

Timing is everything

How to tune your carbureted engine to run on today's reformulated gasoline

By Henry P. Olsen

If you drive a carbureted American performance car, then you know all too well that the new reformulated gasolines are creating lots of problems, including poor driveability, pinging, overheating, and an overall lack of performance. Leaded gasoline that most older cars were designed to run on is no longer sold. The reformulated gasoline that we have no other choice but to use can cause the carburetor to supply an air/fuel mixture that is 2.7% or more leaner than the leaded fuels of the 1970s. Because of the changes in gasoline formulas, your distributor's mechanical/vacuum advance curves and the jetting-air/fuel mixture curve may need to be changed to allow the reformulated gasoline to be properly burned by your muscle car's engine. The premium fuel sold at your local gas station is good for use in engines with up to about 9.5:1 compression ratio; anything higher may require the use of octane additives.

Timing the spark

The correct ignition spark advance helps keep the heat from the combustion of the fuel in the cylinders where it belongs, instead of having it still burning as it enters the exhaust manifolds. The ideal ignition spark timing will cause the pressure in the engine's combustion chamber to be at its maximum of 12-degrees after the piston has gone past top-dead center. Too much spark advance, and the engine may have a ping problem and overheat, lack power and create possible engine damage. Too little spark advance may cause the engine to lack power and overheat, with the leftover fuel throwing away much of the gasoline's energy as it remains burning upon entering the exhaust manifolds. Any distributor, original or aftermarket, should have the mechanical and vacuum advance checked to assure proper operation.

The distributor advance curve that was correct for leaded gasoline in many cases may not be the correct curve for your carbureted muscle car engine using today's reformulated unleaded fuel. This is because today's fuel is designed for use in a modern computer-controlled engine that not only fine tunes the air/fuel mixture, but is also continually adjusting the ignition spark timing for the engine load and rpm. Older, non-computer-controlled engines that were designed for leaded or non-reformulated fuel will need to have the ignition spark timing optimized for today's fuel if you want to have an engine running at its peak performance.

At Ole's Carburetor & Electric, a specialty shop located in San Bruno, California, there are two methods we use to check the distributor's advance curves; the most accurate method involves removing the distributor from the engine and then checking and setting the advance curves in a distributor test stand, and the second choice is the use of an advance timing light to check the advance curves and then remove the distributor to modify the advance curves. The distributor test stand method is the best because it gives you the ability to check the



The OTC/SPX Performance Gas infrared exhaust gas analyzer being used to "read" the air/fuel mixture as the idle mixture is being set on this '68 Fury III's 383-cu.in. V-8.

*“
Having an air/fuel mixture that is correct for all driving conditions will allow your engine to obtain all the power from the gasoline...
”*



Air-fuel mixture being checked and set on a '68 Camaro's 327 using the Innovate Digital meter

advance curve at any rpm or vacuum without over-revving the engine and without any load, and you only have to pull the distributor once to obtain the desired results.

Any old or new distributor you buy should have its advance curve checked for accuracy. Most of the rebuilt distributors that we have checked the advance curves on have curves that are way out of the proper specifications. Most aftermarket performance distributors come with a universal advance curve installed and you are expected to adjust it to obtain the correct advance curve that your engine needs.

The mechanical advance curve we use most for a mild-performance small-block Chevy or Ford V-8 is 24 degrees of Chevy or Ford V-8 is 24 degrees of mechanical advance at 3,600 rpm, plus 10 degrees of additional advance from the vacuum advance. In most cases, initial timing should be set at 12-degrees.

Reading the air/fuel mixtures

Having an air/fuel mixture that is correct for all driving conditions will allow your engine to obtain all the power from the gasoline that is burning without overheating or causing any internal engine damage from having too lean of an air/fuel mixture. This may sound impossible to achieve, but the new advances in exhaust gas analysis technology have made it possible to "read" what the air/fuel mixture actually is, under almost any driving conditions.

