Effective Pest Control: Nozzle and Technology Options for Improved Efficacy and Drift Mitigation
Nozzle Types

for crop protection product applications to conventional crops and herbicide tolerant crops
Nozzle Technology

- Nozzles designed to reduce drift
- Improved drop size control
- Emphasis on ‘spray quality’
Nozzles Types

Flat Spray Patterns

- Flat-fan
- Venturi
- Chamber
Extended Range Flat-Fan

- Spray Pattern width: 80° and 110°
- Operating PSI: 15-60 PSI
- Tapered edge flat spray pattern
- Overlap required: 50-60% for uniform application (20-30% each edge)
- Nozzle Spacing: Typically 20 inches
- Optimum spray height: 80° - 30" above target, or 110° - 20" above target
- Recommended PSI: 20-25 PSI

TeeJet catalog #51A pages 12-13
XR Nozzle Demonstration

XR11004-35 psi

XR11005-40 psi
Spray Pattern width: 80° and 110°
Operating PSI: 15-60 PSI
Tapered edge flat spray pattern
Overlap required: 50-60% for uniform application (20-30% each edge)
Nozzle Spacing: Typically 20 inches
Optimum spray height: 80° - 30" above target or 110° - 20" above target
Recommended PSI: 20-25 PSI

Will not be a part of a herbicide tolerant crop nozzle strategy

Drift Potential to high compared to other nozzle options
Turbulation Chamber Flat-fan

- Spray Pattern width: 110° but more like 125° – 130°
- Operating PSI: 15-90 PSI
- Tapered Edge flat spray pattern
- Overlap required: 50%-60% (20-30% each edge)
- Nozzle Spacing: Typically 20”
- Optimum spray height: 20” above target
- Recommended PSI: 30-40 PSI
TT11004-40 psi
Turbulation Chamber Flat-fan

- Spray Pattern width: 110° but more like 125° – 130°
- Operating PSI: 15-90 PSI
- Tapered Edge flat spray pattern
- Overlap required: 50%-60% (20-30% each edge)
- Nozzle Spacing: Typically 20”
- Optimum spray height: 20” above target
- Recommended PSI: 30-40 PSI

Will not be a part of a herbicide tolerant crop nozzle strategy

But, will still be an option when coverage is required!
Turbo Flat-fan Twin

- Dual outlet
- Superior leaf coverage
- Droplet range slightly larger than comparable TT flat-fan

Turbo TwinJet – TTJ60

TeeJet catalog #51A page 16
Wilger Chambered Flat-Fan

- Spray Pattern width: 80 - 110°
- Operating PSI: 20-80 PSI
- Tapered Edge flat spray pattern
- Overlap required: 50%-60% (20-30% each edge)
- Nozzle Spacing: Typically 20"
- Optimum spray height: 20" above target
- Recommended use PSI: 30-40 PSI

Commonly found on CASE IH Aim Command Sprayers
Wilger Nozzle Demonstration

DR110-04-40 psi

MR110-04-40 psi
Pulse Width Modulation - PWM

- Blended Pulse Technology – Pulse Width Modulation
- Solenoid valve flow control (1-8X) “Tip Changer”
- Control PSI independently
- Ultimate in drop size control/manipulation

Excellent drift mitigation tool; ideal for precision applications

Developed by Ag Engineers at the U of CA - Davis

Technology Update!!!
OEM install on the Tyler Patriot in mid 90’s
Tyler sold to CaseIH two years later
How It Works

• Uses high speed solenoid valves to regulate flow
• Varies application rate with duty cycle: independently of pressure
• Cycles 10X per second

Venturi nozzles can’t be used with pulse width modulation
What is Pulse Width Modulation?

- Type of control system
- Modulates a DC square wave signal

100% Duty Cycle
15 mph

80% Duty Cycle
12 mph

50% Duty Cycle
7.5 mph

20% Duty Cycle
3 mph

TIME: 0.1 sec = 1 cycle

Speed affects a change in duty cycle which affects the amount of flow
PWM Summary Points:

• Wilger nozzle system is a good option
• Will not work with venturi nozzles
• Other PWM technology:
  – Boom flow compensation
    • adjusts flow on radius turns
  – PINPOINT – Individual nozzle control - on/off per nozzle
• Available as retrofit on any spray system as ‘SharpShooter’-Capstan
• Also retrofit via Raven?
New Sources of Pulse Width Modulation

Raven Hawkeye Nozzle Control System

DynaJet Flex 7120
PWM SPRAYER CONTROL
Press Release
August 2, 2016

CAPSTANAG SYSTEMS FILES PATENT INFRINGEMENT SUIT AGAINST
RAVEN INDUSTRIES AND CNH INDUSTRIAL AMERICA

TOPEKA, Kan., August 2, 2016 – Capstan AG Systems, Inc., a privately-owned Kansas company and the nation’s leading manufacturer of pulse-width-modulated agricultural spray control systems, announced today that it has filed a patent infringement lawsuit against Raven Industries, Inc. (RAVN) and CNH Industrial America, LLC, a subsidiary of Netherlands-based CNH Industrial NV (CNHI). The lawsuit was filed in the U.S. District Court for the District of Kansas.

