



Performance and Emissions of The Toyota Prius

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Vehicle Performance, Economy

CAR AND DRIVER TEST RESULTS:

ACCELERATION.....full charge.....battery empty
Zero to..30 mph.....4.4 sec.....6.3 sec
.....40 mph.....6.9 sec.....10.1 sec
.....50 mph.....10.2 sec.....14.7 sec
.....**60 mph.....14.1 sec.....20.7 sec**
.....70 mph.....19.2 sec.....29.6 sec

Street start, 5-60 mph.....13.9 sec.....20.1 sec
Top-gear acceleration,
30-50 mph.....6.1 sec.....8.5 sec
50-70 mph9.4 sec.....14.7 sec
Standing 1/4-mile.....19.7 sec.....22.5 sec
.....@ 71 mph.....@ 63 mph
Top speed (drag limited).....97 mph.....91 mph

BRAKING
70-0 mph 141 impending lockup 185 ft
Fade.....none light moderate heavy

HANDLING
Roadholding, 300-ft-dia skidpad.....0.72 g
Understeer minimal moderate excessive

FUEL ECONOMY
(Japanese-specification Prius)
EPA city driving.....43 mpg
EPA highway driving.....41 mpg
C/D-observed fuel economy.....35 mpg

ANL-observed fuel economy.....38 mpg
during mileage accumulation

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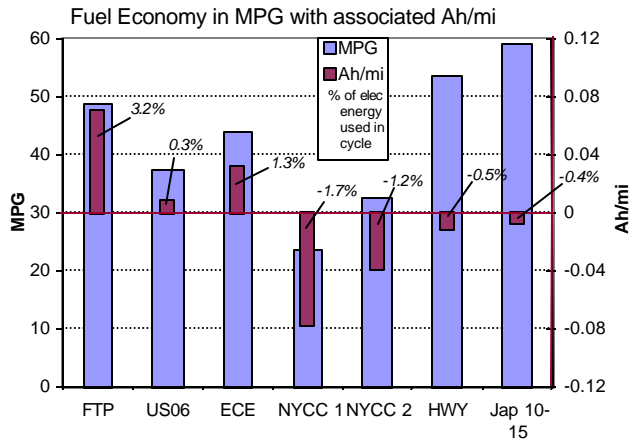


Dynamometer Fuel Economy Results

- Also shown (in italics) are the stored or released electrical energies as a percentage of the total fuel used in each cycle

- Additional tests to facilitate SOC corrections were not made

- FTP, ECE and both NYCC tests fall out of 1% of fuel energy SOC tolerance criteria

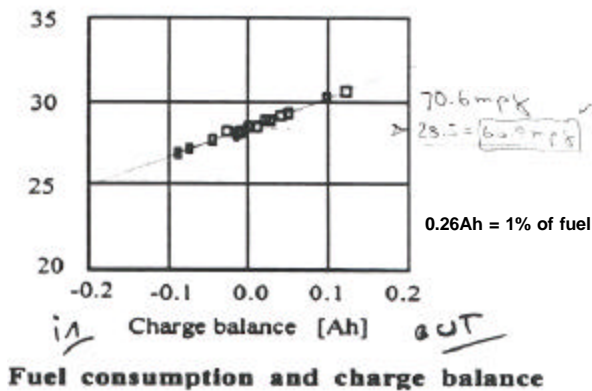


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DSOC Effecting Fuel Economy

Fuel consumption
[km/L]



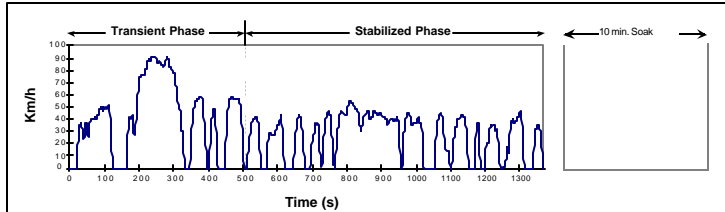
Toyota Data from HEV test procedure memo S.Sasaki, 1/98

