O.S. Max 46 AX Engine Review and Flight Test

By Frank Granelli

Engine reviews at Sport Aviator are a little different from most other model publications. While construction details are important, and extensively covered, an engine's airborne performance is also considered a major topic. As much as possible, we will always try to include airborne information about the engines reviewed in Sport Aviator.

With that in mind, we would like to take a close look at the new O.S. Max 46 AX. Now, O.S. has been making quality engines since the mid 1960's. In fact, my second engine in 1971 was O.S.'s first 60-size engine, the Gold Head 60. That engine flew for 20 years on many airplanes before it was donated to an engine collector.

O.S. developed the first mass produced four-stroke model engine featuring open, uncovered rocker arms. You can see this engine in Sport Aviator's Test Pilot Report on the SIG Kadet Senior. Four Stroke model engines have come a long way since then and O.S. has been a major company leading the way. Many of today's two and four-stroke designs produced by other manufacturers are based on O.S. Max technology.

Photo 1

The 46 AX represents another technological change for O.S. Max engines. The major change involves the coating inside the cylinder sleeve. The sleeve is the hollow round part to the right of the piston/connecting rod assembly in photo 2. The piston travels inside this sleeve which is positioned inside the main crankcase, the only part that still looks like an engine in photo 3.

Photo 2 Photo 3

O.S. calls the new liner material ABL, for Advanced Bi-Metallic Liner. Two alloys, unspecified, are combined to make a hard, durable coating that should last more than 500 flights. This engine is of the “ABC” type, for more details on what that means, check the “Engines 101” article in Sport Aviator’s Pri-Fly Section.

Basically this design features a chromed, brass cylinder nearly the same diameter as the piston. This would normally spell trouble as excessive friction heat would damage the engine. But ABC engines protect the cylinder with the hard chrome coating while the cylinder itself expands from the heat more than does the piston once the engine is running.

These two factors allow for a very effective “seal” between the piston and the liner, increasing power. Since ABC engines have no piston ring, drag is also reduced. ABC engines are the most powerful for their size, up to about .80 cu. in. displacement. Larger engines have rings since ABC construction does not work as well once the displacement increases.

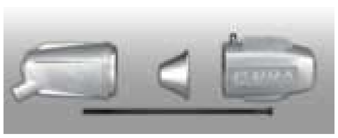
The 46 AX still features brass cylinder construction but replaces the usual “chrome coating” with the new ABL plating. The ABL is designed to reduce friction and offer extended liner “life”. The engine shown in photo 3 had 74 flights on it at the time the photo was taken. No wear was evident at all. This liner should last in excess of 500 flights.

The 46 AX has other advancements: Some of the new features are:

- The needle valve has a more gradual taper with a sharper “point”. This permits finer fuel flow control to make transitions, when the engine accelerates from idle through mid-range to high speed, more precise and stumble free.
- The inlet cylinder ports are ball-milled for smoother, more precise edges. The smoother edges allow more consistent fuel flow and power output. (*Ed. Note: This doesn’t increase total power output but does make it easier for the engine to reach the same top end consistently)*
- The new high-speed needle bracket allows the needle valve to be set horizontally or vertically (photo 5). The needle valve locking mechanism has been improved to ensure the valve stays where the pilot set it throughout the flight.


(Photo courtesy of Great Planes website)

- The propeller shaft is now longer. While this may make the engine safer to use since it allows more threads of the locknut to engage, it also widens the pilot's spinner choices. Backplate thickness is no longer a problem when choosing spinners.


(Photo courtesy of Great Planes website)

- The muffler is a totally new design that offers quieter operation without robbing power. But the muffler is still held together with a long center bolt like most mufflers today. In all my modeling experience, this feature remains the only application for "red" thread locking compound. The red compound is heat proof up to 600 degrees, while the muffler bolt should not exceed 400 degrees. Position the outlet in the desired direction and then lock the nut in place with the compound. Otherwise, that nut will eventually loosen causing the muffler parts to separate.

