



中国环境科学研究院
Chinese Research Academy Of Environmental Sciences

***Status Quo of Heavy-duty Diesel Vehicle
Emissions and Its Regulatory Control Policy***

重型柴油车排放现状和监管对策

Chinese Research Academy of Environmental Sciences

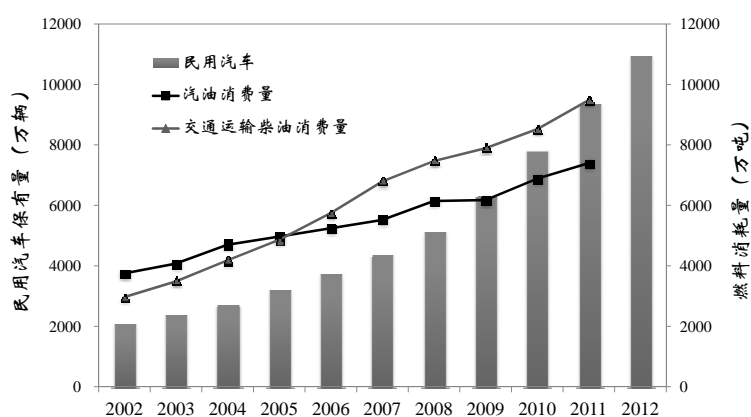
中国环境科学研究院

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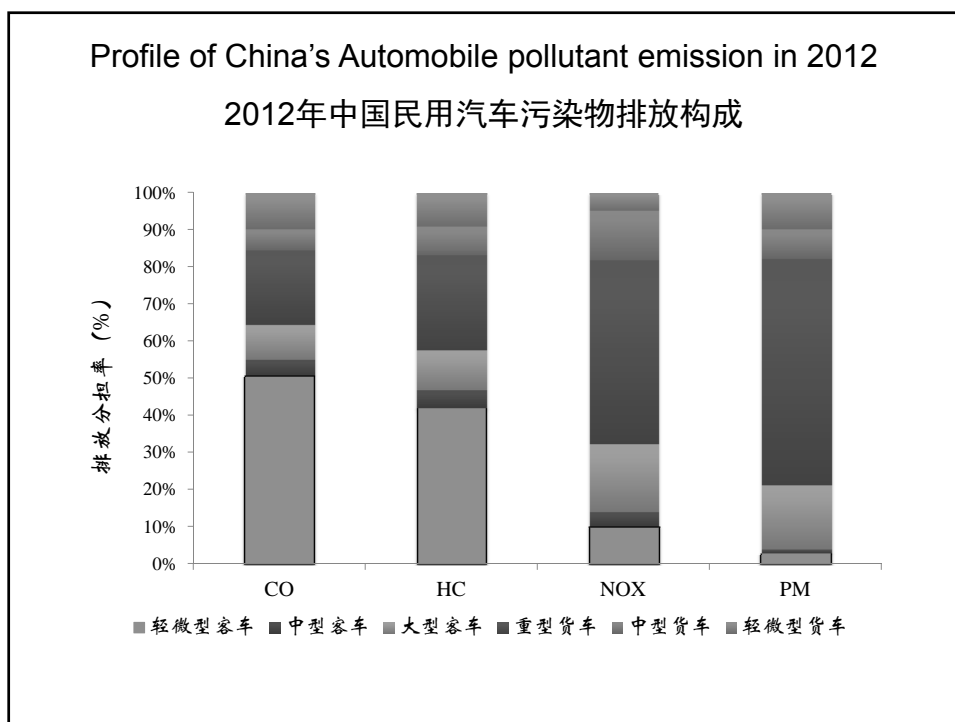
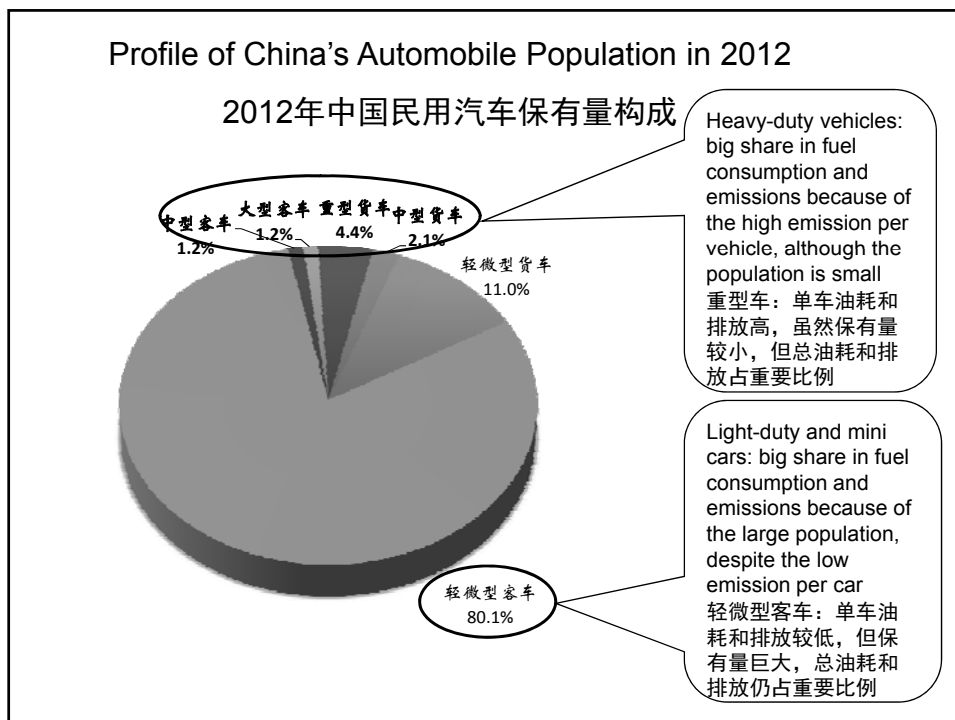
Development of Automobile Population and Related Energy Consumption

