# Effects of Ethanol on Emissions of Gasoline LDVs

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# Objective

Present Toyota’s concern about the effects of ethanol containing gasoline on vehicle emissions.

# *General Results*

**When there is about 10% ethanol in gasoline instead of MTBE:**

**Evaporative Emissions: ↑**

**Tailpipe NOx Emissions: ↑**

**Tailpipe CO ↓**
**Tailpipe HC (=?)**

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# Test Fuels

| | | "MTBE" | E10-A | E10-B |
|---|---|---|---|---|
| | | Phase II (w/MTBE) | E10 (lower RVP) | E10 (higher RVP) |
| RVP | kPa | 47 | 48.5 | 52.2 |
| RON | | 96.3 | 101.3 | 97.2 |
| FIA | vol. % | | | |
| | Aroma. | 24.0 | 23.0 | 24.1 |
| | Olefin | 5.0 | 5.0 | 3.4 |
| | T10 | 60.0 | 57.2 | 57.5 |
| | T50 | 96.0 | 97.6 | 100.0 |
| | T90 | 143.5 | 145.6 | 147.0 |
| Oxy. | vol. % | | | |
| | MTBE | 11.1 | 0.0 | 0.0 |
| | Ethanol | 0.0 | 11.2 | 8.9 |
| S | ppmw | 30 | 29 | 30 |

**E10-C:** Indolene Cert. Fuel + 10% Ethanol; (. igher RVP)

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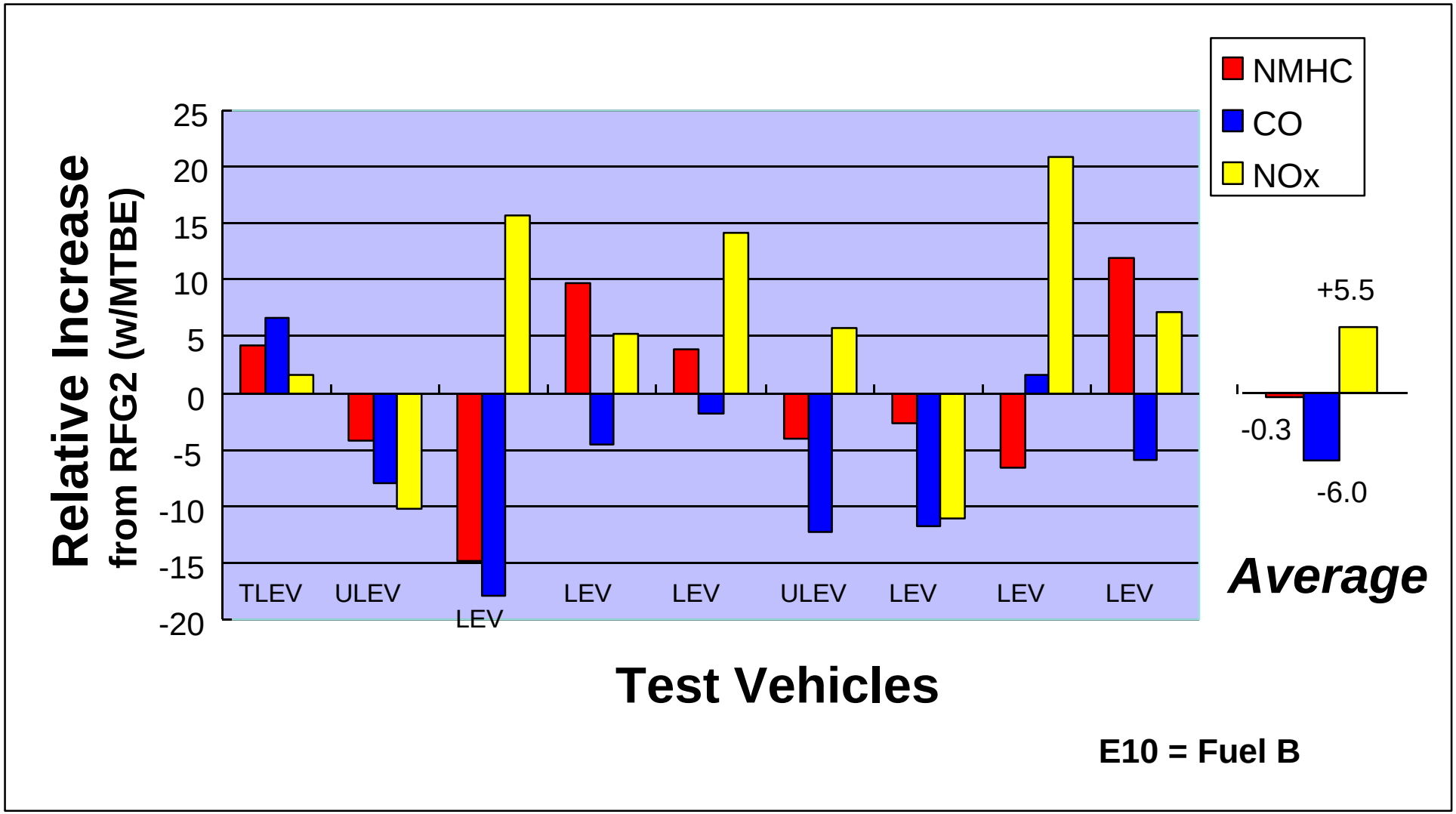
# I. Tailpipe Emissions

