

Gas Engine Needle Adjustment 101

12/12/08

A while back, Damon asked some questions regarding adjusting the carburetor on his DA 150 engine for various atmospheric conditions and fuel blends. I thought I'd share some of my answers with the rest of you out there who might have similar questions. Although this is written for gas engines, a lot of what is presented also applies to two and four cycle glow engines.

An internal combustion engine is nothing more than an air pump. The more air you can put into the engine, the more fuel can be added and the more power can be produced. The amount of air entering the engine is controlled by the throttle. The amount of fuel for optimum combustion (based on the air passing through the throttle) is controlled by the high and low speed needles on the carburetor.

To understand the impacts of changes in atmospheric conditions and changes in fuel blends on needle settings you need to understand the concept of "gulp". Every engine will "gulp" a volume of something equal to the displacement volume of the pistons in one complete cycle of the engine. For example, in 1 complete cycle, a DA 150 will suck in 150 cc's of something. What's in the gulp (i.e. the quantity of air, burnable fuel, etc.) will determine the quality of combustion and power output of the engine.

Depending on atmospheric conditions, the amount of oxygen taken in by the 150 cc gulp of the engine may be different.

1. Changes in Atmospheric Pressure:

The higher the barometric pressure, the denser the air is and the more oxygen is contained in the gulp. Similarly, the lower the pressure the less dense the air is and less oxygen is contained in the gulp. A carb set for 1 pressure will tend to run lean at a higher pressure or rich at a lower pressure. This is especially evident where you fly at different field elevations. At higher field elevations the pressure is less so that an engine set for sea level will need to be leaned out to achieve optimum combustion and performance at the higher elevation. Note that at the higher elevation, although combustion and performance will be optimum, power output will be less than at sea level.

2. Changes in Atmospheric Temperature:

The lower the temperature, the denser the air is and the more oxygen is contained in the gulp. Similarly, the higher the temperature the less dense the air is and less oxygen is contained in the gulp. A carb set for 1 temperature will tend to run lean at a lower temperature or rich at a higher temperature.

3. Changes in Relative Humidity:

Humidity is nothing more than water molecules mixed in with the air. As far as carburetor adjustments are concerned, think of the water molecules as taking up space normally taken up by oxygen molecules. In high humidity conditions, the engine gulp will have fewer oxygen molecules than in low humidity conditions. This means that an engine tuned for low humidity conditions will tend to run rich in high humidity conditions and will have to be leaned out for optimum performance. Similarly, an engine tuned for high humidity conditions will tend to run lean in low humidity conditions and will have to be richened for optimum performance.

Changes in the quantity of oil and the type of oil used can also affect carburetor adjustments. Here it's a matter of determining how the quantity of burnable fuel entering the engine is affected by the oil in the fuel at a given needle setting.

1. Changing the % of Oil in the Fuel:

If you are breaking in a new engine using a 30:1 oil mix and go to a 100:1 oil mix without changing needle settings, the engine will run rich because there are more fuel molecules entering the engine. Fuel molecules now take up the space previously occupied by oil molecules. You will have to lean out the engine for optimum performance at the 100:1 ratio.

2. Changing Oil Type:

There are two types of oil used in RC gas engines: combustible and non-combustible. The former burns, the latter doesn't. Where it does burn, it acts somewhat like the gasoline it's mixed with, but with a lower energy content. It uses oxygen, but less than that needed by the gasoline. If you switch from non-combustible oil to combustible oil at the same ratio the engine will tend to run a little rich because you are in effect adding more fuel for a given needle setting. If you are using combustible oil for break-in at a 30:1 ratio and change to a combustible oil at a ratio of 100:1, the engine will tend to run

richer, but the richening effect will not be as great as that for non-combustible oil due to the oil burning.

The things some people worry about!

Steve Grabowski