汽车保有量和能源消耗发展趋势



Since 2000, the fast growth of automobile population, gasoline and diesel consumption in transportation sector in China brings big pressure to the resources and environment

进入二十一世纪以来，我国的民用汽车保有量、汽油和交通运输柴油消费量都增长迅猛，给资源和环境都带来很大压力



***Investigation of current emissions from
heavy-duty vehicles/engines***

重型汽车/发动机排放现状分析

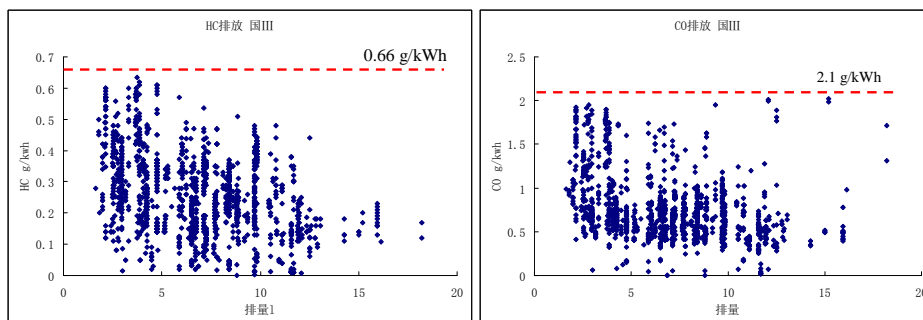
**Emission standards for heavy-duty diesel engines
重型柴油机排放标准**

Emission standards 排放标准	Cut points 限值				
	CO	HC + NO _x	HC	NO _x	PM
Pre-China 1 国一前	Only smoke tested at full load, Filter Smoke Number (FSN) < 4.0 全负荷烟度测试, 滤纸烟度<4.0				
China 1 (ECE R-49) 国一	4.5	-	1.1	8.0	0.36
China 2 (ECE R-49) 国二	4.0	-	1.1	7.0	0.15
China 3 (ESC) 国三	2.1	-	0.66	5.0	0.10
China 4 (ESC) 国四	1.5	-	0.46	3.5	0.02
China 5 (ESC) 国五	1.5	-	0.46	2.0	0.02

OBd and in-use compliance are required since China 4

国四开始要求车载诊断系统 (OBd) 和在用符合性检查

Regulated emissions from heavy-duty engines in China 中国重型柴油机的排放状况

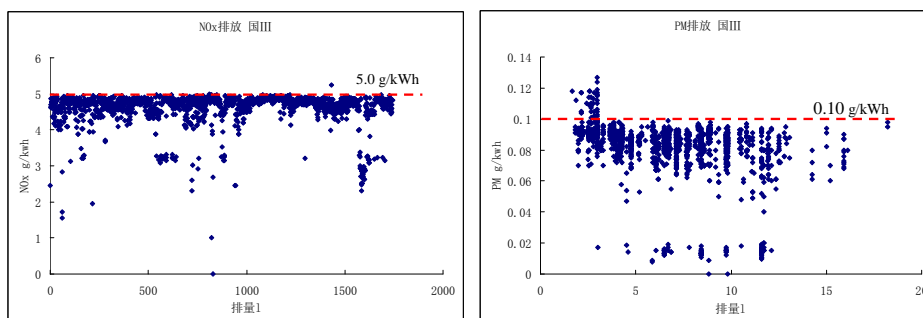


(a) HC排放

(b) CO排放

- It's easy for heavy-duty engines to pass the China 3 type approval in HC and CO emissions, with a big margin left
重型柴油发动机达到HC和CO排放的国三标准比较容易，通常还留有较大余地

