ASEP IWG #12

2019.07.09-11

ASEP IWG #12 meeting

@Berlin

JASIC

Contents

1. ASEP Sound Model - Apply to Series-HEV
2. Summary of test results
3. Ideas to solve the issue

1. ASEP Sound Model - Apply to Series-HEV

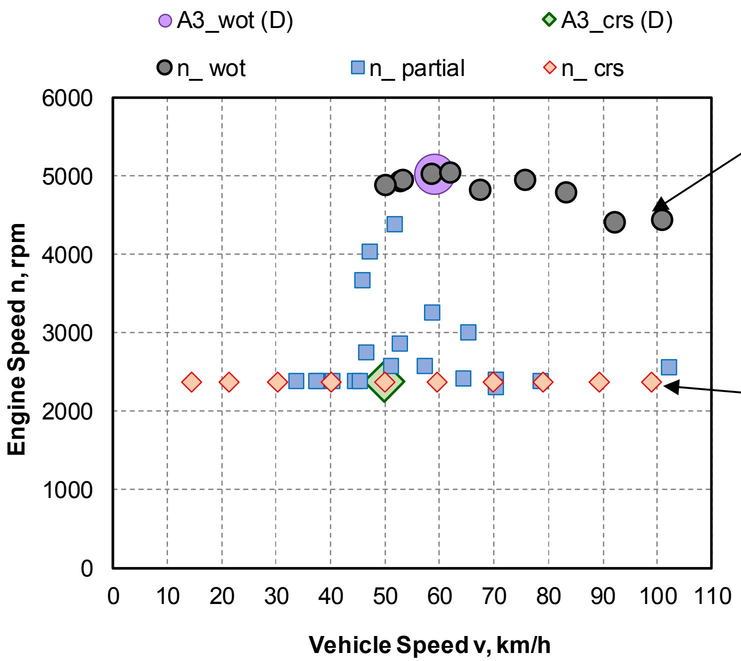
Mechanism of Series HEV

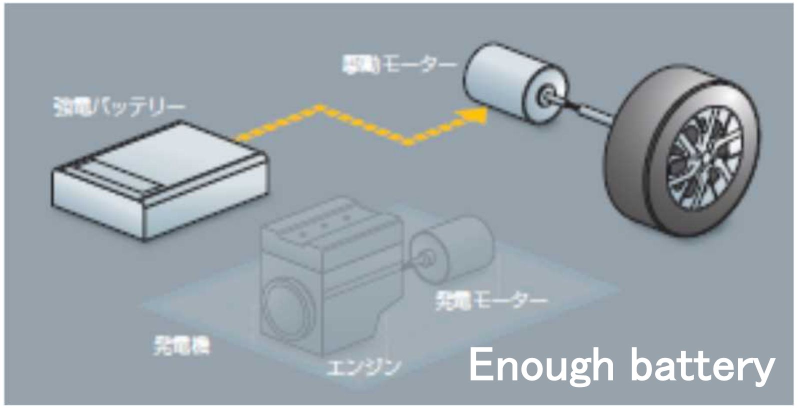
Driven by motor

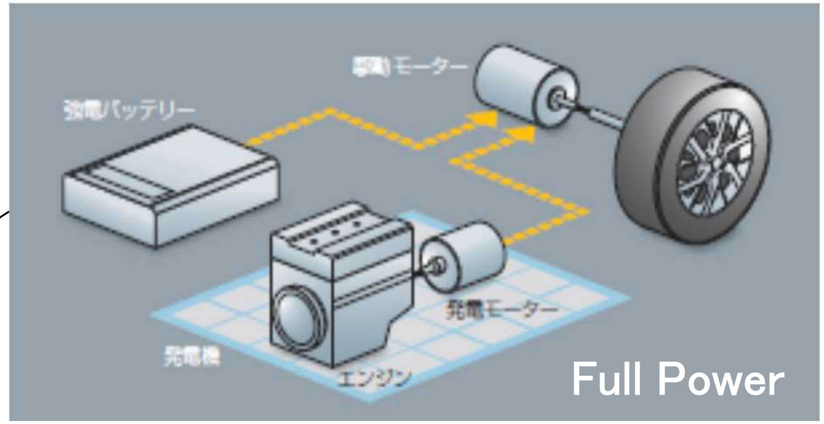
ICE is only as generator.