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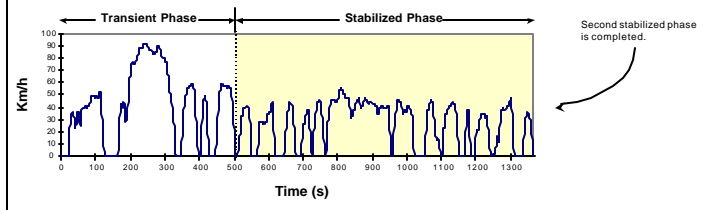


SAE J1711 Prescribes 2 full UDDS (4 bags) for HEV Tests

Cold-Start:



Hot-Start:



Note: SOC corrections require at least two (2) sets of tests

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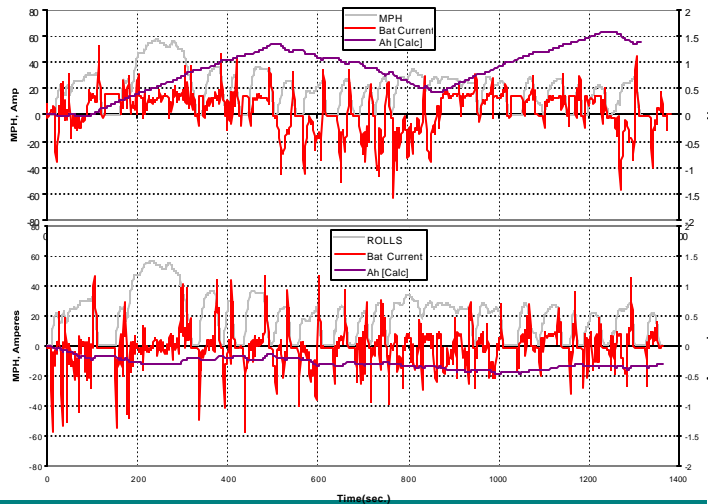
SOC Effecting Fuel Economy

Cold-Start UDDS

- 38.02 MPG
- +1.38Ah=6.5% of fuel
- Battery aggressively finding SOC "bump points"
- According to scan tool:
 - SOCi = 67%
 - SOCf = 69%

Hot-Start UDDS

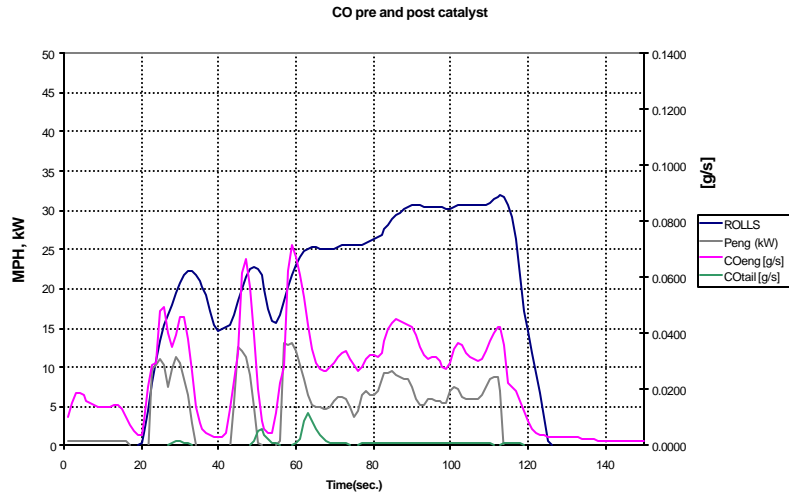
- 61.3 MPG
- 0.318Ah=-2.48% of fuel
- Battery in normal operating mode
- According to scan tool:
 - SOCi = 69%
 - SOCf = 54%



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CO Emissions Correlate Well With Engine Power – No Anomalous Spikes

