

**Objective / Purpose**

The overall objective of this experiment is to demonstrate that this type of equipment can successfully be operated on E-85 ethanol blend fuel instead of gasoline. The objective of this report is to document the diagnostic results of a major tune-up, after a nominal 4000 miles of exposure to ethanol fuel.

**Equipment**

The equipment was a 1973-vintage Volkswagen Type 1 standard “beetle” in more-or-less factory configuration. The vehicle is fitted with an intake manifold vacuum gage, and the trigger and power wires for a tachometer. Most previous reports dealt with the baseline ethanol modification: “configuration 4”. The installation of new tires and an upgrade to the intake air heat is “configuration 5”. The tune-up occurred after installation of new tires, and immediately after the “configuration 5” air intake heat modifications were made, so “configuration 4” is most representative of the diagnosis results.

**Theory**

Overall, this type of conversion need only address three specific issues: (1) metering ratio of the fuel, (2) cold start capability, and (3) materials compatibility concerns.

What was found during the initial “configuration 4” study period (January through March of 2007) was that item (1) metering ratio was seriously impacted by inadequate fuel vaporization in cold weather. In other words, the added air intake heat modification was not sufficient.

Item (2) cold start proved not to be much of problem down to about 15 F. The automatic choke could not be modified in any practical way to provide “instant start”. However, by simultaneously “grinding” the starter and pumping the accelerator pedal, the car would always start within about a dozen revolutions or so.

Item (3) materials compatibility is always of concern when using a “foreign” fuel, hence the removal and photography of spark plugs, not normally done with unleaded gasoline at only 4000 miles. With earlier leaded gasoline fuels, a 4000 mile spark plug cleaning interval had been appropriate, due to lead deposits. With unleaded gasoline, only carbon fouling was of any concern, and that took about 10-15,000 miles to form. Cleaning carbon-fouled plugs required full sandblast (not an ordinary grit blast), and was only effective once.

**Procedure**

A viable tune-up procedure was long ago defined for this (and similar) cars as “2K-4K”, meaning a “minor tune-up” every 2000 miles, and a “major tune-up” every 4000 miles. Minor tune-up addressed points and timing, and valve adjustment. Major tune-up addressed “minor” plus oil change and spark plugs in the leaded gasoline days, and only oil change with unleaded gasoline.

As the vehicle(s) aged, spark plug and connector electrical evaluation, and distributor cap and rotor condition, were added to the major tune-up process. Experience showed that cleaning the oil screen was unnecessary every oil change, once the oil lubricities were good enough (SF or

better) to reduce wear particle sludge to extremely low values. This was re-specified as “every other oil change”, for a 2/4/8K cycle.

The same 2/4/8K cycle was maintained into ethanol experimentation. The tune-up documented herein was a “4K major”, to which spark plug inspection and compression check was added.

### **Data collected**

This work was done during the period 8-28-07 thru 8-30-07, at odometer reading 235,624.1, including some photography. The following items were accomplished:

Air cleaner pre-heater rig – inspected, no changes, damage, or deterioration

Filed / re-set points to exactly 0.016 inch static cold gap (sets the dwell)

Measured distributor rotor OK at 5.5 K-ohm, previous tune-up 5 K-ohm, and cleaned its tip with the point file.

Measured resistance of all four spark plug wires connector-to-distributor cap post as within nominal (connectors are 1 to 1.1 K-ohm, wires are copper):

#1	1.0 K
#2	1.1 K
#3	1.1 K
#4	1.2 K

.....posts needed cleaning of corrosion, which was done with a small screwdriver blade. Coil wire not checked. Spark voltages not checked (no need).

As-found static timing was +19 BTDC with corrected points. Timing strobe-checked “all-in” at 45 BTDC as OK without re-set. Post-strobe static timing checked out at 18 or 19 BTDC.

Valves checked at ambient August 90 F in the shop, and reset as needed. Findings:

#1 intake	.006 OK as-is
#1 exhaust	tight (.006 fit), reset to .008
#2 intake	.006 OK as-is
#2 exhaust	tight (.006 fit loosely), reset to .008
#3 intake	.006 OK as-is
#3 exhaust	.008 OK as-is
#4 intake	.006 OK as-is
#4 exhaust	tight (.006 fit rather tightly) reset to loose .008

....Recommend more frequent check of valve clearances on this high-time engine! The change over the 2000 mile interval is unusual for the history of this engine. This could be “old age” effects, or it could be an effect of the fuel. With previous builds of this engine and others, valve clearances have become changeable towards the end of the life of the valves. These heads are an old build, as air-cooled VW heads go.

