



GLIDER AERODYNAMICS PUZZLER

BY STEVE PLATT

Winds

The Glider Aerodynamics Puzzler is intended to stimulate your thinking about soaring and refresh your understanding of glider aerodynamics and soaring optimization. The correct answers with detailed explanations follow the questions. Have fun.

Surface winds and winds aloft are a major factor in glider flight planning and operations. From the earliest flight lessons, neophyte glider pilots learn the effect of wind on both landing procedures and making it back to the airport. For some experienced glider pilots, the magnitude of the impact of headwinds/tailwinds on glider performance may come as a surprise.

You are about to fly your club's Schweizer 2-33 on a beautiful, but

relatively windy day. The surface winds are blowing 10 kt, gusting 15 kt right down the runway. However, the winds aloft are forecast to be 25 kt (~29 mph) at 3,000 ft and 30 kt (35 mph) at 6,000 ft. As a reminder, the key performance numbers for the 2-33 are: Stall speed ~32 mph; minimum sink speed ~42 mph; and best L/D speed ~52 mph with a best L/D glide ratio of 23.

QUESTION 1: Flying the 2-33 into a 25 kt headwind, what is the effective glide ratio if flown at the optimum speed to fly to maximize distance into a 25 kt (~29 mph) headwind?

- A. Effective glide ratio: ~ 23
- B. Effective glide ratio: ~ 20
- C. Effective glide ratio: ~ 15
- D. Effective glide ratio: ~ 11
- E. Effective glide ratio: ~ 7

QUESTION 2: Flying the 2-33 with a 25 kt tailwind, what is the effective glide ratio if flown at the optimum speed to fly to maximize distance with a 25 kt (~29 mph) tailwind?

- A. Effective glide ratio: ~ 23
- B. Effective glide ratio: ~ 25
- C. Effective glide ratio: ~ 29
- D. Effective glide ratio: ~ 35
- E. Effective glide ratio: ~ 42

Question 3: While the effective glide ratio changes with headwinds/tailwinds, the glide angle changes as well. For the Schweizer 2-33 flown at best L/D speed with a glide ratio of 23-to-1, the glide angle in still air is ~2.5 degrees. As in Question 1, for the 2-33 flying into a 25 kt headwind, what is the actual glide angle if flown at the optimum speed to fly to maximize distance into a 25 kt (~29 mph) headwind?

- A. Glide angle = 2.5 degrees
- B. Glide angle = 3.5 degrees
- C. Glide angle = 4.5 degrees
- D. Glide angle = 5.2 degrees
- E. Glide angle = 7.5 degrees

Explanation for question 1 & 2:

Figure 1 shows the Flight Polar for the 2-33 with the construction for selecting the optimum speed to fly into a 25 kt headwind and with a 25 kt tailwind. Notice that for the headwind, the optimum STF is 54 kt (~62 mph) at a sink rate of 2.6 kt, yielding a net groundspeed of 29 kt and an effective glide ratio of only 11! For the tailwind, the optimum STF is 42 kt (48 mph) at a sink rate of 1.9 kt, yielding a net groundspeed of 67 kt and an effective glide ratio of 35! The answer to question 1 is D, 11. The answer to question 2 is D, 35.

Explanation for question 3: For the 2-33 flying optimally in to a 25 kt headwind to maximize distance, the STF is 62 mph, yielding a ground speed of ~33 mph and an effective glide ratio of 11 to 1 with a glide angle of 5.2 degrees – more than twice the glide angle of the 2-33 flown optimally in still air!

Lessons Learned

Winds matter. For a 23-to-1 Schweizer 2-33 flying with, or against, a 25 kt wind varies the effective glide ratio from 35 to 11! The glide angle varies from 5.2 degrees to 1.6 degrees.

Likewise, when landing a 2-33 with spoilers deployed, the approach angle

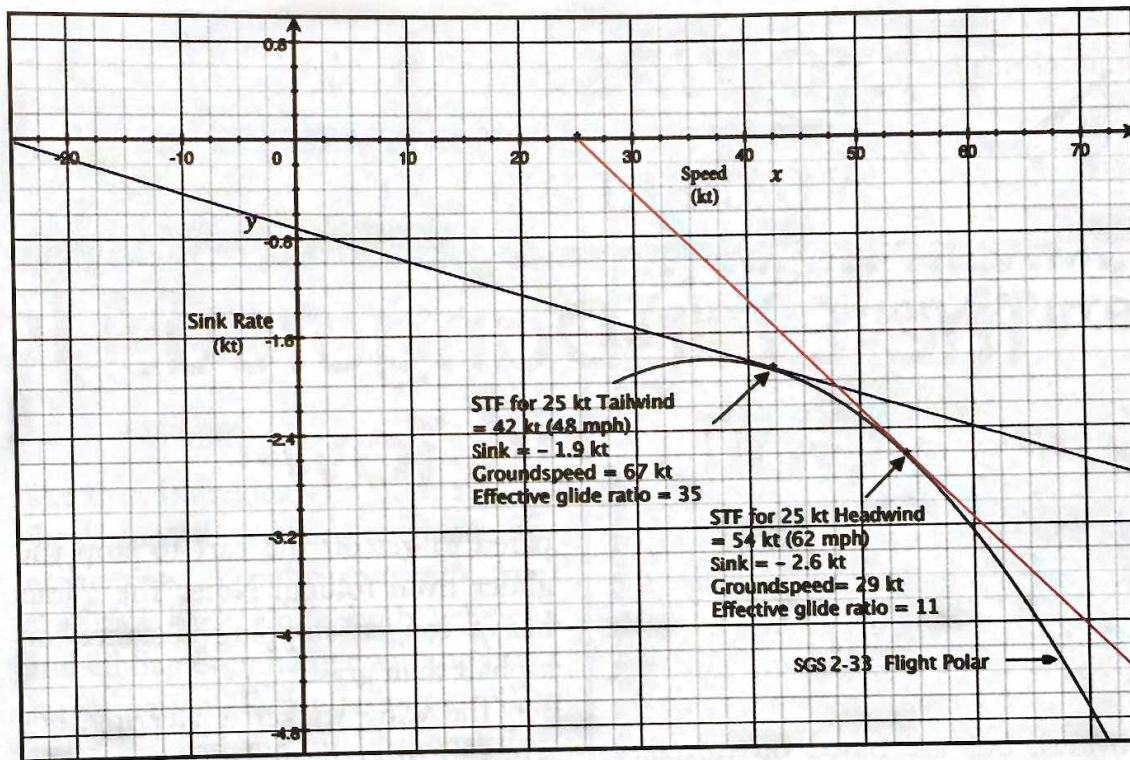


Figure 1: SGS 2-33 Flight Polar with construction for selecting optimum STF with 25 kt headwind and 25 kt tailwind.

increases dramatically with strong headwinds when flown at an appropriate airspeed for the headwind conditions, versus landing with similar spoiler deployment in calm winds.

About the author: Steve is a commercial pilot in single engine airplanes, single engine seaplanes, and gliders. He holds an instrument rating and is a Certificated Flight Instructor for airplanes, instruments, and gliders. He has logged over 4,000 flight hr including over 2,000 hr

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