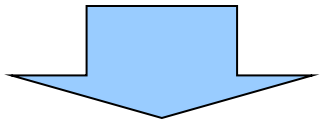
Current status on a development of a Fuel Economy Measurement Method considering the Effect of Air Conditioner in Japan

14 January 2015

Japan

Background and Objective

- Fuel economy (FE) of new vehicles has been improving due to the fuel efficiency standard and car manufacturer's effort.
- However, it is well known that the gap between official/catalogue FE and actual driving FE is still exist due to Air Conditioner, Driving condition, Traffic congestion, Maintenance, etc.
- In order to provide better information to car users, a method for evaluating the A/C effect (one of the big factors) on FE is highly required.

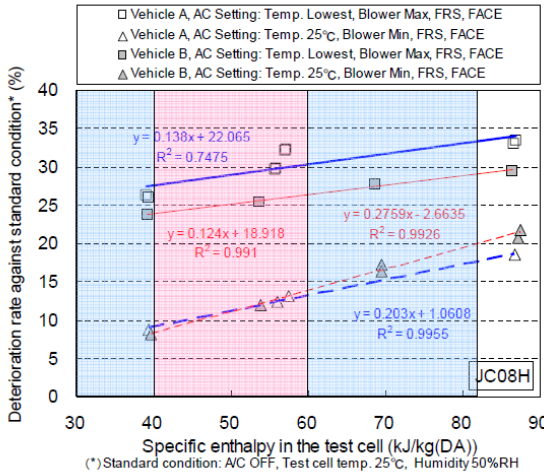


Japan, Ministry Land Infrastructure Transportation (MLIT), intend to develop the method and procedure to evaluate the FE under the A/C operation in the summer season.

Previous study (Test results using JC08)

- Japan have been studying the effect of A/C use on Fuel economy in the Japanese current test mode “JC08” driving mode.
- It was observed that the fuel economy was getting worse according to increase of the specific enthalpy in the test cell.
- A good repeatability was obtained even if the dynamic driving mode “JC08” was used.
- Questionnaire was done in order to investigate the actual A/C use in Japan. (6,000 samples, Internet-based questionnaire)

Relation Between Test Cell Specific Enthalpy and FE Deterioration Rate



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Repeatability

Vehicle	Environment	A/C setting				Fuel economy (km/L)				Rate of change (%)
		A/C use	Temp.	Inlet	Blower	N1	N2	N3	Average	[(MAX-MIN)/AVE]
09A	25℃-50%RH	A/C OFF	-	-	-	15.10	15.02	-	15.06	0.6
	20℃-40%RH		-	-	-	15.08	15.15	-	15.11	0.5
	30℃-75%RH		-	-	-	15.07	15.24	-	15.15	1.1
	21℃-75%RH		-	-	-	15.06	15.10	-	15.08	0.3
09B			-	-	-	16.38	16.61	-	16.50	1.3
10B			-	-	-	12.02	11.55	11.89	11.82	4.0
10C			-	-	-	20.72	20.93	-	20.82	1.0
11A			-	-	-	20.05	20.05	-	20.05	0.0
09A	25℃-50%RH	A/C ON	LOWEST	FRS	HI	10.22	10.21	-	10.22	0.1
	20℃-40%RH					11.11	11.15	-	11.13	0.4
	30℃-75%RH					10.09	10.04	-	10.06	0.5
	21℃-75%RH					10.61	10.57	-	10.59	0.4
	25℃-40%RH			REC		11.64	11.49		11.56	1.3
09B	28℃-60%RH		25℃	FRS	LO	13.66	13.80	-	13.73	1.0
	30℃-75%RH					13.07	12.91	-	12.99	1.3
10A	15℃-80%RH		25℃	FRS	AUTO	7.67	7.70	-	7.69	0.4
	35℃-40%RH			REC		6.87	6.91	-	6.89	0.6
10B	35℃-40%RH		25℃	REC	AUTO	10.76	10.64	-	10.70	1.1
10C	25℃-50%RH		25℃	FRS	AUTO	18.53	19.08	-	18.81	2.9
11A	25℃-50%RH		MID	FRS	LO	15.78	15.94	-	15.86	1.0
					HI	13.84	14.01	-	13.92	1.2
			LOWEST	FRS	LO	15.92	15.95	-	15.94	0.2
					HI	13.82	13.99	-	13.91	1.2
				REC	LO	16.30	16.56	-	16.43	1.6
					HI	14.63	14.79	-	14.81	0.3

