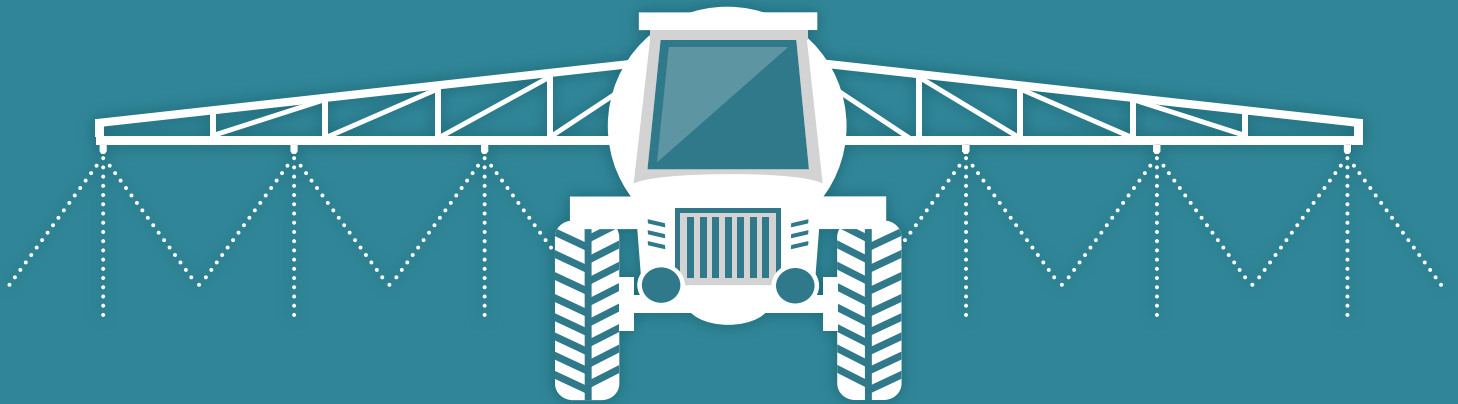


SPRAYER GUIDE

FOR THE

DO-IT-YOURSELF FARMER

SPRAYER EQUIPMENT



FARMERSSM
BUSINESS NETWORK



SPRAYER GUIDE FOR THE DO-IT-YOURSELF FARMER

SPRAYER EQUIPMENT

WHAT'S INCLUDED IN THIS GUIDE?

The Basic Components of a Sprayer

- Tank
- Agitator
- Control valves and gauges
- Pumps
- Hoses
- Strainers and screens

Nozzles: How to Select the Right One

- Spray patterns
- Calculating nozzle flow rate
- Using nozzle size charts
- Selecting nozzle size

How to Get Your Sprayer Squeaky Clean

- Prevention
- Cleaning after spraying
- What the pros know

The Essential Sprayer Maintenance Checklist

- Your go-to sprayer inspection and maintenance checklist to keep equipment calibrated and working properly



IS YOUR SPRAYER EQUIPMENT IN PRIME CONDITION?

If you've recently purchased a new on-farm sprayer, you may still be learning the ins and outs of the equipment. Or, if you are considering the purchase of a new or used tow-behind or self-propelled sprayer, then you may be thinking through the options, features and accessories you want and need. But, even if you aren't considering a purchase right now, it is important that the spraying equipment you do use is kept in prime working order to deliver your applications safely and accurately.