Compression was checked (dry) on this as-reset valve check. Findings:

Cyl	found	last time	(all psig)
#1	137	130	
#2	129	110	(effects of Lucas on oil ring)
#3	131	130	
#4	140	130	(effects of Lucas on oil ring)

... these data were obtained after using 20% by volume Lucas oil stabilizer in the engine oil, (20W50 SM Castrol), since odo 234,475.6, date 7-7-07. (Transmission had been topped up with about ¾ pint Lucas oil stabilizer at odo 234941.9 on date 7-19-07.) This additive was used to control the oil losses past the oil rings in the engine, and to help with overall lubrication in the transmission, which is very near the end of its expected 250,000 mile lifetime. According to these data, the additive provided considerable improvement to oil control and compression.

Plugs were removed, photographed, grit-blasted, photographed again, and replaced, all without resetting the gap. Gaps were all measured at a tight 0.025 inch. At last grit-blast, gaps had been set to a loose 0.024 inch, so there had been essentially no change. There was no soot on these plugs! There was a curious reddish “dust” on the rims, but this came clean after mere seconds of grit blast. There are no hard carbon deposits whatsoever on these plugs. There is not even the paint-like cooked oil “sheen” on the rims, not since using the Lucas oil stabilizer to help with oil control and compression.

Carburetor inspected, and found very “clean” of any fuel evaporation deposits, unlike all previous experiences running on gasoline. The automatic choke setting seemed OK as-is. Later, on the next trip to work, the idle was reset a bit. The mixture screw was found way too rich.

Oil change was done 8-30-07 -- the drained oil was still “good” by the finger test, better than usual. Total mileage on this oil charge was about 3900 miles (last odo 231783.8 on 11-12-06). It smelled very oddly (of ethanol), and was dark (as is usual), but was still a well-functioning lubricant. The oil change interval could be extended! There was absolutely no sign of any sludge or any other solid contaminants in this oil, including a complete lack of gray metal wear particles! It was just clean, darkened oil. The screen was not pulled and cleaned, there was no need.

### **Calculations**

None

### **Presentation of Results**

Besides the numeric data given above (Data Collected section), the following photos were obtained:

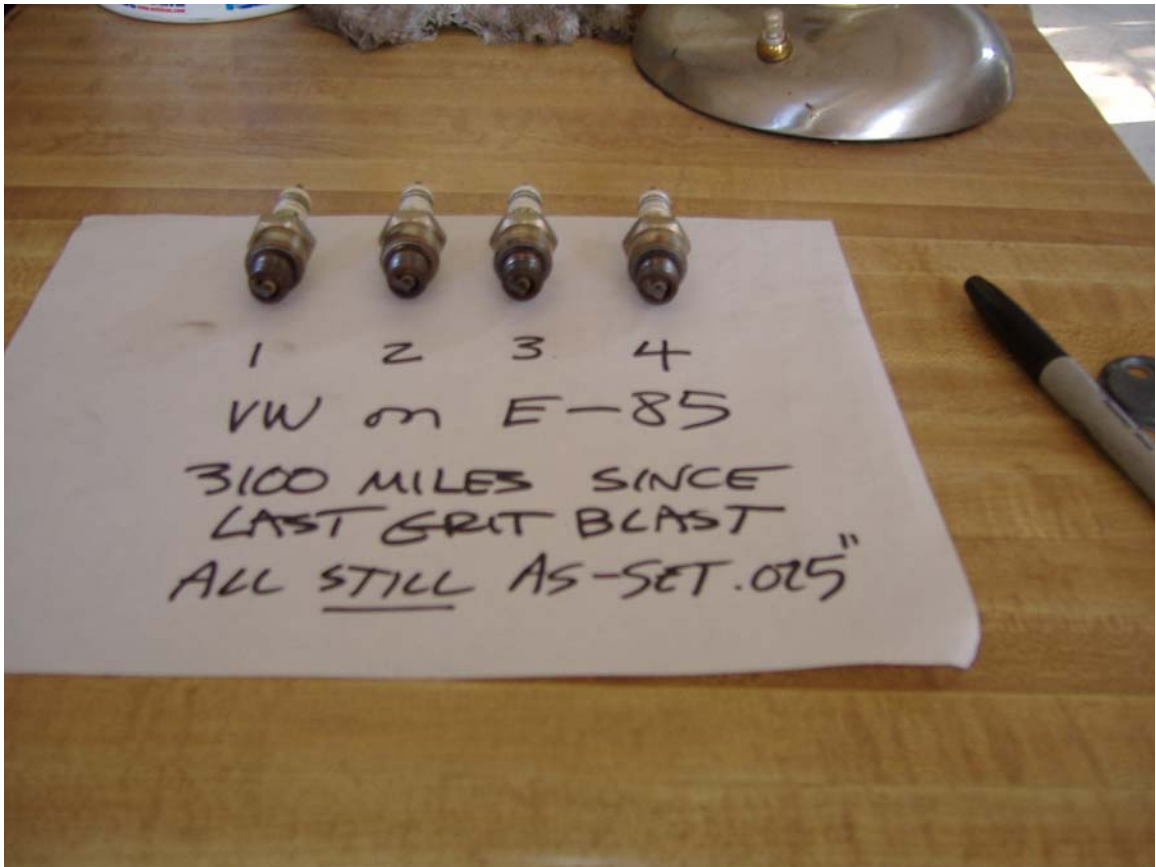


Figure 1. – Appearance of the Four Spark Plugs, Freshly Removed. Note Lack of Black Sooting on Center Electrode Porcelain or Black Deposits on Rim Face Surfaces