# II. Causes of Evaporative Emissions Increase

1. Volatility
2. Permeation

# E10 Gasoline Effect on Tail-Pipe Emissions

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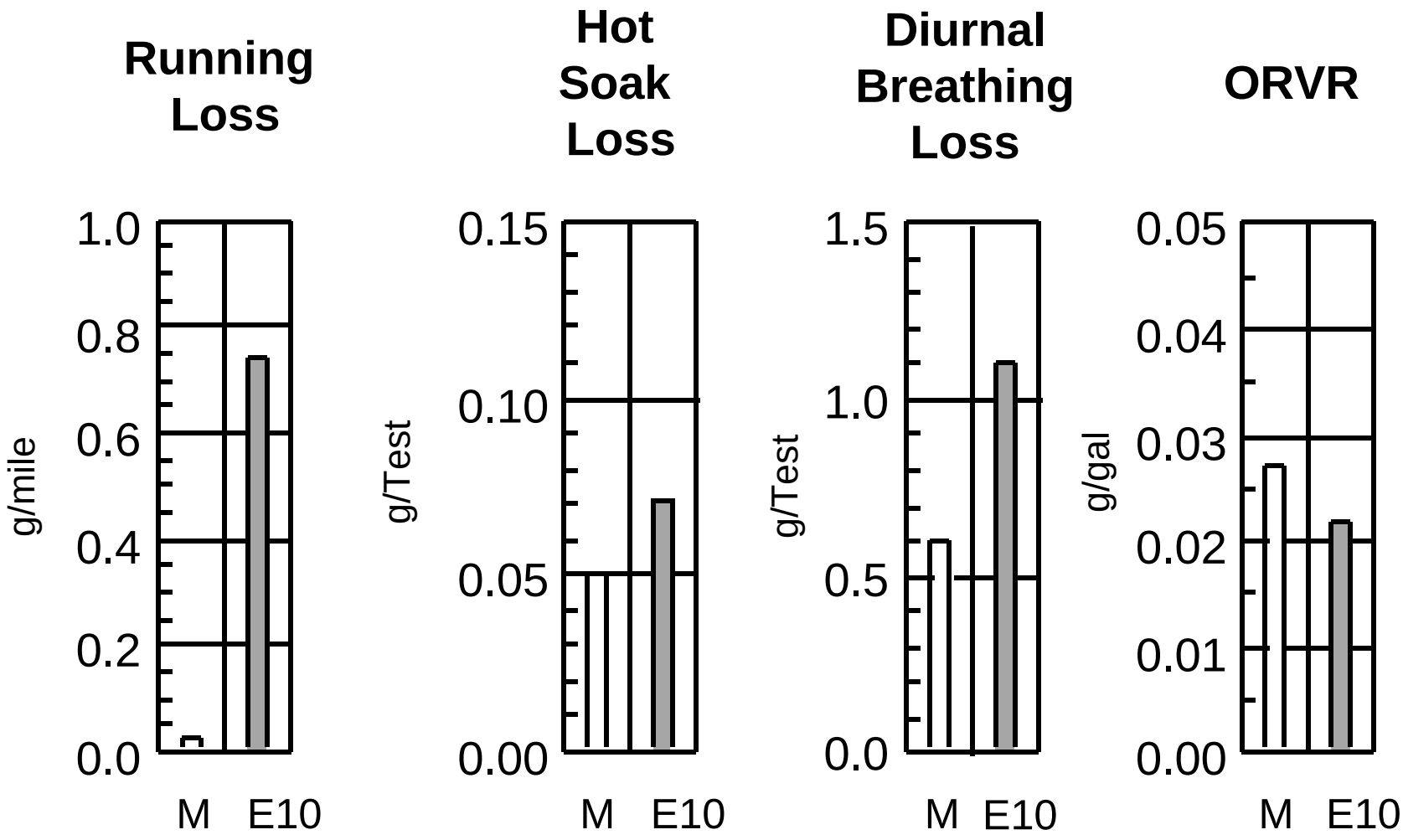
# Results of Evap / ORVR Tests