Regulated emissions from heavy-duty engines in China 中国重型柴油机的排放状况

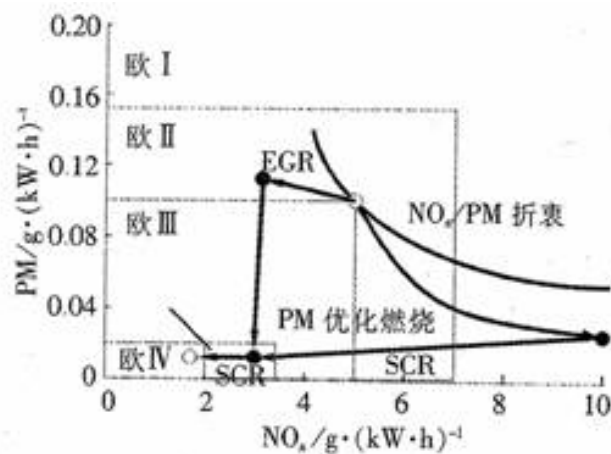


(c) NOx排放

(d) PM排放

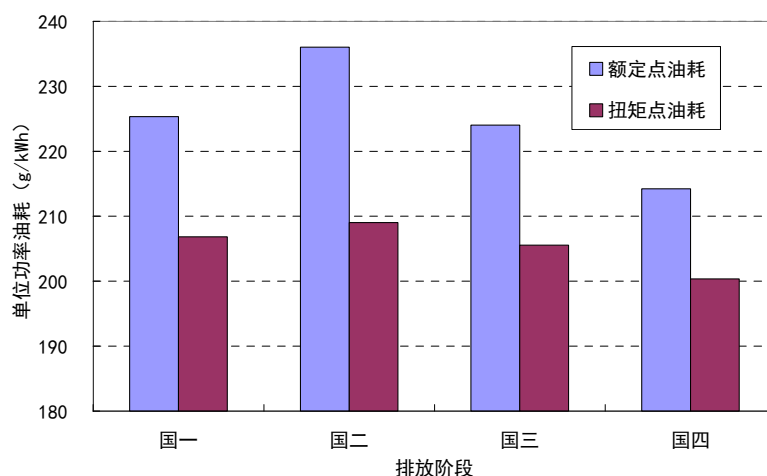
- But it's much more for them to pass the China 3 type approval in NOx and PM emissions (especially for NOx), which are exactly the most important pollutants to control
但重型柴油发动机达到NOx和PM排放的国3标准难度大得多，很多机型刚刚达到限值，这一现象在NOx排放上最为显著，而NOx和PM正是重型柴油车排放控制的重点

The problem of emission control of NO_x and PM 柴油机NO_x和PM排放控制的难题



柴油机的PM和NO_x排放此消彼长，PM减排和节油的目标是一致的，而节油却会导致柴油机的NO_x排放升高

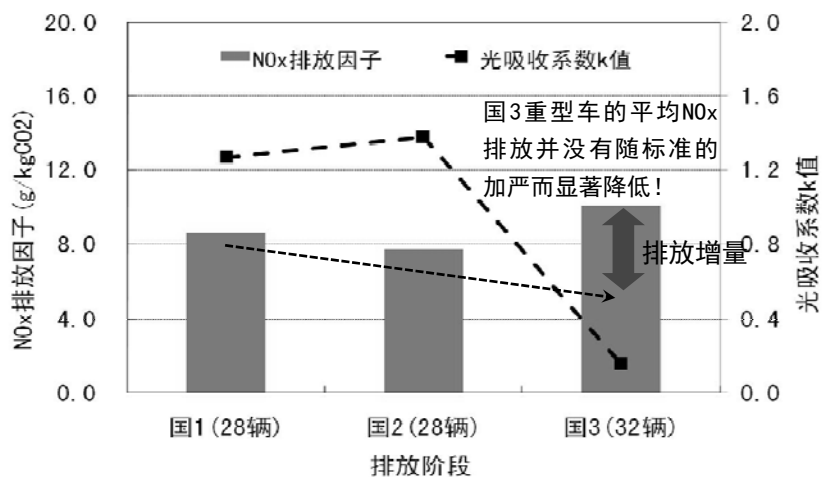
Fuel economy of heavy-duty engines in China 中国重型柴油机的燃油经济性



- Brake specific fuel economy got improved step by step since China 3
单位功率的燃油经济性从国三开始逐渐提高

