

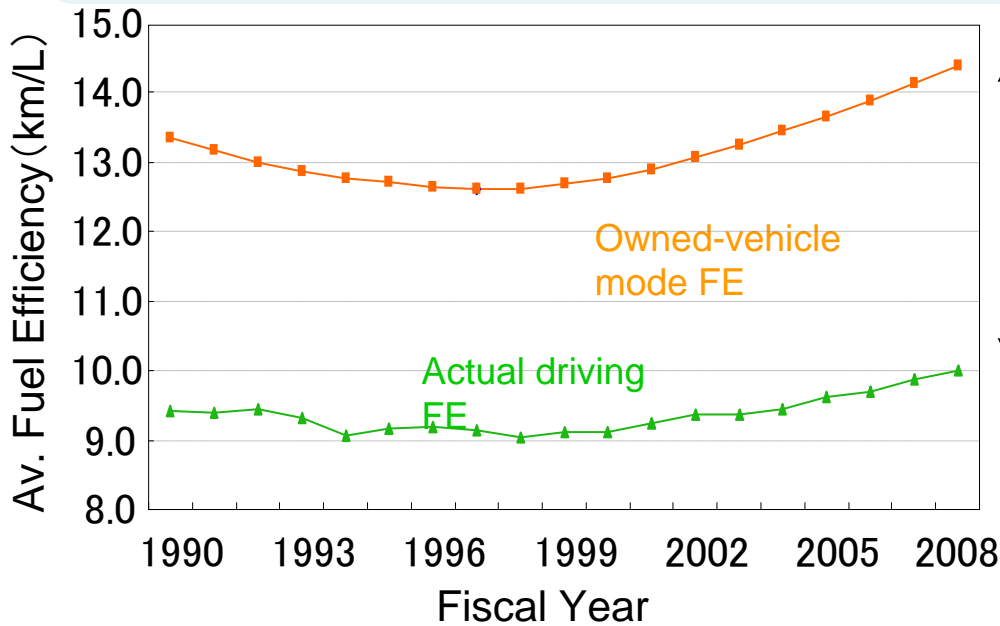
Progress of Studies on Vehicle Fuel Economy Measurement Method with the Effect of Air Conditioner Taken into Account

Masato OKUTSU

Environment Division
Road Transport Bureau
MLIT, JAPAN

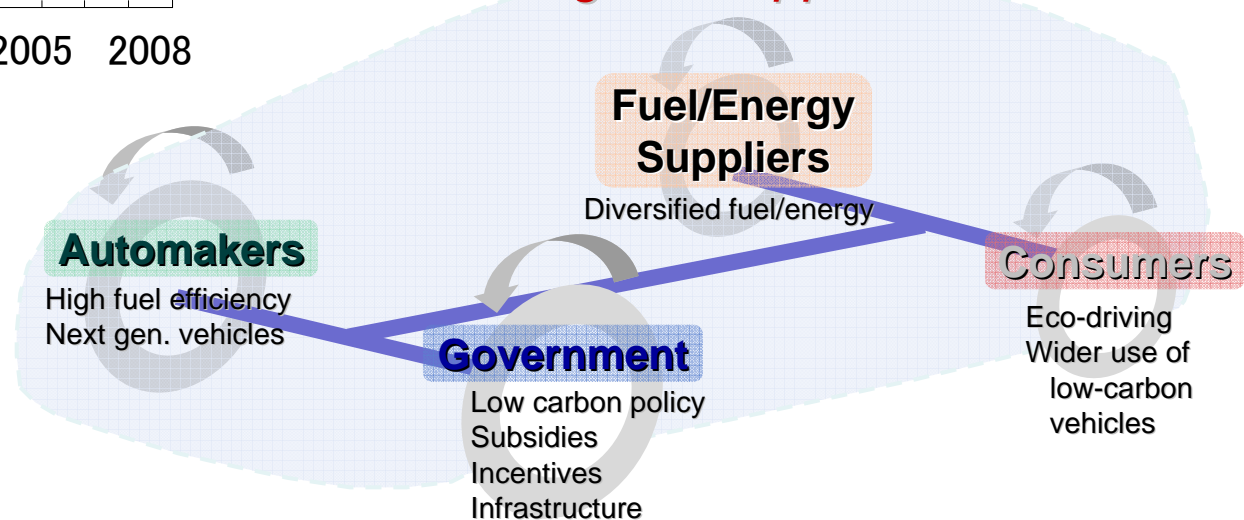
Divergence Between Mode FE and Actual FE; Comprehensive Approach

- Measurable divergence exists between mode FE and actual driving FE.
- Comprehensive approach is taken, including measures not only on the vehicle itself but also on infrastructure building, traffic flow, fuels, better driving method such as eco-driving, and more efficient logistics.



- * AC
- * Driving method
- * Traffic congestion
- * Status of inspection, etc.