*Key:* *M = MTBE*
*E10 = Fuel B (high RVP)*

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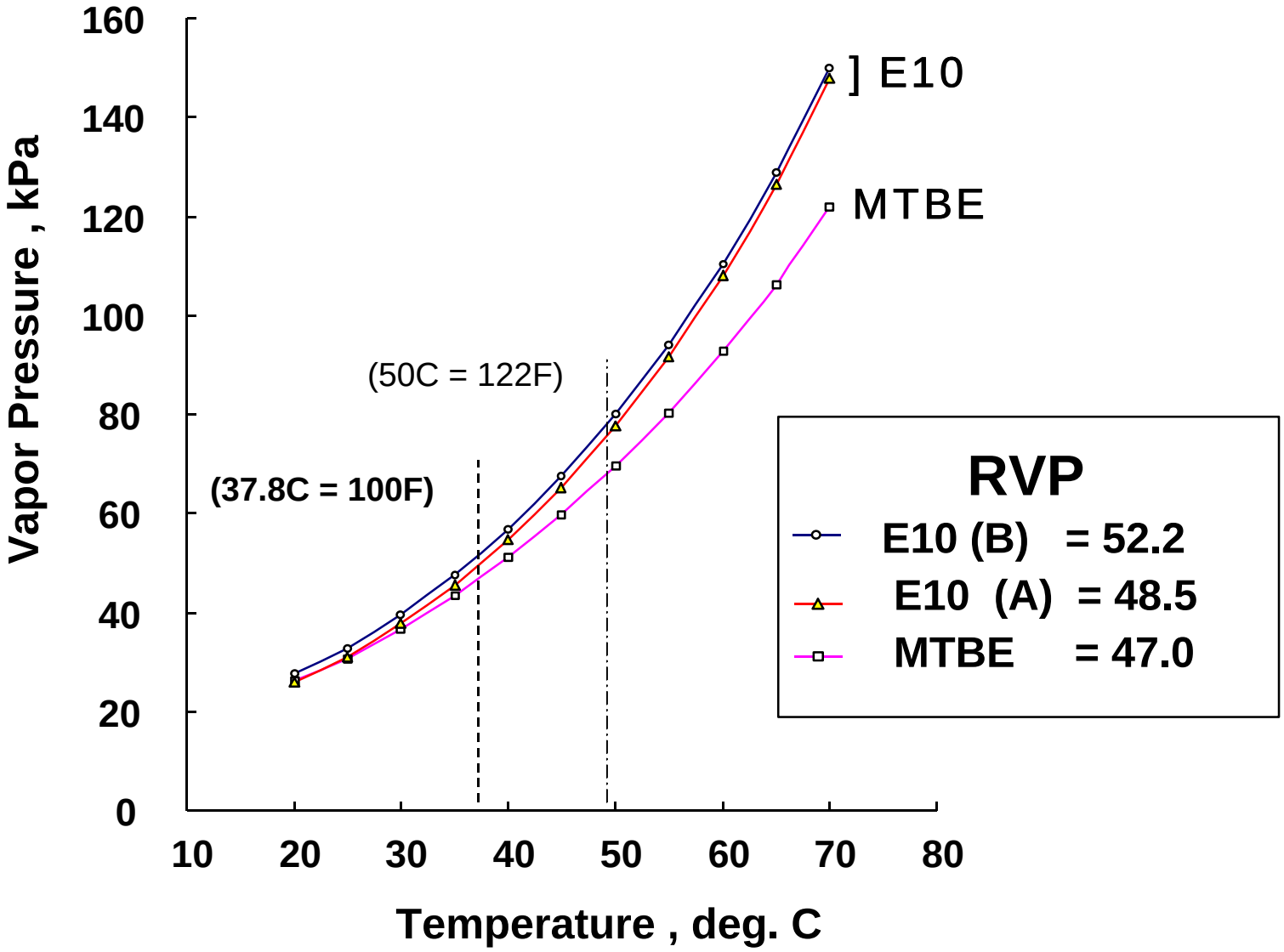
# Fuel Volatility Characteristics

