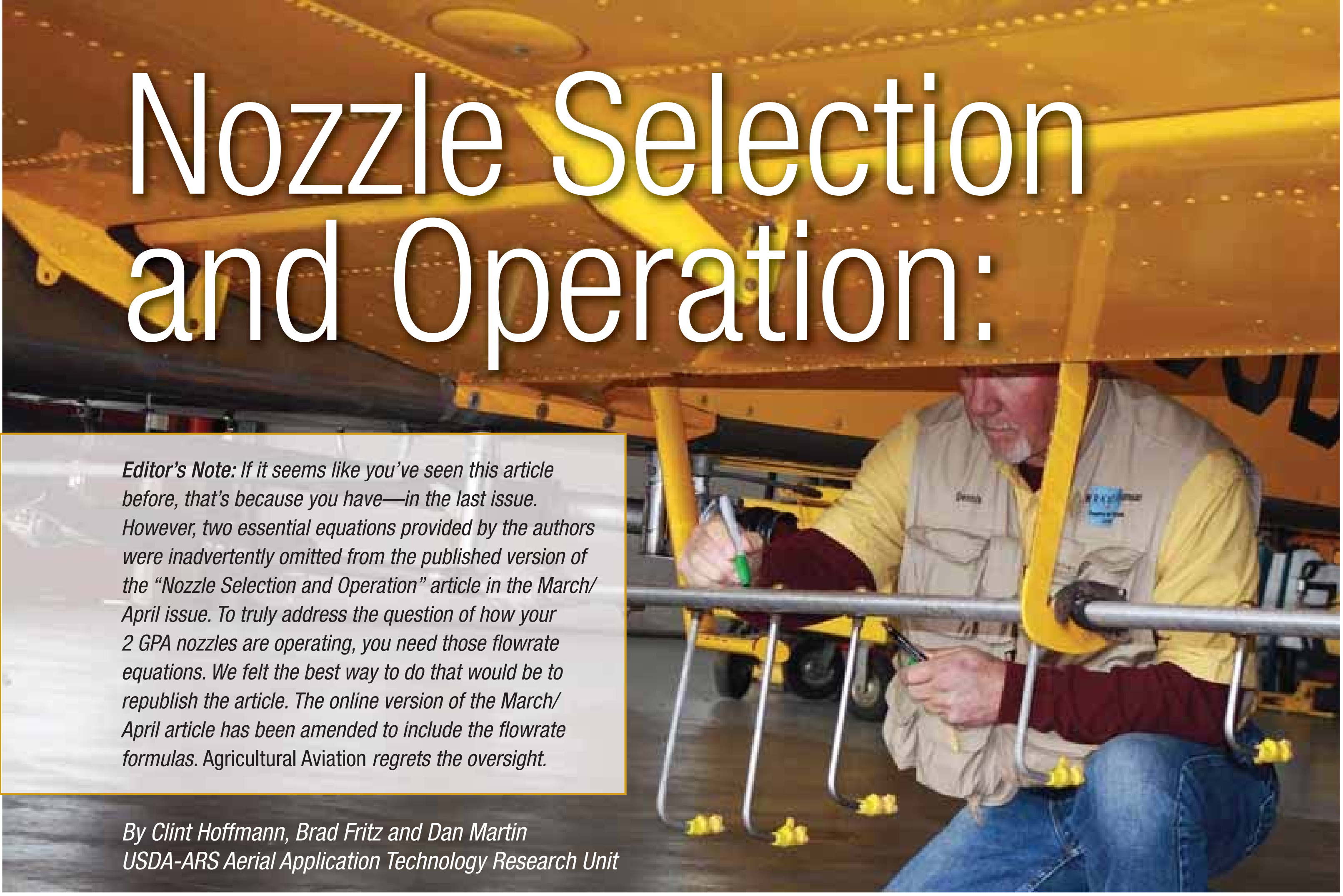

Nozzle Selection and Operation:

Editor's Note: If it seems like you've seen this article before, that's because you have—in the last issue. However, two essential equations provided by the authors were inadvertently omitted from the published version of the "Nozzle Selection and Operation" article in the March/April issue. To truly address the question of how your 2 GPA nozzles are operating, you need those flowrate equations. We felt the best way to do that would be to republish the article. The online version of the March/April article has been amended to include the flowrate formulas. Agricultural Aviation *regrets the oversight.*

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Do You Know How Your 2 GPA Nozzle is Operating?

Basic nozzle setup and operation is something that all applicators routinely do and is a key component of making professional applications. The problem with routines is that one can become complacent in how much time and attention is given to the details of setting up a spray boom. This article will go over calculating nozzle flowrate, nozzle selection, spray droplet size and a few recordkeeping procedures. Through this process, applicators will be shown how to meet droplet size or spray quality requirements that exist on many pesticide labels.