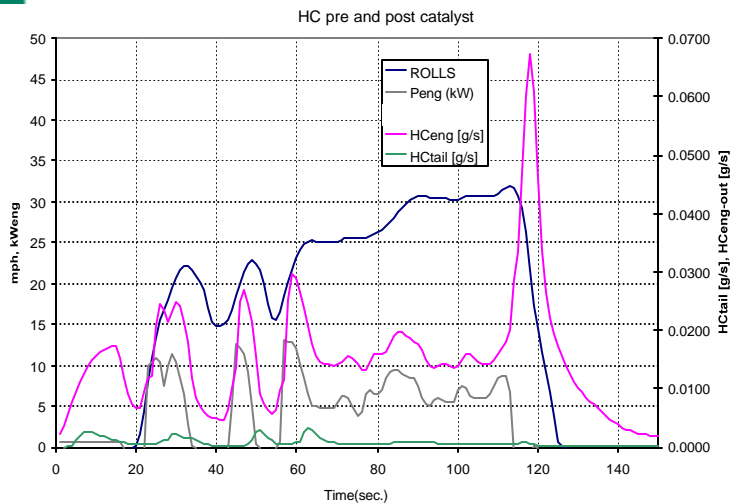


ANL Test at GM-Milford 9/99

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Engine Shutdown Produces HC Spikes

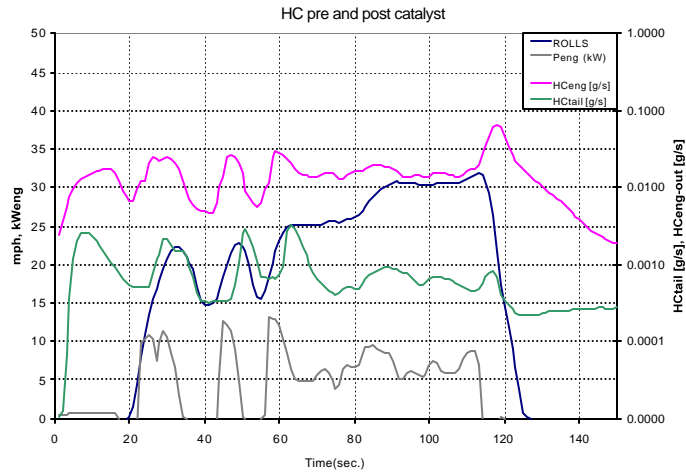


ANL Test at GM-Milford 9/99

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Engine Shutdown Produces HC Spikes, same data, log scale highlights tailpipe

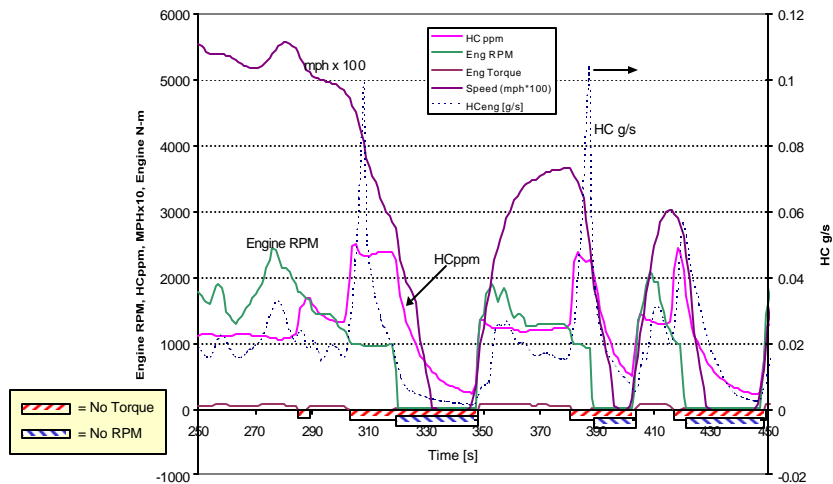


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Mass Emissions Are Measured While Engine Is At Zero Speed!!



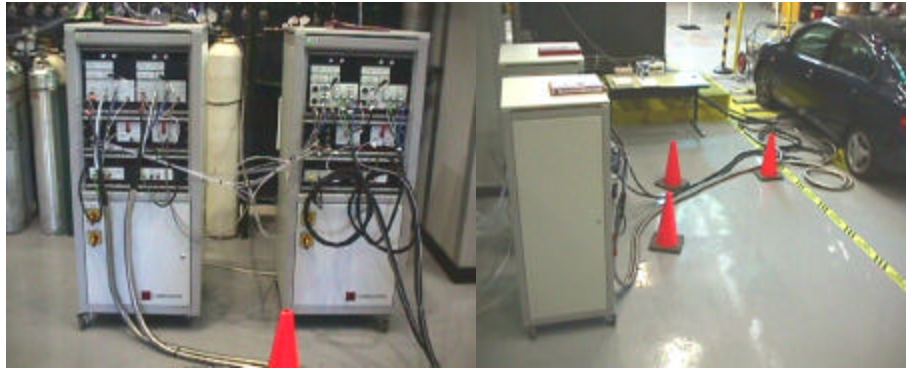
ANL Test at GM-Milford 9/99

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At ANL, Fast Response Emissions Equipment Connected To Prius

