V&F Analyse- und Messtechnik GmbH

Significant Role of IMR-MS (Ion-Molecule Reaction Mass Spectrometer) Technology in Rapid Multi-Component Gas Analysis: Importance in Today's Engine and Catalyst Development plus in Ambient Air Monitoring

ECMA's 11th International Conference ECT 2018: "BS VI and Real Driving Emissions.....Path Forward."

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   c) Real drive emission monitoring

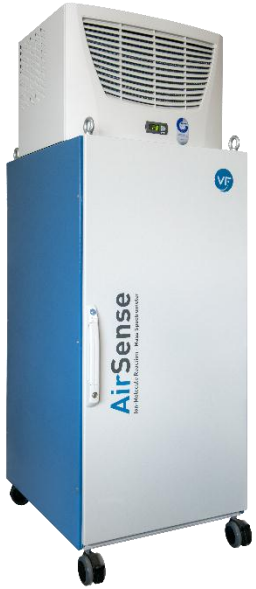
V&F COMPANY OVERVIEW

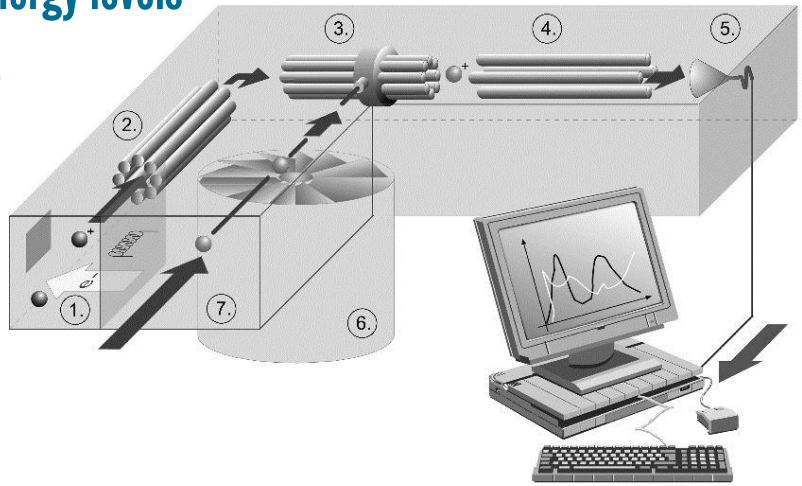
- V&F: Founded in 1985 by Dr. Johannes Villinger and Dr. Werner Federer
- Developer & manufacturer of real-time analyzers based on mass spectrometry:
  - Ion Molecule Reaction - Mass Spectrometer (IMR-MS)
  - Electron Impact - Mass Spectrometer (EI-MS)
  - Sector Field - Mass Spectrometer (SF-MS)
- Patents: European States, USA, Korea, Japan, China, PCT
- Areas of applications:
  - Automotive
  - Catalysts
  - Food & beverages
  - Environmental monitoring
  - Plastic emissions, etc.

INTRODUCTION OF IMR-MS TECHNOLOGY

- Sample molecule ionization by use of ion beams of discrete energy levels
- Called: IMR-MS (Ion Molecule Reaction – Mass Spectrometry)
- Hg: 10.44 eV Xe: 12.13 eV Kr: 13.99 eV

+ EI–MS: 70 eV





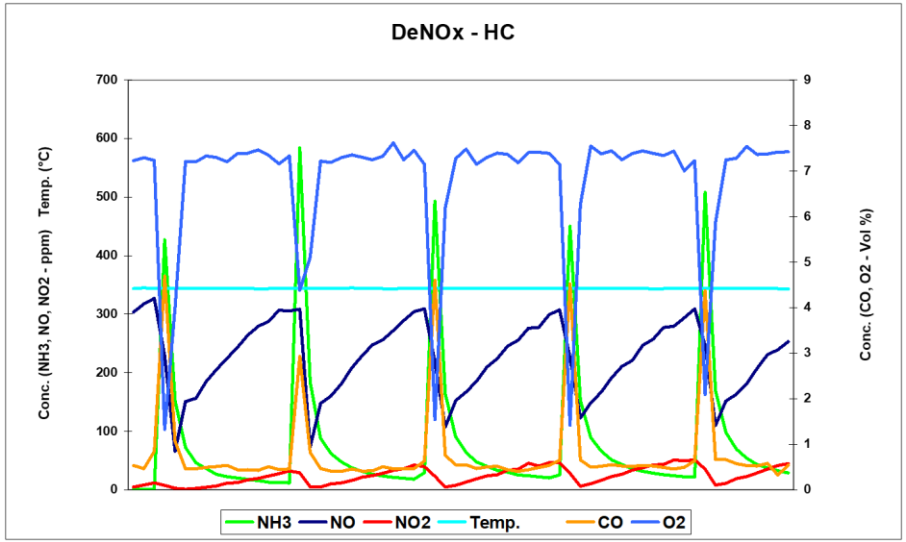
1. Primary Ion Source
2. Octopole Seperation Device
3. Charge Exchange Cell
4. Quadrupole - Mass Filter
5. Particle Detector
6. Vacuum System
7. Gas Inlet System