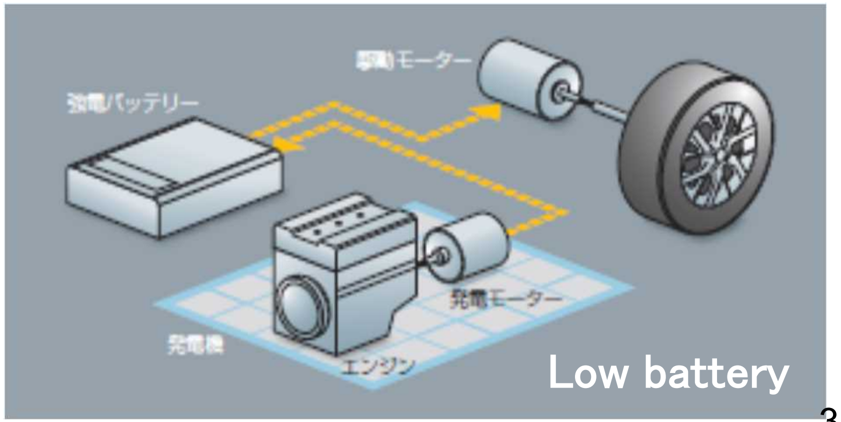
No relationship between vehicle speed and ICE engine speed.

Series-HEV









Test vehicle information

<table>
<tr><td colspan="2">Test vehicle</td><td colspan="3">Vehicle-08 (Series-HEV)</td></tr>
<tr><td rowspan="9">Spec.</td><td>Category</td><td colspan="3">M1</td></tr>
<tr><td>Power unit</td><td colspan="3">Motor</td></tr>
<tr><td>Max. power</td><td colspan="3">80 kW</td></tr>
<tr><td>mro</td><td colspan="3">1285 kg</td></tr>
<tr><td>PMR</td><td colspan="3">62.3</td></tr>
<tr><td rowspan="2">Engine for power generation</td><td colspan="3">1198 cc</td></tr>
<tr><td colspan="3">Max. power @ 5400 rpm</td></tr>
<tr><td>Tyre size</td><td colspan="3">185/70R14</td></tr>
<tr><td colspan="2">R51-03 Annex 3</td><td colspan="3">D-range</td></tr>
<tr><td>Conditions</td><td>Gear</td><td>V, km/h</td><td>n, rpm</td><td>a, m/s^2</td></tr>
<tr><td>Vehicle running (Wot, Partial, Crs)</td><td>D</td><td>14-103</td><td>2400-5000</td><td>0.3-4.0</td></tr>
</table>

Overview of Sound Model

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(A) Tyre Rolling Sound Model, L_{TR}

$$L_{TR} = Slope_{TR} * \log(v_{test} / 50) + L_{REF,TR}$$

$$L_{REF,TR} = X\ \%\ \text{of}\ L_{CRS,REP}$$

X %(Tyre noise contribution at cruise test in Annex 3 is actually set to by 90%)

