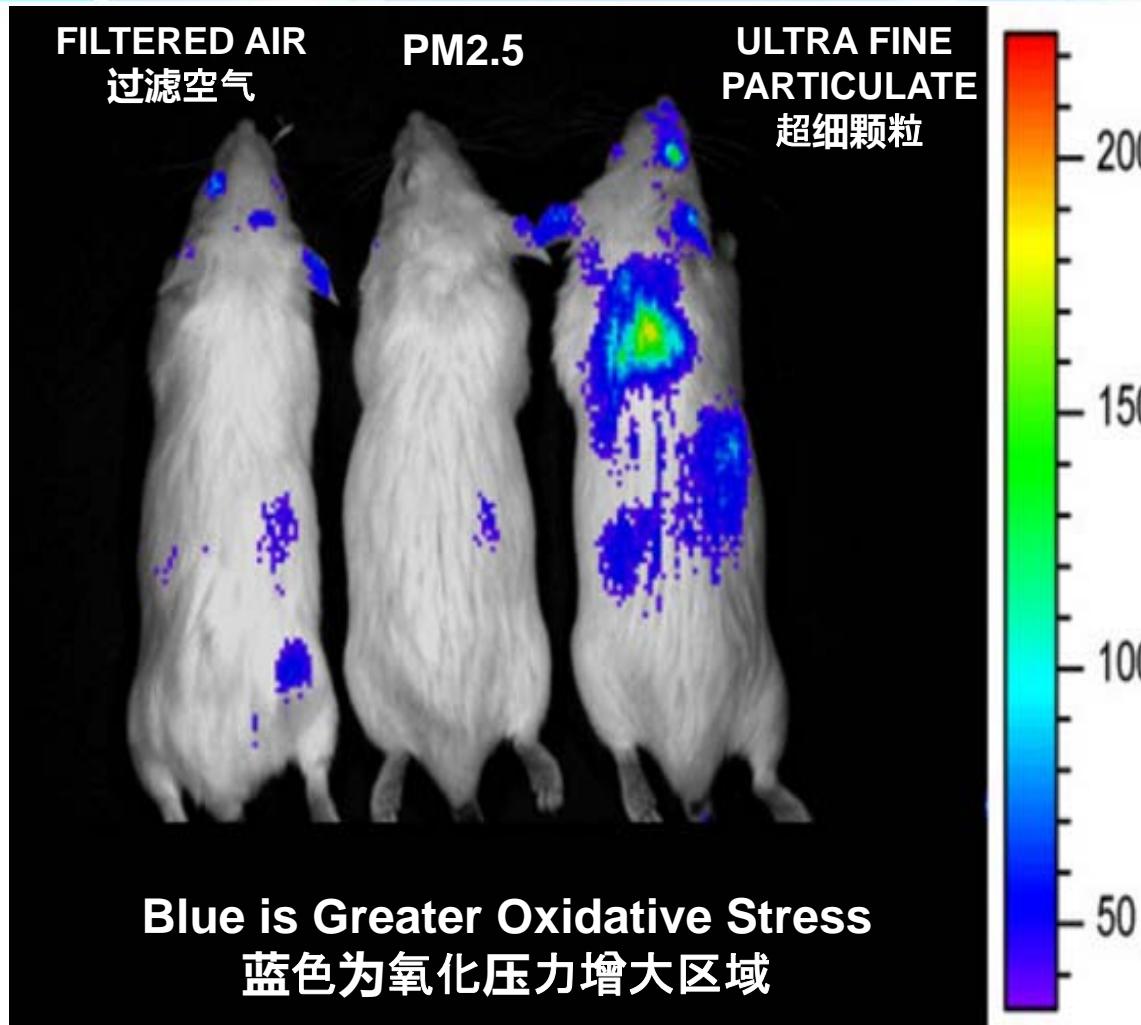


- The particulate masks “will not help reduce exposure to gases and vapors such as ozone, sulphur dioxide and nitrogen dioxide.” -3M
- 颗粒物防护口罩“不会有助于减少对臭氧, 二氧化硫和二氧化碳等气体和蒸汽的暴露”---
-3 M 公司

UFP and PAH - Aromatics Increase Oxidative Stress 芳香烃使氧化压力增大



URBAN AIR INITIATIVE
都市清洁空气行动



Mice exposed for 5 hours in downtown Los Angeles Mobile Lab 300 meters away from the I-110 freeway.