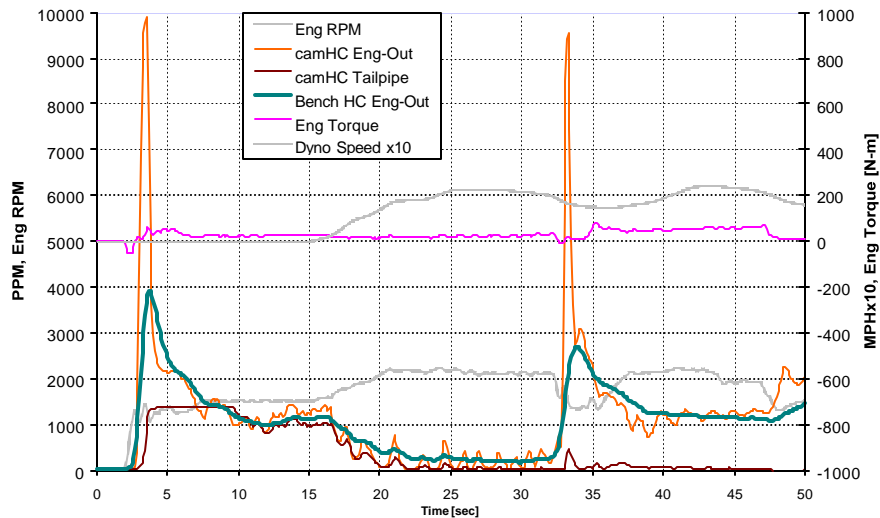
- Combustion, 2-channel "Fast FID" HC analyzer
- Combustion, 2-channel "Fast CLD" NOx analyzer



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Fast HC Data Shows Actual Peaks Cold-Start UDDS

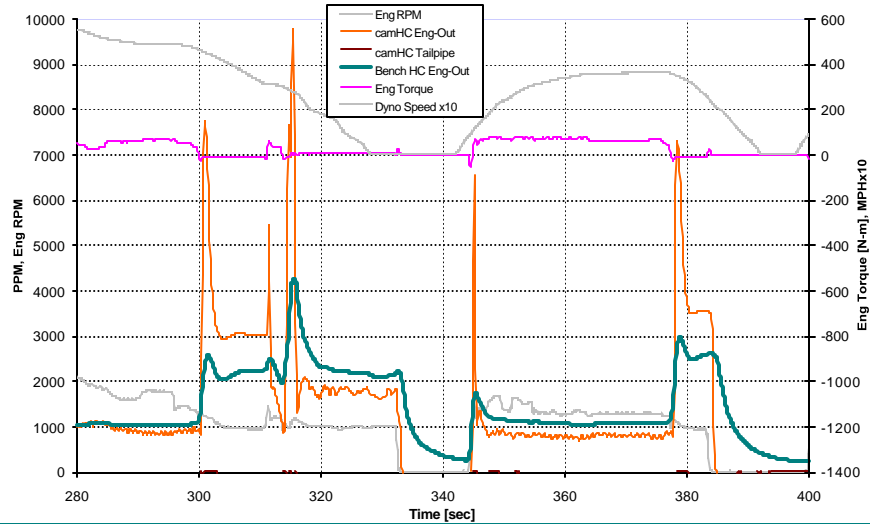


ANL Test at ANL's Advanced Powertrain Test Facility 10/99

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Fast HC Data Shows No Emissions In Tailpipe During Engine Off Cycles



