An Oil Flow Study and Turbulator Installation on a Schweizer 1-26 Wing

By Richard H. Johnson- *Printed in Soaring Magazine-May 1997.*

Introduction

Although the ubiquitous Schweizer 1-26 single seated Sport Sailplane has been a very popular sailplane on the American scene for almost 44 years now, and over 700 have been built since it was introduced in 1953, only two reports have been published in Soaring Magazine to date evaluating its modest flight performance. The first was in Paul Bikle's famous "Polars Of Eight" that was published in the June, 1970 issue (Alan Bikle performed the actual piloting). He reported an L/Dmax value of about 21.5 at 42 kts, and a minimum sinking speed of about 165 ft/min at 32.5 kts. That performance was measured with an early A model S/N 100, with a steel tube and fabric fuselage.

Seven years later I was able to make measurements with the latest E model. It was equipped with top and bottom surface airbrakes, a lowered nose and instrument panel, and an all aluminum semi-monocoque fuselage. There I measured an L/Dmax as about 21.6 at 43 kts, and a minimum sinking speed of about 170 ft/min at 32 kts. My test E model was S/N 634, and it was flight tested at a gross weight of about 620 lbs, which was about 40 lbs heavier than that at which Alan Bikle flight tested the A model. I understand that Dave McNay performed an additional 1-26 flight test was at Mississippi State during the early 1960's with a highly modified configuration. It was said to include a lowered upper fuselage fairing with a bubble canopy, and landing skid replacing the wheel. He later told me that even those modifications failed to significantly improve its performance.

Oil Flow Tests

When Dan Mockler, past 1-26 National Champion and owner of S/N 182, observed my oil flow testing on the PW-5 wing, he suggested that we do the same with his 1-26 wing. He had noted that when flying in light rain, a stagnant bead of water had formed along the full span of his wing top surfaces, not very far aft of the wing leading edges. **Photo 1** shows me applying the blackened 10-W40 motor oil to his left wing as he looks on. The oil was applied at 5 spanwise locations on the left wing upper surface and 4 locations on the right wing. In addition, it was also applied to 2 locations on the left wing bottom surface.

Photo 1. The author applying blackened 10-40 motor oil to the 1-26's wing top surface with a paint brush.

Dan then flew S/N 182 in weak thermals for about 1/2 hour, and we then took the following 4 photos after he landed. **Photo 2** was taken of the left wing top surface about 5 feet out from the fuselage. It indicates that laminar flow existed back to about .124 chord, followed by a surprisingly large (about 2.5 inch wide) separation bubble, and normal turbulent flow behind that (indicated by the gradual thickening of the oil). The small break in the mid portion of the bubble is a turbulent flow wedge that was caused by a small piece of dirt or grass embedded in the oil near the leading edge. It was likely kicked up by the tow plane during takeoff.

Photo 3 is the corresponding photo of the left wing top surface, showing all 5 of the oil flow test stations on that wing. Again, a number of dirt induced turbulent flow wedges can be seen in the oil flow patterns. The relatively wide laminar separation bubble can be seen to exist along the full span of the wing upper surface.

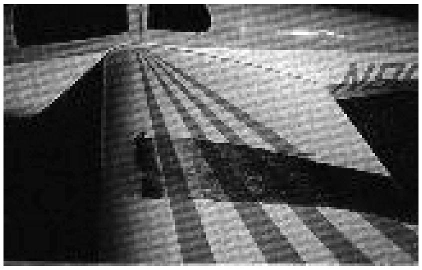


Photo 2. Oil flow pattern on wing top surface after 30 minute flight, with large laminar separation bubble shown by the wide black band near the leading edge.

Photo 4 is of the oil flow pattern that existed on the bottom surface of the wing, near the fuselage. The gradual thickening of the oil indicates that little or no laminar flow existed there, and normal attached turbulent flow ap-

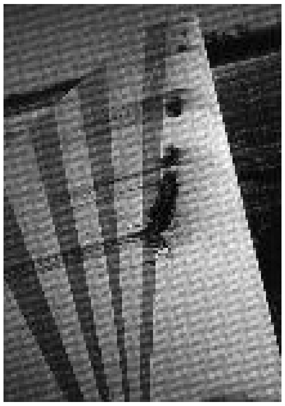


Photo 3. Similar post-flight oil flow patterns at 5 test stations on left wing top surface.