Driving Sustainability through an Integrated Approach



Source: JAMA

- **MLIT aims to develop a vehicle FE measurement method that takes into account the effect of AC use, rather than the evaluation on the AC itself. Currently, studies conducted by government and industry have begun.**

- **The method for evaluating the AC efficiency/effect on FE**
 - (1) **Should represent the effect on FE in the real world.**
 - (2) **Should be able to evaluate different AC systems fairly.**
 - (3) **Should be able to be incorporated into the vehicle FE test method.**
 - (4) **Should improve the AC efficiency and the resultant FE through its incorporation into the FE test method.**
 - (5) **Should be cost-effective.**

- **International harmonization of standards is needed.**

➤ Regarding the effect of AC on the vehicle FE, the following study was conducted in fiscal 2009.

Overview of the test

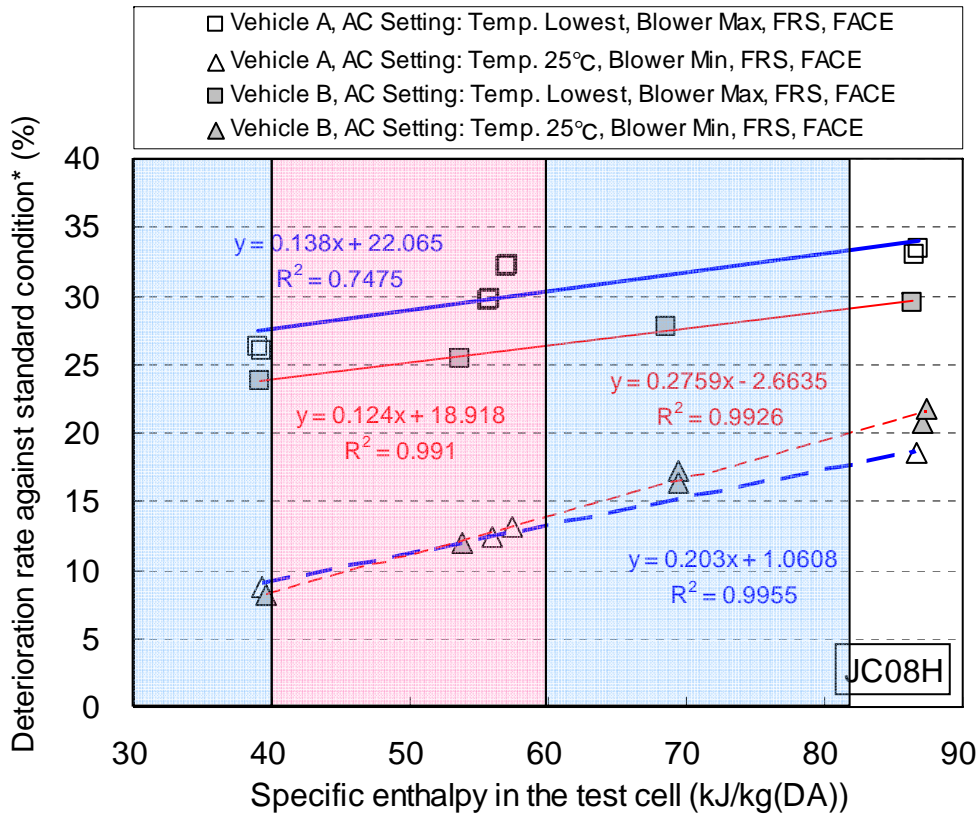
- 1) Test vehicle: Vehicle A: Passenger car A (1.5L, 5AT) Vehicle B: Passenger car B (1.5L, CVT)
- 2) Time: July and October 2009
- 3) Test conditions: 20 – 30°C, 40 – 75% RH
- 4) Test mode: JC08 mode (Hot)
- 5) Insolation condition: N/A
- 6) Blower level: Max./Min.
- 7) Air: FRS
- 8) Main measurement parameters:
 Vehicle speed, engine speed, coolant temperature, engine oil temperature, test cell temperature/humidity, temperature/humidity at A/C filter, temperature/humidity in vehicle compartment (behind front passenger seat, air vent), compressor working condition, exhaust gas, FE