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In-Situ Engine Test Results

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Engine-Focused Testing

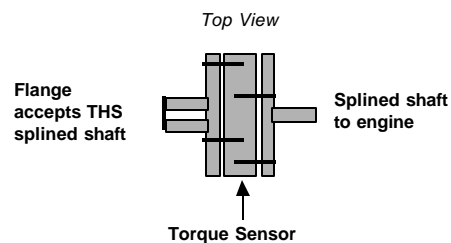
- Engine, Battery, Motor/Generator, and HEV computers communicate within a multiplex network
- Without support, engine removal and dyno testing very difficult and time consuming
- Decision to install short-length torque sensor for in-situ engine testing

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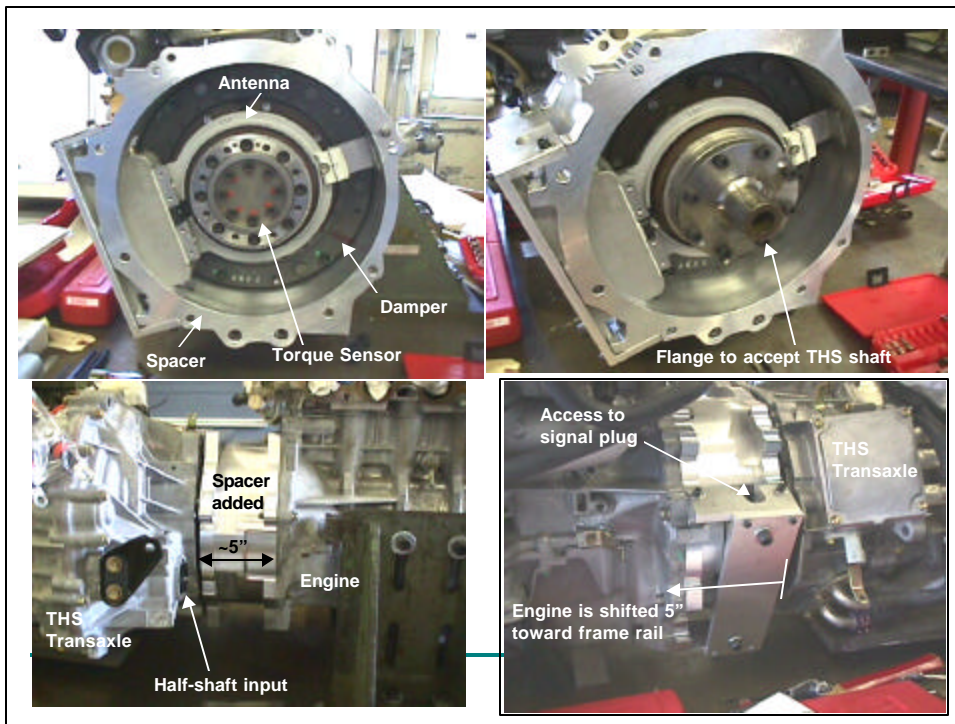


Engine Torque Sensor

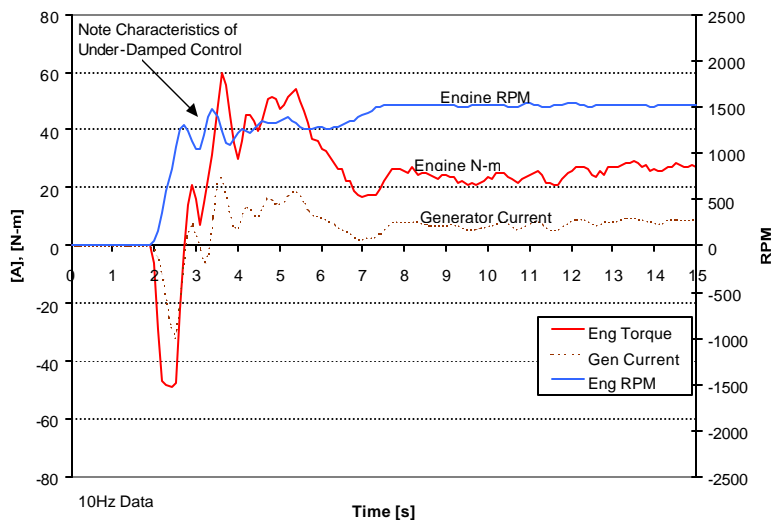
- HBM
- T10F Short-design torque sensor
- Rated: 200 N-m
- Contact free
- Mounted sensor between two flanges



