

Supplementary Materials

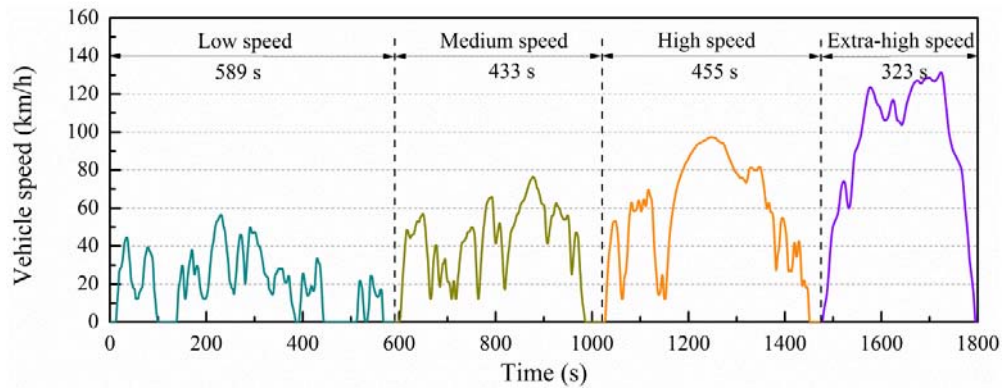


Fig. A1 Speed distribution of the WLTC.

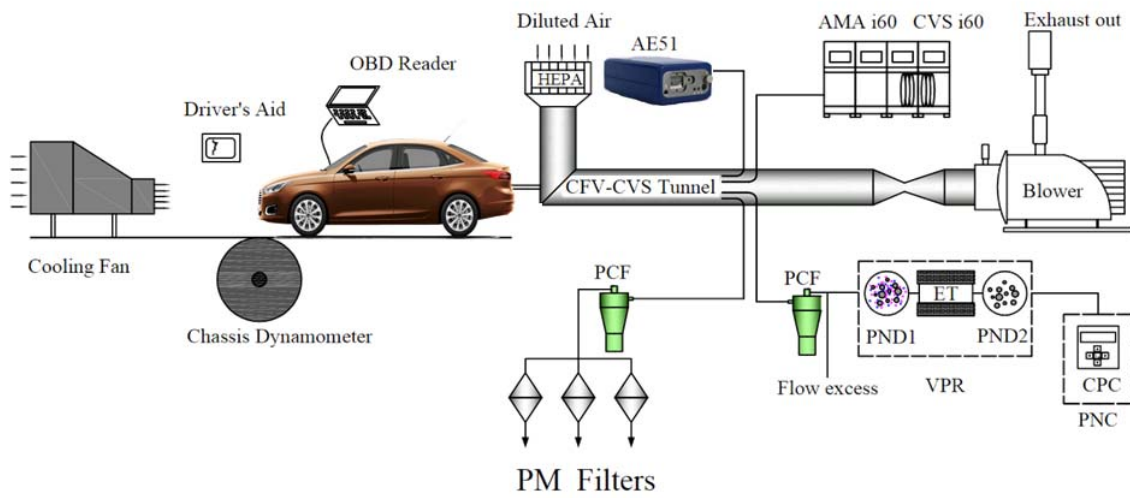


Fig. A2 Schematic diagrams of the emission test and sampling system (VPR: volatile particle remover; HEPA: high-efficiency particulate air system).

Table A1 Accuracies and ranges of the instruments used in the test.

Instruments	Range	Accuracy ^a	Manufacturer
Chassis Dynamometer	0~200 km/h	±1%	HORIBA
Test Chamber	-10~+40°C	±1°C	IMTECH
	50~80% R.H.	±5% R.H.	
CVS i60	5~26 m ³ /h	±1%	AVL
AMA i60	THC: 0~1000 ppmC3	±1%	AVL
	CH ₄ : 0~3000 ppmC1	1%	
	NO _x : 0~1000 ppm	±1%	
	CO ₂ : 0~6.0%	±1%	
PSS i60	0~100 L/min	±1%	AVL
CPC 3790	0~10 ⁴ #/cm ³	±10%	TSI
AE51	0~1 mg/m ³ ;	1 ng/m ³	Aethlabs

^a: the degree of closeness of the measurement of a quantity to its actual (true) value, which is given by the manufacturer.

Table A.2 Original data for Figure 1 and Figure 2 in the manuscript.