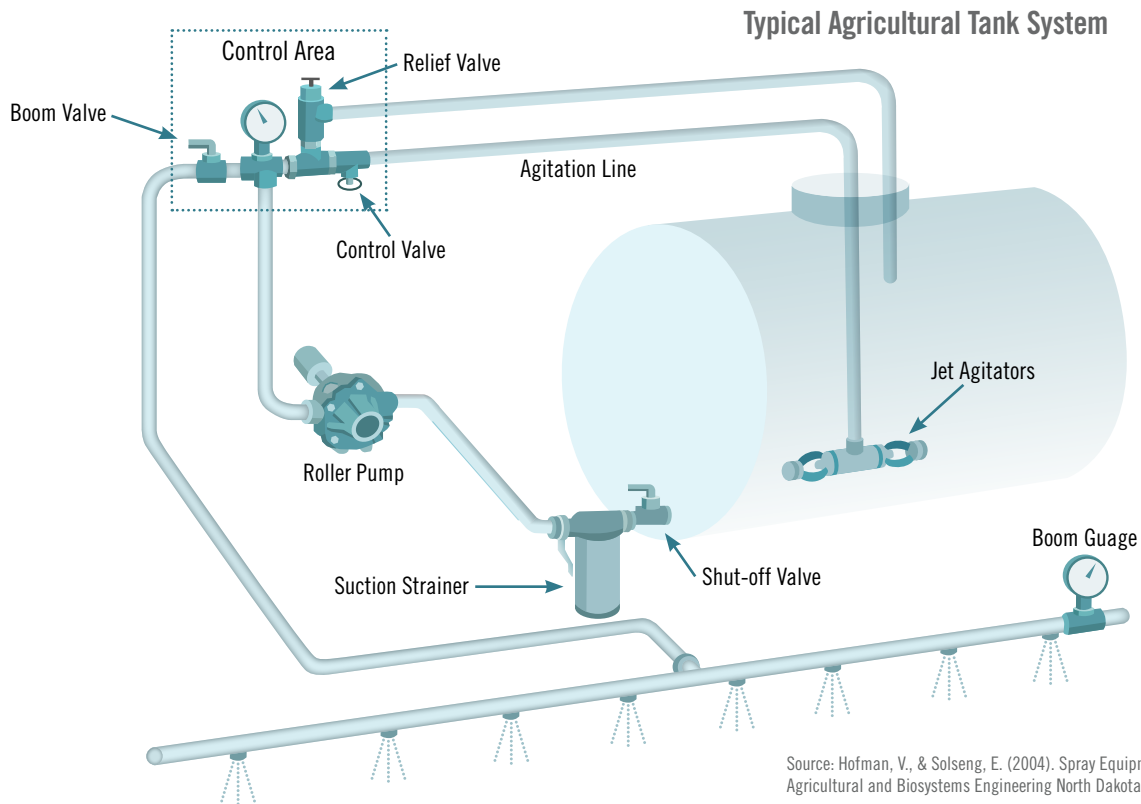
This guide will help you learn the basics of owning and operating your own sprayer – it is for farmers who want to learn what the pros know so they can do it themselves. And that starts with equipment expertise.

Uncle John's advice of "whacking it twice with a hammer" won't be included in our best practices for the sake of brevity...and accuracy. But we do hope the information will be just as easy to remember and put into practice, if only slightly more efficient than the ole hammer whacking.





THE BASIC COMPONENTS OF A SPRAYER



Source: Hofman, V., & Solseng, E. (2004). Spray Equipment and Calibration, Agricultural and Biosystems Engineering North Dakota State University.

TANK

Since many crop chemicals can be corrosive, it's also important to select a tank with corrosion-resistant material, such as stainless steel, fiberglass or polyethylene plastic. Even when they aren't in use, it's important to keep tanks clean and free of dirt, rust and other contaminants that can damage the pump and nozzles.

AGITATOR

A tank agitator mixes materials in the tank homogeneously (i.e. with a uniform composition) and keeps chemicals in suspension instead of settling on the bottom of the tank. **Different agitators are required for the various types of chemicals being applied.** Wettable powders require intense agitation in suspension, so you should use a separate agitator – either a hydraulic or mechanical type.¹ An adjustable agitator can minimize foaming that occurs from certain chemicals as the volume in the tank decreases.

PRO TIP

If your spray tank includes a jet agitator, do not install it on the pressure bypass line. Low pressure and intermittent liquid flow will likely produce poor results because it will agitate the spray solution only when the spray boom is shut off.



CONTROL VALVES AND GAUGES

The relief valve on a sprayer should always be in the bypass position during start-up. Check your gauges at every start-up.

A pressure gauge should have a total range of twice the maximum expected reading.

The gauge should indicate spray pressure accurately. If you're seeing spikes, then the gauge may always read high afterwards and should be replaced. Likewise, an opaque or leaking gauge should be replaced. Measure the discharge rate at a specific pressure on the gauge during calibration and install a gauge protector or damper to prevent damage to your gauges.