INTRODUCTION OF IMR-MS TECHNOLOGY: FEATURES

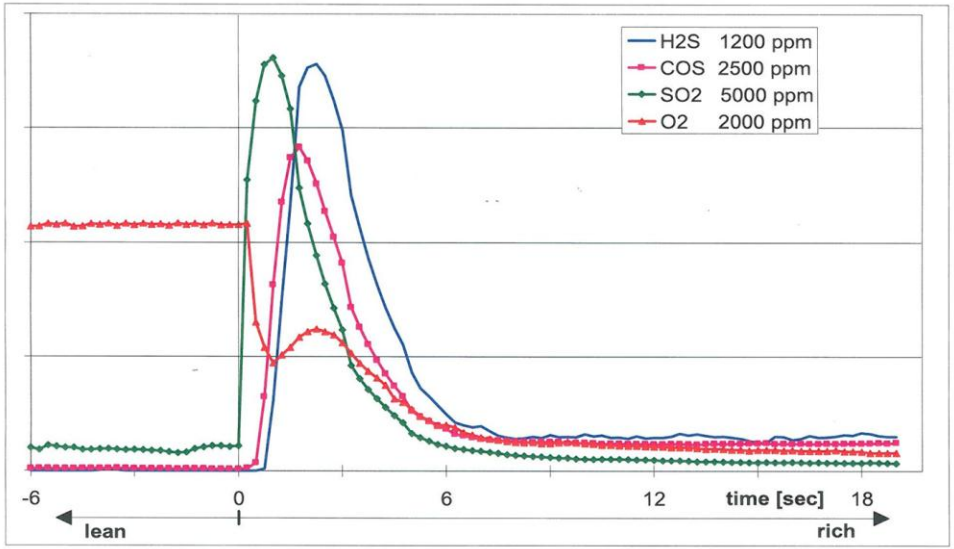
- Real-time monitoring of organic and inorganic compounds
  - Aliphatics, aromatics, alcohols, aldehydes, ketones, carboxylic acids, mercaptans, amines, inorganic acids and bases, halogenated HC's
  - E.g. CH_4, C_2H_2, C_2H_4, C_3H_6, C_4H_6....C_6H_6, C_7H_8, ..., SO_2, H_2S, COS, NH_3, NO, NO_2,...
- Concentrations: < ppb – 100 Vol%
- Time of analysis: > 1 msec per mass
- No H_2O-, bulk gas, etc. cross sensitivity: Ionization of molecules by single two-body reactive collisions