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Torque Sensor Allows Excellent Insight Into Engine Operation And Control

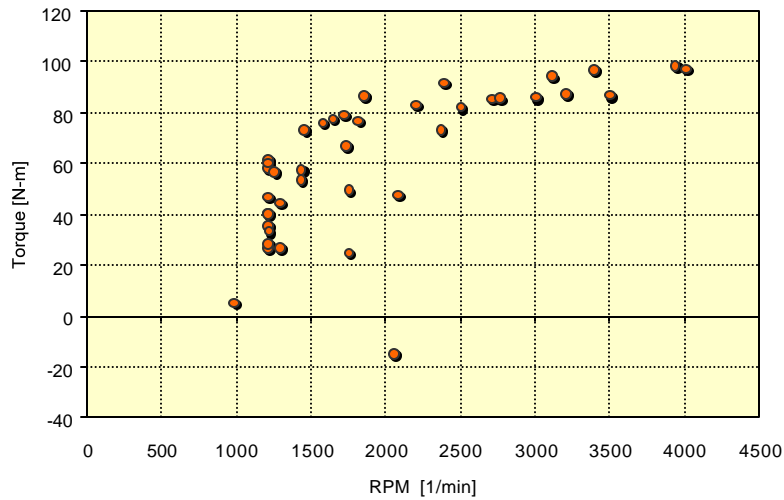


ANL Test at ANL's Advanced Powertrain Test Facility 10/99

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Mapped Area of Engine Operation

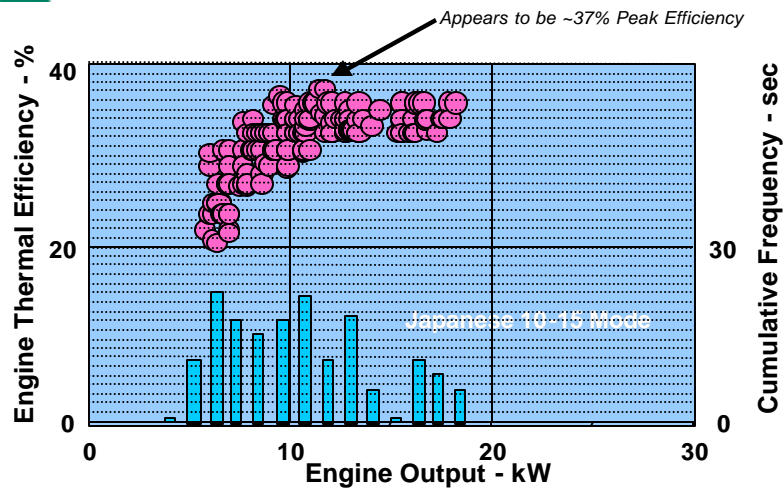


ANL Test at GM-Milford 9/99

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Engine Efficiency

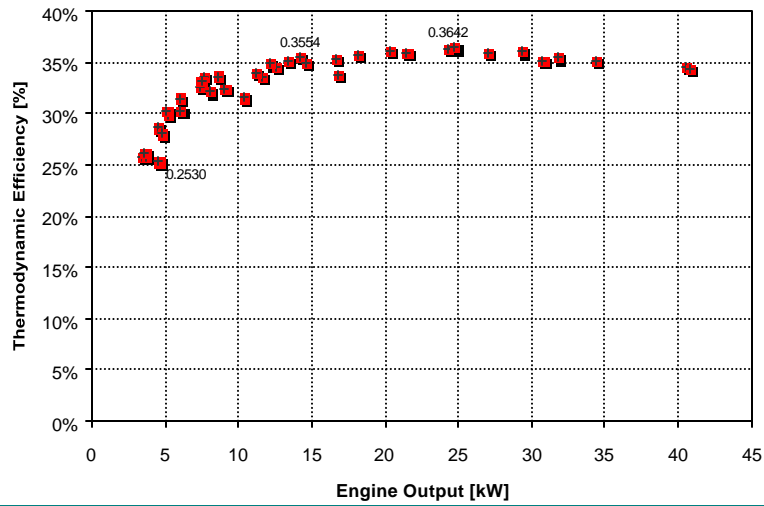


Taken from Toyota SAE TOPTC 99 Slides

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Engine Efficiency vs. Output