Emission change of heavy-duty diesel vehicles from China 1 to China 3

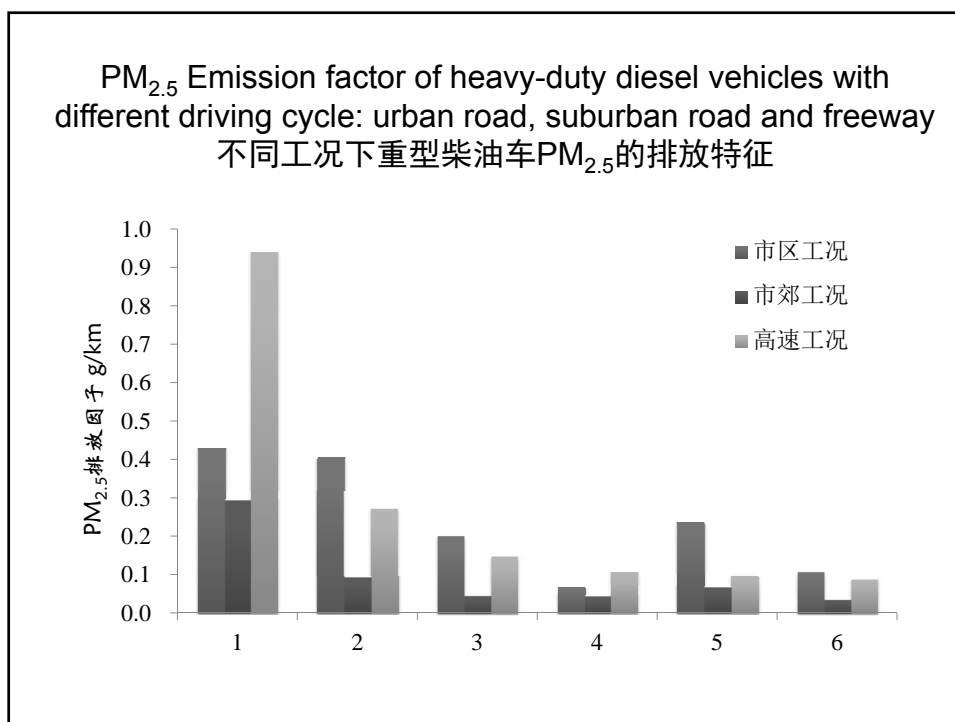
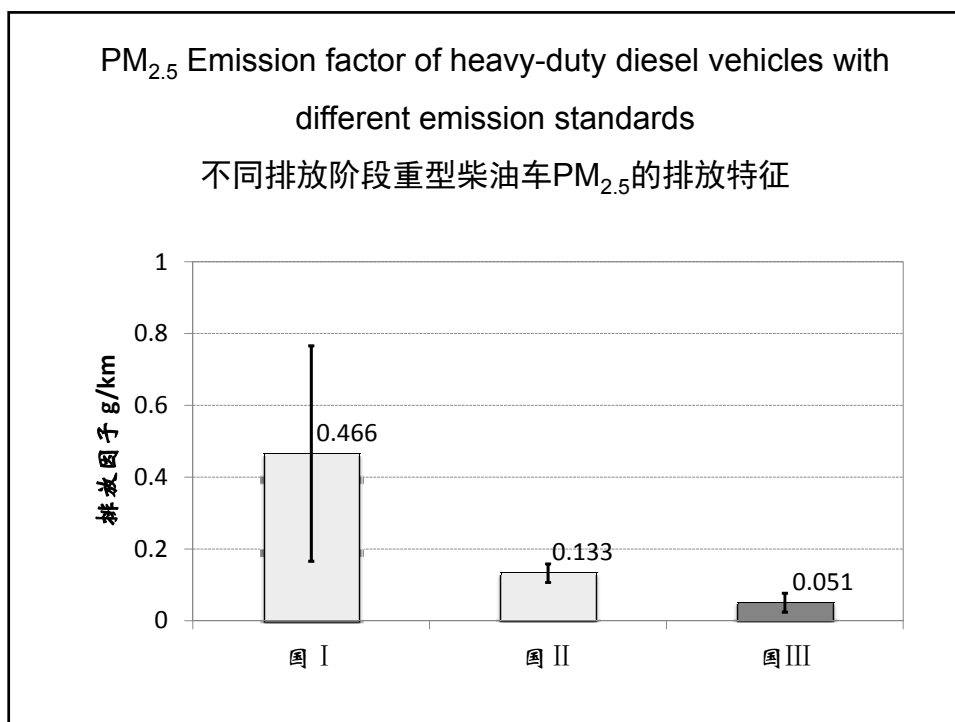
国1~国3阶段重型柴油车的排放变化

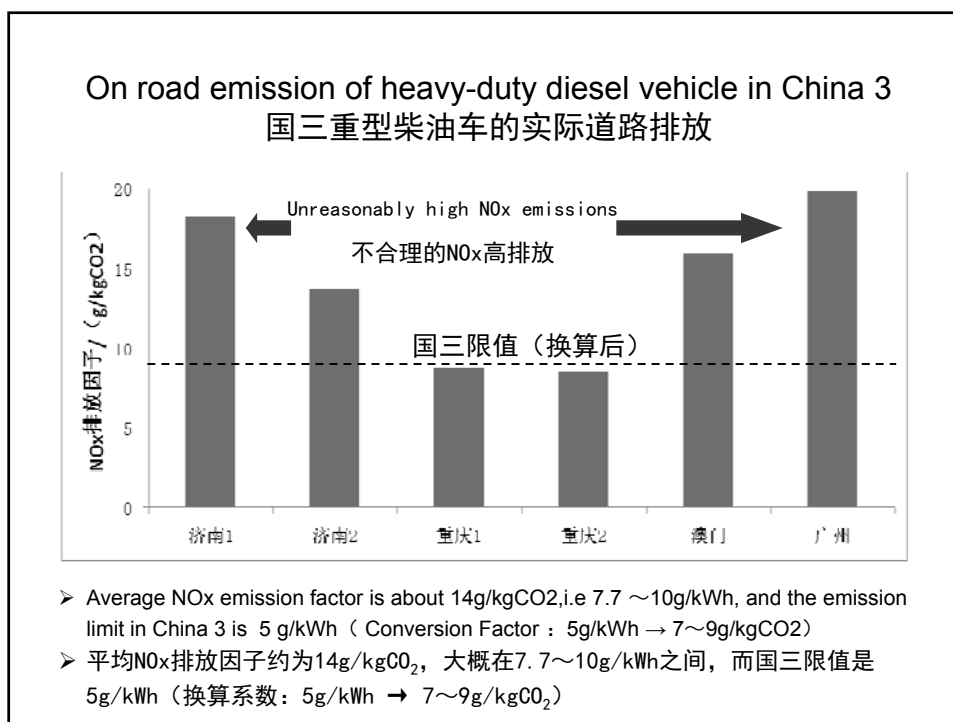
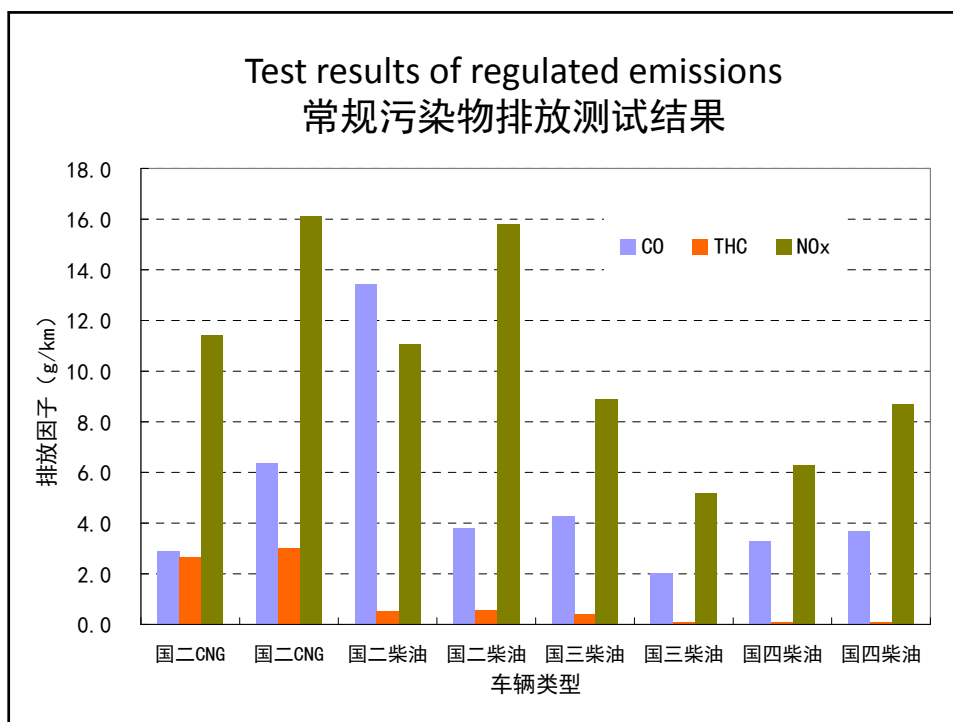