		Test No.	Temp (°C)	CVS (m ³ /min)	THC (mg/km)	NOx (mg/km)	CO/10 (mg/km)	CO ₂ (g/km)	FE (L/100 km)	EC (MJ/100 km)		
Vehicle 1	Gasoline	Tests	T1	30	12	51	7	62.7	180.484	7.779	246.627	
			T2	30	12	43	21	48.9	192.907	8.3	263.145	
		Average				47.0	14.0	55.8	186.7	8.0	254.9	
		Error bars	SD			5.7	9.9	9.8	8.8	0.4	11.7	
	SE				4.0	7.0	6.9	6.2	0.3	8.3		
		E10	Tests	T1	30	18	50	19	49.3	188.136	8.449	259.108
			T2	30	18	49	15	75.4	186.864	8.411	257.943	
			T3	30	18	74	6	102.1	186.644	8.423	258.311	
		Average				57.7	13.3	75.6	187.2	8.4	258.5	
		Error bars	SD			14.2	6.7	26.4	0.8	0.0	0.6	
	SE				8.2	3.8	15.2	0.5	0.0	0.3		
		M15	Tests	T1	30	18	37	13	32.7	190.429	8.809	287.142
			T2	30	18	5	16	41.9	191.482	8.866	289.000	
			T3	30	18	48	16	42.1	197.305	9.135	297.768	
		Average				42.5	15.0	38.9	193.1	8.9	291.3	
	Error bars	SD			7.8	1.7	5.4	3.7	0.2	5.7		
SE				5.5	1.0	3.1	2.1	0.1	0.1	3.3		
	Gasoline	Tests	T1	-7	12	220	14	229	201.662	8.821	279.663	
		T2	-7	14	101	13	88.7	200.265	8.651	274.273		
		T3	-7	14	183	11	188.2	201.085	8.764	277.856		
	Average				168.0	12.7	168.6	201.0	8.7	277.3		
	Error bars	SD			60.9	1.5	72.2	0.7	0.1	2.7		
SE				35.2	0.9	41.7	0.4	0.0	0.0	1.6		
	E10	Tests	T1	-7	18	210	18	215.5	208.709	9.507	291.554	
		T2	-7	18	218	12	247.8	204.658	9.35	286.739		
		T3	-7	18	214	18	218.9	206.082	9.393	288.058		
	Average				214.0	16.0	227.4	206.5	9.4	288.8		
	Error bars	SD			4.0	3.5	17.7	2.1	0.1	2.5		
SE				2.3	2.0	10.2	1.2	0.0	0.0	1.4		
	M15	Tests	T1	-7	18	228	5	187.9	212.826	9.98	325.312	
		T2	-7	18	320	10	246.6	207.974	9.811	319.803		
		T3	-7	18	365	11	274.3	208.349	9.855	321.238		
	Average				304.3	8.7	236.3	209.7	9.9	322.1		
	Error bars	SD			69.8	3.2	44.1	2.7	0.1	2.9		
SE				40.3	1.9	25.5	1.6	0.1	0.1	1.7		
Vehicle 2	Gasoline	Tests	canry	30	12	27	12	80.6	211.563	9.119	289.111	
			canry	30	12	21	8	70.1	216.628	9.328	295.737	
			canry	30	12	42	12	86.5	216.523	9.337	296.023	
			canry	30	12	25	7	60.3	216.182	9.303	294.945	
		Average				24.3	9.0	70.3	214.8	9.3	293.3	
		Error bars	SD			3.1	2.6	10.2	2.8	0.1	3.6	
	SE				1.8	1.5	5.9	1.6	0.1	2.1		
		E10	Tests	canry	30	18	20,000	24,000	55,100	216,551	9,719	298,055
			canry	30	18	19,000	34,000	45,000	215,862	9,681	296,890	
			canry	30	18	24,000	18,000	47,700	222,893	9,998	306,612	
		Average				21.0	25.3	49.3	218.4	9.8	300.5	
		Error bars	SD			2.6	8.1	5.2	3.9	0.2	5.3	
	SE				1.5	4.7	3.0	2.2	0.1	3.1		
		M15	Tests	canry	30	12	68	16	89	223,605	10,384	338,481
			canry	30	18	100	18	76.4	222,347	10,321	336,428	
			canry	30	18	79	21	75.2	226,653	10,516	342,784	
		Average				82.3	18.3	80.2	224.2	10.4	339.2	
		Error bars	SD			16.3	2.5	7.6	2.2	0.1	3.2	
	SE				9.4	1.5	4.4	1.3	0.1	1.9		
		Gasoline	Tests	canry	-7	14	457	21	204.7	248,084	10,825	343,199
			canry	-7	14	438	16	187.6	248,518	10,829	343,325	
			Average				447.5	18.5	196.2	248.3	10.8	343.3
		Error bars	SD			13.4	3.5	12.1	0.3	0.0	0.1	
	SE				9.5	2.5	8.6	0.2	0.0	0.1		
		E10	Tests	canry	-7	18	537,000	19,000	272,800	248,155	11,355	348,227
			canry	-7	18	349,000	19,000	253,700	243,214	11,095	340,254	
			canry	-7	18	421,000	16,000	211,700	248,143	11,295	346,387	
	Average				435.7	18.0	246.1	246.5	11.2	345.0		
	Error bars	SD			94.9	1.7	31.3	2.8	0.1	4.2		
SE				54.8	1.0	18.0	1.6	0.1	2.4			
	M15	Tests	canry	-7	18	1212	21	349.4	261,854	12,489	407,097	
		canry	-7	18	1576	11	527.6	263,773	12,756	415,800		
		canry	-7	18	1123	28	497	270,164	12,968	422,710		
	Average				1303.7	20.0	458.0	265.3	12.7	415.2		
	Error bars	SD			240.0	8.5	95.3	4.4	0.2	7.8		
SE				138.6	4.9	55.0	2.5	0.1	4.5			