In its complaint, Capstan AG Systems alleges that Raven’s “Hawkeye” agricultural sprayer system infringes two of Capstan’s patents: U.S. Patent Nos. 8,191,795 and 8,523,085. Capstan’s patents relate to agricultural sprayer systems and methods that incorporate individual valve control, yielding more efficient and precise application of liquid agricultural products.

The complaint also alleges that CNH has entered a partnership with Raven to offer the infringing Hawkeye sprayer system on CNH equipment, under the name AIM Command FLEX. Until recently, CNH had offered Capstan’s products on its sprayers, under the names AIM Command and AIM Command PRO.
Cost $ $$ $$:
JD quoting $38K ordered w/machine and factory install.
Raven Hawkeye priced for a JD sprayer 120’ boom at $40K installed.
HYPRO® Duo React
Compact and Economical Twin Pneumatic Valve Nozzle Body and Control System

Boom Configuration Example

- Pneumatic (Follower)
- Pneumatic (Follower)
- Electro-Pneumatic Nozzle Body (Leader)
- Pneumatic (Follower)
- Switching Node
Venturi Designs - Low Pressure

- Spray Pattern: 110°
- Operating PSI: 15-90 psi
- Tapered Edge flat spray pattern
- Overlap required: 50%-60% for uniform application (20-30% each edge)
- Nozzle Spacing: Typically 20”
- Optimum spray height: 110° - 20” above target
- Recommended PSI: 40-50 PSI
AIXR11004-50 psi
Venturi Designs - High/Medium Pressure

- Contains venturi - air aspirator
- Promotes an internal pressure drop – 4:1
- Spray Pattern: 80° and 120°
- Operating PSI: 30 - 100 psi
- Tapered Edge Flat Spray Pattern
- Overlap Required: 50%-60% for Uniform Application (20-30% each edge)
- Nozzle Spacing: Typically 20”
- Recommended PSI: 50-80 PSI

Air Induction – Air Inclusion – Air Injection
Designed so air is drawn into the nozzle cavity and exits with the fluid
Pre-Orifice VENTURI Nozzles
High and Medium Pressure

Pressure drop ratio = 4:1

Greenleaf TurboDrop XL
TeeJet Air Induction
Chamber
Pre-orifice
Air Inlets
Mixing Chamber
Exit orifice

Venturi Section
Hypro Ultra LowDrift
Exit orifice = 2X Pre-orifice
Influencing Droplet Size - Nozzles

Nozzle Comparison - 40 PSI Wind XR, AI, AIXR TeeJet®

©Winfield Solutions, LLC.
Influencing Droplet Size - Pressure

Pressure Comparison Wind - 10-80 PSI Al TeeJet® AI11002

©Winfield Solutions, LLC.
Turbulation Chamber w/Venturi
Air Induction Nozzle for Maximum Drift Control

Best drift mitigation option!

Turbo Induction - TTI

Removable Insert
Pre-Orifice
Mixing Chamber

Sweet Spot

Exit Orifice with 15° offset from vertical position

TTI110-VP Spray Tip
(Cross Section View)

50-80 PSI

AI Turbo TwinJet – AITTJ60
Single Outlet
Double Outlet

50-80 PSI

40-50 PSI

Best drift mitigation option!
TTI 11004-60 psi
Nozzle Demonstration

TTI 11004-60 psi

TDXL11004-60 psi

ULD120-04-60 psi
Nozzles—Recommended Use

**Not Recommended!!**

**chamber** 30-40 PSI

**Low Pressure Venturi** 40 PSI

**High Pressure Venturi** 50-80 PSI
Venturi Designed Twin Sprays

Watch closely! May be an option in the future!
Modular Versatility

TDXL11003  TADF03  TDXL11003-D  TADF03-D
M C VC    M C VC    VC XC UC    VC XC UC

One TurboDrop® Venturi.
Any pattern or spray category you need.
Nozzles for fertilizer on wheat:

- Hi-Flow
- StreamJet-7
- StreamJet-3
- CP Triple Stream Tip
Variable flow flat fan nozzle

- Flow varied by moving plunger in sleeve
- Plunger position determined by diaphragm and spray pressure – use pressure to adjust GPM
- 0.15 to 0.80 GPM, 110 degree spray angle,
- Available with various droplet size caps, 15 - 50 psi
Technology Alert!!!