Photo 3

Photo 3 is repeated here to illustrate the various engine parts. The crankshaft is supported by over-sized ball bearings front and rear. The rear bearing can be seen inside the crankcase. We don't like to remove and then re-install the same bearings from an engine after it has had 74 flights so they were left in place. For details on bearing removal and installation, see the Sport Aviator article, "Getting Your Bearings".

While complete, general engine construction details are in Sport Aviator's Engines 101 and other "From The Ground Up" reprints in the Pri-Fly Section, a quick review here might help.

The piston, and its connecting rod, on the left moves inside the cylinder pictured just to its right. The cylinder hole on the right side is the exhaust port. This port lines up with the exhaust section in the crankcase, the large part in the right center. The other holes are called "transfer ports" but think of them performing the same function as the intake valves in a car engine. These ports bring, (transfer?), the fresh fuel/air mixture into the cylinder about the time the piston has pushed the previously burned mixture out the exhaust port. The timing of all this is actually more complicated but full details are in the Engine 101 article.

But for our purposes, we don't need that detail level here. If you are wondering where the fresh fuel/air mixture comes from, look at the part on the far right. This seemingly simple piece of metal is called the crankshaft. It is a very complicated hunk of steel. Yes, the propeller bolts on the front. And yes, the connecting rod from the piston hooks onto the rear pin converting the piston's up and down motion to rotational energy that the propeller can use (photo 4).

Photo 4

But that slot in the center, called a Rotary Disk Valve, works like the intake manifold of your car. The carburetor sits right above the slot and "sends" the fuel/air mixture it created into the hole and through the hollow crankshaft towards the rear. The rear of the crankshaft has a hole that lets the fuel/air mixture escape into the crankcase area just under the piston. The transfer ports then bring the fuel/air mixture up into the combustion area on top of the piston when the timing is right.

This is why it is so important to make sure the four rear bolts holding the Backplate onto the engine are always tight. A backplate leak allows excess air into the crankcase "gas storage area" under the piston. This excessively leans the mixture - not a good thing.

Photo 5

The fuel/air mixture is created in the carburetor. Look at photo 5 and note the two projections into the open space formed by the wide-open throttle barrel. The left projection is the fuel inlet. The fuel flow through this inlet is first regulated by the high speed needle valve. It then enters the big open area and is separated into very small bits (atomized particles) that, while remaining solid, easily mix with the incoming air flowing through the open carburetor inlet.

The right side projection is the low-speed mixture needle that controls idle mixtures. The 46 AX uses this superior idle adjustment method to allow precise idle mixture control resulting in very reliable idles. The low-speed needle's point moves into the fuel inlet as the carburetor's opening closes. When fully retracted as in the photo, the low-speed mixture needle valve has no effect.

But the low-speed needle begins to enter the fuel inlet somewhere around half throttle. As the throttle is closed further, its effect increases while the high-speed needle's effect decreases. At idle, high-speed mixture is relatively ineffective but still has some control. For this reason, always set the high-speed needle first before adjusting the idle mixture control. Once at idle, do not adjust the high-speed needle since that will have very little idle effect while it will ruin the high-speed settings.

Use the low-speed needle to adjust the idle. The low-speed needle also adjusts the transition mixture. If the engine stumbles and spits fuel out of the carburetor opening during acceleration, the low-speed setting is too rich. If the engine dies when the carburetor is opened suddenly, the low-speed mixture is too lean. For complete mixture setting details, see page one of the Sport Aviator article, "Things You Need To Know That No One Tells You" in the Flight-Tech Section.

Engine Performance

Let's put the engine back together again as instructed in Sport Aviator's "Getting Your Bearings" article in the Flight-Tech Section and see what it can do. Before we try the real world testing, O.S. lists the following specifications for the 46 AX engine:

MANUFACTURER'S SPECIFICATIONS

Displacement: 0.455 cu. in. (7.5cc)
Bore: 0.866 in. (22.0mm)
Stroke: 0.772 in. (19.6mm)
Output: 1.65 hp @ 16,000 rpm
RPM Range: 2,000-17,000
Weight with muffler: 17.2 oz. (489g)
Suggested prop sizes: 10.5x6, 11x6-8, 12x6-7

The first thing a new pilot learns about manufacturer's engine specifications is that some of them are definitely not real world. All manufacturers do this because it makes "good press" but horsepower specifications are usually meaningless. Why? No pilot is going to operate the 46 AX at 16,000+ rpm. The propeller required to reach this high rpm is probably in 8-inch diameter range and would be nearly useless flying the average 45-sized aircraft.