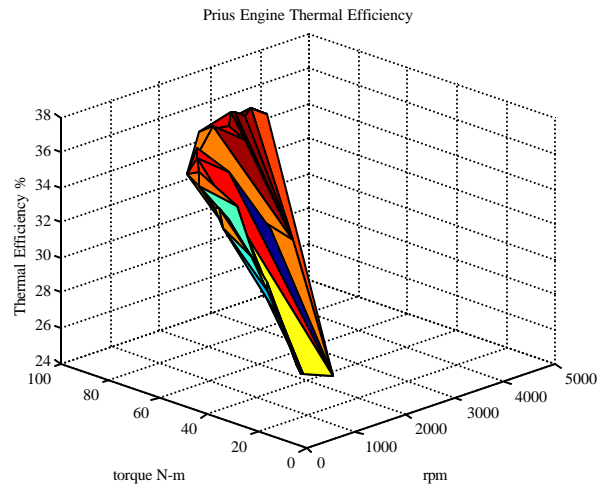


ANL Test at GM-Milford 9/99, Chassis Dyno used

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Prius Engine Efficiency Map



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Engine Fuel Use and Emission Map Data

Speed (ft/min)	Torque (ft-lb)	HC eff (%)	CO eff (%)	NOx eff (%)	Gallons (gal/min)	HC (g/h)	CO (g/h)	Nox (g/h)	Power (kW)	Gallons (gal/min)	HC (g/h)	CO (g/h)	Nox (g/h)	Thermo Eff
1299.7	58.91	99.27	98.40	99.96	0.000187	0.016387	0.031	0.023467	7.369	0.0916	8.262	15.186	11.496	0.3260
1577.3	75.89	99.17	98.40	97.77	0.00030	0.02300	0.05060	0.03913	12.536	0.086443	6.605	14.532	11.238	0.3455
1852.7	86.63	98.57	97.87	99.73	0.00041	0.02853	0.07860	0.04600	18.807	0.08857	5.684	16.835	9.853	0.3372
1210.3	40.43	99.47	99.40	65.13	0.00014	0.01247	0.02093	0.01360	5.126	0.099772	8.756	14.703	9.551	0.2993
1210.3	26.88	99.40	99.40	66.20	0.00011	0.01067	0.01540	0.00707	3.407	0.115809	11.271	16.273	7.467	0.2579
1292.7	26.86	99.60	99.40	97.10	0.00012	0.01187	0.01760	0.00813	3.636	0.115879	11.751	17.428	8.054	0.2577
1210.0	35.33	99.40	99.33	90.33	0.00013	0.01293	0.01913	0.01213	4.477	0.104386	10.400	15.385	9.756	0.2861
1210.0	61.49	99.13	99.13	81.67	0.00019	0.01660	0.03040	0.02540	11.610	0.088971	8.158	11.205	9.422	0.3357
2199.0	82.88	98.33	97.90	99.57	0.00044	0.03167	0.08847	0.06953	20.294	0.082592	5.666	15.829	12.435	0.3616
2388.7	91.58	97.70	99.20	97.53	0.00054	0.03207	0.10260	0.06927	16.683	0.084666	12.398	39.772	26.898	0.3527
1216.7	33.24	99.80	99.00	99.90	0.00013	0.01260	0.02073	0.01027	4.772	0.106605	9.740	15.997	7.913	0.2801
1211.3	46.93	99.57	98.87	99.90	0.00016	0.01467	0.02707	0.01753	5.953	0.09479	8.871	16.372	10.601	0.3150
1211.0	60.14	99.20	97.37	99.90	0.00019	0.01693	0.03280	0.02433	7.627	0.08896	7.992	15.480	11.486	0.3357
1718.7	79.04	98.97	98.40	99.77	0.00033	0.02647	0.05947	0.04760	14.225	0.08402	6.698	15.050	12.047	0.3554
3115.0	94.21	97.90	99.37	82.83	0.00073	0.04540	0.16060	0.09820	30.760	0.085015	5.324	18.766	11.469	0.3513
3206.0	87.34	96.53	96.57	98.73	0.00068	0.04167	0.16473	0.11100	29.323	0.082871	5.115	20.224	13.628	0.3604
2714.0	85.38	98.60	99.50	80.97	0.00055	0.03560	0.12367	0.09220	24.266	0.082129	5.282	18.347	13.678	0.3636
1647.3	77.53	99.67	97.50	99.90	0.00032	0.02180	0.06460	0.04347	13.375	0.08486	5.868	17.388	11.699	0.3519