Heavy-duty vehicle test: PEMS

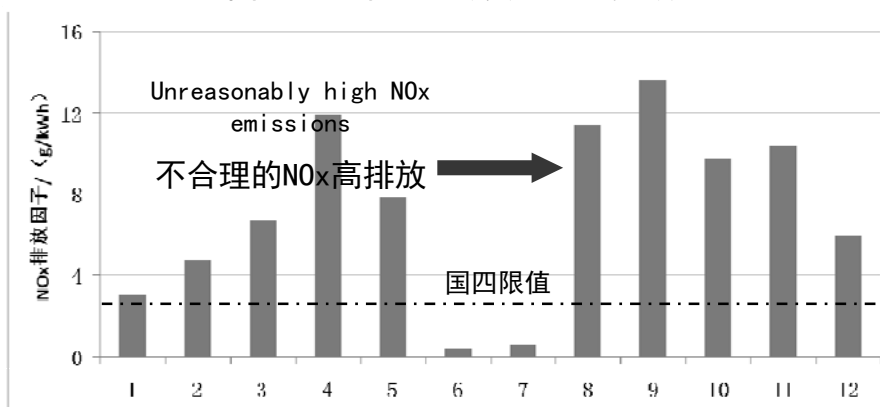
重型车排放测试：车载排放测试







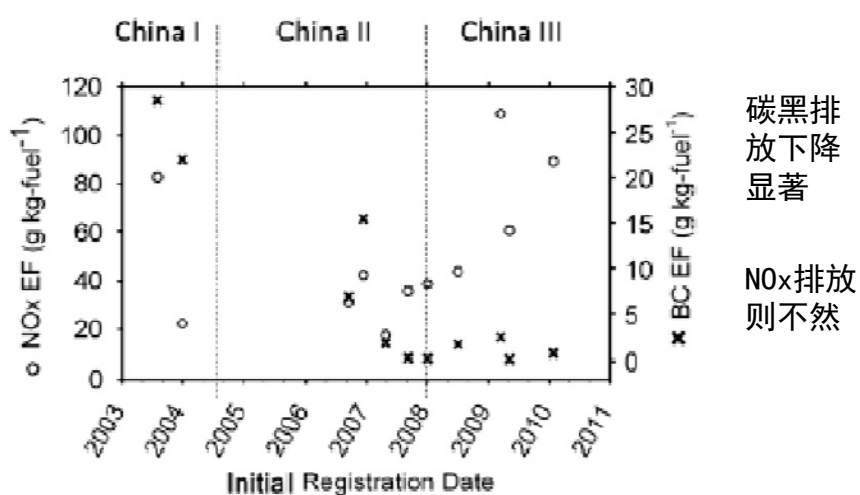
On road emission of heavy-duty diesel vehicle in China 4 国四重型柴油车的实际道路排放