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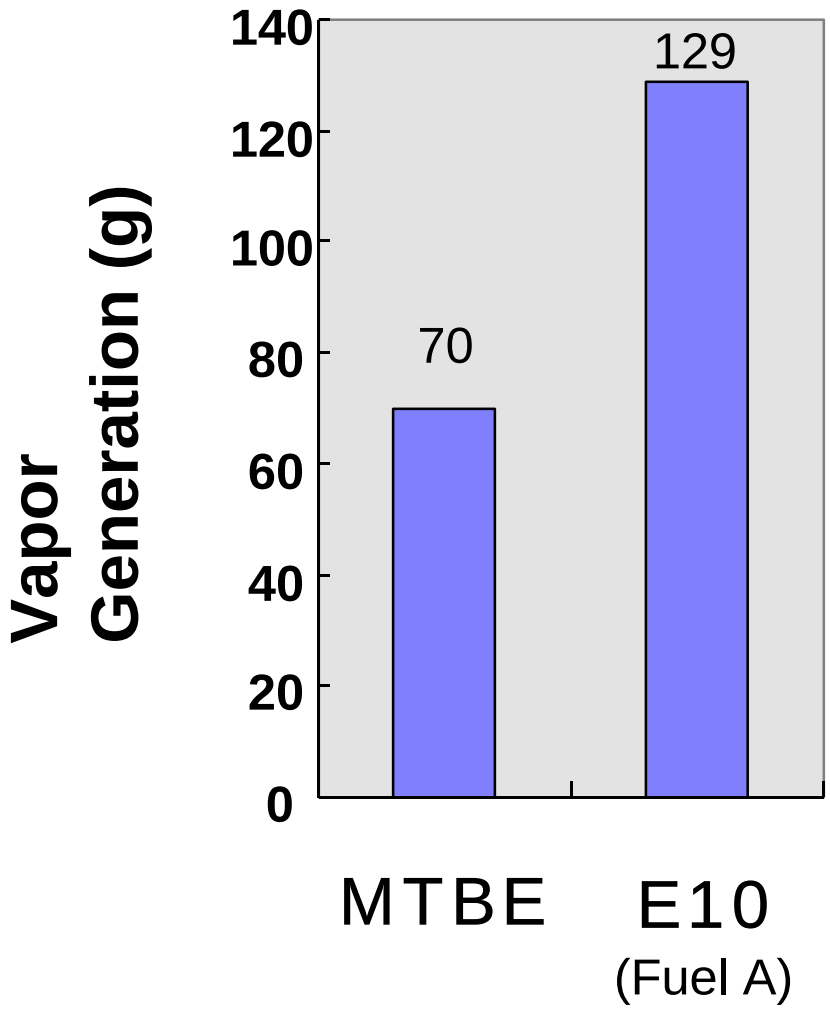
# Vapor Generation during Running Loss Tests