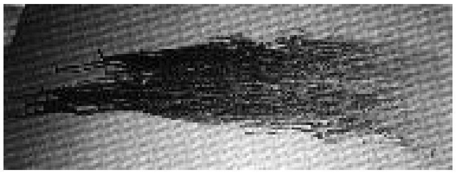


Photo 4. Oil flow pattern on wing bottom surface near fuselage after 30 minute flight, showing little or no low drag laminar flow, but normal attached turbulent flow to trailing edge.

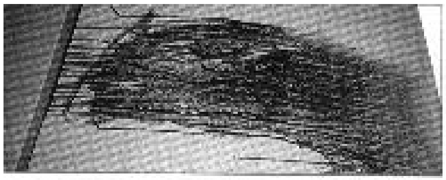


Photo 5. Oil flow pattern on wing bottom surface ahead of aileron, again showing little or no laminar flow. Normal attached turbulent flow is shown back to aileron hinge line gap, but oil flow fails to cross the gap, as it should have.

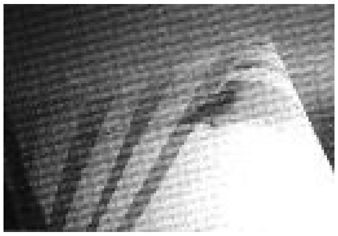


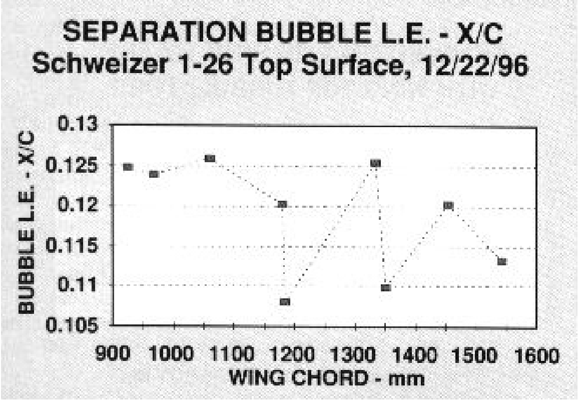
Photo 6. In-flight oil flow patterns of left wing top surface without turbulators. Small mid-winter cumulus clouds are seen in background.

pears to exist along the full chord. **Photo 5** is a similar photo taken farther out on the wing; ahead of the aileron. Again, normal attached turbulent flow is indicated. However, note that the oil completely fails to jump the aileron hinge gap for some reason. It is likely that a spanwise vortex existed in the aileron hinge gap cavity, thus preventing the oil from crossing over to the aileron. The aileron is top hinged, and its hinge line was sealed at the wing top surface by a fabric extension cemented to the wing top surface. A my-lar gap seal installed over the aileron bottom surface gap will likely be beneficial in reducing the wing drag to some degree.

Separation Bubble Location

The chordwise location of the leading edge of the wing top surface separation bubble was then measured at each of the 9 wing oil flow test stations, and those data are shown in **Figure 1.** The 925 mm (36.4 in) chord test station was near the wing tip, and it showed that the leading edge of the bubble was at about .125 chord. The 1543 mm (60.75 in) chord test station was near the fuselage. It showed the leading edge of the bubble to be at about .113 chord behind the wing leading edge.

FIGURE 1



Turbulator Configuration And Location

Now that we had the separation bubble location measured, we needed to determine the configuration and the location of the best turbulator that would eliminate the high drag separation bubble. The Reference C wake rake data showed that too high a turbulator would indeed destroy the bubble, but could cause more drag than the bubble that it removed. To arrive at a satisfactory turbulator configuration and location, we installed short 3 inch long segments of home made Zig-Zag tape that we made from 3/8ths inch (9.5 mm) wide by .010 inch (.25 mm) thick Dymo labeling tape. The tape was cut lengthwise down its middle with a pair of ordinary pinking scissors, and installed with the Zig-Zag edge facing forward at 12 spanwise locations on the right hand wing upper surface.

Their chordwise locations were staggered along the span, with their leading edges varying in distance from about 1 to 2 percent of the wing chord ahead of the bubble's leading edge. For optimum results, it is necessary to turbulate the laminar airflow at the minimum distance ahead of the separation bubble where they are effective in removing the bubble. When located too far back and in the bubble, they will not destroy the bubble. When located too far forward, they will incur unnecessary drag by destroying more of the low drag laminar region than necessary.