注：车辆1-3是广东的货车，车辆4-12是北京的公交车

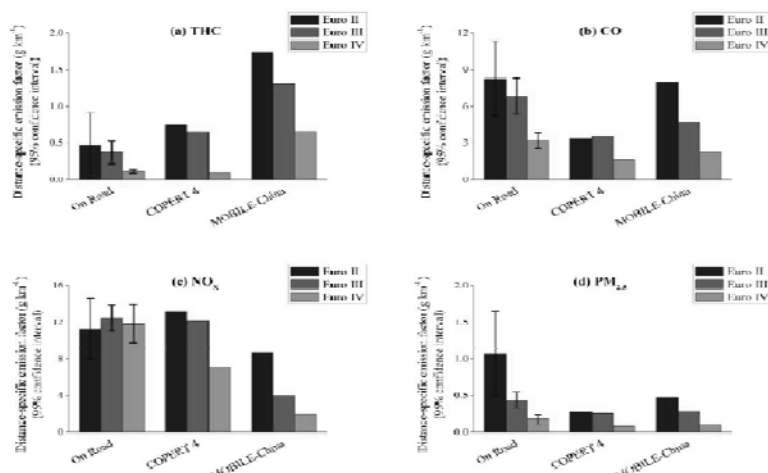
- Average NOx emission factor is 7.2 g/kWh, and China 4 emission limit is 3.5 g/kWh
- 平均NOx排放因子约为7.2g/kWh，而国四限值是3.5g/kWh

典型地区重型柴油车排放研究结论类似



Source: X. Wang et al., 2012

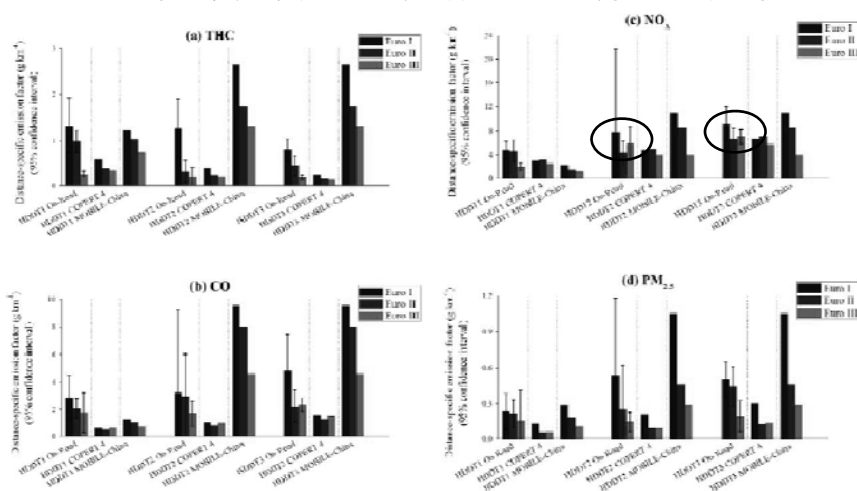
Comparison of the results of diesel bus between the on road test and model calculations
柴油公交车实际道路排放与模型测算结果的比较



Emission factor of diesel bus under a typical urban driving cycle with an average speed of 18 km/h

Source: Wu et al., 2012

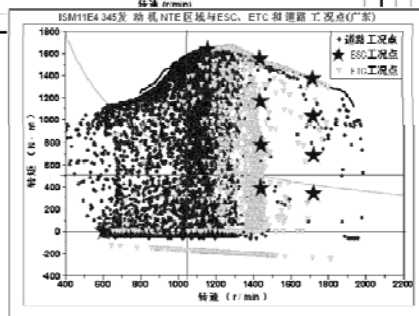
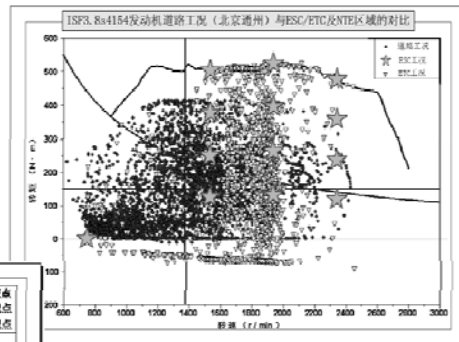
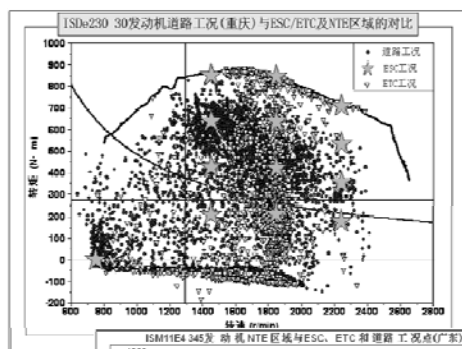
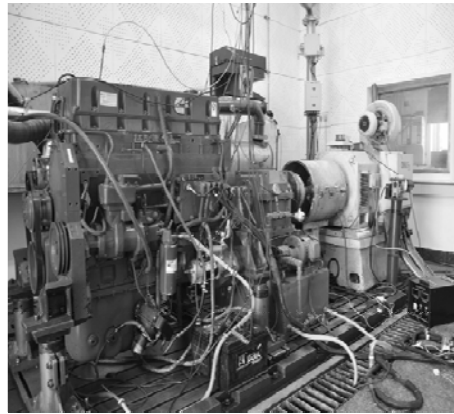
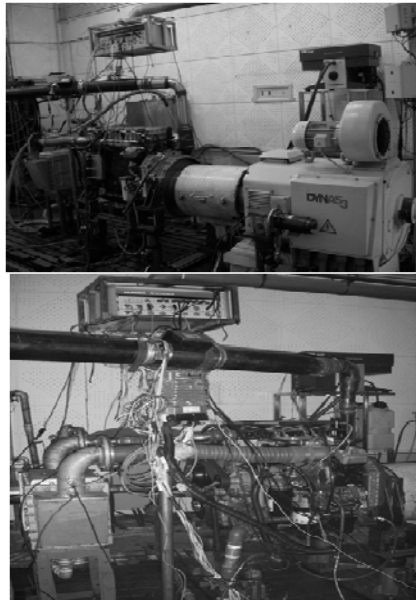
Comparison of the results of heavy-duty diesel truck between the on road test and model calculations
重型柴油货车实际道路排放与模型测算结果的比较