Even if the airplane would fly well with the small diameter propeller, the engine and propeller noise would be prohibitive. The high sound level, even muffled, would violate most club noise regulations. Even if the club had no noise standards, the other pilots at the field would be stuffing their ears with cotton, tissues and even grass every time the airplane flew by.

Finally, any engine consistently turning 16,000 rpm's every flight is plain going to wear out quickly. It will be running on fuel containing 30%, or more, nitromethane, and running hot with a fully leaned out mixture. So forget the 1.65 hp for the 46 AX and never use manufacturer's horsepower specifications when making engine choices.

But what can the engine really do? Trying to keep inline with the real world, we ground tested the O.S. Max 46 AX mounted on an aircraft. Firm bench mounting reduces engine vibration, allowing higher rpm readings than when the engine is installed on an airplane.

We used three APC propellers to test the 46 AX. The first was a 10 x 7 in. APC Sport propeller. The other APC Sport propellers measured 11 x 5 in. and 11 x 6 in. The 10 x 7 propeller provides extra airspeed at the expense of climb performance. The 11 x 5 propeller dramatically slows the aircraft while retaining good climbing ability. The 11 x 6 is the compromise propeller. It is faster that the 11 x 5 while still providing excellent climbing ability and yet is slower than the 10 x 7, making landing easier.

Photo 6 Photo 7

Warning: Do Not Do This At Home! Never work in front of the propeller as was done in photo 6. Always take measurements and make all adjustments from *behind* the engine. The sun and obstructing buildings were in such positions as to make photography impossible working behind the engine when this *one* photo was taken. All others were able to be done properly. Propellers draw things from in front of them into the spinning prop, mince them and then spit the tattered remains out the back. This includes tachometers and fingers.

All tests and flights were performed using Magnum 15% sport fuel. This fuel was also used during the Avistar's original flight test program. Temperature was 55 degrees F and the humidity was reported at 55%.

Photo 6 shows the top rpm available using the 10 x 7 in. propeller. The O.S. 46 AX turned a very respectable 13,200 rpm. Remember this is not true top end, which was 13,600 rpm. Real World flying requires that the engined mixture be set slightly rich to insure proper cooling and good fuel draw. Richening the high-end mixture until the rpm's drop about 400-500 rpm from peak is usually the proper setting. Therefore, we report only the useful, Real World top rpm; here 13,200.

The 46 AX gave better performance with this propeller than do some 50-size engines. 13,000+ rpm does get a little noisy but it represents a very good top speed. However, there are some down sides. First, the propeller disc is smaller so the force applied to pull the aircraft through the climb is lessened. For a complete discussion on this topic, including propeller tests, see the Sport Aviator article "The Rest Of The Engine" in the Pri-Fly Section.

Even worse is the best idle rpm obtainable with this propeller shown in photo 7. The engine would not reliably idle much below 2,800-2,900 rpm. With a 7 in. pitch propeller idling at such high rpm's, it is difficult to slow the aircraft for landings. The approach is "hot", meaning fast and the glide is long and the bounces are many.

Photo 8 Photo 9

Next up was the 11 x 5 in. APC Sport propeller. Again the 46 Ax's performance was impressive. It turned this propeller, again set 4-500 rpm rich, at 13,000 to 13,100 rpm as shown in photo 8. This is the same performance as with the smaller 10 in. diameter propeller. However, the lower pitch, 5 inches here, means that the aircraft does not fly nearly as fast. The climb is better than with the 10 x 7, usually, but top speed can be disappointing.

The 46 AX idled high with this propeller also. Best reliable idle speed was 2,800 rpm with this propeller (photo 9). But the 5 in. pitch would slow the airplane's final approach and landing speeds. Still, airplanes tend to bounce landing with engines idling this fast despite the lower landing airspeeds.