Undercover

Y-Drops
Technology Alert!!!
Backpack Sprayer Drift Mitigation
Spray Management Valve

Reduce chemical use by up to 24%... Less sprayer pumping too!

- Reduces number of times manual sprayer needs to be pumped.
- Regulates pressure for steady, even flow.
- Shuts off spray if pressure falls below set amount.
- Allows for constant, precisely calibrated spray application.
- Reduces drift and spray waste—environmentally sound.
- Makes operator training faster and easier.
- Available in 15, 21, 25, and 44 psi (1, 1.5, 2, and 3 BAR)
- Costs less than $10 (Sug, list)

The CFValve™ (constant flow valve) attaches to your existing Chapin® or Solo® sprayer nozzle to help maintain a consistent flow rate with ±1.5% accuracy, regardless of pressure variations. It reduces pumping with backpack sprayers, reduces drift and saves you money by using less spray material. Valve automatically closes if the output pressure drops below the preset valve pressure. Available in 14.5-, 21-, 25-, and 43.5-psi outputs, depending on your sprayer type and application. 14.5- and 21-psi valves are designed for handheld and backpack sprayers and are ideal for drift control when applying herbicides. 25- and 43.5-psi valves are designed for 12-volt and motorized sprayers, which demand higher pressures. USA made. Specify valve psi when ordering.

Phone 1-800-745-2392 to learn more about our CF Valves.
Converting to a flat-fan and/or drift reducing nozzle

Addition of a spray management valve (SMV) to a compression or backpack sprayer will help maintain a constant pressure while spraying. Thus, spray rates and patterns will be more consistent, drift potential is reduced, calibration is easier, and the valve will provide an instant on and off with no dripping. Spray management valves are available in four preset pressure ranges: 14.5, 21.0, 29.0, and 43.5 pounds per square inch (psi). Find information about purchasing a spray management valve at [www.barnes_website.com/green-garde.html](http://www.barnes_website.com/green-garde.html). The cost is minimal.

Converting common hand sprayer adjustable nozzle systems to flat-spray nozzle types

For certain applications, it may be advantageous to convert a hand sprayer to a flat-spray nozzle with:

- Female (1) and male (2) adapters without diaphragm
- Female (3) and male (4) adapters with diaphragm
- 90-degree (5) and 45-degree (6) elbow adapters
- Quick cap, screen, and seat gasket (7)
- Quick cap, screen, and seat gasket set (7)
Hand Sprayer Calibration Steps Worksheet

The key to hand gun calibrator is to know the volume you are spraying over a given area. If you know the size of the area you are spraying, you can estimate the volume and calibrate the hand gun accordingly.

A simple formula is:

\[ \text{Volume} = \text{Length} \times \text{Width} \times \text{Height} \]

For example, if you are spraying a field 100 ft x 200 ft x 2 ft deep, the volume is:

\[ \text{Volume} = 100 \times 200 \times 2 = 40,000 \text{ cubic feet} \]

To convert cubic feet to gallons, use the formula:

\[ \frac{\text{Volume in cubic feet}}{1000} \times 7.48 \]

So, the volume is:

\[ \frac{40,000}{1000} \times 7.48 = 300 \text{ gallons} \]

2. With a straight edge, draw the lines to estimate the area. Use this for the volume calculation.

3. To calculate the gallons per acre, use the formula:

\[ \frac{\text{Gallons}}{\text{Area}} \times \frac{1}{1000} \]

So, the gallons per acre is:

\[ \frac{300}{1000} \times 1 = 0.3 \text{ gallons per acre} \]

4. To calculate the gallons per 1000 gallons, use the formula:

\[ \frac{\text{Gallons}}{\text{Volume}} \times \frac{1}{1000} \]

So, the gallons per 1000 gallons is:

\[ \frac{300}{1000} \times 1 = 0.3 \text{ gallons per 1000 gallons} \]

5. To calculate the gallons per 1000 gallons per 1000 ft, use the formula:

\[ \frac{\text{Gallons}}{\text{Volume}} \times \frac{1}{1000} \times \frac{1}{1000} \]

So, the gallons per 1000 gallons per 1000 ft is:

\[ \frac{300}{1000} \times \frac{1}{1000} = 0.0003 \text{ gallons per 1000 ft} \]

6. To calculate the gallons per 1000 gallons per 1000 ft per 1000 ft, use the formula:

\[ \frac{\text{Gallons}}{\text{Volume}} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \]

