Irrigation Infrastructure & Emission Devices

Anthony Tasselli
Toro Ag - Technical Sales
History of Toro Ag

- Originally built by Reed Irrigation Systems in 1972
- Acquired by James Hardie in 1978
- Acquired by Toro in 1995

- Since those acquisitions, most of our growth has come from products developed by Toro
  - Aqua-Traxx Azul & FlowControl
  - Blueline
  - Greenhouse products
  - Disc filters
  - Buyout relationships for allied products

- The Toro Company celebrated it’s 100 year centennial in 2014

- Toro Micro Irrigation changed name to Toro Ag in 2017
Drip Irrigation Products

- Emission Devices
  - Dripline with emitters built in
  - Drip tape
  - Drip emitters – on-line with polyethylene tubing
  - Micro-sprinklers / jets
- Water distribution tubing
  - Oval Hose
  - Lay Flat
  - Micro Tubing
- Accessories
  - Filters
  - Automation/Controllers
  - Valves
  - Fittings
Typical Drip Irrigation System

- Surface Reservoir and Pump
- Chemical Injection Tanks and Equipment
- Greenhouse and Hydroponics
- Well Pump
- Central Valves and Backup Filters
- Sentriesand Filters
- Toro Ag-900 Series Valves
- Irrigation Controller

Drip Tape Variants:
- AQUA-TRAXX and FLOWCONTROL
- BLUE STRIPE
- BLUELINE

- Drip Tape - Subsurface Drip Irrigation
- Oral Nozzles - Row Crops
- Hose & Emitters - Permanent Crops
- Dripline - Permanent Crops
Typical Drip System Components

Essential Components

- Water source
- Pipeline
- Filter
- Control Valve
- Air/Vacuum Relief
- Emission Devices

Supplemental Components – Enhance performance & improve functionality

- Pressure Regulation
- Chemical Injection Equipment
- Flow meter(s)
- Pressure Gauges
- Solenoid Valves
- Automated control system
- Flush Valves/Flushing Manifolds
Design Considerations

A balance of properly sized components & cost saving measures

- **Intended Use**
  - Crop(s)
  - Life Expectancy

- **Field conditions**
  - Water availability
  - Soil types & characteristics
  - Crop water requirements

- **Type and Size**
  - Pump
  - Pipe
  - Valves
  - Filtration
  - Emission devices
Intended Use

Permanent Installations
- Emitter line
- Poly hose with external emitters
- Micro Sprinklers/Jets/ Spray stakes
- SDI

Annual Installations
- Drip Tape
- Lay Flat hose for mainlines, submains, and manifolds
- Oval Hose/Poly Hose for distribution manifolds

Mobile Infrastructure
- Trailer-mounted pumps
- Trailer-mounted filters
- Skid-mount injection sleds
- Lay-flat mainline/manifolds
- Aluminum mainline

Permanent Infrastructure
- Wells
  - Wet-well / Sumps
  - Canned Subs
  - Line shaft turbines
- Reservoir- Surface Pump
- Filter Stations
- Chemigation Sheds
- Buried Mainlines
Permanent Installations

- Grapes
- Blueberries
- Tree Nuts
- Apples
- Hops
- Peaches
- Plums
- Cherries
- Raspberries
- Apples
- Citrus
- Olives
- Nursery
Annual Installations

- Strawberries
- Tomatoes
- Peppers
- Lettuce
- Corn
- Onions
- Potatoes
- Cucumbers
- Squash
- Melons
- Sweet Corn
- Carrots
- Herbs
Permanent Infrastructure

In-field headworks – 4 zone control valves & reliefs

Primary Headworks - 48”x2” Sand Media Filter & Zone Valves

Valve manifold at primary head works

Engine driven Line Shaft Turbine

PVC Mainline, submain and manifold – shared trench

Primary Headworks - 8” Automatic Screen filter at turbine discharge
Mobile Infrastructure

- Skid-mount Sand Media Filter
- 2-Zone Head Works
- Layflat Supply to Oval hose manifolds
- Engine-driven Centrifugal pump
- Riverbank pump site
- FlowControl drip tape on layflat manifold
- Layflat Supply & layflat manifold; 2 tapes per bed
- Trailer-mounted Pump, filter, and fertilizer injection
Successful Micro-Irrigation systems should...

- Increase yield, crop quality, and income
- Reduce inputs - water, fertilizer, labor, tillage
- Distribute content uniformly and efficiently
Irrigation Uniformity (EU)

- Uniform application of water and nutrients
- Efficient resource use
- Uniform crops
## Irrigation Uniformity (EU) – What does it mean?

