Optimizing Ignition Timing by Changing Octane of Fuel
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Gas engines used in RC models are, in general, pretty good out of the box, but they do have one shortcoming: they have fixed ignition timing. This is no big deal if you are among the majority of flyers who are happy with the performance of their engines based on their flying ability and flying style. If you are interested in gaining a competitive edge in your flying, there are some things you can do with the octane content of the fuel you use to overcome some of the restrictions in engine performance resulting from fixed ignition systems.

This article covers some ignition basics, explains operating restrictions imposed by fixed ignition engines, explains what octane is and how it affects combustion, and provides some useful tips for optimizing engine performance to better match engine output with your flying style.

Ignition Basics: For optimum torque and power output, you want the fuel to ignite and reach maximum pressure with the piston close to its highest position in the cylinder. If it ignites too soon (i.e. ignition is too far advanced), the burning fuel resists the upward motion of the piston. Best case is reduced torque and power output with a higher operating temperature of the engine. Worst case is broken engine parts (head bolts, cylinder heads, mufflers, etc due to the extreme loads imposed on the rising piston and attached engine components.

If the fuel ignites too late (i.e. the ignition is too retarded), the piston is already on its power stroke before optimum burning occurs. Torque and power output will be less. Engine will tend to run hot.

Fuel is ignited by a high voltage spark produced at the spark plug gap. The signal to produce that spark is generated by a magnet embedded on the crankshaft that passes by a sensor located on the crankcase. Engine designers determine the location of the sensor based on various design parameters of the engine and lots of engine testing.

What makes the choice of ignition timing difficult is that it is greatly affected by piston speed (i.e. RPM). The higher the RPM the sooner the spark needs to be signaled. The lower the RPM the later the spark needs to be signaled. Full power RPM requires an advanced ignition timing; a good idle requires a retarded ignition timing; a strong midrange requires something in between for maximum acceleration to full throttle operation. Car engines correct base ignition timing for these different operating conditions by sensing engine RPM, manifold pressure, and throttle opening and send an advanced or delayed signal to the plugs. The ignition systems used on RC models do not do this. In effect, the setting of the ignition timing is fixed, and you live with whatever the manufacturer believes is the best compromise over the entire operating range of the engine.

<u>Fixed Ignition Timing Restrictions</u>: For all intents and purposes, a fixed ignition engine designer is limited in his ability to optimize an engine over its entire expected throttle range. In reality they will probably design their engines to 2 possible limiting operating scenarios:

1. Optimum ignition for peak RPM conditions. This will result in a high ignition advance setting. The engine will run strong at full throttle conditions and will be adequate for mid range operation. Engine may be hard to start and will probably have a very rough idle. If the advance is set too high, serious engine damage may occur. Great engine for racing. Call this a Type I engine.
2. Optimum ignition for mid range RPM conditions. This will result in a more moderate ignition advance setting. The engine will have strong mid-throttle response and will be easier to start; will idle well. Downside is the top end will not have the performance of a Type I engine. Great engine for 3D maneuvers with lots of hovering at half throttle. Call this a Type II engine.

<u>Octane to the Rescue</u>: Surprisingly, a lot of the restrictions imposed by fixed ignition design can be resolved by making changes to the octane content of the fuel. Octane is a chemical compound which is one of many compounds that exist in a chemical mix we call gasoline. Its burn rate is ideal for use in gasoline engines, so this compound is used as a relative measure of burn rate in any gasoline mix. To understand how octane works to control the burn rate you have to understand that an air/fuel mixture does not explode in an operating engine; it burns at a very fast, but controlled rate. The higher the octane, the slower the burn rate, so in effect, more octane can be used in place of variable ignition timing to retard ignition. Similarly, the lower the octane, the faster the burn rate. By lowering octane content, you have the ability to advance ignition timing. How you use it is dependent on what range of engine operation you want to optimize.

<u>Some Examples</u>:
1. You have a Type I engine that has a reputation for breaking parts. Rather than sending the engine back for re-timing the ignition, you might try going to a higher octane fuel. This will effectively retard the ignition timing over the entire operating range of the engine. If you have been using 87 octane pump fuel, go to 91 octane pump fuel, or try an octane enhancer available at any auto parts store. Experiment with engine performance. I don’t think you’ll need to go higher than 96 octane to solve your problem. Using racing fuel or avgas is a waste of money, as you will probably reduce the overall performance of the engine by retarding ignition too much over the entire operating range.
2. You have a Type I engine, but you do a lot of hovering maneuvers at half throttle and like to accelerate vertically. Try a higher octane fuel to retard ignition in the critical midrange for more torque and power. Why does this work? Remember that a Type I engine has an advanced ignition timing for optimized full throttle operation, making midrange timing too advanced.
3. You have a Type I engine that starts poorly and has a rough idle that shakes your airframe. Remember that a good idle requires a retarded ignition. Try increasing octane to where you are satisfied with the idle and still are OK with the other

operating ranges you run the engine at. You'll know when the octane level is too high when you see an observable reduction in idle RPM due to the timing becoming too retarded.

4. You have a Type II engine, but you want to improve its full throttle response. In effect, what you would like to do is to advance the ignition timing in the higher RPM range. Changing octane is no help here unless you are already using a high octane fuel in the mis-belief that high octane fuel gives you more power. Remember that ignition timing in a Type II engine is optimized for midrange operation by retarding the ignition over the entire operating range. Increasing octane will further retard ignition giving you less performance at full throttle. If you have been using high octane fuel, go to 87 octane. If you have been using 87 octane, you have 3 choices: Find some 85 octane fuel, send the engine back to the manufacturer to change the ignition timing, or buy a Type I engine.
5. You have a Type II engine and are looking for a stronger mid range response. Try increasing octane levels until you get the result you're looking for. Increasing octane may retard the ignition enough to give you more performance in the midrange. Again, if you go too high in octane content, overall performance will suffer.

Hopefully these examples will provide you with enough insight for other problems you may be trying to resolve. By using the information provided, you just might solve those problems with octane changes to the fuel and a lot of fun testing in the air.

May the optimizing gods be with you!

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