The easiest and most accurate method that we have found for checking the air/fuel mixture is through the use of an infrared exhaust gas analyzer. With this tool, the carburetor's jetting (air/fuel mixture) curve can be checked at idle, cruise, or power loads and then be tailored to your engine's specific needs to run at its optimal best.

An optional method of checking air/fuel mixtures is by using a wide-band oxygen sensor installed into the exhaust header; this sensor is then read by using a digital air/fuel meter. An extended-range oxygen sensor can read air/fuel mixtures as rich as 9 to 1 or, on the lean side, can read air/fuel mixtures of 19 to 1 or leaner (a standard oxygen sensor is only accurate at air/fuel mixtures of around 14.7 to 1). This method determines the air/fuel mixture by looking at the oxygen/unburned combustibles in the exhaust; the readings are very fast and accurate, but false readings can be created by exhaust leaks, engine misfire, or a high-performance camshaft at low rpm (these false readings are



Performance Automotive Warehouse

EARLY CHRYSLER HEMI



2000 PERFORMANCE PARTS CATALOG ONLY \$295 818-678-3203

Our exciting NEW 48-page color catalog contains all the parts you need to build and service early Chrysler Hemi. From timing covers to transmission adapters, from individual gaskets to complete supercharged engine kits, it's all here. We've included many new, exclusive parts, plus a spotter's guide to help identify these legendary engines.

NEW 600 PAGE CHRYSLER ENGINE PARTS CATALOG

Performance Automotive Warehouse

2004 CHRYSLER PERFORMANCE ENGINE PARTS CATALOG



818-678-3000 ONLY \$4.95

Brand new 600-page catalog just for the Chrysler enthusiast. Contains Stock, High Performance and Racing parts and accessories for Dodge, Chrysler & Plymouth V8s.

YOUR #1 SOURCE FOR PERFORMANCE ENGINE PARTS

NOW ONLY \$5.95 (Reg. Price=\$10.95)

- AMC
- BUICK
- CADILLAC
- CHEVY
- FORD
- OLDS
- PONTIAC



P.A.W. is one of the nation's leading mail-order suppliers for the automotive enthusiast. Our 1,100+ page master catalog contains engine parts, kits and accessories for street, strip, oval track and marine applications. Performance, Racing or Stock parts available. Don't rebuild your engine without this catalog!

CATALOG ORDER HOTLINE:
818-678-3203

Monday thru Friday, 8:30 am to 5:30 pm (PT)



FAX# (24 Hours/Day): **818-678-3001**
(Sorry, No COD's Accepted!)

Name _____ Phone# _____
Street Address _____
City _____ State _____ Zip _____

Bill My: VISA MASTERCARD AM. EX. DISCOVER/NOVUS
Card#: _____ Exp.: _____
 Master Parts Catalog=\$5.95 Early Chrysler Hemi Catalog=\$2.95
 Dodge, Chrysler, Plymouth Catalog=\$4.95

PLEASE SEND & MAKE PAYABLE TO:



PERFORMANCE AUTOMOTIVE WAREHOUSE
21001 NORDHOFF ST., Dept. HMM,
CHATSWORTH, CA 91311



With the engine running, the safest way to test this 1957 Chevy's air-fuel mixture using an infrared exhaust gas analyzer is outdoors

caused by the extended-range oxygen sensor misreading the extra oxygen in the exhaust).

The use of an infrared exhaust gas analyzer, while slower in reaction time than a wideband oxygen sensor (seconds instead of fractions of a second), has the advantage that it not only reads the oxygen/unburned combustibles content of the exhaust, but also allows you to determine the air/fuel mixture by observing the CO (carbon monoxide) reading, the engine's rate of misfire by observing the HC (hydrocarbon) reading, and the engine's efficiency by observing the CO₂ (carbon dioxide) reading. The NO_x (oxides of nitrogen) reading can be used as a method to determine if the ignition timing is too advanced; a high NO_x reading indicates excessive heat in the combustion chamber caused by the ignition timing being too far advanced for the octane of the fuel.

