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CRC E-65-3 Interim Report Summary

Fuel Permeation From Automotive Systems:
E0, E6, E10 and E85

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E-65-3 - Project Objectives

- Investigate the permeation characteristics of advanced technology (i.e., LEV II, PZEV) evaporative emissions control systems
- Determine if changes in ethanol content affect permeation rates
- Establish the permeation effects of E85 in a flexible fuel vehicle (FFV)
- Determine if permeation rates are sensitive to changes in aromatics content



E-65-3 - Project Description

- Five vehicle fuel system test rigs (2000 – 2005 MY)
 - 2000 Honda Odyssey enhanced evap system (Rig 2 – E-65)
 - 2001 Toyota Tacoma enhanced evap system (Rig 1 – E-65)
 - 2004 Ford Taurus LEV II “near zero” evap system (Rig 11)
 - 2004 Chrysler Sebring PZEV evap system (Rig 12)
 - 2005 Chevrolet Tahoe FFV system (Rig 14)
- Five test fuels (vapor pressures targeted at 7.0 psi)
 - E0 non-oxygenated base fuel
 - E6 5.7 vol% ethanol (26 vol% aromatics)
 - E6Hi 5.7 vol% ethanol (39 vol% aromatics)
 - E10 10 vol% ethanol
 - E85 85 vol% ethanol
- Order of testing: E0, E6, E6Hi, E10, E85



E-65-3 - Project Description *(continued)*

- Testing protocols consistent with E-65 study
 - Stabilize rigs at 105°F
 - Measure steady-state permeation at 105°F
 - Measure diurnal permeation over one day of CA 2-day diurnal (65-105-65°F) cycle
- Test rigs hold fuel system components in same orientation as on vehicle
- Early in 2006, an E20 test fuel was added to this program; those results will be included in the final report to be published later this year



E-65-3 - Typical Test Rig



2004 Chrysler Sebring PZEV Fuel System



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E-65-3 - Results

Diurnal Permeation Rates, mg/day								
	Test Fuel					Differences from E0, mg/day		
Rig	E0	E6	E6Hi	E10	E85	E6	E6Hi	E10
1	84	475	361	468	-	391	277	385
2	463	1426	1227	1301	-	963	764	838
11	48	144	89	123	-	96	41	75
12	35	50	45	64	-	15	10	29
Avg.	158	524	430	484		366	272	326
14	260	-	-	466	128			



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E-65-3 - Results *(continued)*

Permeate Specific Reactivities, g O ₃ /g VOC					
	Test Fuel				
Rig	E0	E6	E6Hi	E10	E85
1	4.31	3.07	3.30	3.03	-
2	4.26	3.54	3.66	3.45	-
11	2.91	2.09	2.58	2.33	-
12	4.79	3.30	3.14	2.85	-
Avg.	4.21	3.01	3.17	2.80	-
14	3.85	-	-	3.05	2.73



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E-65-3 - Conclusions

- The low-level ethanol blends (E6, E6Hi and E10) increased permeation in all the vehicle systems and technologies tested, compared to the non-ethanol fuel (E0).
- The advanced technology LEV II and PZEV systems had much lower permeation emissions than the enhanced evaporative systems tested.
- The PZEV system had the smallest permeation increase due to ethanol of the systems tested.
- The high-level ethanol blend (E85) tested in the FFV system had lower permeation emissions than the non-ethanol fuel (E0).



E-65-3 - Conclusions *(continued)*

- Diurnal permeation rates do not appear to increase between E6 and E10.
- Diurnal permeation rates were lower on all four systems tested with the higher-aromatics fuel (E6Hi) versus the lower-aromatics fuel (E6).
- The average specific reactivities of the permeates from the low-level ethanol blends (E6, E6Hi and E10) were similar to one another and lower than those measured with the non-ethanol fuel (E0).



E-65-3 - Caveats

- The results of this program have not been statistically analyzed, so differences noted among and between the permeation rates and permeate specific reactivities for the various test fuels and fuel systems should not be assumed to be statistically significant.
- These data represent a limited number of samples; care should be taken in extending these results to the in-use fleet.



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E-65-3 - Interim Report and Data

- The E-65-3 Interim Report, “Fuel Permeation From Automotive Systems: E0, E6, E10 and E85,” as well as the data from the study, are available on the CRC website at:

<http://www.crcao.org>

- The report and data will also be available on CARB’s website shortly.



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