Environmental conditions

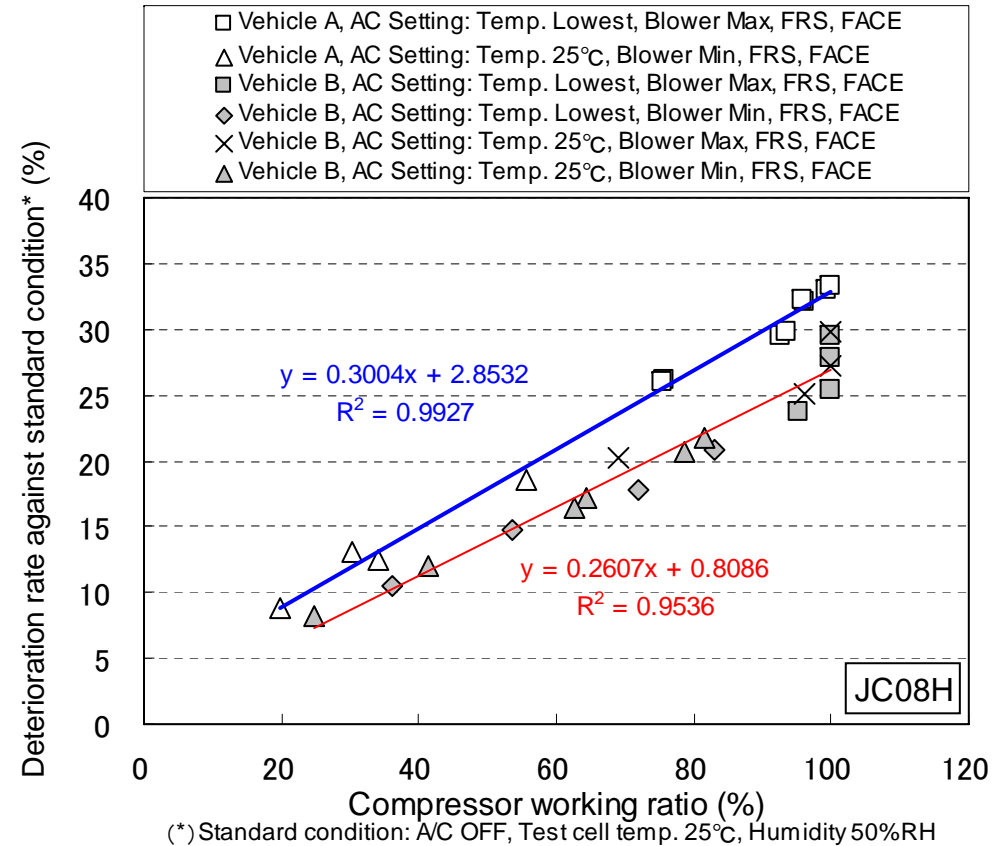
AC settings

Env. conditions	Temp.	Humidity	Specific enthalpy (kJ/kg)	A/C condition	ON/OFF	Setting	Temp. set	Blower level	Circulation method	Vent direction
Env. A	25°C	50%	50	AC0	OFF	-	-	-	-	-
Env. B	20°C	40%	35	AC1	ON	Manual	Lowest	Max.	Fresh air intake	Face
Env. C	30°C	75%	82	AC2				Min.		
Env. D	21°C	75%	51	AC3			Mid	Max.		
Env. E	28°C	60%	65	AC4				Min.		

Relation Between Test Cell Specific Enthalpy and FE Deterioration Rate



Relation Between Compressor Working Ratio and FE Deterioration Rate



- **Effect of the AC use on FE**
 - The higher the test cell specific enthalpy, the higher the compressor working ratio and the more deteriorated the FE.
 - Compressor working ratio varies depending on the AC setting, which affects the FE.
 - Compressor working ratio and FE value are highly correlated by linear regression .
 - The relation between AC settings and compressor working ratio differs between vehicles.



Future Tasks

- To set the appropriate representative values, we need to study in detail how the FE would change when the AC settings (Blower level, circulation method, etc.) and/or environmental conditions (fresh air temperature, humidity, insolation condition, etc.) are changed.
- The effect needs to be grasped for vehicles using power-saving technologies, such as automatic AC control and variable capacity compressor, as well as vehicle equipped with multiple AC units.

- **To study in detail the effect of AC settings and/or environmental conditions on the FE, it is scheduled to measure data under various conditions.**

Overview of the test scheduled to be conducted by MLIT in fiscal 2010

- 1) Test vehicle: Vehicle A: Passenger car A (1.5L, 5AT) Vehicle B: Passenger car B (4.0L, 5AT)
- 2) Time: Scheduled for January 2011
- 3) Test conditions: 25°C-50%RH, / 30°C-40%RH
- 4) Test mode: JC08 mode (Hot/Cold)
- 5) Insolation condition: N/A
- 6) Blower level: Auto/Mid/Max.
- 7) Air: FRS/REC
- 8) Main measurement parameters:
Vehicle speed, engine speed, coolant temperature, engine oil temperature, test cell temperature/humidity, temperature/humidity at A/C filter, temperature/humidity in vehicle compartment (behind front passenger seat, air vent), compressor working condition, exhaust gas, FE

- **MLIT aims to develop a vehicle FE measurement method that takes into account the effect of AC use, rather than the evaluation on the AC itself.**

- **The method for evaluating the AC efficiency/effect on FE that we need to establish**
 - (1) Should represent the effect on FE in the real world.**
 - (2) Should be able to evaluate different AC systems fairly.**
 - (3) Should be able to be incorporated into the vehicle FE test method.**
 - (4) Should improve the AC efficiency and the resultant FE through its incorporation into the FE test method.**
 - (5) Should be cost-effective.**

Therefore, it should be studied carefully without hasty discussions.