(B) Power Train Base Mechanic Sound Model (No Load), $L_{PT,NL}$

$$L_{PT,NL} = Slope_{PT,NL} * \log((n_{test} + n_{shift}) / (n_{CRS,REP} + n_{shift})) + L_{REF,PT,NL}$$

$$L_{REF,PT,NL} = (100 - X\ \%)\ \text{of}\ L_{CRS,REP}$$

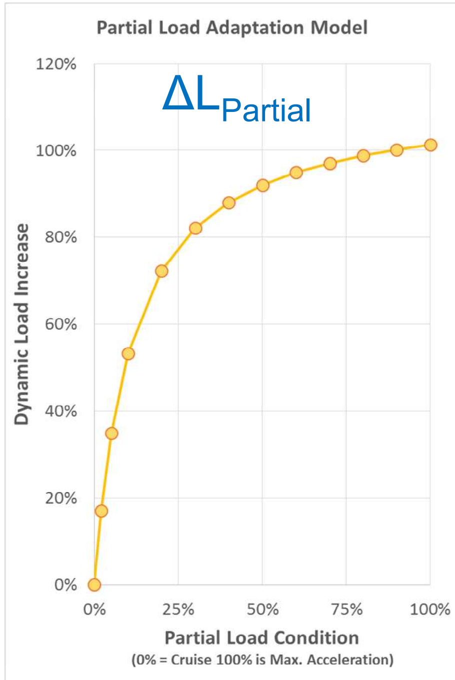
(C) Dynamic Model, L_{DYN}

$$L_{DYN} = Slope_{DYN,NL} * \log((n_{test} + n_{shift}) / (n_{WOT,REP} + n_{shift})) + L_{REF,DYN,NL} + \Delta L_{DYN} * \Delta L_{Partial}$$

$$L_{REF,DYN,NL} = L_{REF,PT,NL} - 15$$

$$\Delta L_{DYN} = [L_{WOT,REP} \ominus L_{TR}(V_{WOT,REP}) \ominus L_{PT,NL}(n_{WOT,REP})] - L_{REF,DYN,NL}$$

$\Delta L_{Partial}$ (See right figure)



(D) Expectation level, L_{exp}

$$L_{test} \le L_{exp} = (L_{TR} \oplus L_{PT,NL} \oplus L_{DYN}) + \Delta L_{MARGIN}$$

(A) (B) (C)

An Issue of current sound model

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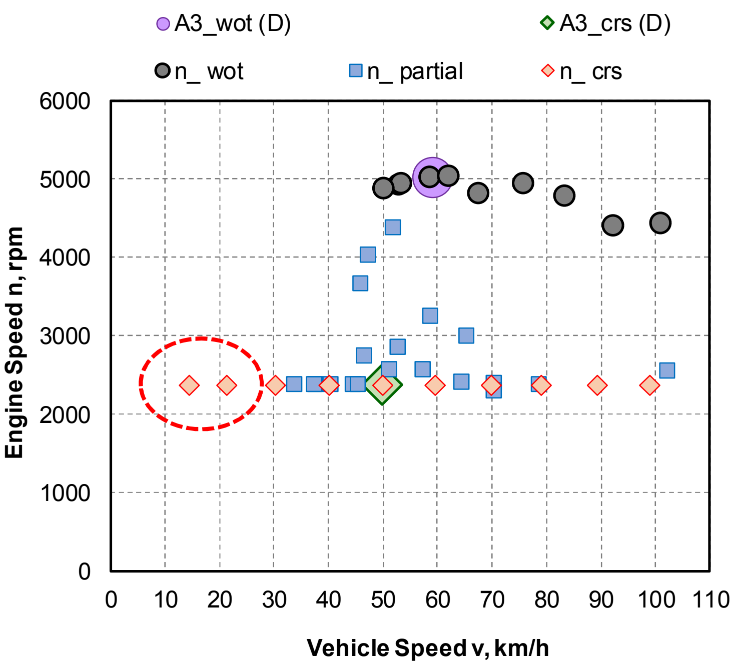
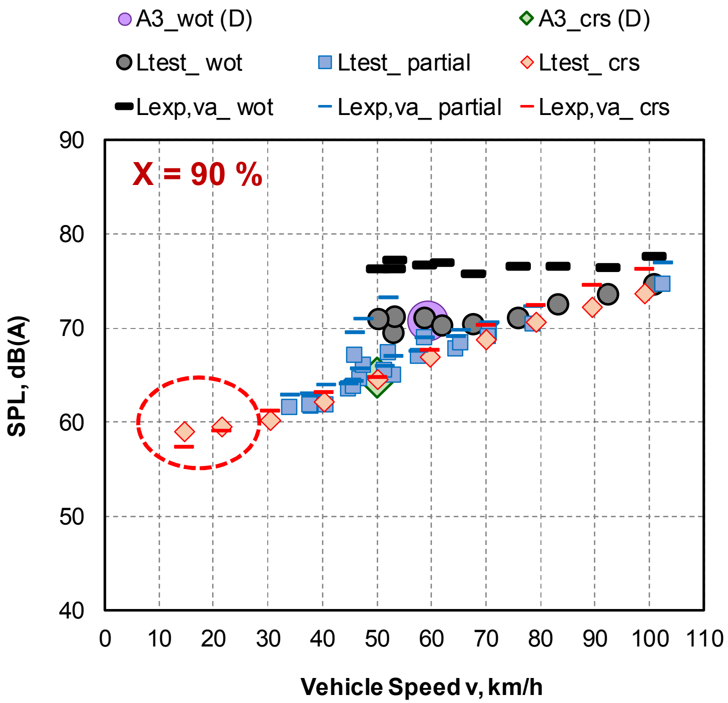
ASEP sound model can work well at most of conditions.
Only L_{test} on cruise test at lower vehicle speed exceeds L_{exp} by sound model if using X=90%.

