

Calculating Tail Volume

From A.A. Lidberg Model Plan Service: www.aalmps.com

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The Tail Volume Coefficient (TVo) is a very handy tool for understanding why a model acts like it does, and for determining what can be done to help it act more like what is desired. TVo will help decide just how big the stabilizer should be and provide a starting point for the Center of Gravity location. Here's the formula:

Tail Volume = (Tail Area/Wing Area) x (Tail Arm/Wing Avg. Chord)

where:

Tail Area = area of the horizontal stabilizer

Wing Area = area of the wing

[both areas include that encased by or covered by the fuselage]

Tail Arm = distance from LE of wing to LE of stab

[for untapered surfaces; for tapered, use LEs at average chord]

Wing Avg. Chord = area/wing span

Looking at the formula, one can see [other parts being the same] that a larger tail area and/or a longer tail arm will produce a larger tail volume.

Here are some sample TVo numbers:

AMA gas models 1.0 to 2.0

Mulvihill rubber 1.5 to 2.2

Wakefield rubber 1.4 to 1.7

Indoor rubber duration 1.0 to 1.5

Hand launched glider .6 to 1.1

Full size 1913 Moraine-Saulnier, Type 'L' .16

OK, so what do we do with the TVo number? We can find a good starting point for the center of gravity location using this formula:

CG [in % back from the wing's LE] = 16 + (36 x Tail Volume)

An example: if Tail Volume is .50, then CG is:

$16 + 36 \times .5 = 34\%$

In practice, one should experiment around this recommended number, to see if duration could be improved.

This CG calculation is really handy for those old timer gas models that have no balance point marked on the plans!

What else does this mean? In general, a forward CG such as the typical "1/3 back" or the 36% noted above, means that the wing will need to be at a higher angle of attack—and a powered model will, because of that greater angle, require more down-thrust. Both of these factors contribute to a model that could be considered less efficient, but, if it's a scale model, you don't have much latitude for changes. You do, at least have the balance point at a near-optimum location for that design. Check out that Moraine-Saulnier 'L' above—with its 6% stab area, the TVo is very small and the balance point will have to be quite far forward.

For a model that you're designing [or a scale model that you're working up], checking out the TVo is a good idea so you can tune the design for more efficiency. You can adjust the tail arm length and/or the tail area to get a greater TVo. Do you

remember some of the post-WWII gas models like the Civy Boy that had a balance point at or beyond the wing's TE? When you look at such a model, you see a large stab plus a long tail arm—thus a large TVo. You will also see the wing and stab incidence at/near zero/zero. Now, that rearward CG is interesting, but the zero/zero makes climb adjusting a scary proposition, even though the glide can benefit from that set-up. It's been said that when the Civy Boy works, it's really hard to beat—but when it doesn't, the impacts will scare everyone!

So—give TVo a try—see how it works!

Portions of this page have been taken from William F. McCombs "Making Scale Model Airplanes Fly." See ads in Flying Models and the NFFS Digest for information on how to buy this book—which has many very helpful ideas for competition models as well as scale models. The comments are mine, as I am a firm believer in TVo and have used it on all my models for about 20 years. / A