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# I. Tailpipe Emissions

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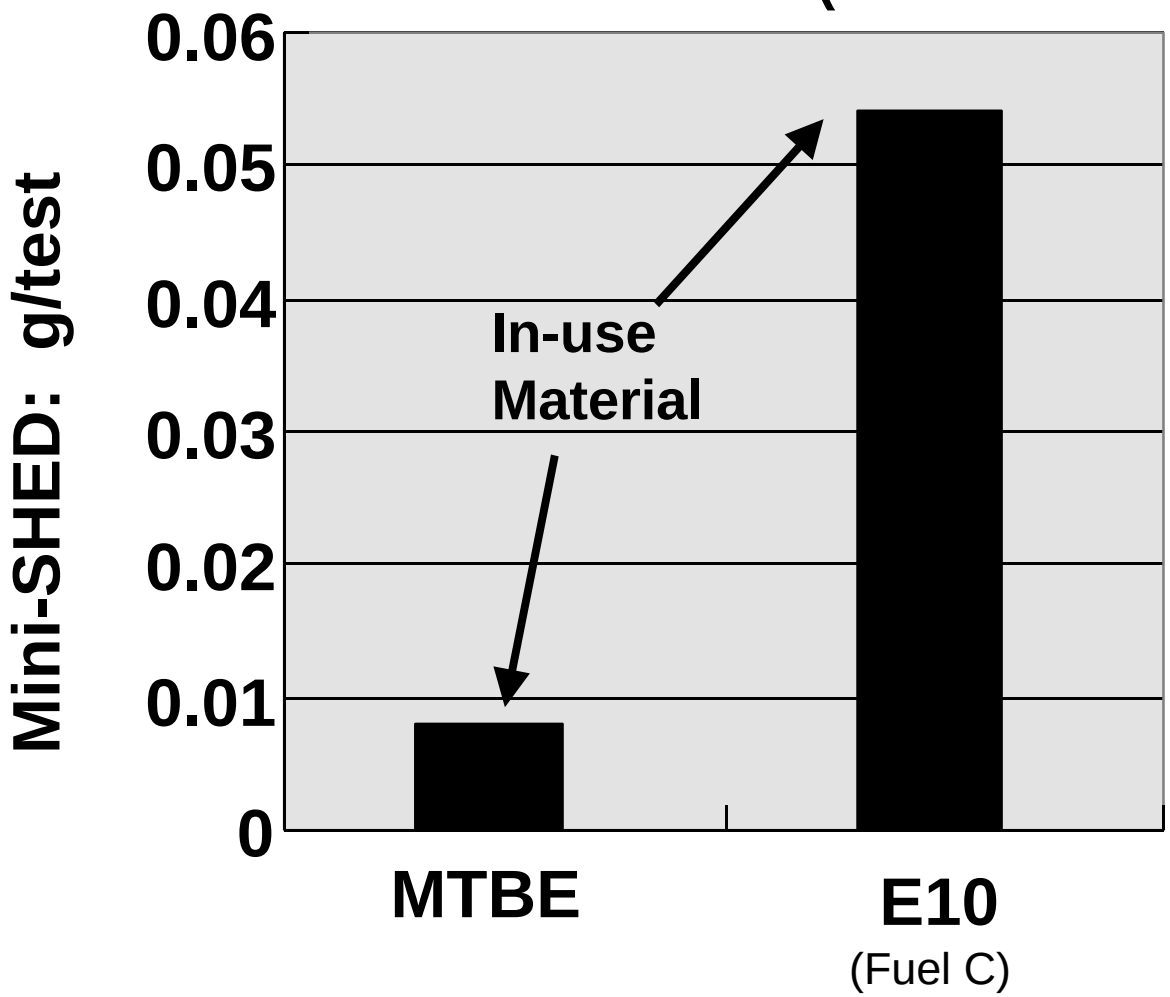
# ***Component Testing***