Photo 10 Photo 11

The compromise, 11 x 6 in. propeller proved that this engine is a powerhouse but reliable sport engine. Top rpm, again running 400-500 rpm below peak, was a very impressive 11,700-11,800 rpm (photo 10). This propeller provides good top speed but also transmits a strong climbing force when the nose points towards the blue. The 46 AX would reliably idle at 2,200 to 2,300 until the fuel was gone (photo 11). This low idle should mean slow, very controllable approaches and impressive landings.

In its previous 74 flights and in the 10 flights that were to follow, the O.S. 46 AX proved itself to be pilot friendly. Once the low-speed mixture was set, after the tenth flight, it never needed adjusting again even when the engine changed aircraft! The idle was smooth and reliable. Having an engine the pilot can trust makes for a better pilot. It is easier to fly pretty approaches and landings when you know your engine will always be there for you if the approach gets a little too slow.

Maneuvers can be flown with more confidence, especially those that are performed at low throttle such as spins, stall turns and snap rolls, and at lower altitudes when the pilot knows that the engine never quits. Trusting your engine makes piloting more fun. After nearly 100 flights as proof, you can trust this engine with your airplane.

"Souping up" that Stock Airplane

Photo 12

Running engines on the ground is informative. Seldom is an engine as pilot-friendly as is the 46 AX also as powerful. But what happens when the engine actually flies? After all, that is why the engine was purchased. Airborne performance is especially important if the intent was to improve an existing aircraft's performance. So, we tried it.

The Hobbico Avistar 40 Select is an excellent advanced trainer. You can read about it in Sport Aviator's review in the "On The Flight Line" Section. The Avistar Select, The RTF version is called "Select", already has an engine and radio installed by the manufacturer. The installed engine is a very good and reliable O.S. Max LA-40. This engine rotates the supplied Top Flight 10 x 6 in, propeller at a respectable 11,100 rpm while idling well at 2,750 rpm. Unlike the 46 AX, the LA-40 engine does not have ball bearings to support the crankshaft.

The LA-40 powered Avistar is fun to fly and performs well with good vertical climbs and reasonably sized loops. Still, the pilot is sometimes left with the thought that this airplane has a lot more to offer than can be provided in its "stock" LA-40 configuration. The engine, while economical and reliable could be holding back the airplane.

The natural next step is to up the power. The O.S. 46 AX is ideal for this task since it fits into the same bolt holes as does the LA-40. This makes engine swapping easy. Even easier, the Avistar uses the popular clamp-on mount so bolt hole location is irrelevant.

Photo 12 shows the installation procedure. Note that a piece of thick paperboard is inserted behind the engine during installation. This insures that the engine does not touch the motor mount while retaining the proper engine thrust offset. Remove the paperboard before flying.

Photo 13

Study photo 13 carefully. The needle valve assembly is plastic. Notice how close to one of the fuel outlets the screwdriver comes during installation. To be honest, I broke the assembly because I was lazy. Laziness and shortcuts are among a pilot's surest trails to Mistake World and I took the express lanes this trip.

What I should have done was to unscrew the assembly first. The assembly's two mounting screws are clearly visible in the photo. Dismount the needle valve assembly first, mount the engine and then reinstall the needle valve assembly.

Don't do that and you will have to wait 5 days for the replacement assembly to arrive from Great Plane's, the engine's distributor, service department. Also to be honest, I did receive the replacement part in just five days and it was just ordered by my hobby shop through regular channels. Great Planes never knew the part was required for an article. This was just their usual excellent customer service.

Flight Results

Photo 14   Photo 15

The 46 AXZ was slightly heavier than the LA-40. I added ½ oz. to the tail and balance was restored. The propeller also extends beyond the fuselage about ¼ in. more but that never seemed to make a difference.

So what happened? One of my old performance cars had a speedometer that read up to 160 mph. Past the 160 mark on the dial, I put a little sign that read "OH WOW". That expression does not even begin to describe the pilot's feeling when the "souped-up" Avistar broke ground for the first time.

Takeoff occurred far sooner than the stock version. Once airborne, the airplane was held close to the ground to be sure the trim was good. It was. Then we pulled up elevator and the Avistar shot skyward, *accelerating* in the climb. At about 500 feet, and it seemed to take only a second to get there, the airplane leveled out on its back, accelerating across to the center. Coming down the back side in a rolling half-square loop, the Avistar raced inverted into the center and then performed an outside loop that topped out at about the 500 ft. level.