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Questionnaire

A/C setting in summer

A/C type		Item	Results
Manual A/C		Penetration	Manual A/C penetration: 41.3%
		A/C use rate	Almost always: 54%, Rather using: 30% (Total 85%)
		Temp.	Coolest: 47%, middle: 18%
		Blower level	Middle (3/5): 27%, Week (2/5): 25%
		Intake air	Circulation: 46%, Fresh air: 18%
		Face/Foot	Face: 47%, Face & Foot: 34%
Auto A/C		Penetration	Auto A/C penetration: 45.2%
		A/C use rate	Almost always: 70%, Rather using: 23 % (Total 93%)
		Temp.	25℃: 21%, 20℃: 13%
		Blower level	Auto: 40%, Medium (3/5): 23%
		Intake air	Circulation: 43%, Fresh air: 16%
		Face/Foot	Auto: 31%, Face & Foot: 30%
Dual A/C	Total	Penetration	Dual A/C penetration: 13.5%
		A/C use rate	Almost always: 75%, Rather using 18% (Total 93%)
	Front	Temp.	25℃: 17%, 20℃: 14%
		Blower level	Auto: 38% Medium (3/5): 25%
		Intake air	Circulation: 48%, Fresh air: 14%
		Face/Foot	Face & Foot: 31%, Auto: 29%
	Rear	Temp.	Impossible: 32%, 25℃: 13%
		Blower level	Auto: 30%, Medium (3/5): 25%

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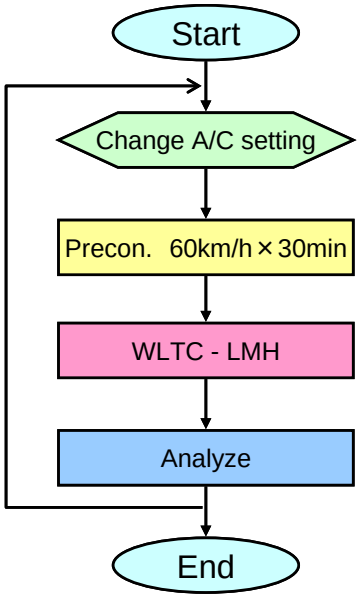
Test Program in FY2013

- A/C tests were conducted in various conditions (ambient temperature and humidity) using 2 vehicles in order to confirm whether the same characteristics and good repeatability can be obtain or not, if WLTC was applied instead of JC08.
  - Vehicle A: 1.3L Petrol, CVT, Manual A/C, Idling stop system
  - Vehicle B: 2.0L Petrol, CVT, Auto A/C, Idling stop system
  - Test cycle: **WLTC CL3-2 Phase1~3 (Low + Medium + High)**
  - Pre. conditioning: 60 km/h × 30 min. with A/C operating

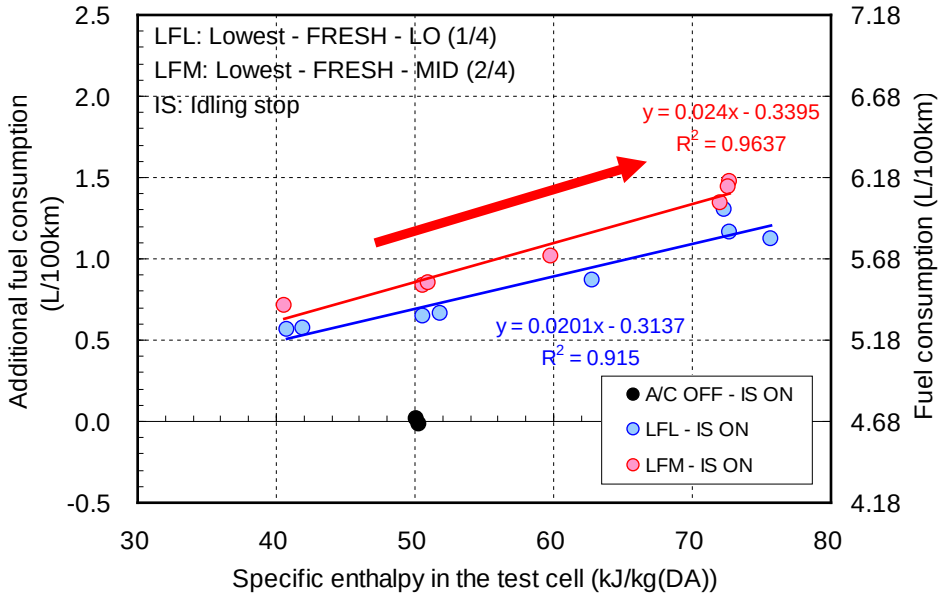
Vehicle ID A/C type	A/C setting / Vehicle condition						Environmental condition				Remark (Test ID*)
	A/C operation	Temp. setting	Inlet mode	Blower level	Outlet mode	Idle stop(IS) operation	23℃-40%-40 kJ/kg	25℃-50%-50 kJ/kg	28℃-55%-61 kJ/kg	35℃-40%-71 kJ/kg	
Veh.A Manual A/C	A/C OFF	-	(FRESH)	-	(FACE)	ON	-	●	-	-	Standard
	A/C ON	LOWEST	FRESH	LO (1/4)	FACE	ON	○	●	○	●	LFL - IS ON
		LOWEST	FRESH	MID (2/4)	FACE	ON	○	●	○	●	LFM - IS ON
Veh.B Auto A/C	A/C OFF	-	(FRESH)	-	(FACE)	ON	-	●	-	-	Standard
	A/C ON	22℃	AUTO	AUTO	AUTO	ON	○	●	○	●	22AA - IS ON
		22℃	FRESH	MID (4/7)	FACE	ON	○	●	○	●	22FM - IS ON
		25℃	AUTO	AUTO	AUTO	ON	○	●	○	●	25AA - IS ON