v vs n



v vs SPL



Influence of X(%); tyre noise contribution of L_{crs}

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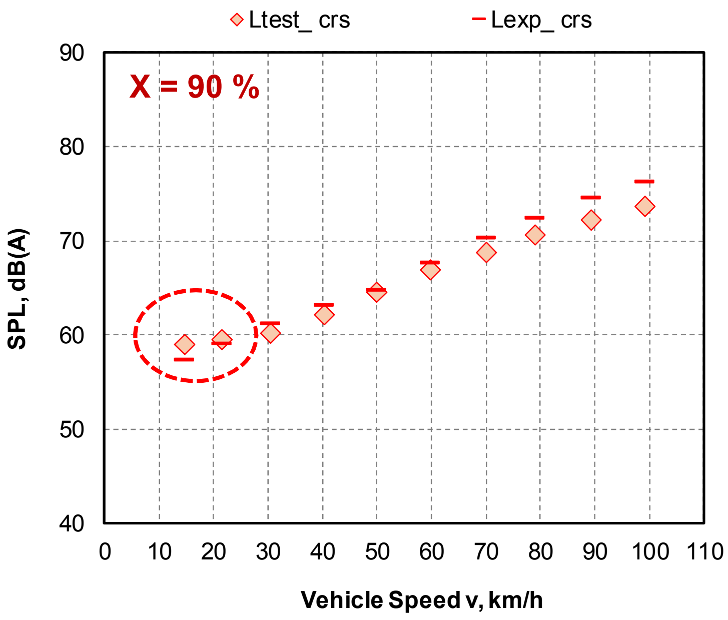
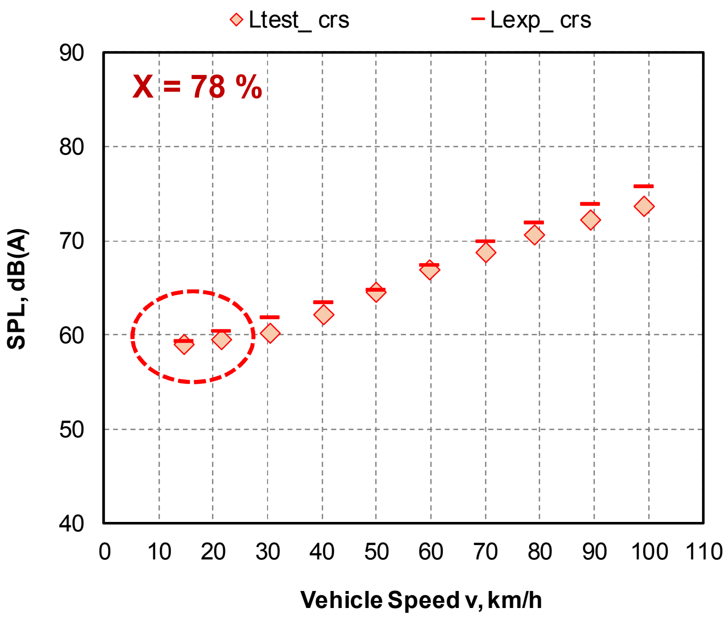
If using the fixed value X = 90 %, L_{test} > L_{exp} at low vehicle speed.