小鼠待在距离 I-110高速公路300米远的洛杉矶市区移动实验室内5小时

“Urban UFP contain a higher content per unit mass of PAH, whichcan induce oxidative stress....”
“城市UFP每单位质量PAH的含量更高,会使组织的氧化压力增大并引起亲电化学反应。”

-Barajas, Kleinman, Wang, Bennett, Gong, Navab, Harkema, Sioutas, Lusis, et al.: Circ Res 2008, 102(5): 589–596. 10.1161/CIRCRESAHA.107.164970

-Barajas, Kleinman, Wang, Bennett, Gong, Navab, Harkema, Sioutas, Lusis, 等人:《循环研究》2008, 102(5): 589–596. 10.1161/CIRCRESAHA.107.164970

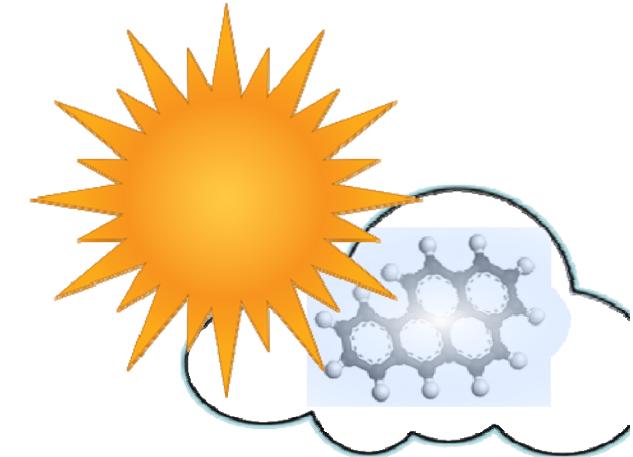
-Contag, (Stanford) Zhao, Vreman, Hajdena-Dawson, Wong, Stevenson, J Mol Med 2002, 80(10):655–664. 10.1007/s00109-002-0375-x
-Contag, (斯坦福) Zhao, Vreman, Hajdena-Dawson, Wong, Stevenson, 《分子医学杂志》2002, 80(10):655–664. 10.1007/s00109-002-0375-x

Aromatics increase SOA's – Secondary Organic Aerosol



- “SOA are produced through a complex interaction of **sunlight** andemissions, and other airborne chemicals. -EPA Website 2016

“SOA通过太阳光和挥发性有机化合物(来自.....排放物和其他弥漫在空气中的化学物质)之间复杂的化学反应产生。SOA是细颗粒污染物(PM.2.5)的主要成分。”
-环保署网站2016



- SOAs are a major component of fine particle pollution (PM.2.5).”
-EPA Website 2016

二次有机气溶胶是超细颗粒物污染(PM2.5)的主要成份— 美国环保署网站2016

- “.... PM2.5 formation potential of whole gasoline vapor can be **accounted for solely in terms of the aromatic fraction of the fuel.**”

- Odum JR, Science. 1997;276:96–99

表明，整个汽油蒸汽PM2.5 的生成潜势完全取决于燃料中芳香烃的比例

Aromatics Increase Black Carbon 芳香烃使黑炭增加



-[Black carbon is a] component of particulate matter (PM), and is formed by the incomplete combustion of fossil fuels...BC can absorb a million times more [sun] energy than carbon dioxide (CO₂). BC is a major component of "soot".

- U.S. EPA Website 2016

.....[黑炭是]颗粒物(PM)的组成部分，由化石燃料的不完全燃烧所形成...黑炭吸收[太阳]能量的能力是二氧化碳(CO₂)的一百多万倍。黑炭是“烟尘”主要成分。 - 美国环保署网站2016