CATALYST: DENOX AND DPF DESULFATION

DeNOx Strategies

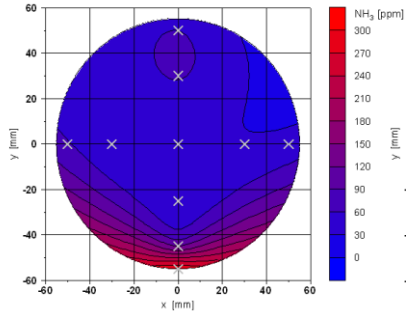


Sulfur emissions under rich engine operation



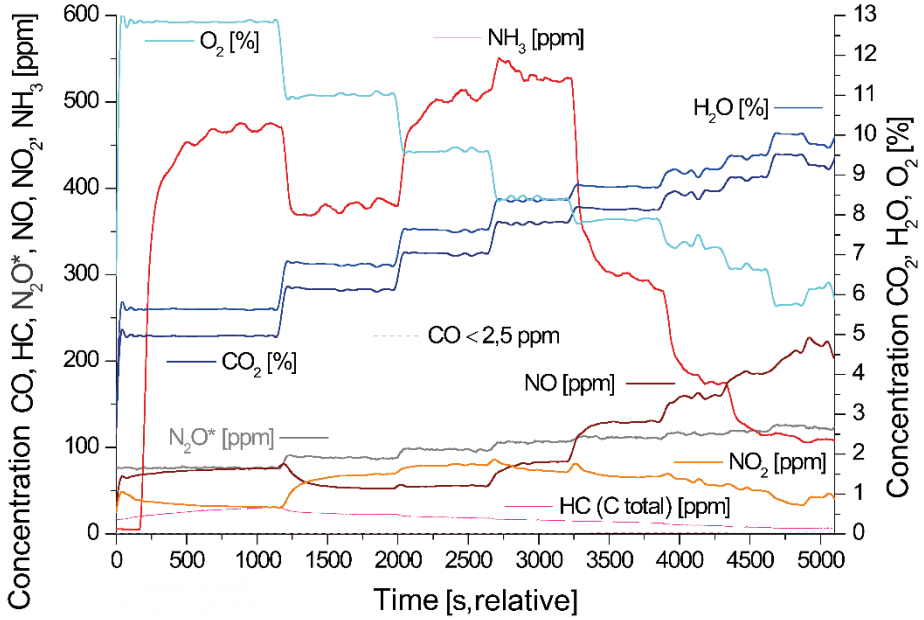
SCR CATALYST DEVELOPMENT

NH_3 distribution in exhaust after urea injection pre-catalyst



Urea deposition after a mixer in exhaust system pre-catalyst

IMR-MS Breakthrough monitoring on SCR catalysts



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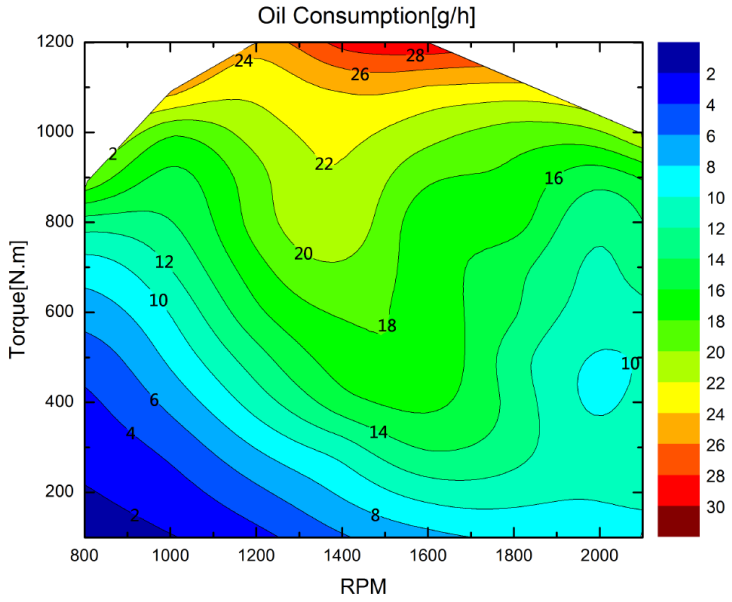
Madhuchitt Industries

