Proficient Pilot

MYTH BUSTER
A CLOSER LOOK AT A COMMON MISCONCEPTION

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Every field of endeavor is plagued by myth, and general aviation is no exception. One persistent myth involves the operation of normally aspirated engines with constant-speed propellers.

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The myth claims that it is harmful to operate a non-turbocharged engine using a power setting with more manifold pressure (in inches) than rpm (in hundreds), such as 24 inches and 2,200 rpm. Such a power setting is colloquially referred to as being "over square." A square power setting is when manifold pressure and rpm are the same (23 inches and 2,300 rpm, for example), and an "under-square" setting is when rpm exceeds manifold pressure (such as 2,400 rpm and 22 inches).

Manifold pressure is the pressure in the intake manifold but can be very loosely considered as the pressure in a cylinder during its power stroke. This pressure is relieved by rpm. The faster the engine turns, the more frequent are the exhaust strokes that allow cylinder pressure to escape. It would be natural to conclude, therefore, that as engine rpm increases, pressure within each cylinder is more quickly relieved and results in less strain on the engine.

This might have been significant when engines were less reliable than a politician's promise, but it does not apply to modern engines. The myth is disproved, for example, during every low-elevation takeoff when manifold pressure is almost 30 inches and engine rpm is substantially

less than 3,000 (an over-square condition). Furthermore, it usually is permissible to operate these engines indefinitely at such over-square settings.

If an airplane equipped with a fixed-pitch propeller were to be equipped with a manifold-pressure gauge, you would see manifold pressure exceeds rpm by an even larger margin. This is because the rpm of a fixed-pitch propeller is substantially less than its redline during takeoff and climb. It is only during cruise and while diving that a fixed-pitch propeller can achieve redline rpm (because of reduced propeller loading at high airspeed). If the myth were correct, operating such an engine at full throttle would be much more harmful than when equipped with a constant-speed propeller.

Many pilots operate their engines using a square power setting perhaps because the numbers are easier to remember—"23 and 23," for example—but this can be a lazy way to operate an engine. If these pilots were to consult the power charts provided in the pilot's operating handbook (or, better yet, the engine operating handbook available from the engine manufacturer), they would discover that operating an engine over square is not only permissible but more efficient and economical.

During World War II, pilots of the Lockheed P–38 Lightning had difficulty flying long-range missions and returning to base with a safe fuel reserve. Charles Lindbergh demonstrated that fuel economy could be improved by operating these engines at higher manifold pressure and reduced rpm, a revelation that increased range. For general aviation pilots, this translates into saving money, potentially lots of it.

For example, the operating handbook of a Lycoming O-540-B, 235-horsepower engine shows that there are several permissible combinations of manifold pressure and rpm that can be used to operate the engine at 65-percent power. You are allowed to use extremes of 21 inches and 2,575 rpm (below square), and 25.2 inches and 1,875 rpm (above square), or several in-between combinations. One reason for selecting a power setting with a relatively low rpm and high manifold pressure is fuel economy. When operating this engine at 21 inches and 2,575 rpm at sea level, fuel consumption is 13.8 gph. But when using a power setting of 25.2 inches and 1,875 rpm, fuel consumption drops 12 percent to 12.1 gph, a saving of 1.7 gallons every hour (without affecting horsepower). A bonus of operating at a lower rpm is reduced noise.

The main reason for improved fuel economy is that lowering rpm reduces internal engine friction; at high rpm, more fuel is consumed simply overcoming the increased friction associated with higher rpm. This can also pay long-term dividends; reducing engine friction also can extend the time between overhauls.

According to representatives of both Lycoming and Continental, a pilot can usually and safely operate her naturally aspirated engine using a power setting such that manifold pressure exceeds rpm by as much as four. For example, she could be comfortable using 24 inches and 2,000 rpm. To this must be added the caveat that a pilot should always abide by the power charts for his engine.

Yes, a pilot can operate his engine using square or under-square power settings, but he should consider how much more costly and less efficient this is than operating the engine over square and contrary to myth.

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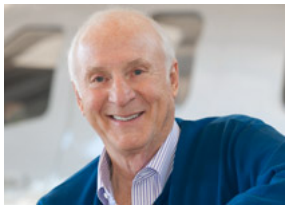

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