## Permeation of Pump Sender Gaskets

**(Gasket material : NBR)**

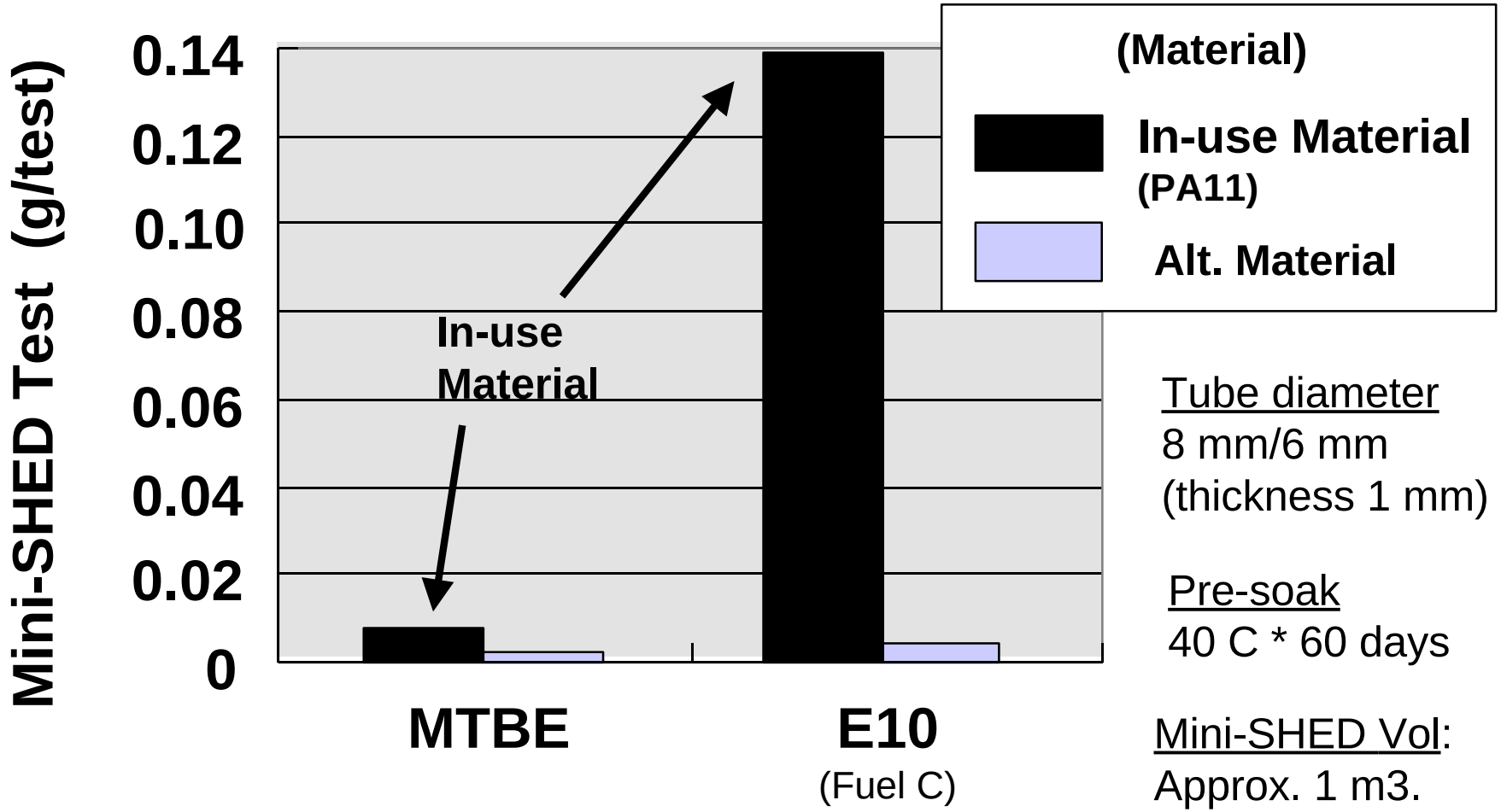



NBR = Nitrile Butadiene Rubber; Used on all fuel tank gaskets.

Mini-SHED Vol: Approx. 1 m3.

**Pre-soak**
**40 C * 28 days**

# ***Component Testing***
## Permeation of Plastic Fuel Tubes




Tube diameter
8 mm/6 mm
(thickness 1 mm)