Figure 2. – Close-up of Plug from No. 1 Cylinder. Note Lack of Carbon on Center Electrode Porcelain, and Reddish Color of Rim, in Spite of Blurry Photography. Reddish Color Was a Soft, Fluffy Dust, Easily Removed



Figure 3. – Plugs Ready-to-Install Look Exactly as They Appeared Freshly Removed

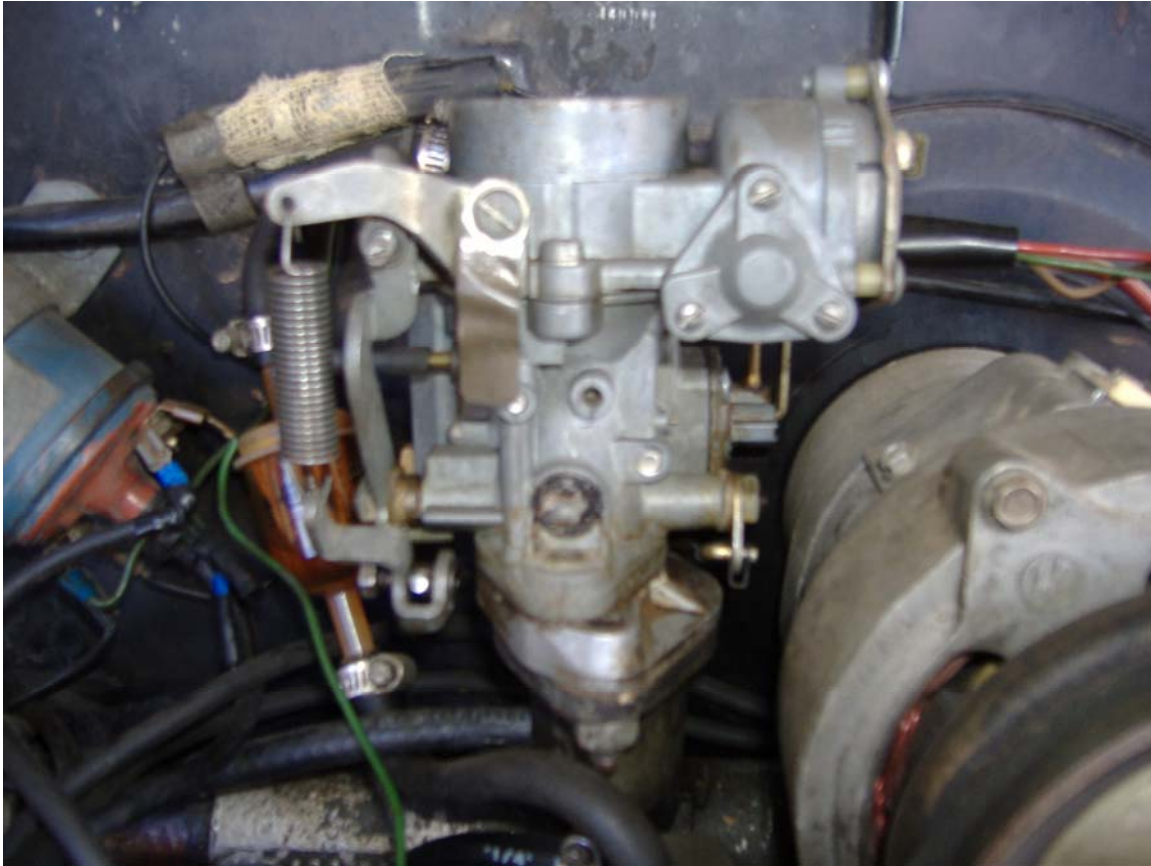


Figure 4. – Carburetor Is Remarkably Clean of Fuel Evaporation Deposits, The Ones Visible Here Are Stains Left From The Gasoline Baseline Testing. Ethanol Has Removed Most of Them

### **Conclusions / Recommendations**

- (1) Decrease the valve clearance check interval to 1000 miles. If tightening continues, try adding a top lube (Marvel Mystery Oil) to the fuel, pending a top lube compatibility check. The tune-up schedule is then 1Kvalve/2Kignition/???Koil.
- (2) Increase the oil change interval to a value set by the “finger test” as the nearest thousand below detection of reduced lubricity.
- (3) There is no need to monitor plugs excepting to determine if life exceeds about 12-15,000 miles (typical of unleaded gasoline operation).
- (4) Continue to monitor compression as a means to detect valve/seat wear in addition to ring and cylinder condition.

Questions and comments should be directed at the author/experimenter:

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