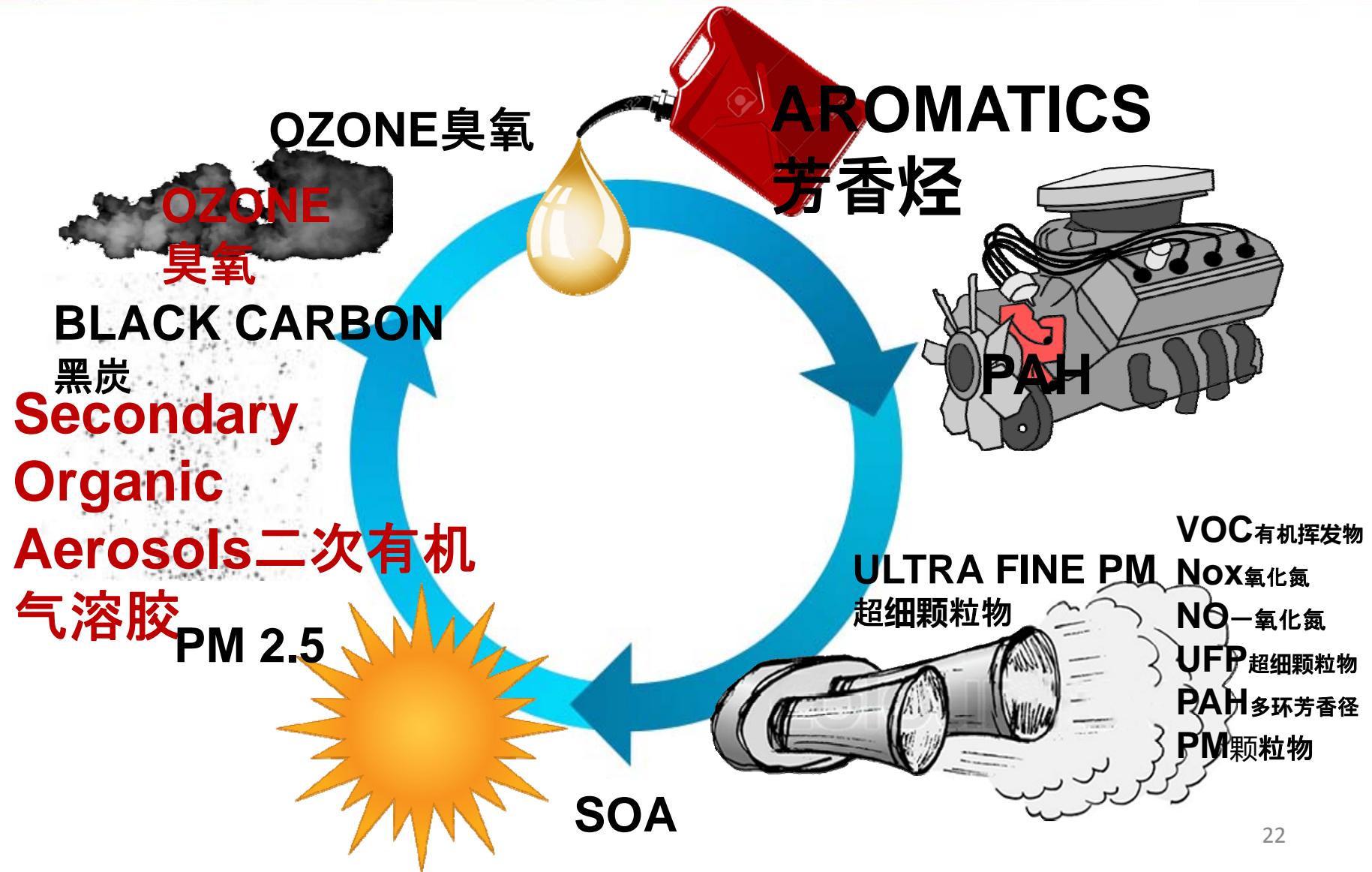


- “...reduced aromatic concentrations are associated with reduced PM mass and reduced Black Carbon from Gasoline Direct Injected vehicles. Thus, increasing the ethanol fraction in gasoline could help to reduce climate and human health impacts attributed to particle emissions from GDI vehicles.” This study showed Black Carbon increasing 350% from fuels with 15% aromatics compared to 35%.

- Riverside/Karavalakis – Durbin 2015

“我们的结果显示，降低芳香烃浓度与直接喷射式汽油机(GDI)车辆产生的颗粒物质量和黑炭数量的降低相关。因此，增加汽油中乙醇的比例有助于降低GDI车辆产生的颗粒排放物对气候和人类健康的影响。”这项研究表明，燃料中芳香烃的含量从15%增至35%导致黑炭数量增加350%。 - Riverside/Karavalakis – 都柏林2015

Ethanol Reduces Aromatics 乙醇令芳香烃数量减少



Choose Ethanol

选择乙醇



Great Engine Performance

Less Greenhouse Gases

Lower Carbon Footprint

Cleaner Air

引擎性能出众

降低温室气体排放

减少碳足迹

净化空气

Thank You! 谢谢!

Jeff Scharping

Wichita, KS, U.S.A. 美国堪萨斯州威奇托

Jeff@UrbanAirInitiative.com