Leaving center inverted, the airplane pulled straight up into a 500 ft. high, it could have been higher still if desired, stall turn. After the turn and with the throttle at idle, the Avistar gradually slowed on its way back to center. At about 200 ft. past center, flying with reduced airspeed, we applied full power and pulled the Avistar strait up into a vertical square figure 8. This maneuver requires a 400 ft. vertical climb starting from low speed, followed by a 400 ft. long inverted pass across center and then into another 400 ft. high vertical climb from inverted.

Performing such a large vertical 8 from the "bottom" can tax even high-performance Precision Aerobatic and IMAC aircraft that usually have enormous power reserves. Yet the 46 AX powered Avistar was able to finish that torturous double climb. There weren't any power or lift reserves left at the top and the right rudder was full over, but the airplane did perform the maneuver. Not many sport aircraft can.

Rather than drone on about the performance change, the following chart may help highlight the gains this engine provided:

Maneuver	LA-40	46 AX
Take Off Speed:	36 mph	33 mph
Climb Out Speed:	39 mph	36 mph
Best Cruise Speed:	50 mph	50 mph
Top Speed:	59 mph	67 mph
Sustained Climb Rate:	1,200 fpm	2,200 fpm
Range:	25-30 minutes	15-18 minutes
Dive Speed:	68 mph	70+
Best Glide Speed:	45 mph	45 mph
Gliding Descent Rate:	1,200 fpm.	1,300 fpm
400' Glide Distance:	1,307 ft.	1,250 ft.
Level Stall Speed:	27 mph	25 mph
60-deg. Bank Stall Speed:	27 mph	27 mph
Landing App. Speed:	46 mph	40 mph
Touch Down Speed:	35 mph	33 mph

The takeoff speed was lower because the more powerful engine supplied more thrust once the nose was raised meaning the wings had to do less lifting to leave the ground. Climb out airspeed was less for the same reason. But look at that climb rate. The 46 AX powered Avistar had almost twice the climbing ability. 2,200 fpm is among the highest we have seen yet in a Sport Aviator aircraft.

Top speed was also higher, but for two reasons. The engine turned a six-inch pitch propeller 600 rpm faster meaning more ground was covered per minute. But the total area applying the propeller's force to the air was 21% larger. More power able to be applied to overcome the airframe's various drag components.

Stall speed decreased a little even though the airplane was a few ounces heavier. The difference was close and could be a test artifact but, it also could be that the larger diameter propeller was still providing extra airflow and thrust over and to the airframe. This would slightly lower the stall speed. The 60 degree bank stall speed was identical.

Landing speeds were much slower. The better airflow over the wing and tail from the larger propeller combined with the 46 AX's outstanding low idle speed performance to lower approach speeds by 13%. The LA-40 idled over 2,700 rpm contributing to the stock version's higher approach and landing speeds.

There was a 26 degree temperature difference which will affect performance by increasing air density. But this difference also affects the reported airspeeds. Still, lift will increase in the colder air as will engine power.

The Avistar airframe handled the extra power with no protests. We were ready to add more right engine thrust should it be needed for straight flight with the more powerful engine. But we put those thrust washers back in the box because the airplane flew straight even with the increased thrust. This is a well-designed airplane.

But there was a price to pay for the performance improvements. Look at the range figures. The 46 AX used about 20% more fuel than did the LA-40. We kept the stock fuel tank in place to make this transition as simple as possible,(getting lazy again?). Upping the power usually means installing a fuel tank that is the "next size" larger. For a 40-size airplane this usually means going from a 9-11 oz. tank to one holding 11-13 oz. of fuel. The LA-40 powered Avistar will get about fifteen flights to a gallon of fuel while the 46 AX powered version will fly fewer than twelve times before the pilot opens another fuel bottle.

So now you know what happens when you up your aircraft’s power ante with a reliable, powerful and pilot-friendly engine. The pilot winds up with terminal smiles and giggles flight after flight after flight.

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