A pressure gauge can be used for more than measuring pressure. It also can be a helpful tool in diagnosing other problems – such as pump or plumbing issues – within the sprayer system. Keeping your gauges in good working order will make a big difference in sprayer performance and accuracy.¹

PUMP

There are four general types of pumps: centrifugal pumps, roller or rotary pumps, piston pumps and diaphragm pumps. The nuances of different pump styles are primarily about how much water they displace and how they deliver the volume of material.

More importantly than the style itself, your pumps should be resistant to corrosion from pesticides, and the materials used in pump housings and seals should be resistant to chemicals, including organic solvents. This shouldn't be an issue for new equipment, but as your sprayer ages, or if you are considering buying used equipment, take a closer look at the pump.

HOSES

Undersized hoses and fittings can severely reduce the capacity of any pump. Suction hose diameter should be at least as large as the pump intake opening. **Before spraying, all hoses and connections should be examined for cracks or leaks while under pressure.** Avoid splices where possible – they offer another opportunity for leaks or failure in your system.

STRAINERS AND SCREENS

There are three types of strainers commonly used on sprayers: line strainers, tank-filler strainers and nozzle screens. Strainers (and nozzles) should be cleaned after every spray day. It's best to use a bristle brush, because flushing will not completely clear them.



NOZZLES: HOW TO SELECT THE RIGHT ONE

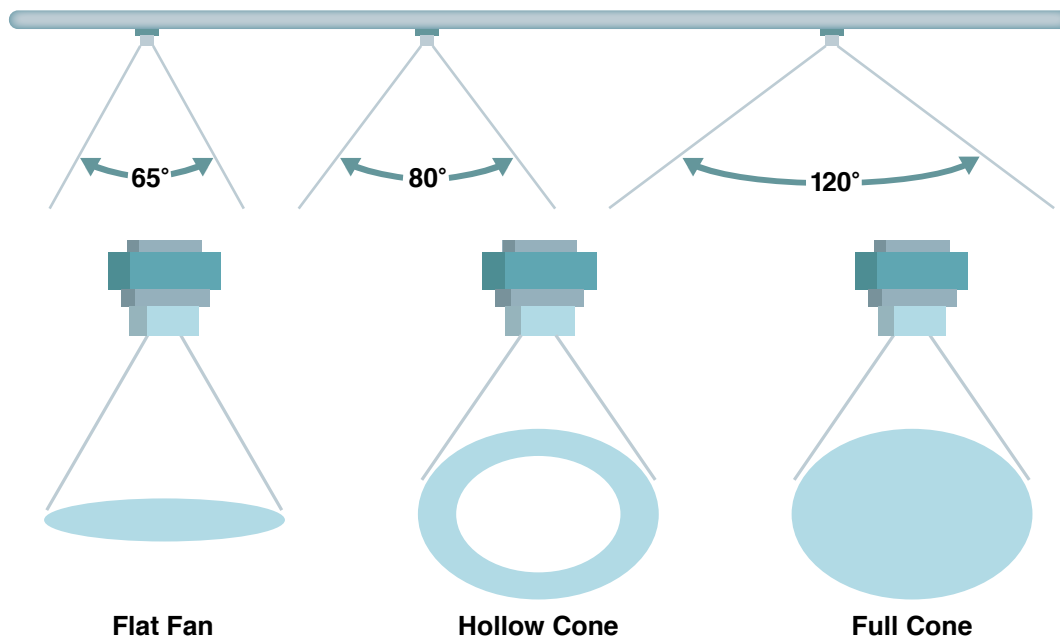
Sprayer nozzles are responsible for converting the substance(s) in your tank into droplets, regulating flow and dispersing the spray in a desirable pattern based on the crop you're spraying, and what you're spraying the crop with at that time.

NOZZLE SPRAY PATTERN AND SHAPE

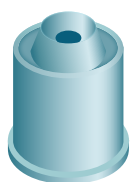
Nozzle spray patterns typically have two basic characteristics: the spray angle and the shape of the pattern.