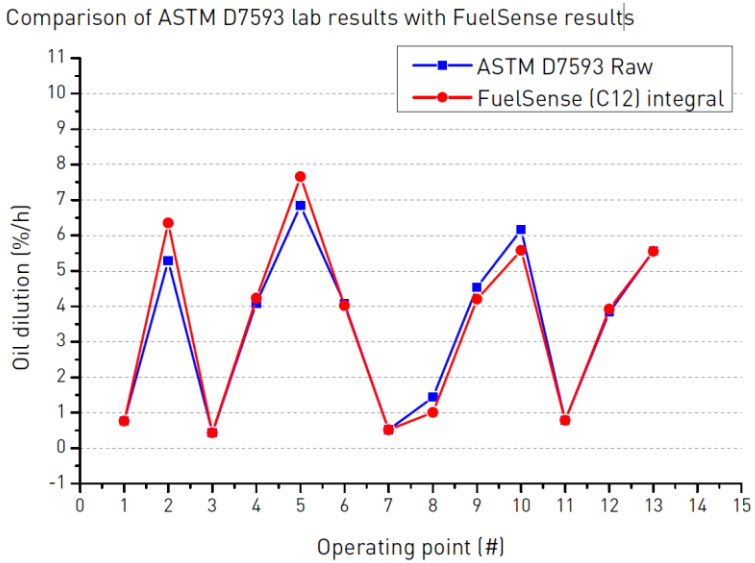
ONLINE ENGINE OIL CONSUMPTION MEASUREMENT

- LubeSense & GasOxidizer using the SO_2 tracer method
- Suitable for diesel, gasoline and CNG engines
- Pre and post turbocharger or each cylinder
- Detection level below 1g/h



ONLINE ENGINE OIL DILUTION MEASUREMENT

- FuelSense & LubeSampler for continuous oil sampling with recirculation to the oil sump
- Suitable for diesel and gasoline engines
- Fast measurements within minutes
- Detection level below 0.2 % dilution

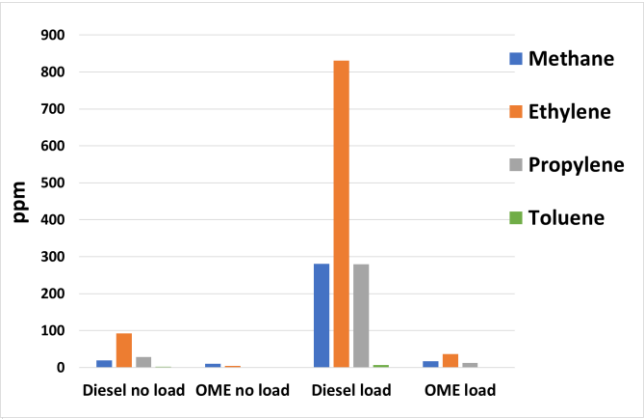


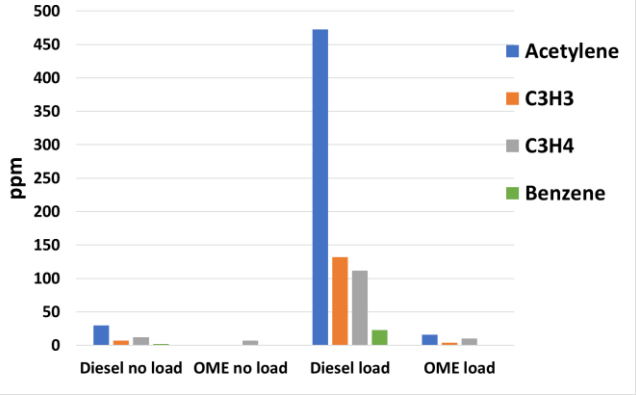
OXYMETHYLENETHER (OME) VS. CONVENTIONAL DIESEL EMISSION CHARACTERISTICS

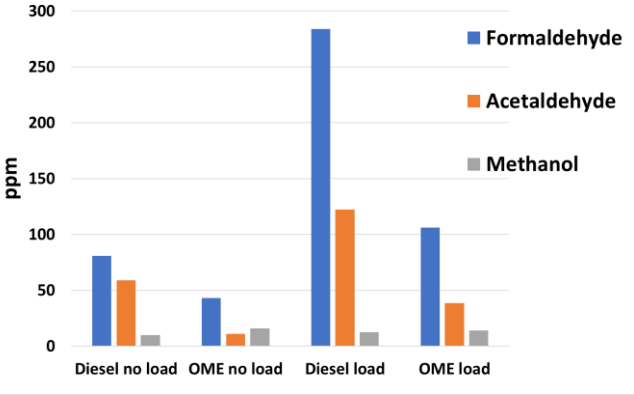
SENDLING Diesel D7:

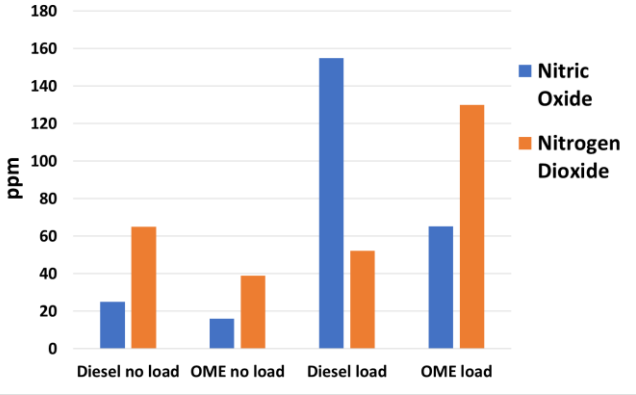
- Bore 100mm
- Stroke 140 mm
- Capacity 1.1 l
- Power: 7 hp @ 940 rpm

V&F AirSense









AUSTRIAN EPA: IMR-MS IN COMPARISON WITH INTEGRAL OFF-LINE MEASURING METHODS

Location: largest Austrian intersection in Vienna

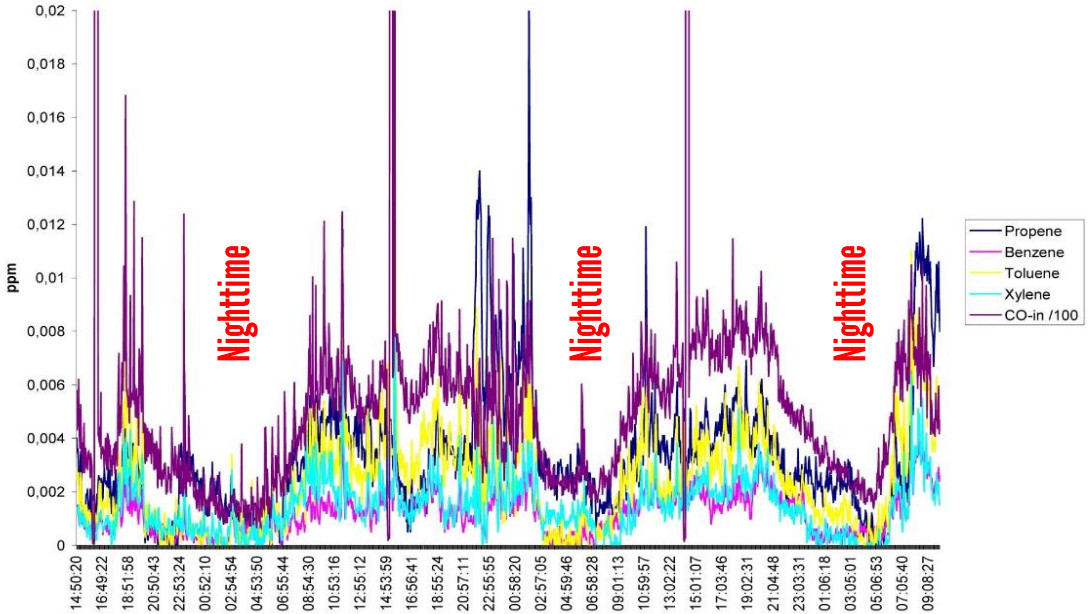
Short term intergral comparison

14:24-16:05	Benzene [ug/m3]	Toluene + Xylene [ug/m3]
AirSense	5.62	17.8
Sorption Tube	3.35	16.9
16:11-17:14	**Benzene [ug/m3]**	**Toluene + Xylene [ug/m3]**
AirSense	5.74	19.5
Sorption Tube	3.66	18.4
17:27-08:24	**Benzene [ug/m3]**	**Toluene + Xylene [ug/m3]**
AirSense	4.34	12.5
Sorption Tube	3.26	10.5