<table>
<thead>
<tr>
<th>Crop Water Use at Peak ET, Inches per Week*</th>
<th>Drip gross application rate, inches/day**</th>
<th>90% EU Drip net application rate, inches/day</th>
<th>Days per week to irrigate</th>
<th>Gross application rate, inches/day</th>
<th>60% EU Net application rate, inches/day</th>
<th>Days per week to irrigate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8</td>
<td>1.44</td>
<td>1.30</td>
<td>2.2</td>
<td>1.44</td>
<td>0.86</td>
<td>3.2</td>
</tr>
</tbody>
</table>

* Assuming peak ET = .40"/day x 7 days/week = 2.8"/week

** System Details: 0.06"/hr gross application rate x 24 hrs/day = 1.44 inches/day

### Days per Week to Irrigate, Peak

- **90% EU System**: 2.2 days
- **60% EU Drip System**: 3.2 days

30% less run time with high EU!
Management / Scheduling

Equipment Malfunction

Challenges to Optimize Uniformity (EU)
Challenges to Optimize Uniformity (EU)
Challenges to Optimize Uniformity (EU)

Design (Terrain, Layout, Pipe Sizing)

- 2" manifold, middle feed: 89% EU
- 3" manifold, middle feed: 94% EU
- 3" manifold, end feed: 89% EU
Designing for Uniformity

- Terrain, layout, pipe-sizing
- Emission Device Selection

Types of Micro-Irrigation Emission Devices

- Micro-Sprinklers
- On-line Emitters
- Heavy Wall Dripline
- Flow Control Tape
- Tape
**Drip Tape Considerations**

Not all drip tape is created equal

<table>
<thead>
<tr>
<th>Tubing Construction</th>
<th>Emitter Type</th>
<th>Filtration Requirement</th>
<th>Published Flow Information</th>
<th>Other Differentiators</th>
<th>Product Traceability</th>
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</thead>
<tbody>
<tr>
<td>Seamless</td>
<td>Flowpath</td>
<td>100 mesh</td>
<td>GPH @ 8 psi</td>
<td>Emitter Exponent</td>
<td>Laser Etched</td>
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<tr>
<td>Seamed – Cast</td>
<td>Discrete Emitter</td>
<td>120 mesh</td>
<td>GPH @ 10 psi</td>
<td>Emitter spacing</td>
<td>Printed</td>
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<tr>
<td>Seamed – Blown</td>
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<td>155 mesh</td>
<td>Q/100 – GPM per 100ft</td>
<td>Minimum order quantities</td>
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</table>
The Discharge Exponent (X) of an emitter determines the sensitivity of that emitter’s flow rate to differences in pressure.

\[ Q = K \times P^X \]

- \( Q = \) flow rate, gph (L/H)
- \( P = \) operating pressure, psi (kPA)
- \( K = \) flow coefficient
- \( X = \) flow exponent

\[ X = 1.0 \quad \text{Fully laminar} \]

\[ X = 0.0 \quad \text{Fully pressure-compensating} \]
<table>
<thead>
<tr>
<th>Product Positioning</th>
<th>$x$ Value</th>
<th>Emitter Type</th>
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</thead>
<tbody>
<tr>
<td><strong>Pressure Compensating</strong></td>
<td>0.0</td>
<td>Pressure Compensating</td>
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<tr>
<td>BlueLine PC, Drip In PC, Dripnet PC, Inbar, Olympos</td>
<td>0.1</td>
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<tr>
<td></td>
<td>0.2</td>
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<tr>
<td></td>
<td>0.3</td>
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<tr>
<td><strong>Turbulent Flow</strong></td>
<td>0.4</td>
<td>Vortex Emitters</td>
</tr>
<tr>
<td>Aqua-Traxx, Neptune, T-Tape, Streamline, Chapin, Irriway, Eolos, etc.</td>
<td>0.5</td>
<td>Orifice Flow or Tortuous-Path</td>
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<tr>
<td></td>
<td>0.6</td>
<td>Orifice Flow or Tortuous-Path</td>
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<tr>
<td><strong>1970’s</strong></td>
<td>0.7</td>
<td>Long or Spiral Path</td>
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<tr>
<td></td>
<td>0.8</td>
<td>Microtube</td>
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<tr>
<td><strong>1960’s</strong></td>
<td>0.9</td>
<td>Capillary Flow</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>Capillary Flow</td>
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</table>
Advantages vs. PC:
- Flexibility to increase system flow if needed
- Greater control over watering decisions
- Available in thinner walled options
- Closer emitter spacing

Advantages vs. Turbulent Flow
- Improved uniformity on:
  - Longer runs
  - Undulating terrain
- Better Performance