●: Number of test = 2, ○: Number of test = 1
*) Test ID: Temp. setting - Inlet mode - Blower level - IS Operation

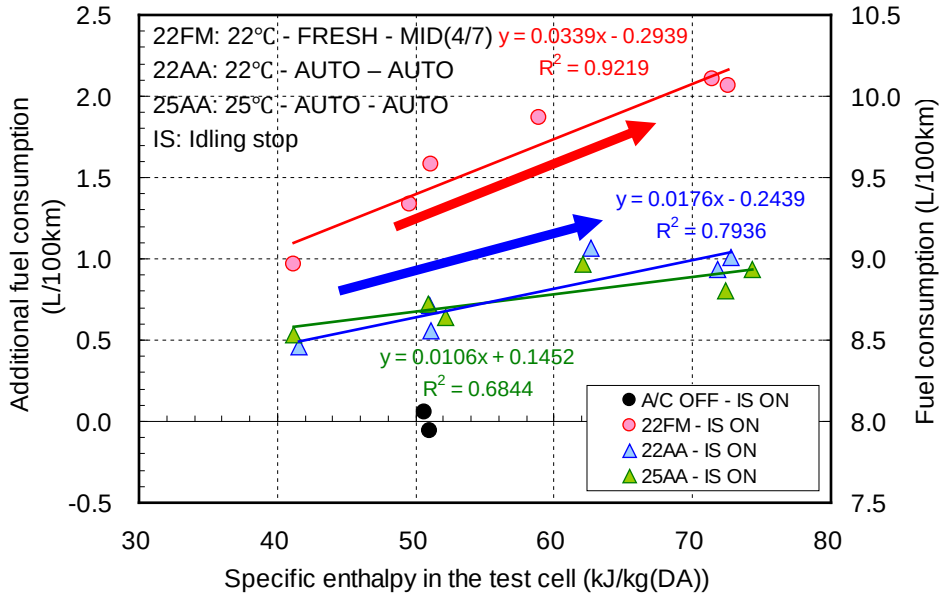


Test results using WLTC

[Manual A/C system]



[Auto A/C system]



- The good repeatability on fuel consumption (less than 3%) was also obtained when the WLTC was used.
- It was observed that the additional fuel consumption was increased according to increase of specific enthalpy in the test cell same as in JC08 driving mode.

Summary and Future plans

- This method might be applicable to evaluate the effect of air conditioner on fuel consumption.
- Japan plans to conduct further study in FY2014

Parameters

- Environmental condition
- A/C type (Manual/Auto)
- A/C setting (Blower level, Temp. setting, inlet mode)
- Volume in a vehicle cabin
- etc

Actual data in use

- Representative environmental condition by statistics
  - ✓JPN Aug.: 30 degC, 60%RH, 71 kJ/kg
- Actual A/C use from questionnaire
- etc

Develop the test procedure with the WLTC