Tuning the air/fuel mixtures

The carburetor's idle jets and/or main jets may need to be changed to get the air/fuel mixture back to where it was with the gasoline that was sold when the car was new. In most cases the jet size will need to be increased, but this may not always be the case since the assembly line tolerance was not that tight when these older carburetor-equipped cars were built. Since there was no concern for exhaust emissions or fuel mileage before the late 1960s, we have seen identical model cars where one engine would have a very lean air/fuel mixture while the other was not nearly as lean. The best way to check to see if an engine's fuel mixture is correct is by using an infrared exhaust analyzer; readings from this type of equipment can show what the air/fuel (a/f) mixtures actually are.

The reading from the infrared exhaust gas analyzer to deter-



- 100% NEW
- Lifetime Warranty

It's All About The Quality.

High Quality, High Performance
Starters and Alternators for
Ford, Lincoln, Mercury, & GM Muscle Cars,
Street Rods and Kit Cars.



www.PA-Performance.com • Call Toll Free: 877-471-8010

Local: 610-754-1100 • P. O. Box 31, 3021 Big Road (Rt 73), Frederick, PA 19435



- GM - 80 Amps at Idle
- Ford - 100 Amps at Idle

mine the air/fuel mixture is CO (carbon monoxide). A CO reading of .75 to 1.25% (14.2:1 to 14.0:1 a/f mixture) is normal; these readings are for an unloaded engine at idle thru 3,000 rpm. An a/f mixture of .70 CO or lower may be too lean, while an a/f mixture reading of over 3% CO may be too rich. If the air/fuel mixtures are too rich, the engine will run poorly and pollute the air; if the air/fuel mixture is too lean, the engine will be down on power and have a tendency to run too hot.

To obtain the correct mixture ratio, first the engine must be properly tuned; this includes the correct fuel pressure, ignition timing curve, spark plug gaps, etc. The next step is to determine what the air/fuel mixture is at idle through 3,000 rpm. If the cruise mixture (high rpm setting) is off, first change the jets in order to get the air/fuel mixture correct at the 2,500- to 3,000-rpm range. Then check and set the idle mixture. If the air/fuel mixture is too lean or too rich at idle or part throttle, and the idle mixture screws do not provide enough adjustment, the correction may be in changing the idle jet size.

If the mixture is still rich or lean at 1,000 through 1,800 rpm, the idle channel restriction, if used, may have to be modified to allow the correct air/fuel mixture to be delivered at part-throttle. Most of the time we find a lean air/fuel mixture condition at part-throttle; this causes the engine to miss or stumble on light acceleration. This problem is very common on most of the aftermarket performance carburetors sold today. The

Innovate Motorsports Digital Air/Fuel Ratio Meter



method used to solve this lean, part-throttle problem is to enlarge the idle channel restrictor, but first get the idle and cruise air/fuel mixtures correct.

The next step in the process is to conduct a road test in order to check the cruise speed air/fuel mixture under actual driving conditions, followed by a check of the power air/fuel mixture under full-throttle driving conditions. This will allow you to correct the air/fuel mixture so it can be more precise at idle, cruise/light throttle and full power. The best method to accomplish this task is to use an exhaust gas analyzer, but it requires two people. Just clamp the analyzer's probe into the tailpipe and, with the probe's long connection running through an open window, hold the unit while seated in the passenger seat and observe the readings at speed,

all while another person drives the car. Some exhaust gas analyzers will allow you to record the readings and then play back the data after the road test is completed.

Gas analyzer readings and what they mean

- CO (carbon monoxide): This determines the air to fuel ratio. CO is partially burned fuel.
- HC (hydrocarbons): The amount of unburned fuel or an indicator of an engine misfire. The best mixture gives you the lowest HC.

**American
Autowire**

**Factory
automotive
wiring
Fit®**

We Make Wiring Easy!!

(800) 482-9473

**Completely Original
Replacement Harnesses
For GM Vehicles**

Over 9000 GM harnesses, from 1955 to 1982! The only complete wiring source for restoration, street rod, and custom automotive applications. Alternator & HEI conversions made very easy, CALL NOW!

When Only Perfection Will Do!