Pre-soak
40 C * 60 days

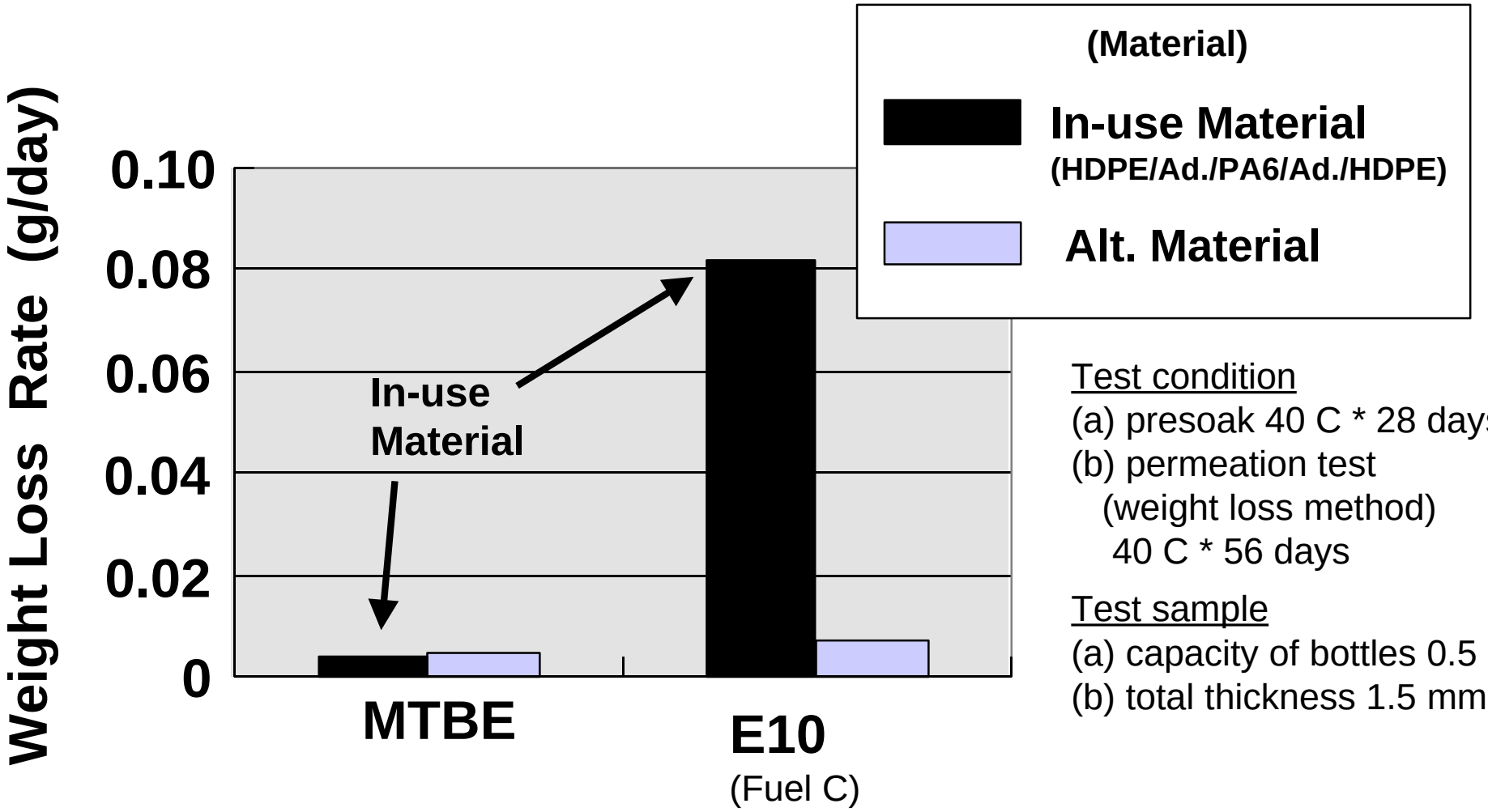
Mini-SHED Vol:
Approx. 1 m3.

Alt. Material: ETFE/Ad./PA12 *(Ad. = adhesive)*

*(PA = Poly Amid; ETFE = Ethylene Tetra Fluoro-Ethylene Copolymer)*

# ***Component Testing***

## Permeation of Plastic Bottles




Test condition
(a) presoak 40 C * 28 days
(b) permeation test
(weight loss method)
40 C * 56 days

Test sample
(a) capacity of bottles 0.5 L
(b) total thickness 1.5 mm

Alt Material: HDPE/Ad./EVOH/Ad./HDPE *(Ad. = adhesive)*
*(HDPE = High Density Poly Ethylene; EV-OH = Ethylene Venyl Alcohol Copolymer)*

# Summary of Ethanol Effects

| | In-use Vehicles | Future Models |
|---|---|---|
| **Evaporative Emissions** | RL ↑<br>HSL ↑<br>DBL ↑ | Near-zero Emissions:<br>*"Challenging"*<br><br>Zero Emissions:<br>*"Very Difficult"* |
| **Permeation Effects** | Rubber ↑<br>Plastic Tanks ↑<br>Plastic Hoses ↑ | |
| **Tailpipe Emissions (Ave.)** | HC -0.3%<br>CO -6.0%<br>NOx +5.5% | Requires re-calibration of engine controls |

# Conclusions

**The use of ethanol will cause:**

- **Evaporative emissions to increase in comparison to MTBE.**
- **Significant increases of *in-use vehicle* evaporative emissions.**
- **Tailpipe emissions of NOx to increase.**

**More study is needed to determine the emissions effects of RFG3 with ethanol.**

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