Emission factor of heavy-duty diesel truck under a typical driving cycle with an average speed of 40 km/h

Source: Wu et al., 2012

Engine test 发动机排放测试



On road, ESC/ETC test in NTE area
道路工况, ESC/ETC 工况与NTE区域

受试发动机ESC/ETC循环以及道路和台架测试的NO_x排放因子

单位: g/kWh

发动机编号	测试工况		DS-道路测试	DS-台架测试	MEXA-台架测试
	ESC	ETC			
1 (国Ⅲ)	3.10	4.03	5.66	6.57	6.38
2 (国Ⅳ)	2.84	3.39	13.55	12.59	13.11
3 (国Ⅳ)	2.54	---	4.53	6.15	5.38
国Ⅲ限值	5.0	5.0			
国Ⅳ限值	3.5	3.5			

注: ISDe230 30发动机的排量为6.7L, 满足欧Ⅲ排放标准, 无排气后处理装置; ISF3.8s4154发动机排量是3.8L, ISM11E4 345排量是10.8L, 均满足欧Ⅳ排放标准, 采用SCR作为NO_x的后处理装置。

柴油车排放测试研究: Lugdown-2

重型车排放测试: 简易工况法

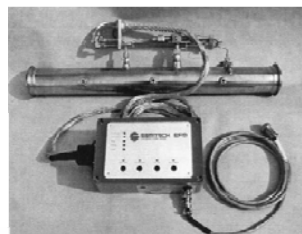


在用重型车lug-down测试

NO_x排放检测: 不分光红外 (NDIR)

重型柴油车排放测试研究-Lug-down-3

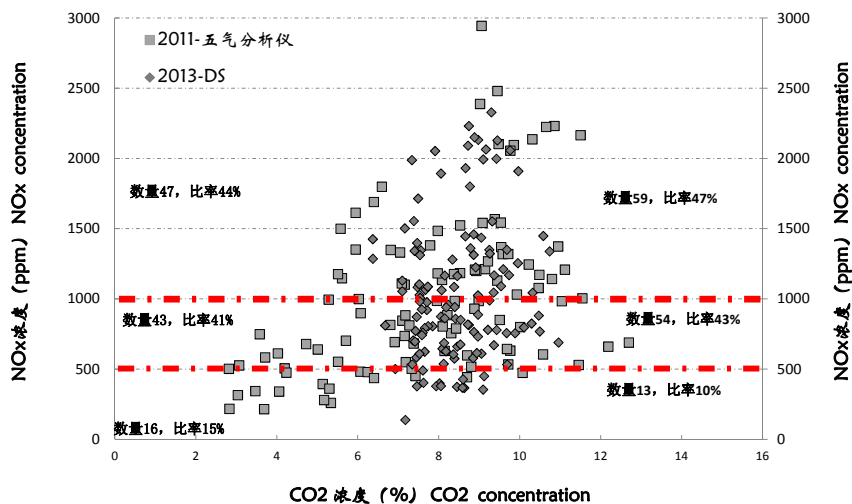
重型车排放测试：简易工况法



在用重型车lug-down测试

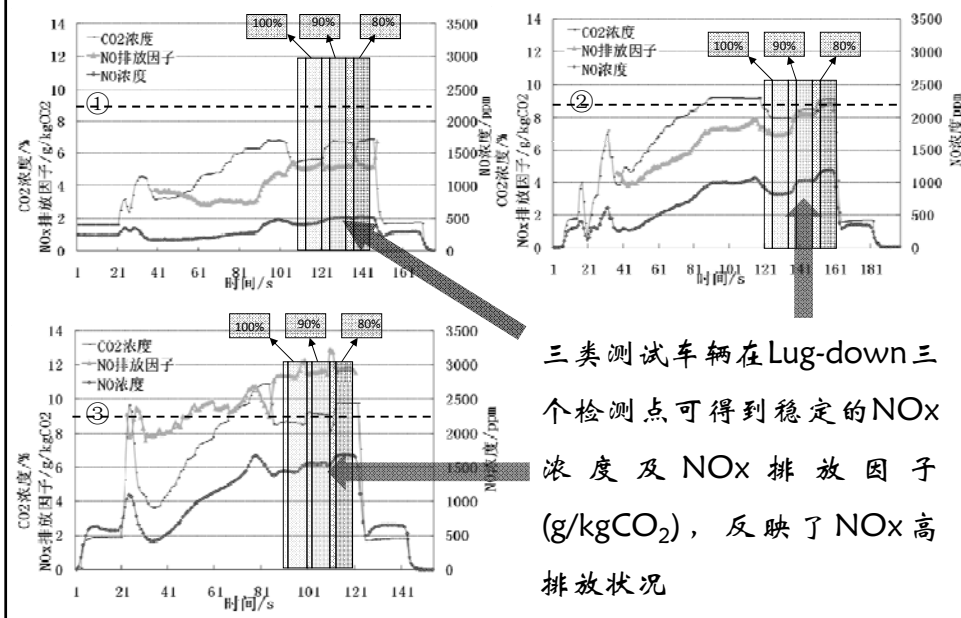
NOx排放检测：不分光紫外 (NDUV)