Most agricultural nozzles have a spray angle from 65 to 120 degrees. While narrow spray angles produce a more direct and penetrating spray, flat or wide-angle nozzles can be mounted closer to the target (crop or weed), spaced farther apart on the boom and provide overlapping coverage if needed.

Though there are many spray nozzle types and sizes, there are only three basic spray patterns: **the flat fan, the hollow cone and the full cone**. Each one has specific characteristics and applications.¹



The nozzle tips look like this:



Full Cone



Hollow Cone



Flat Fan

Source: Hofman, V., & Solseng, E. (2004). Spray Equipment and Calibration, Agricultural and Biosystems Engineering North Dakota State University.



NOZZLE SIZE

Finding and selecting the right nozzle is one of the most important activities of a successful spray. It's the combination of nozzle size along with nozzle pattern and shape that make for the most accurate sprays.

If you need to find the right nozzle size for your application, sometimes a simple chart is the easiest way to figure this out.

Here's an example of nozzle size charts that most manufacturers can provide:

Nozzle size	Pressure psi	Flow rate US gal/min	Numbers in Table Body are mph (15" nozzle spacing)													
			3 gpa	4 gpa	5 gpa	6 gpa	7 gpa	8 gpa	9 gpa	10 gpa	12 gpa	14 gpa	16 gpa	18 gpa	20 gpa	
01 Orange	30	0.09	11.4	8.6	6.9	5.7	4.9	4.3	3.8	3.4	2.9	2.4	2.1	1.9	1.7	
	40	0.10	13.2	9.9	7.9	6.6	5.7	5.0	4.4	4.0	3.3	2.8	2.5	2.2	2.0	
	50	0.11	14.8	11.1	8.9	7.4	6.3	5.5	4.9	4.4	3.7	3.2	2.8	2.5	2.2	
	60	0.12	16.2	12.1	9.7	8.1	6.9	6.1	5.4	4.8	4.0	3.5	3.0	2.7	2.4	
	70	0.13	17.5	13.1	10.5	8.7	7.5	6.5	5.8	5.2	4.4	3.7	3.3	2.9	2.6	
	80	0.14	18.7	14.0	11.2	9.3	8.0	7.0	6.2	5.6	4.7	4.0	3.5	3.1	2.8	
	100	0.16	20.9	15.7	12.5	10.4	8.9	7.8	7.0	6.3	5.2	4.5	3.9	3.5	3.1	
015 Green	30	0.13	17.1	12.9	10.3	8.6	7.3	6.4	5.7	5.1	4.3	3.7	3.2	2.9	2.6	
	40	0.15	19.8	14.9	11.9	9.9	8.5	7.4	6.6	5.9	5.0	4.2	3.7	3.3	3.0	
	50	0.17	22.1	16.6	13.3	11.1	9.5	8.3	7.4	6.6	5.5	4.7	4.2	3.7	3.3	
	60	0.18	24.2	18.2	14.5	12.1	10.4	9.1	8.1	7.3	6.1	5.2	4.5	4.0	3.6	
	70	0.20	26.2	19.6	15.7	13.1	11.2	9.8	8.7	7.9	6.5	5.6	4.9	4.4	3.9	
	80	0.21	28.0	21.0	16.8	14.0	12.0	10.5	9.3	8.4	7.0	6.0	5.3	4.7	4.2	
	100	0.23	29.7	22.3	17.8	14.9	12.7	11.1	9.9	8.9	7.4	6.4	5.6	5.0	4.5	
02 Yellow	30	0.17	22.9	17.1	13.7	11.4	9.8	8.6	7.6	6.9	5.7	4.9	4.3	3.8	3.4	
	40	0.20	26.4	19.8	15.8	13.2	11.3	9.9	8.8	7.9	6.6	5.7	5.0	4.4	4.0	
	50	0.22	29.5	22.1	17.7	14.8	12.6	11.1	9.8	8.9	7.4	6.3	5.5	4.9	4.4	
	60	0.24	32.3	24.2	19.4	16.2	13.9	12.1	10.8	9.7	8.1	6.9	6.1	5.4	4.8	
	70	0.26	34.9	26.2	21.0	17.5	15.0	13.1	11.8	10.5	8.7	7.5	6.5	5.8	5.2	
	80	0.28	37.3	28.0	22.4	18.7	16.0	14.0	12.4	11.2	9.3	8.0	7.0	6.2	5.6	
	100	0.30	39.6	29.7	23.8	19.8	17.0	14.9	13.2	11.9	9.9	8.5	7.4	6.6	5.9	
025 Lilac	30	0.22	28.6	21.4	17.1	14.3	12.2	10.7	9.5	8.6	7.1	6.1	5.4	4.8	4.3	
	40	0.25	33.0	24.8	19.8	16.5	14.1	12.4	11.0	9.9	8.3	7.1	6.2	5.5	5.0	
	50	0.28	36.9	27.7	22.1	18.4	15.8	13.8	12.3	11.1	9.2	7.9	6.9	6.1	5.5	
	60	0.31	40.4	30.3	24.2	20.2	17.3	15.2	13.5	12.1	10.1	8.7	7.6	6.7	6.1	
	70	0.33	43.7	32.7	26.2	21.8	18.7	16.4	14.6	13.1	10.9	9.4	8.2	7.3	6.5	
	80	0.35	46.7	35.0	28.0	23.3	20.0	17.5	15.6	14.0	11.7	10.0	8.8	7.8	7.0	
	100	0.38	49.5	37.1	29.7	24.8	21.2	18.6	16.5	14.9	12.4	10.6	9.3	8.3	7.4	
03	30	0.26	34.3	25.7	20.6	17.1	14.7	12.9	11.4	10.3	8.6	7.3	6.4	5.7	5.1	
	40	0.30	39.6	29.7	23.8	19.8	17.0	14.9	13.2	11.9	9.9	8.5	7.4	6.6	5.9	
	50	0.34	44.3	33.2	26.6	22.1	19.0	16.6	14.8	13.3	11.1	9.5	8.3	7.4	6.6	

