Introduction of the research concerning exhaust gas from the vehicle entering cabin

2017. 1. 11

Korea Transportation Safety Authority
Korea Automobile Testing & Research Institute
Background

- Consumer complaints “Exhaust gas entering into vehicle cabin”
  - Exhaust smell can disturb driving and raises safety concerns
- Ministry of Land, Infrastructure and Transport had launched an investigation into this issue
  - Possible leakage of exhaust fumes and exposure to carbon monoxide inside the vehicle
    - Defect Investigation in 2011 (49 vehicles) and in 2016 (1 vehicle)
    - 3 vehicle models: Free repair service in 2012

<KBS news regarding “exhaust gas entering into vehicle cabin”>

<Official Press Release by MOLIT>
How could the exhaust gas enter into vehicle cabins?

- When cars pick up speed with the air conditioning system on internal circulation mode, exhaust gases could enter the passenger compartment due to pressure difference in cabin and vortex flow in back part of the car.

- **Warning in vehicle owner’s manual**: The boot lid must always be completely closed when the vehicle is moving, otherwise exhaust fumes can be drawn into the interior.
Computational Fluid Dynamics (CFD)

- Simulation for exhaust gases entering into cabin using the CFD method

- The vortex flow occurs in the back part of sedan vehicles depending on vehicle speed

*Source: Fundamentals of Vehicle Dynamics, Thomas D. Gillespie
Computational Fluid Dynamics (CFD)

- Simulation for exhaust gases entering into cabin using the CFD method
Study on emission gas test on chassis dynamometer

- Identify air pollutant sources and measurements on Emission test mode

- Carbon monoxide occurring from very high speed (over 140km/h) and high acceleration (WOT)

![Test result of carbon monoxide in vehicle speed on gasoline vehicle](image1)

![Test result of carbon monoxide depending on acceleration rate on gasoline vehicle](image2)
Expectation pass of exhaust gas entering into cabin

- Most vehicles have ventilation holes near trunk area
  - i.e. Air Extractor

<Trunk picture>
Test for exhaust gas entering into cabin in proving ground

- Measurement devices setting position
  - nose position of front seat, back seat
  - center position of truck
Test for exhaust gas entering into cabin in proving ground

- Real driving test taking into account CFD and emission test on chassis dynamometer
  - Idling condition, constant high speed condition, high acceleration condition
- Test vehicle: Gasoline vehicle, 3,000 cc, sedan
Test for high speed condition (circulation mode/fresh air mode)

- CO not detected in 80, 100, 120, 140 km/h
- CO detected in 160 km/h, in circulation mode (Front seat 0.5 ppm, back seat 4.0 ppm)
- CO not detected in 160 km/h, in fresh air mode
Proving Ground Test

- Test for acceleration condition (windows open instead of sunroof)
  - High level of CO detected in trunk in high acceleration condition
  - CO detected in cabin (front seat 8.7 ppm, back seat 9.1 ppm)
Discussion on exhaust gas entering issues

- Meeting with car industry association
  - KAMA (Korea Automotive Manufacturer`s Association)
  - KAIDA (Korea Automotive Importers & Distributors Association)

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<td><strong>Idling mode</strong> (basic condition)</td>
<td>- Engine idling in normal condition</td>
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| **Constant driving mode** (normal condition) | - Driving vehicles at constant speed  
  . 80±5 km/h  
  . 100±5 km/h  
  . 120±5 km/h  
  . 140±5 km/h |
| **Acceleration mode** (worst condition) | - Accelerate vehicles from 65 km/h to 130km/h after that coast-down (deceleration) to 65 km/h , repeat mode |
Discussion regarding regulation

- Discussion on the draft of test procedures
  - Most manufactures agree on using the three test mode instead of existing test mode
  - Vehicle categories, substances to be measured, limit values of substances [draft document]
  - What kind of regulation will be made from MOLIT? [Under discussion]

- Conclusion

  ✓ If any contracting parties and members are interested in this issue, we are willing to share our results, technical data, and expertise with you
Thank you

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