Average concentration of NOx and CO2 in lug-down cycle Lug-down测试的NOx、CO₂浓度平均值

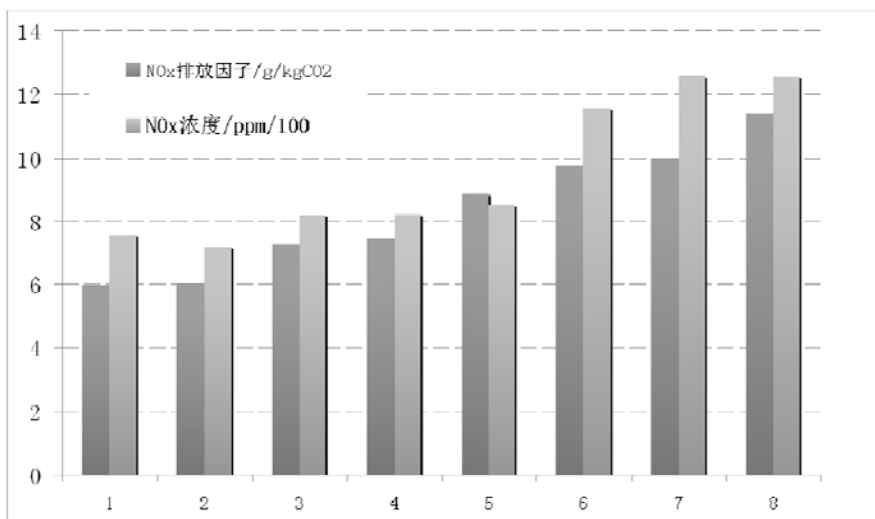


three kinds of typical heavy-duty diesel truck

三类典型车辆



不同品牌重型柴油车的NOx排放比较



发现的问题

- There are big difference in NOx and PM emission of heavy-duty diesel vehicle with different emission standards on real road, some of them are much higher than that emission in the type approval

不同国三、国四重型车的实际道路NOx排放个体差异很大，部分车辆远高于型式核准时的水平

- NOx emission did not decline as expected, which is a serious warning for China 4 heavy-duty diesel vehicle
- 国三重型车的NOx排放并没按预期下降，这对国四重型车标准的实施是个严重的警示

➤ 原因分析

- The difference of emission control technologies:

To comply with the China 3 emission standard, the heavy-duty diesel vehicle fleet in China is usually either equipped with High-pressure Common Rail (HPCR) systems or Exhaust Gas Recirculation (EGR) systems. However, it seems the new control technologies cannot offset the increment of NOx emissions due to the engine improvement

不同技术路线的差异：

例如采用高压共轨和废气再循环两种技术的国3重型柴油车实际道路排放差异大

➤ 原因分析

- After-treatment technology adaptability: SCR systems could not perform well at the low load, exhaust temperature and ambient temperature (especially winter), so the NO_x purification efficiency prone to low

后处理技术的适应性：例如SCR系统对排气温度有一定的要求，在发动机低负荷、环境温度过低（冬季）的情况下易出现NO_x的净化效率低

- Currently, the engine test cycle (ESC and ETC) is not well reflect the real road conditions

目前发动机台架的法规测试循环(ESC和ETC)不能很好反映实际道路工况

重型柴油车主要污染物减排措施测算评估-1

1. 新车问题（新车达标、生产一致性）

监管机制-重型柴油车生产一致性

2. 车用油品问题（燃料油、润滑油、添加剂）

监测手段-柴油有害物质和清净性的快速检测技术和设备；
防止车用柴油和普通柴油混用的监管办法

监管机制-车用油品管理办法

3. 在用车问题（在用车符合性、高排放车淘汰）

法规标准-可行、有效的重型柴油车在用符合性检查

监测手段-在用符合性检测方法(PEMS)和在用车简易工况法

监管机制-在用符合性管理办法、高排放车淘汰补偿机制

在用符合性检查的整车道路测试

On-road emission test in IUC program

- 使用PEMS对排放进行测量，并记录发动机运行工况
Using PEMS to test emissions with recording the engine operation data
- 采用规范的数据处理方法，可参考欧盟的窗口平均值法 (AWM) 或美国的工况区达标法 (NTE)
Regulatory data analysis methodology, referring to the EU AWM or US NTE
- 优点是可以准确判断测试车辆的排放是否达标，不足之处在于操作要求高、耗时较长
Advantage: can judge the emission compliance accurately;
Disadvantage: complicated requirement, time-consuming

简易测试方法 Simplified Methods

- 对车辆的排放水平进行预判，初步筛选出高排放车，为法规测试分析做准备
Preliminary judgment of the emission compliance to screen high-emission vehicles, prepared for regulatory test
- 可仅用NO_x和CO₂浓度来估算该车的排放水平
Only use NO_x&CO₂ concentrations for emission estimate
- 简易方法操作便捷，耗时短，可快速获得大量样本
Easy operation, to collect many samples in a short time
- 简易测试方法包括简易工况测试 (lug-down) 和简易车载测试 (S-PEMS) 等
Simplified (S-) methods include lug-down test, S-PEMS test and others

Thank You! 谢谢!

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