Source: sprayers101.com

In this chart, identify your water volume along the top row, and follow the column until you encounter the travel speeds. Once you've encountered your travel speed, move along the row to the left to identify the nozzle size and spray pressure. **Make sure that your travel speeds are achieved at a pressure that's right for the nozzle you're using.** For most air-induced nozzles, this will be about 60 to 70 psi (highlighted in grey above).

Once you've decided on a nozzle size, the travel speed column for that size becomes the travel speed range at various pressures. Avoid operating a low-drift spray below 30 psi – the pattern will be too narrow and, more than likely, its spray quality will be too coarse for the results you want to see.



NOZZLE SIZE CHARTS

Click on the links below to download a high-quality PDF of each chart.
Print, laminate, and place in your sprayer cab!

U.S. 15" Spacing

U.S. 20" Spacing

U.S. 30" Spacing

Metric, 50 cm Spacing

SELECTING YOUR NOZZLE SIZE

If you're not using a chart, you'll need to determine a few factors. You'll want to determine the nozzle flow rate at **gallons per minute (gpm)**. To find that, start with your application rate in **gallons per acre (gpa)**.

Next, find an efficient and safe ground speed in **miles per hour (mph)**. Then, determine the **spray width per nozzle (W)**.

Different types of spray methods will require different spray width (W):

Band Spraying: W = band width in inches

Broadcast Applications: W = nozzle spacing (distance between two nozzles on the boom) in inches

Directed Spraying: W = row spacing in inches (or band width) divided by the number of nozzles per row (or band)

Now, you'll be able to determine the **flow rate (gpm)**, with the following equation⁴:

$$\text{gpm} = \frac{\text{gpa} \times \text{mph} \times W}{5,940}$$

5,940 ← this is a constant to convert gpa, mph and inches to gpm

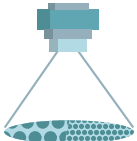
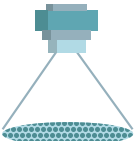
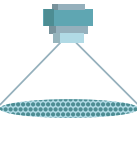
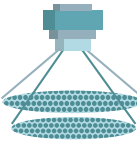
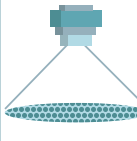
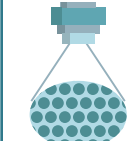
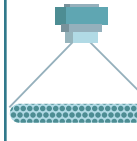
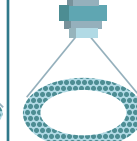
Finally, you'll be able to select a nozzle size that will give the flow rate (gpm) determined above. If a specific nozzle size is not available, try changing the travel speed and determine the new flow rate needed.