1255.3	56.56	99.80	98.97	100.00	0.00019	0.01487	0.03313	0.02393	7.426	0.090171	7.198	16.043	11.587	0.3312
3397.0	96.59	98.30	96.93	98.97	0.00081	0.05567	0.19747	0.11133	34.360	0.085109	5.832	20.689	11.665	0.3509
2763.3	85.47	98.00	98.80	99.23	0.00056	0.04053	0.13320	0.09300	24.734	0.081986	5.900	19.387	13.536	0.3642
1738.3	66.76	99.80	99.57	99.83	0.00029	0.02193	0.06013	0.04113	12.098	0.08667	6.527	17.889	12.242	0.3486
1434.7	57.39	99.83	99.83	99.90	0.00021	0.01713	0.04007	0.02787	8.622	0.088767	7.154	16.730	11.636	0.3384
1211.7	40.25	99.90	99.57	99.63	0.00014	0.01320	0.02353	0.01393	5.107	0.098562	9.307	16.588	9.821	0.3030
1751.0	24.81	99.90	99.60	99.73	0.00015	0.01587	0.02667	0.01033	4.550	0.118047	12.555	21.099	8.176	0.2530
1753.0	49.37	99.80	99.30	99.87	0.00023	0.02100	0.04573	0.02967	9.063	0.092145	8.362	18.166	11.784	0.3241
2379.7	73.12	99.10	97.93	99.60	0.00042	0.03240	0.08727	0.06900	18.146	0.084490	6.439	17.325	15.554	0.3576
3938.3	98.19	98.00	99.40	78.77	0.00097	0.05447	0.21227	0.13500	40.496	0.08635	4.841	18.871	12.001	0.3458
1293.0	44.81	99.43	99.43	73.90	0.00017	0.01427	0.02597	0.01917	6.040	0.09857	8.504	15.477	11.424	0.3030
1456.3	73.25	99.67	99.57	92.70	0.00027	0.02027	0.05187	0.03613	11.171	0.087924	6.501	16.721	11.643	0.3396
1429.7	53.34	99.73	94.37	99.93	0.00021	0.01857	0.04013	0.02637	7.988	0.092903	8.378	18.088	11.879	0.3214
1817.0	76.73	99.27	97.83	99.63	0.00035	0.02530	0.06643	0.05210	14.600	0.085371	6.240	16.387	12.843	0.3498
886.7	5.23	99.87	96.03	97.13	#DIV/0!	0.01810	0.01877	0.00663	0.540	#DIV/0!	120.862	125.024	4.219	#DIV/0!
1211.3	28.39	99.10	99.60	89.07	0.00011	0.01173	0.01907	0.00870	3.602	0.114141	11.738	19.067	8.689	0.2616
2079.7	47.63	99.40	99.47	95.13	0.00027	0.02263	0.05237	0.03707	10.372	0.094726	7.857	18.162	12.866	0.3353
2503.0	81.99	97.23	96.73	99.20	0.00050	0.03843	0.10637	0.08177	21.490	0.083092	6.102	17.817	13.698	0.3594
3605.0	85.89	98.67	99.47	92.47	0.00062	0.04527	0.14747	0.10220	27.028	0.08321	6.028	18.843	13.613	0.3589
3503.0	86.65	98.57	99.37	95.43	0.00074	0.04670	0.19327	0.12457	31.790	0.084246	5.283	21.892	14.106	0.3545
4009.0	97.23	97.97	97.70	90.30	0.00098	0.05587	0.23210	0.14037	40.821	0.086759	4.925	20.472	12.379	0.3442
2867.3	14.95	99.90	73.47	0.00	0.00001	0.01667	0.00133	0.00000	1.220	0.10122	18.807	1.435	0.000	-2.6615

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