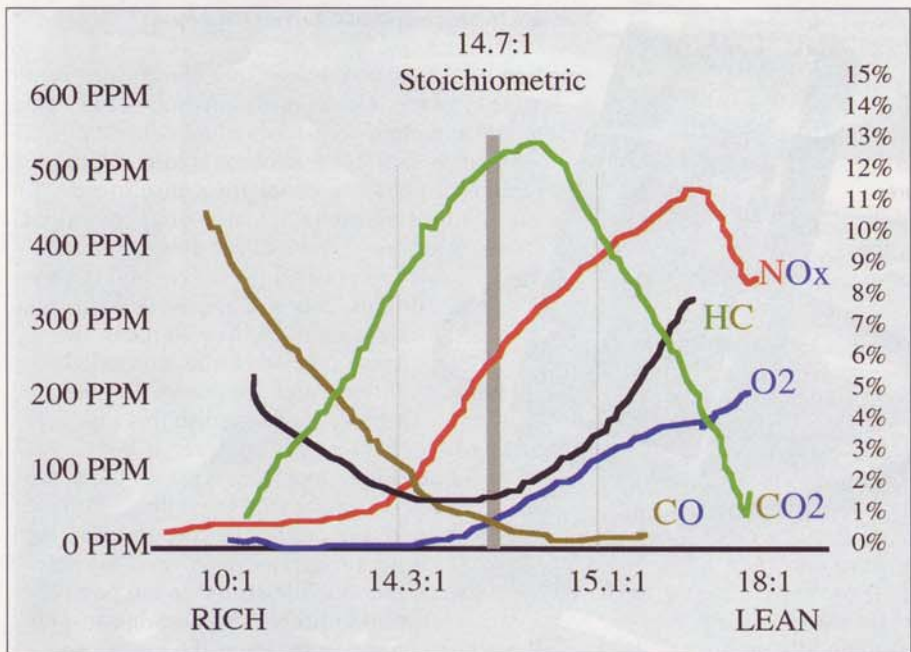


From 9-fuse to 18-fuse harness systems to our very popular Classic Update Series there is a harness for you!



150 Heller Place, #17W, Bellmawr, New Jersey 08031-2555

www.americanautowire.com



Tuning air/fuel mixtures for high altitude

With more enthusiasts driving their carbureted muscle cars from sea level to a high altitude event such as Reno's Hot August Nights, tuning the air/fuel mixture for higher altitudes can be an area of concern. If you are going to drive at higher altitudes for an extended period of time you will need to tune the air/fuel mixture for the thinner air.

As the altitude increases, the density of the air decreases; this will cause the air/fuel mixture to go richer as the air gets thinner. Late-model cars with electronic fuel injection will automatically adjust the air/fuel mixture to compensate for the changes in air density. When you take your carburetor-equipped muscle car to higher altitudes for an extended period of time, you may need to re-jet the carburetor. The suggested change in jet size is: for every 1,500 feet in altitude you travel up, go down 1 jet size. If

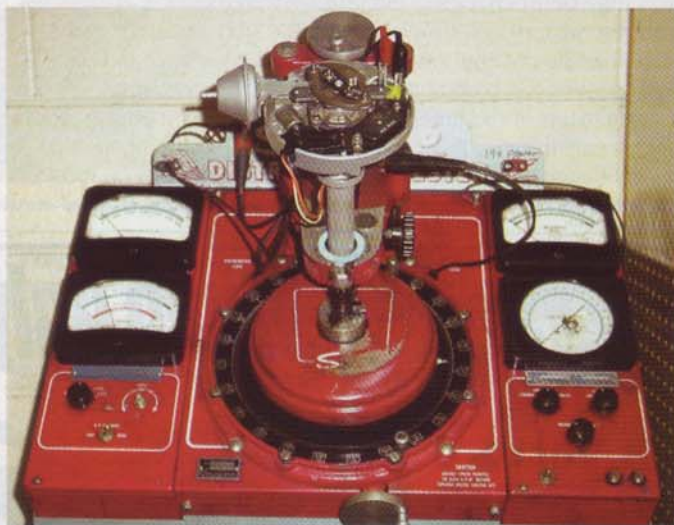
The gas content of the exhaust changes as the air/fuel mixture changes from a rich to a lean mixture