Long term integral comparison

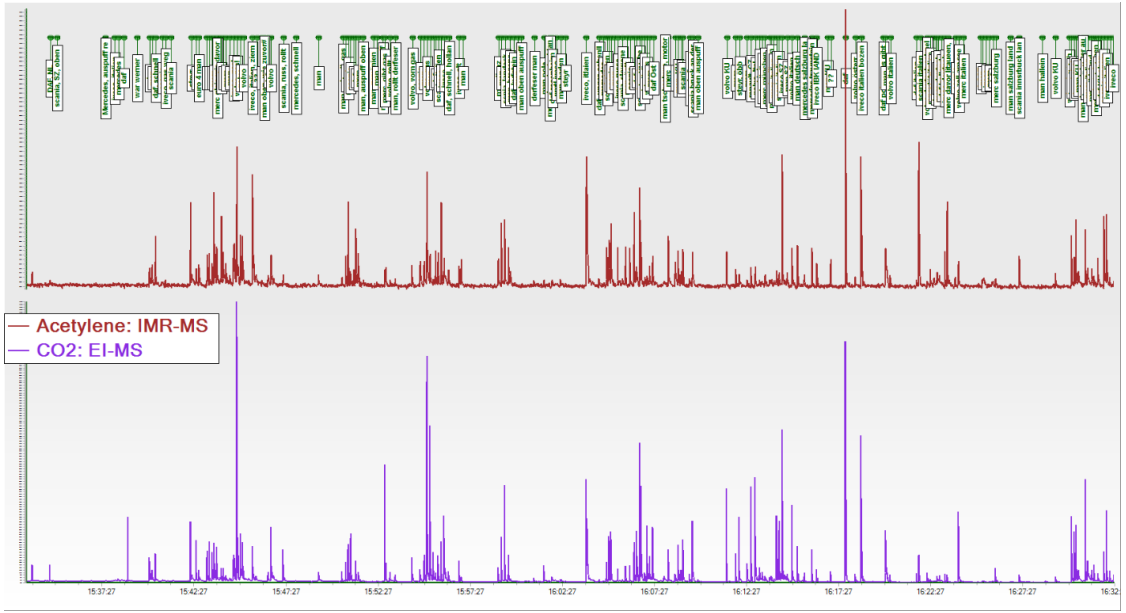
Substance	AirSense* [ppb]	Sorption Tube [ppb]
Benzene	2.44	2.5
Toluene	3.97	3.6
Xylene	3.01	3.2

*… integral over 29000 measurements

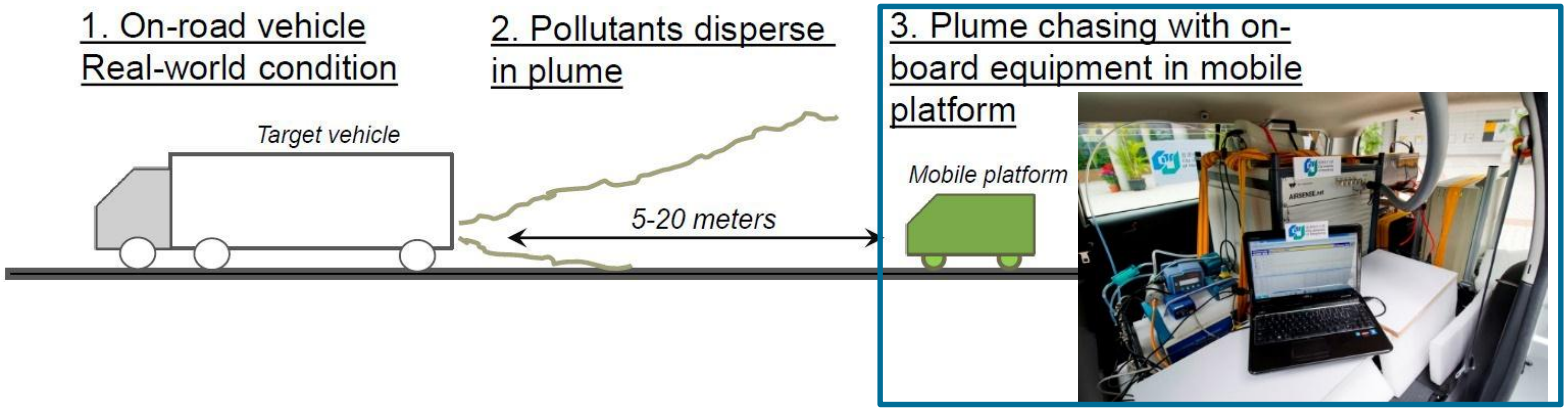


MONITORING OF EMISSION QUALITY OF DRIVING VEHICLES

Fast monitoring of acetylene and CO_2 for particulate emission correlation of diesel vehicles



REAL DRIVING EMISSION MONITORING



Hung Hom Toll station | Cross harbor tunnel | In traffic to Wan Chai

Ref: Zhi Ning et al 2012. PM, NOx and butane emissions from on-road vehicle fleets in Hong Kong and their implications on emission control policy. Atmospheric Environment 61 (2012) 265-274.

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