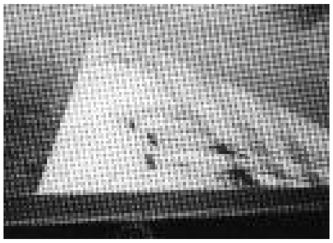


Photo 7. In-flight oil flow patterns of right wing top surface, with experimental turbulator patterens located at 4 spanwise test stations.

After the experimental patterns were positioned on the right hand wing, we reapplied the oil to both wing upper surfaces, and I flew S/N 182 for about 35 minutes in weak winter thermals. I took the **Number 6 photo** of the turbulatorless left wing during that flight. It shows that the separation bubble was still there, as were a few dirt induced turbulent wedges through the separation bubble. Photo Number 7 is of the right hand wing in flight, with the

Photo 8. The same right wing top surface after landing.

staggered experimental turbulators installed. There it appears that all the turbulator were successful in suppressing the bubble in the regions behind each turbulator. Note the small mid-winter cumulus clouds in the background that were used to extend the test flight duration.

Photo 7 was taken of the right wing shortly after landing. It shows the same oil flow patterns that **Photo 8** showed in flight, except that the separation bubble oil located at the inboard edge of the 2nd test station out on the wing did flow inboard by gravity, mostly after the landing. In the 4th test station turbulator pattern, located near the wing tip and barely visible in the photograph, I tried a thinner .007 inch (.18 mm) thick Zig-Zag turbulator. It proved to be too thin to break up the bubble at one location there.

From those test data we concluded that our best turbulator configuration was the .010 inch (.25 mm) thick Zig-Zag located about .01 chord (about 1/2 inch) ahead of the separation bubble's leading edge. Using Figure 1's bubble chordwise location data, we installed the final turbulator as a continuous straight line strip; from about 1 inch out from the fuselage side to about 2.5 inches short of the wing tips. We located its leading edge at .10 chord aft of the leading edge at the wing root and .115 chord aft of the leading edge at the wing tip.

Photo 9. Oil flow pattern after flight with a full span black turbulator strip attached about 11% of chord aft of the leading edge. Note that the turbulator was successful in eliminating the high drag laminar separation bubble along the entire span, except for a small area, near the wing tip.

Flight Testing With A Full Span Turbulator

For the final testing, I applied the blackened motor oil over the full span of both wing panels; but only in a 3 to 4 inch wide band behind the turbulator strips. That was the region where we knew the separation bubble had existed, and by applying oil there we could easily see if the .010 inch thick turbulator did indeed eliminate it during flight. Dan made the next 2 high tow test flights. Not only did he observe the oil flow patterns during those flights, he also performed sink rate measurements at various airspeeds.

Photo 9 shows both the black turbulator strip on S/N 182's wing top surfaces, and the oil flow patterns after the first flight. Note that the flow patterns indicate that our turbulator was 100% successful in eliminating the unwanted separation bubble over the entire wingspan, except for the final 2.5 inches at the tip where I had omitted installing the turbulator because I had thought that it would not be needed there. I later extended the turbulator strip an additional 2 inches.

Dan's sink rate measurement data are shown in **Figure 3**, and for a first time effort he did quite well. The upper air winds were stronger than we would have liked, and mid-level clouds began to move into our test area. His data indicated an L/Dmax of about 21.8 at 43 kts, and a minimum sink rate of about 186 ft/min at 37 kts.

Airspeed Calibration

Subsequent to Dan's 2 sink rate test flights, I performed an airspeed calibration flight with S/N 182, and those data are shown in Figure 2. Those data show that only about 1/2 kt needs to be added to its