So, the gallons per 1000 gallons per 1000 ft per 1000 ft is:

\[ \frac{300}{1000} \times \frac{1}{1000} \times \frac{1}{1000} = 0.0000003 \text{ gallons per 1000 ft per 1000 ft} \]

7. To calculate the gallons per 1000 gallons per 1000 ft per 1000 ft per 1000 ft, use the formula:

\[ \frac{\text{Gallons}}{\text{Volume}} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \]

So, the gallons per 1000 gallons per 1000 ft per 1000 ft per 1000 ft is:

\[ \frac{300}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} = 0.0000000003 \text{ gallons per 1000 ft per 1000 ft per 1000 ft} \]

8. To calculate the gallons per 1000 gallons per 1000 ft per 1000 ft per 1000 ft per 1000 ft, use the formula:

\[ \frac{\text{Gallons}}{\text{Volume}} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \]

So, the gallons per 1000 gallons per 1000 ft per 1000 ft per 1000 ft per 1000 ft is:

\[ \frac{300}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} = 0.0000000000003 \text{ gallons per 1000 ft per 1000 ft per 1000 ft per 1000 ft} \]

9. To calculate the gallons per 1000 gallons per 1000 ft per 1000 ft per 1000 ft per 1000 ft per 1000 ft, use the formula:

\[ \frac{\text{Gallons}}{\text{Volume}} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \]

So, the gallons per 1000 gallons per 1000 ft per 1000 ft per 1000 ft per 1000 ft per 1000 ft is:

\[ \frac{300}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} \times \frac{1}{1000} = 0.0000000000000003 \text{ gallons per 1000 ft per 1000 ft per 1000 ft per 1000 ft per 1000 ft} \]

Table 1: Sample sprayer application rates

<table>
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<tr>
<th>Sprayer type</th>
<th>1 gallon</th>
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<th>3 gallons</th>
<th>5 gallons</th>
<th>10 gallons</th>
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<td>4 solutions</td>
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<td>6 solutions</td>
</tr>
<tr>
<td>7 solution</td>
<td>2 solutions</td>
<td>3 solutions</td>
<td>4 solutions</td>
<td>5 solutions</td>
<td>6 solutions</td>
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</table>

Table 2: Selected nozzle manufacturer websites.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain Bird</td>
<td><a href="http://www.rainbird.com/">http://www.rainbird.com/</a></td>
</tr>
<tr>
<td>Netafim</td>
<td><a href="http://www.netafim.com/">http://www.netafim.com/</a></td>
</tr>
<tr>
<td>Hunter</td>
<td><a href="http://www.hunterirrigation.com/">http://www.hunterirrigation.com/</a></td>
</tr>
<tr>
<td>automation</td>
<td><a href="http://www.automaticirrigation.com/">http://www.automaticirrigation.com/</a></td>
</tr>
<tr>
<td>Marlo</td>
<td><a href="http://www.marloirrigation.com/">http://www.marloirrigation.com/</a></td>
</tr>
<tr>
<td>Rain Gun</td>
<td><a href="http://www.rangun.com/">http://www.rangun.com/</a></td>
</tr>
</tbody>
</table>

Fact Sheet: MF2915

Boomless Nozzles
Off-Center Venturi Flat-fan
Boom Buster
XP BoomJet
Boom Extender:

Boom X Tender® Spraying
(last tip on the boom)

Right-of-Way Pattern
Stainless steel | Polycetal
Flow rates = 3.7 - 9.8 gpm at 30 - 60 psi

Medium-Coarse Droplets
Distances = 15-16 feet
An Evaluation of ATV-Mounted Boomless Spray Nozzles for Weed Control

Robert Wolf, Associate Professor and Extension Specialist, Bio and Ag Engineering
Dallas Peterson, Extension Weed Management Specialist

In recent years, all-terrain vehicles (ATVs) equipped with small-capacity spray tanks and boomless nozzle systems have become popular for controlling and eliminating weeds on rangeland, pasture, and farmland and are thought to have potential to spray 25-30 foot swaths using a centrally located single or dual nozzle arrangement.

Several nozzle designs have recently been introduced for ATV-mounted application systems. Use of these nozzles, however, is occurring without a clear understanding of correct operating procedures. These nozzles may not be effective for weed control. The large spray droplets created by these nozzle types often do not provide full weed coverage over the entire spray width.

Considerations for Using Boomless Nozzles

Field Trials

Field trials were conducted to evaluate the effectiveness of spray nozzles on ATVs.

Trials evaluated pattern quality, swath width, droplet range, and coverage effectiveness using four different nozzle types.
Thank You

Follow (Bob Wolf) on Twitter @spraydrift