- CO₂ (carbon dioxide): The product of complete combustion. The best mixture gives you the highest CO₂ reading.
- O₂ (oxygen): A high O₂ reading indicates a lean mixture, an exhaust leak or the engine has a high-performance camshaft. If O₂ is above 2% to 3%, the CO readings may not be accurate.
- NOx (oxides of nitrogen): A gas which is created by excessive combustion chamber heat. In many cases, a high reading of NOx may be related to excessive ignition timing, which is the cause of detonation.

The best idle, cruise and power air/fuel mixtures (CO reading) will burn all the available oxygen (O₂ reading) in the cylinder and cause the least amount of engine misfires (HC reading). The ideal air/fuel mixture for each engine rpm and load condition will also cause the engine efficiency (CO₂ reading) to be at its highest.

A starting point for air/fuel mixtures for most engines is:

- Idle: 1% to 3% CO or a 14.1:1-13.4:1 air/fuel mixture
- Cruise rpm: 1% to 3% CO or a 14.1-13.4:1 air/fuel mixture
- Power mixture and acceleration: 6.6% CO or a 12.0:1 air/fuel mixture



A distributor test stand is the best and most accurate way to test a distributor's advance curve

Think Demons are pricey? Think again.

Check out the price of the 10 most popular Demons with the comparable models of the leading competitor. On average Demons cost no more. Visit www.barrygrant.com for comparisons.



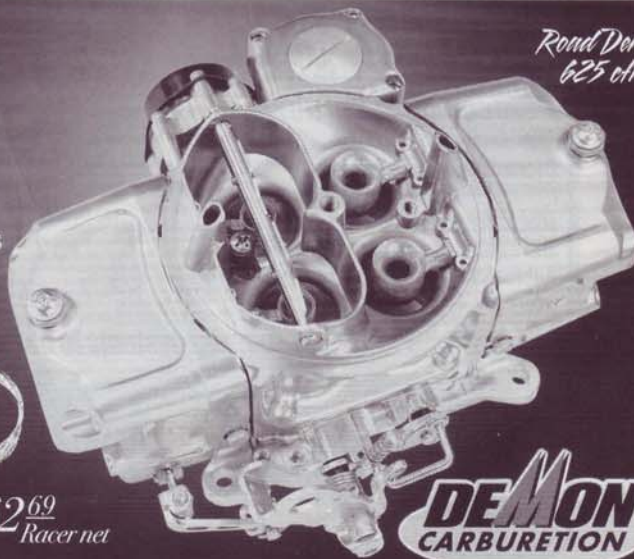
Mild to Radical, Demons are calibrated for your cam.

- More power
- Better Driveability
- Reliability & great looks at a fair price

Call for a dealer today (706)864-8544
www.barrygrant.com



\$362⁶⁹
Racer net



These are not Holley® Carburetors but exclusively manufactured by Demon Carburetion™. These products are not legal for pollution-controlled vehicles.



OTC/SPX's advanced Digital Timing Light

you do not correct the air/fuel mixture for the change in altitude density, the engine will tend to run sluggish, load-up and foul the spark plugs.

The results of proper tuning

A properly tuned fuel and ignition system will allow your engine to perform up to its potential and will supply you with a better-performing, more reliable and efficient running car that will be a whole lot more fun to drive. Considering how rare and valuable some of the old high-performance V-8s are getting, proper ignition timing for these carbureted engines using today's fuel, along with the use of an infrared exhaust gas analyzer and/or extended-range oxygen sensor to check and set the air/fuel mixture that is correct for your engine, is the best way to ensure you are taking proper care of your engine. Taking the time to properly tune your classic muscle car's fuel and ignition advance systems will not only allow you to have a more reliable car with more driveable engine power, but it may help avoid the engine damage that can result from incorrect ignition timing or overly lean air/fuel mixtures. ⚡