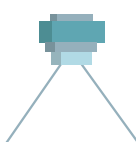
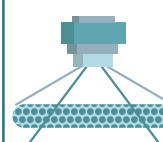
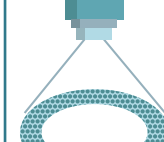
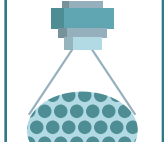
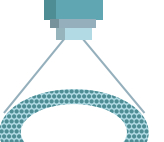


NOZZLE SPRAY PATTERNS

Here are some examples of nozzle patterns that work well for common herbicide, fungicide and insecticide applications.¹

Source: Hofman, V., & Solseng, E. (2004). Spray Equipment and Calibration, Agricultural and Biosystems Engineering North Dakota State University.

Nozzle Guide for Broadcast Spraying								
								
	Extended Range Flat Fan	Standard Flat Fan	Drift Guard Flat Fan	Twin Flat Fan	Turbo Flood Wide Angle	Wide Angle Full Core	Flood Nozzle Wide Angle	Raindrop Hollow Cone
Herbicides								
Soil-incorporated	Good	Good	Very Good		Very Good	Very Good	Good	Good
Pre-emerge	Very Good (at low pressure)		Very Good		Very Good	Very Good		Good
Post-emerge Contact	Good	Good		Very Good				
Post-emerge Systemic	Very Good (at low pressure)	Good	Very Good		Very Good			Good
Fungicides								
Contact	Very Good	Good						
Systemic	Very Good (at low pressure)		Very Good		Very Good			
Insecticides								
Contact	Good	Good		Very Good				
Systemic	Very Good (at low pressure)		Very Good		Very Good			

Nozzle Guide for Band and Directed Spraying					
					
	Even Flat Fan	Twin Even Flat Fan	Hollow Cone	Full Cone	Disc and Core Cone
Herbicides					
Pre-emerge	Very Good	Good		Good	
Post-emerge Contact	Good	Very Good	Very Good		
Post-emerge Systemic	Very Good	Good			
Fungicides					
Contact	Good			Good	Very Good
Systemic	Very Good				Good
Insecticides					
Contact		Very Good	Very Good		Very Good
Systemic	Very Good				Good
Growth Regulators					
	Good			Very Good	

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HOW TO GET YOUR SPRAYER SQUEAKY CLEAN

You already know why you need a properly cleaned sprayer: residue that has been left behind from a previous spray can harm a crop and ruin your next application. The damage might not show up for more than a week, and it usually takes longer to identify that the symptoms and damage patterns are from chemical residue. Once you are able to identify the cause, there isn't much else you can do except wait for unavoidable yield loss.

So how do you know when your sprayer is really clean *enough*? It starts with prevention and ends with a complete clean of all parts, while following best practices along the way.

PREVENTION

Cleaning a sprayer is a lot like doing the dishes. Using the right detergent, soaking the hard stuff, being thorough, and rinsing properly – they all matter.²

It all starts, though, with preventing the problem in the first place.

TRICKY MIXES

The main culprits that cause sprayer contamination from the mix itself have the following properties:

- Dry formulation
- Potent in low doses
- Poor water-solubility
- Poor solubility at low pH

The best advice on preventing a cleanout problem is to make sure the product is fully dissolved or suspended – and that takes proper mixing technique and time.

PRO TIP Many products in herbicide Group 2 mode of action (MOA) have the types of properties listed above and are worth keeping a close eye on when tank mixing.

Why? Because most herbicides are weak acids. Problems occur when you involve tank mixing with weak acid herbicides, including glyphosate, but especially those formulated as emulsifiable concentrates (oils, EC).