Flowrate Calculation

While applicators have calculated total application flowrate many times during their career, let's revisit the equations for completeness. For these examples, let's assume you normally apply at 145 mph with a 65-foot swath and, in your operation, you routinely do 2 and 5 GPA work. The flowrate equation is shown in Fig. 1.

$$\text{Flowrate (gpm)} = \frac{\text{Airspeed (mph) X Swath Width (ft) X Spray Rate (gpa)}}{495}$$

Fig. 1. Total application flowrate equation

Therefore, your flowrate would be 38 and 95 gallons per minute (GPM) for the 2 and 5 GPA settings, respectively. Next, the flowrate per nozzle needs to be determined, so let's assume we have 40 nozzles on the boom (see Fig. 2).

$$\text{Flowrate per nozzle (gpm)} = \frac{\text{Flowrate (gpm)}}{\text{Number of Nozzles}}$$

GPM for 2 GPA = 38/40
GPM for 5 GPA = 95/40

Fig. 2. Flowrate per nozzle equation

Fig. 3. Screen capture of the flowrate calculations for different nozzles (Courtesy of CP® Products website)

SPEED	MPH »	145		« MPH
SWATH WIDTH	Feet »	65		« Meters
RATE	GPA »	2		« L/Ha
	# Nozzles »	40		« # Nozzles
	Calculate!			

				CALCULATED RESULTS Flow rate needed with # of nozzles entered.	
Single Nozzle Flow Rate L,om				0.9520	0.0000
Acres or Hectares/Minute with entered data				19.04	0.00
GPM or L/min Total Boom flow rate (Ac/min) x (GPA)				38.08	0.00
Boom flow rate is based on given values.					
This information should be used for purposes of selecting the correct nozzle size only.					
Nozzle	Reference Pressure	Ref. Flow Rate GPM/Nozzle	L/min/nozzle	*Estimate* of Pressure Needed	
Pressures between 25-60 PSI are recommended. 30 to 35 PSI may be necessary for good boom dynamics.					
CP's Flat Fan Tips				English	Metric
#2 Flat Fan	40	0.2	0.757	997	0
#3 Flat Fan	40	0.3	1.136	443	0
#4 Flat Fan	40	0.4	1.514	249	0
#5 Flat Fan	40	0.5	1.893	160	0
#6 Flat Fan	40	0.6	2.271	111	0
#8 Flat Fan	40	0.8	3.028	62	0
#10 Flat Fan	40	1.0	3.785	40	0
#12 Flat Fan	40	1.2	4.542	28	0
#12.5 Flat Fan	40	1.25	4.732	26	0

Table 1. Possible nozzle selections, operating pressures and droplet size

GPA	Nozzle/orifice	Pressure (psi)	Dv0.1 (μm)	Dv0.5 (μm)	Dv0.9 (μm)	Spray Quality
2	#10 flat fan	40	118	296	491	Fine
2	CP-09- 0.078 @ 30°deflection	44	135	277	421	Medium
2	CP-09- 0.078 @ 0°deflection	44	171	345	578	Medium
2	Disc core - #10-45	40	163	282	421	Medium
5	#25 flat fan @ 44 psi	40	228	312	493	Medium
5	CP09–0.125" orifice @ 30°deflection	41	144	285	483	Medium
5	CP09–0.125" orifice @ 0°deflection	41	170	338	596	Medium
5	CP-11TT Straight Stream - #25 orifice	40	203	293	504	Medium

The flowrate per nozzle would be 0.95 and 2.38 GPM for the 2 and 5 GPA settings. Then, using a nozzle manufacturer's website or catalogue, the most appropriate nozzle and spraying pressure would be selected to fit these flowrates. For this example, the Aerial Set-Up Calculations section of the CP Products Company website (www.cpproductsinc.com) will be used. Using the same inputs as above, Fig. 3 contains the results for the 2 GPA application.

Reading the Chart

The chart in Fig. 3 shows that if you wanted to use a #8 orifice flat fan nozzle, the operating pressure would need to be 62 psi, while the #10 orifice requires a pressure of 40 psi. Since operating pressures of at least 35 psi will help ensure good operating dynamics, one would select the #10 orifice for this application scenario. Further down in the chart on the website, one could also select a CP-09 body set to a 0.078" orifice and operated at 44 psi. Another option would be D10-46 (disc core nozzle) at 40 psi. These selections and other nozzle options for the 2 and 5 GPA rate are summarized in Table 1.

Recording Droplet Size

The next step is to ensure that the selected nozzle and operating pressure results in the proper droplet size required for the given application. Using the USDA-ARS Droplet Size Models (apmru.usda.gov/aerial), and assuming we use all 40 nozzles on the boom, the droplet size for each of the nozzle selections above is also shown in Table 1. If the desired droplet size could not be obtained for a given nozzle type at the pressures specified to maintain the total flowrate required with the 40 nozzles specified, changes to spray pressure, nozzle orientation and airspeed can be tweaked until required spray droplet size is obtained. It should be noted that changing airspeed and spray pressure changes the flowrate and application rate requiring modifying the number of nozzles used. Fine tuning these variables can be a repetitious process, which will be covered in a follow-up article.

Being fluent in these calculations ensures proper nozzle selection and boom setup for proper application rate and applied droplet size to meet specific product labels and maintain product efficacy. A reference like Table 1, for your specific nozzle sets, can provide a handy reference to both the applicator and the ground crew and is something that can be assembled during the offseason. Given that your spray nozzles are your primary point of influence on spray rate and quality, it is critical that appropriate time and energy be given to their proper selection and operational setup. ■