If using actual measured value X=78%, sound model can fit.

L_{test} and L_{exp} of CRS, X = 90 %



L_{test} and L_{exp} of CRS, X = 78 %



The Reason of Underestimation with fixed X=90%

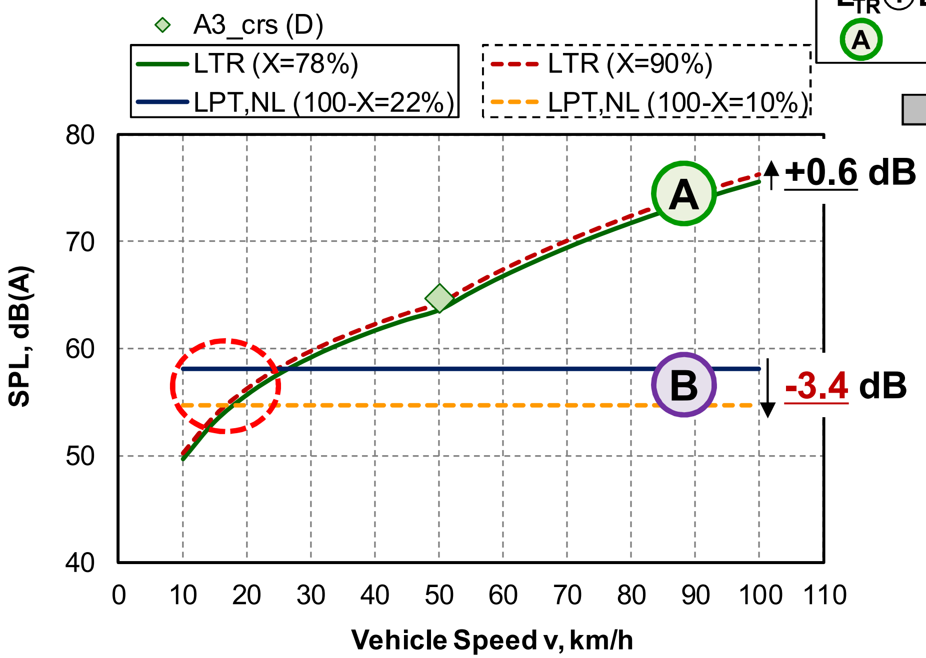
If 78% of X change to 90%,

(A) Tyre sound level L_{TR} → +0.6 dB

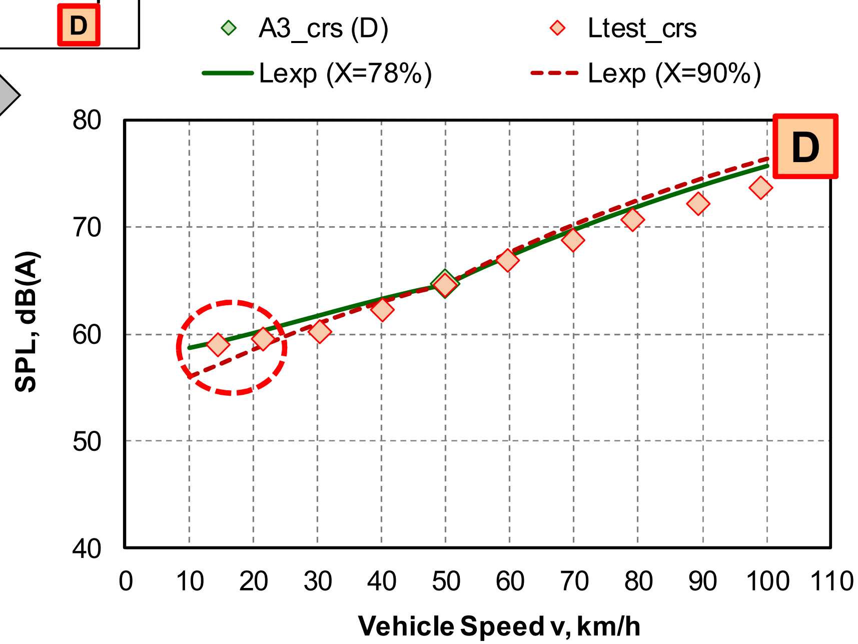
(B) Power train sound level $L_{PT,NL}$ → -3.4 dB

In case of X=90%, $L_{PT,NL}$ (mechanical sound) is underestimated.
Due to higher contribution of $L_{PT,NL}$ at low vehicle speed, L_{exp} is lower than L_{test}.

At higher vehicle speed or acceleration conditions, L_{TR} (tyre sound) and L_{DYN} (dynamic sound) are combined , then less influence of X values.



At CRS condition,
$L_{TR} \oplus L_{PT,NL} = L_{exp}$
(A) (B) (D)



2. Summary of Results

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- The sound model can be applied to series HEV at most of operation conditions except for the condition at low speed and low load.