Two problems can occur with weak-acid herbicides:

1. The weak-acid herbicide lowers the pH of the spray mix, possibly reducing the solubility of the problematic Group 2s.
2. The oily formulation can adhere the herbicide to plastic and rubber sprayer parts such as tanks, connectors and hoses.²

(See our other spraying guide for more on common modes of action and how they affect your applications.)

[Spraying Guide](#)

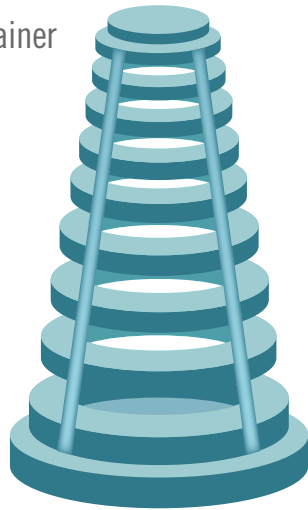


SCREENS AND STRAINERS

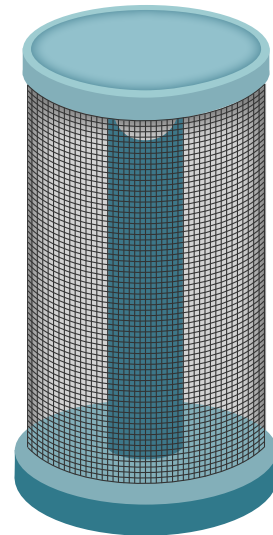
Once properly mixed, you may still encounter problems with nozzle screens or strainers. Dry formulations require a screen mesh of 50 or coarser (according to product labels), but many sprayers contain 80 mesh screens, some 100 mesh.²

All screens should be inspected before, during and after spraying these products. Screen residues cause longer-term contamination, so cleaning them is an important part of the entire process.

Slotted Strainer



50 Mesh Screen



Source: Hofman, V., & Solseng, E. (2004). Spray Equipment and Calibration, Agricultural and Biosystems Engineering North Dakota State University.

CLEANING AFTER SPRAYING

After spraying, the cleaning process relies on three main steps²:

All screens should be inspected before, during and after spraying these products. Screen residues cause longer-term contamination, so cleaning them is an important part of the entire process.

STEP 1. Remove as much of the mixture as possible.

The best way to remove the remainder is to spray it out in the field you've just treated. You can overspray some products again, based on what the product label advises, but it's never a good idea to drain the tank without thinking through how it will drain off.

STEP 2. Dilute the remainder as much as possible and use it to clean the boom plumbing.

Next, dilute the remaining mix, using tank cleaning adjuvants like ammonia (this raises the pH and helps remove those products whose solubility benefits from a higher pH) and detergent (this removes the oily layer formed by EC formulations). You can find commercial cleaners that combine these properties in one jug.

Diluting is most effective when done in multiple smaller batches, as long as you can verify you've reached the entire surface area of the tank walls. Wash-down nozzles installed in your tank can do this for you.



Here's an example scenario²:

Let's assume your sprayer has a 150-gallon clean water reservoir. It's tempting to empty the whole thing into the tank, but let's calculate the diluting power of doing it this way:

If we had 10 gallon remainder in the tank and added 150 gallons water, the remainder would be diluted by a factor of 16. After spraying this out, we would then have to refill the rinse tank, if we wanted to do more.

If we rinsed in two 75-gallon batches (add 75 gallons, agitate via wash-down nozzle, spray out, repeat), we would dilute by a factor of 72.

And, better still...

If we did three rinses of 50 gallons each, our final dilution factor would be 216. That's the same dilution as adding about 2,150 gallons to the first 10 gallon spray tank remainder. It's also about 14 times better than dumping the whole 150 gallons in at the beginning.

PRO TIP

You can improve diluting power by adding a separate clean water pump. Commercial applicators will often introduce clean water to the tank as "rinsate" (the mixture of pesticides diluted by water, solvents, oils, commercial rinsing agents or any other substances) is sprayed out, reducing boom water use even further.

STEP 3. Ensure anything that came in contact with the spray mix has been cleaned.

Lastly, pay attention to the things you can't see: screens, boom lines and boom ends. The total inside surface area of black rubber boom hoses on a 100-foot sprayer with seven sections can be as much as 30-50 square feet (or 3-5 square meters) and this surface can bind residues.² This job requires detail: scrub screens, soak boom lines and flush boom ends.