FIGURE 2

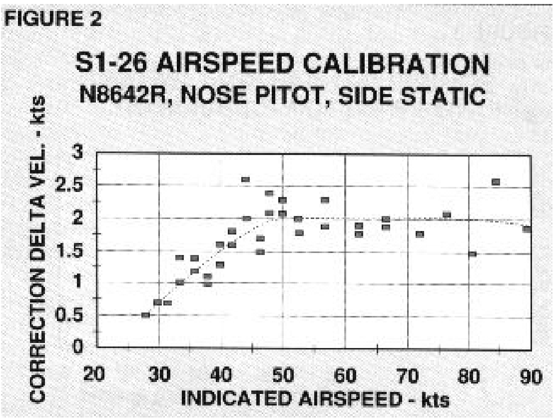


FIGURE 3

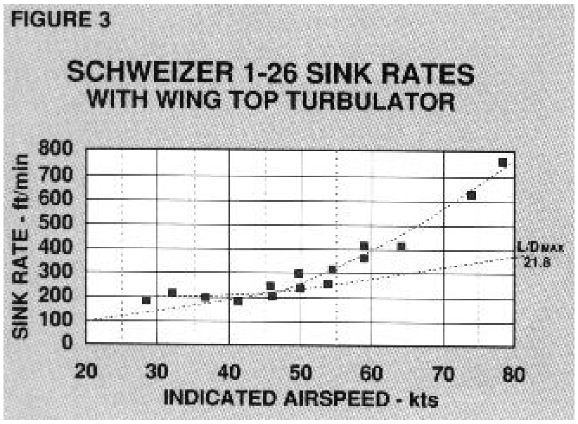
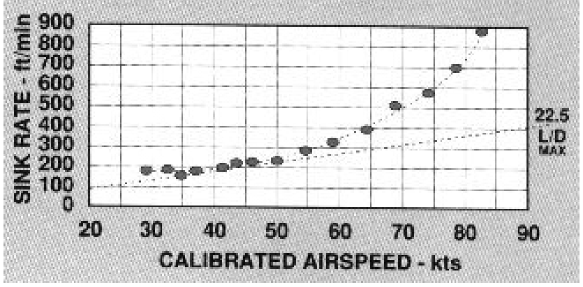


FIGURE 4

SCHWEIZER 1-26 SINK RATES WITH WING TOP TURBULATORS



indicated airspeed at its 28 kt indicated stalling speed to arrive at true calibrated airspeed. However, above 50 kts indicated, one must add 2.0 kts.

Final Sink Rate Measurements

A week later the clouds cleared and the winds subsided sufficiently for me to perform one more sink rate test flight with the turbulators installed. Before that flight, I wiped the oil from the wings. Also, because the prior 2 tests of S/N 100 and S/N 634 had been flown without a draggy external VHF antenna attached to the top of the fuselage, I removed S/N 182's prior to the last test flight.

That flight's test data are shown in **Figure 4**. An L/Dmax of about 22.5 is shown at 40 kts, and a minimum sink rate of about 170 ft/min at 33 kts. That appears to be an improvement of almost 5 percent in L/Dmax over that previously documented in the earlier Reference A and B measurements. Dan plans to further refine his 1-26 wings by sealing over the aileron bottom surface gaps with Mylar strips. Also, by installing soft foam weather stripping on the wing at the ends of the ailerons, the vertical airflow through those relatively slots can be greatly reduced. Perhaps the 1-26 brochure's 23:1 claim can finally be achieved! Likely we will report on that at a later date.

Thanks go to Dan Mockler for the use of his good 1-26A for the interesting and long overdue oil flow flight testing, and to the Texas Soaring Association and their tow pilots for providing the high tows needed for the data measurements.

Epilogue

The airfoil used for the Schweizer 1-26 wings is the venerable 43012 section that NACA developed during the 1930's. Although it is not a low drag airfoil, its high maximum lift and low pitching moments made it a favorite for many designers. It is still used with many airplanes and gliders. At the higher airspeeds (Reynold's Number) at which the airplanes normally operate, it is likely that the laminar separation bubble shown during the 1-26 testing will not exist. Many airplanes still use this airfoil, so brush a little oil on yours and see if a separation bubble can be found. Schweizer Aircraft used the 43012 airfoil for many of their gliders and sailplanes; from the 1-19 utility to the 2-33 trainers. The 1-29 and 2-32 were the exceptions because those sailplanes were the start of Schweizer's use of the lower drag laminar airfoils.

References

A. Paul F. Bikle, "Polars Of Eight," Soaring Magazine, June, 1970.

B. R. H. Johnson, "A Flight Test Evaluation Of The Schweizer 1-26E Sailplane," Soaring Magazine, February, 1977.

C. R. H. Johnson, "Are Your Turbulators Too Large ?," Soaring Magazine, January, 1995.