Note: numbers marked in red were judged as outliers

Table A.3 Original data for Figure 3 and Figure 4 in the manuscript.

Vehicle	Fuel	Phase	PM emissions (mg/km)				PN emissions ($\times 10^{12}$ #/km)				Ratio of particle number/mass ($\times 10^{11}$ #/km)			
			30°C		-7°C		30°C		-7°C		30°C		-7°C	
			Average	Error bars	Average	Error bars	Average	Error bars	Average	Error bars	Average	Error bars	Average	Error bars
Vehicle 1	Gasoline	Low	10.11	0.39	60.00	2.03	6.47	0.04	19.60	2.10	6.41	0.29	3.28	0.41
		Medium	1.52	0.10	3.64	1.08	1.38	0.09	1.53	0.04	9.05	0.02	4.85	1.10
		High+Extra	1.68	0.01	1.88	0.10	1.78	0.31	1.52	0.02	10.61	1.89	8.14	0.46
		WLTC	2.75	0.05	9.89	0.37	2.13	0.16	3.83	0.22	7.75	0.73	3.84	0.35
	E10	Low	2.75	0.72	36.14	2.98	3.50	0.19	14.72	0.11	12.45	2.89	4.13	0.33
		Medium	1.33	0.28	2.09	0.17	1.09	0.03	1.44	0.11	12.32	4.06	7.00	0.78
		High+Extra	1.04	0.05	1.06	0.24	1.57	0.14	1.40	0.04	17.31	0.93	14.43	2.73
		WLTC	1.32	0.18	5.86	0.56	1.53	0.09	3.05	0.03	12.98	0.98	5.31	0.51
	M15	Low	6.84	0.61	109.51	17.15	6.77	0.59	20.49	0.59	9.90	4.56	8.13	3.12
		Medium	2.25	0.26	3.02	0.19	1.64	0.16	2.41	0.16	7.30	0.41	1.30	0.30
		High+Extra	1.69	0.08	2.13	0.27	2.09	0.17	1.81	0.04	12.35	0.14	1.33	0.10
		WLTC	2.87	0.47	16.60	2.47	2.41	0.22	4.34	0.07	8.38	2.04	3.88	1.74
Vehicle 2	Gasoline	Low	2.15	0.82	94.53	4.86	1.30	0.06	26.60	3.63	-	-	-	-
		Medium	1.03	0.34	1.98	0.05	0.03	0.01	0.16	0.00	-	-	-	-
		High+Extra	2.71	0.68	3.05	0.09	0.25	0.02	0.61	0.32	-	-	-	-
		WLTC	2.30	0.22	14.97	0.72	0.29	0.02	3.92	0.67	-	-	-	-
	E10	Low	0.84	0.00	80.42	15.86	0.50	0.15	18.64	1.79	-	-	-	-
		Medium	0.32	0.28	1.19	0.79	0.02	0.01	0.09	0.02	-	-	-	-
		High+Extra	1.49	0.41	1.58	0.34	0.05	0.02	0.21	0.01	-	-	-	-
		WLTC	1.17	0.21	11.89	2.34	0.12	0.02	2.58	0.24	-	-	-	-
	M15	Low	9.32	3.00	364.91	53.99	7.58	0.68	61.01	4.78	-	-	-	-
		Medium	1.47	0.21	2.32	0.55	0.19	0.09	0.82	0.28	-	-	-	-
		High+Extra	3.23	0.10	5.12	1.01	0.43	0.03	1.51	0.18	-	-	-	-
		WLTC	3.21	0.61	52.42	7.77	1.25	0.09	8.80	0.87	-	-	-	-

Table A.4 Original data for Figure 6 in the manuscript.

Vehicle	Fuel	BC emissions (mg/km)			
		30°C		-7°C	
		Average	Error bars	Average	Error bars
Vehicle1	Gasoline	1.46563	0.15000	2.89937	0.08972
	E10	0.78174	0.14183	3.28992	0.14571
	M15	1.12007	0.05551	3.78165	0.30728
Vehicle2	Gasoline	0.15099	0.13807	3.48043	0.93509
	E10	0.08422	0.07146	4.03086	0.40166
	M15	1.22926	0.31425	6.90947	0.89637