WHAT THE PROS KNOW

- Upgrade to more steel components (tanks and booms). Stainless steel is easier to clean than plastic.
- Flush your boom ends. Traditional ball valves do a decent job, but there are some nozzle body end caps that do it automatically. These inexpensive units eliminate the dead space in boom ends, and as a bonus, bleed air from the lines on the go.
- Have defoamer handy, since adding a surfactant or a commercial cleaner can generate a lot of foam.
- Use a bucket to help collect and clean screens. Drop them right in!

Done well, sprayer cleaning doesn't have to be unpleasant, difficult or time consuming. And, it certainly results in a better night's sleep before your next application.



THE ESSENTIAL SPRAYER MAINTENANCE CHECKLIST

Use this sprayer inspection checklist to help make sure your equipment is calibrated and working properly at the beginning of every season²:

PUMPS AND HOSES

- Leaky pump valves, and/or plungers checked/replaced
- All hoses and fittings sound (while under pressure)
- Pump flushed and spray discharge clear
- Pump lubricated.

FILTERS, STRAINERS AND NOZZLES

- All filters (tank basket, suction filter, in-line filters and nozzle strainers) clear and not damaged
- Check that valve diaphragms are clean and functioning
- All nozzles clean and unbroken
- Each nozzle shut-off and/or flip body is working

REGULATORS, GAUGES AND CONTROLS

- All gauges are accurate
- Pressure and shut-off valves (ball or solenoid) work smoothly
- Regulator(s) and/or bypass valve(s) move easily
- Pressure gauge defaults to zero and does not bounce or leak

BELTS AND POWER TAKE OFF (PTO)

- All belts have proper tension and no wear or cracks
- PTO greased, connection zones checked and guard in place

DRIVETRAIN AND HYDRAULICS SYSTEM

- Clean engine air filter and cab air filter
- Engine air intake is secure and clamps around the air filter and charge air tubes are tight
- Levels of engine coolant, transmission oil and hydraulic fluid are topped off
- Hydraulic system is leak-free

SPRAY PRESSURE ADJUSTMENT

- Regulator/bypass adjusted to achieve desired pressure at usual tractor RPMs
- Each boom operating at desired pressure for each nozzle combination
- Inspect boom for damage and boom pipe for leaks

TIRES AND TANKS

- Tires have correct pressure, tight bearings and no cuts
- Drain plug can be removed
- Tank has clear vents, is secure to chassis and has no punctures or damage
- Agitation shaft is supported, bearings lubricated and shaft packing suitably tight (no leaks)



SOURCES

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3. John Deere Spray Parts Guide
www.jdparts.deere.com/partsmkt/document/english/featbene/SprayerPartsGuide.pdf
4. Ozkan, E. (2016). Selecting the Best Nozzle for the Job. Retrieved from www.ohioline.osu.edu/factsheet/fabe-528

This information should not be used as a replacement for consulting the applicable product label. Please consult the label for the most complete and up-to-date information about any referenced product. Readers must have a valid applicator license to use restricted use pesticides. Please consult your state department of agriculture for complete rules and regulations on the use of restricted use pesticides as some products require specific record-keeping requirements.



FARMERSSM
BUSINESS NETWORK

ABOUT *FARMERS BUSINESS NETWORK*SM

CONCEIVED BY FARMERS, BUILT BY INNOVATORS AND IMPROVED TOGETHER

At the core of *Farmers Business Network*SM is a mission to put *Farmers First*SM and create transparent markets around agricultural inputs. That is why we created an independent network that delivers information from farmers directly *to farmers*, right at their fingertips.

There is strength in numbers. By aggregating and analyzing large, diverse datasets, the *FBN* network helps farmers make better decisions based on historical trends and performance across many farming operations. Now, you can make your toughest decisions with the confidence of millions of acres of real-world production data.

We promise to help farmers learn how independent, unbiased agronomic information, input price transparency and direct-to-farm e-commerce can improve whole-farm profitability. That's how farming gets better for farmers.

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