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<tr>
<td>BlueLine PC, Drip In PC,</td>
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<td>Flow Control</td>
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<tr>
<td>Dripnet PC, Inbar, Olympos,</td>
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<td>Vortex Emitters</td>
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<tr>
<td>Ram, Amnon</td>
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<td>Orifice Flow or Tortuous-Path</td>
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<tr>
<td></td>
<td>1.0</td>
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</table>
How Emitter Exponents Relate

Emitter Exponent

Flow Rate (GPH)

Operating Pressure (PSI)

Design Flow: 1.0 GPH
Operating Pressure: 15 PSI
Pressure Variation: ±3 PSI

At 15 PSI Operating Pressure
1.0 = Laminar Flow (Flow Variation: ±0.2 GPH)
0.5 = Turbulent Flow (Flow Variation: ±0.1 GPH)
0.3 = Flow Control (Flow Variation: ±0.06 GPH)
0.0 = Full Pressure Compensation (Flow Variation: ±0 GPH)
Design Flexibility

Get the wetting pattern you want!

12” 0.22 GPM / 100’

8” 0.22 GPM / 100’
## Design Flexibility

<table>
<thead>
<tr>
<th>Emitter Flow Rate</th>
<th>Outlet Spacing</th>
<th>Emitter Flow Rate</th>
<th>Q-100</th>
<th>Emitter Exponent</th>
<th>Filtration Requirement</th>
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<td>0.07 gph emitter</td>
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<td>0.20</td>
<td>0.76</td>
<td>0.50</td>
<td>2.38</td>
</tr>
</tbody>
</table>

- 9 Flow rates (0.07 – 0.53 gph)
- 7 Wall thicknesses (4 – 15 mil)
- 5 Tubing diameters (5/8” – 1 3/8”)
- Emitter spacing options (4 to 36 inches)
Drip Tape

**Aqua-Traxx® Azul**
- Available in ultra-low emitter flow rates (0.07, 0.09 and 0.10 gph) as well as low, medium and high emitter flow rates (0.13, 0.15, 0.20, 0.27, 0.34 and 0.53 gph)
- Enhanced clog resistance with filtration requirements as low as 100 mesh - lowest for any drip tape in the industry! *(0.13, 0.15, 0.20, 0.27 gph)*
- Greater filtration area with patent-pending Multi-Stage filters
- Optimized flow passages further resist clogging
- One price for any emitter spacing from 6 – 24 inches

**Aqua-Traxx® Azul Sweet Spot™**
- Longer runs and better uniformity than 5/8” ID drip tape
- Lower system costs resulting from less hose, layflat, connections and labor
- Less expensive than 7/8” ID drip tape
- More environmentally friendly than 7/8” ID drip tape, plus more water savings due to less runoff

**FlowControl®**
- High uniformity on longer runs and hilly terrain
- Retain flexibility to increase or decrease application rate for greater control over watering and scheduling decisions
- Available in a wider range of thicknesses including more affordable 5/8in 6mil and 7/8in 8mil
BlueLine® Pressure Compensating

- The Latest Technology – the exclusive Toro flow path technology is the result of 30 years of emitter design in combination with the latest in computer aided design.
- More Resistant to Plugging – With unique raised inlets, the amount of debris is dramatically reduced at emitter inlet.
- Unmatched Uniformity – The Toro flow path technology uses a shark tooth design providing a fully turbulent flow path that is independent from the wall of the tubing providing unmatched uniformity.
- Self-flushing Diaphragm – patented new design flushes during operation and shutdown further resisting clogging providing longer life for your system.

BlueLine® Classic

- Efficient Emitter Design - The unique "shark tooth" emitter flow path design allows uniform application of water and nutrients in demanding field applications, including long lengths of run or undulating terrain
- Accurate Flow Rate Between 5 and 60 psi - A wide operating window means less waste and uniform application
- Low Profile Emitter Design - Reduced friction loss saves energy and helps ensure uniform application
- Uniform Manufacturing Platform - State of the art injection molding technology yields an "industry best"
Poly Hoses

Blue Stripe® Oval and Round Hose

- Large diameter sizes for submain and mainline applications as a cost-effective alternative to PVC
- Smaller diameters can be used in lateral run applications on permanent crops
- When pressurized Oval Hose becomes round just like standard Blue Stripe round hose – offers freight savings of up to 50%
- The unique Oval configuration allows you to reduce storage space
- Available in a wide range of diameters, wall thicknesses, coil lengths and working pressures.
- Minimum 2% carbon black added for protection
- Also available in white, ideal for nursery and greenhouse irrigation systems

Blue Stripe® Round Hose

- Available in a wide range of diameters, wall thicknesses, coil lengths and working pressures.
- Minimum 2% carbon black added for protection
- Also available in white, ideal for nursery and greenhouse irrigation systems
Supporting Products