Contacts

OTC/SPX Corporation

800-533-6127
www.otctools.com
• Timing lights, exhaust gas analyzers

Innovate Motorsports

949-388-4442
www.innovatemotorsports.com
• Digital air/fuel ratio meters

Ole's Carburetor & Electric

650-589-7377
olescarb@sanbrunocable.com
• Carburetor and distributor service

Hot Rod Tuning

650-343-4860
jfb396@aol.com
• Fuel and ignition tuning services

J.C. Taylor Antique Auto Insurance Information Sheet

Underwritten by Maryland Casualty (A member of the worldwide Zurich Insurance Group) with offices and claim facilities in principal U.S. cities.

1 (800) 345-8290 (610) 853-1300

Applicant _____ Date of Birth _____

Occupation _____

Address _____

Zip _____ Phone Number () _____

1. Operator License Number _____ No. of Antique Autos owned _____

2. List all losses in past three years and moving violations - antique and modern cars. (Date-Cause-Payment.) _____

3. Total Annual Mileage: Club Functions _____ Other Purposes _____

4. Name of antique or car club to which you belong _____

5. List modern cars used by daily transportation (owned) (or company cars) _____

6. Where are cars garaged? Under one roof? Construction of garage-brick-frame-fire resistive _____

7. Has rated horsepower or other specifications been changed? Yes ____ No ____

If yes, explain: _____

8. Following coverages available. Indicate those desired by placing "X" in proper boxes.

Liability (\$100,000 single limit) Bodily Injury and Property Damage.

Annual Rates: 1st car \$15.00, 2nd \$10.00, 3rd \$5.00

Uninsured/Underinsured Motorist - Rates as required by your State

Car 1 \$ _____ Car 2 \$ _____ Car 3 \$ _____

Liability (\$300,000 single limit) Bodily Injury and Property Damage.

Annual Rates: 1st car \$20.00, 2nd \$14.00, 3rd \$8.00

Medical Payments of \$1,000: 1st car \$4.00, 2nd car \$3.00, 3rd car \$2.00.

Units in excess of 3, NO CHARGE

Physical Damage

Physical Damage (Comprehensive Includes Fire and Theft) - Annual Rates - \$0.35 per \$100 of insurance for each vehicle. NO DEDUCTIBLE. Vehicles 25 years or older.

Physical Damage (Collision) - Annual Rate - \$0.35 per \$100 of insurance for each vehicle. NO DEDUCTIBLE. Vehicles 25 years or older.

(Note - Collision is not written as a singular coverage but is available with Comprehensive)

Physical Damage (Comprehensive Includes Fire and Theft) - Annual Rate - \$0.70 per \$100 of insurance for each vehicle. NO DEDUCTIBLE. Vehicles less than 25 years.

Physical Damage (Collision) - Annual Rate - \$0.70 per \$100 of amount of insurance for each vehicle. NO DEDUCTIBLE. Vehicles less than 25 years.

9. Date this coverage is to be effective _____

Policy Minimum Premium \$50.00.

ANTIQUÉ AUTOS TO BE INSURED

We Require: 1. PHOTO of all vehicles listed 2. APPRAISAL for each vehicle valued at \$20,000 or over

Year	Make	Body Type	V.I.N. (Vehicle I.D. #)	Present Valuation
		Series or Model	Serial or Motor Number	(Amount of Insurance)
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Use separate sheet for additional cars to be insured.

An application may be forwarded to you for additional information.

My vehicle(s) will be used mainly in exhibitions, club activities, parades and other functions of public interest and will not be used primarily for the transportation of passenger goods. **NOT AVAILABLE IN ALL STATES**
If you are a resident of FL, PA, or NJ, send copy of regular car policy.

Signature: _____ Date: _____

NOTE: Your insurance will become effective upon payment of the entire premium, acceptance of the risk and compliance with all state specific laws & regulations. Please sign & forward with your remittance, payable to:



J.C. TAYLOR ANTIQUE AUTO INSURANCE AGENCY, INC.

320 South 69th Street • Upper Darby, Pennsylvania 19082

web site: www.jctaylor.com