- In this condition, since mechanical sound model is dominant, estimated uncertainty is not better than the other conditions which sound model is combined three models.
- Then, X% which links to mechanical sound level is sensitive.

→ Need consideration only at low speed and low load condition.

3. Ideas to solve the issue

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Using proper value of X for each test car instead of fixed value can improve sound model.

i

Measure coast-by test (tyre sound level) to use measured X%

Con; Need additional measurement

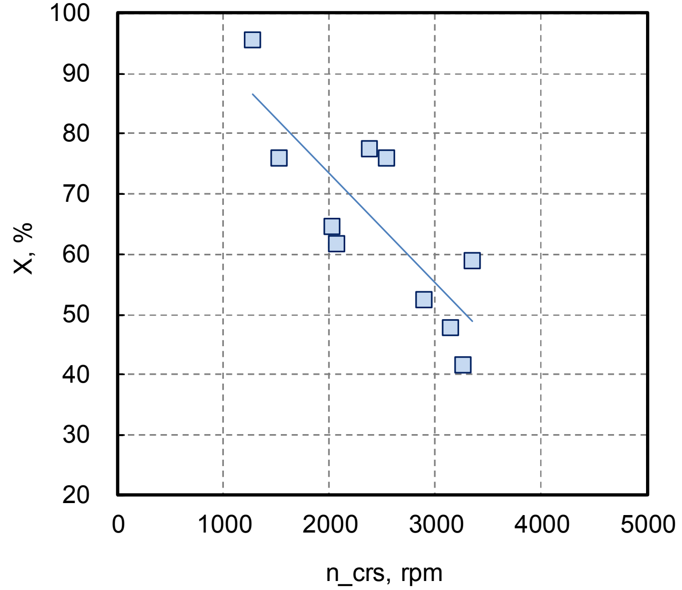
ii

Use formula for relationship between engine speed n_{CRS} and X%.

Function of n_{CRS}
(engine speed in Annex3 cruise test at 50km/h)

$$X\ (\%) = \frac{10^{\frac{L_{TR}}{10}}}{10^{\frac{L_{CRS}}{10}}} \times 100 = \left(1 - \frac{10^{\frac{L_{pT,NL}}{10}}}{10^{\frac{L_{CRS}}{10}}}\right) \times 100$$

X = -0.0182 * n_{CRS} + 109.8
r = -0.82



Thank you for your attention.