HEAP LEACHING GUIDE
Mineral Recovery, Dust Control, Effluent Dispersion, Evaporation, Side of Slope Leaching
MINING INDUSTRY SOLUTIONS

FOUNDED IN 1963

Senninger has provided efficient “Low Pressure – High Performance” irrigation by developing products that conserve energy and provide exceptional uniformity. Senninger products became popular in 1970, for agricultural applications and grew to include the mining industry. Special acid-resistant sprinklers were specifically developed to support the copper industry. Senninger sprinklers, spray nozzles and pressure regulators are used globally for mineral recovery, dust control, effluent dispersion, evaporation, side of slope leaching and other industrial applications.

NEW DEMANDS

Modern heap leaching practices include expanding technology which demands higher performance to meet strict industry requirements. Heap leach depths have increased to more than 500 ft of ore depth from only 50 to 65 ft a decade ago.

Layers of coarse and fine textured material during material comprise leach piles. Leaching solutions flow more readily in the conductive layers, potentially leaving areas unleached.

DRIP SYSTEMS

Drip systems depend on source point application of the solution, which promotes channeling. With minimal lateral movement of the solution applied, close spacing of the drippers and laterals is necessary to achieve the desired application rate.

Drip Lateral Lines
(Emitters are placed every two feet within the line)

Unleached area

Channeling

ORIFICE COMPARISON

The small orifices and flow passages in drip emitters have a greater potential for clogging. Leaching drip emitters often require filtration of 150 mesh or finer. The Senninger mini-Wobbler offers three nozzle sizes minimizing clogging without expensive filtration.

LATERAL LINE EMITTER EFFECTIVE DISCHARGE FLOW AREA

<table>
<thead>
<tr>
<th>MINI-WOBBLER® NOZZLE ORIFICE SIZES</th>
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MINI-WOBBLER®

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MINI-WOBBLER®
WOBBLER TECHNOLOGY

WOBBLER BENEFITS

- Low pressure operation reduces energy costs.
- Uniformity of distribution (90+ percent) over full 360º area.
- Versatility of being moved and used repeatedly
- Visual confirmation of uniformity not afforded by drip systems.
- Adjustable flow and application rates.
- Adapts to pad rinsing for reclamation.
- ½ to ⅓ the cost of drip systems.

Uniformity of solution distribution is essential to maximizing metals recovery. At 90+ percent of uniformity, Wobbler technology is the most effective method for total solution contact. Wobblers can utilize the same low pressures as drip systems.

WOBBLER TECHNOLOGY

LOW PRESSURE - HIGH PERFORMANCE

Low pressure, 10-20 psi (1.03-1.38 bar) spray nozzles like the mini-Wobbler® evenly applies solution over large surface areas, much like a gentle rain, maximizing solution/ore contact, while minimizing the potential for channeling or clogging.

MINI-WOBBLERS®

Available in:
copper, gold/silver
1/2” NPT connection

XCEL-WOBBLERS®

Available in:
copper, gold/silver
High and Mid angle
⅛” and ¼” NPT connection

WINSIPP2 CUSTOM MINING SOFTWARE

Developed to help mining leaching installations achieve the required application rate and uniformity. It provides visual comparisons of various combinations of applicators, flows, pressures, and spacing options. Analyzing these combinations in advance helps assure optimal system design and operation.

MINI-WOBBLERS®

Available in:
copper, gold/silver
1/2” NPT connection

XCEL-WOBBLERS®

Available in:
copper, gold/silver
High and Mid angle
1/4” and 1/8” NPT connection

WINSIPP2 DENSOGRAM®

<table>
<thead>
<tr>
<th>Model</th>
<th>Nozzle</th>
<th>Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINI WOBLER</td>
<td>7</td>
<td>1.51 gpm (343 L/hr)</td>
</tr>
</tbody>
</table>

| Layout: | Rectangular |
| Offset Spacing | 0 ft (0 m) |
| Head Spacing | 20 ft (6 m) |
| Row Spacing | 23 ft (7 m) |

| Average Precipitation (gpm/ft²) | 0.0033 gpm/ft² (8.2 L/hr/m²) |

| Coefficient of Uniformity | 92.88% |
| Distribution Uniformity | 88.64% |
| Scheduling Coefficient | 5% |
LEACHING COMPARISON

DRIP
To provide this application rate, drip irrigation systems would require spacing of laterals and emitters to be about 2 ft or (0.61 m) between drip lines and emitters.

WOBBLERS®
Mini-wobblers® and Xcel-Wobblers are spaced 20 ft x 23 ft (6 m x 7 m) between sprinklers and lateral lines. Material and labor costs can vary significantly in these two systems.

LOW PRESSURE SYSTEMS
Save energy and allow greater areas to be leached in less time. Many applicators are not designed to operate at low pressure. Senninger Wobblers® have been engineered and designed to provide optimal performance at low pressures, in many cases as low as that used for drip emitters. At low pressure of 15 to 20 psi (1 to 1.38 bar), Wobblers® provide a consistent droplet size throughout the entire wetted profile. The solution reaches the ore surface with a gentle even distribution.

BILL OF MATERIAL

<table>
<thead>
<tr>
<th>Material</th>
<th>Sprinkler</th>
<th>Drip</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 mm PE lateral / (20 mm) PE lateral</td>
<td>4,700 linear ft (1,433 linear m)</td>
<td>54,000 linear ft (16,459 linear m)</td>
</tr>
<tr>
<td>Fittings</td>
<td>15</td>
<td>328</td>
</tr>
<tr>
<td>Emitters</td>
<td>255</td>
<td>27,000</td>
</tr>
<tr>
<td>ENERGY REQUIRED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sprinkler</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Drip</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Pipes</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Fittings</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Emitter Operating Pressure</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Filtration</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>91</td>
<td>95</td>
</tr>
</tbody>
</table>

Based on IrriMaker® design for pad 328 ft x 328 ft (100 m x 100 m)

VERSATILITY

<table>
<thead>
<tr>
<th></th>
<th>Sprinkler</th>
<th>Drip</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE lateral recyclable?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Emitter recyclable?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Visual performance assessment</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Can flow be changed?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Plugging potential?</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Filtration required?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Can orifice be cleaned?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
3123 AND 4123 PART-CIRCLE IMPACT SPRINKLERS

Available in copper, gold/silver
- Eliminates costly mobile watering
- Conserves water
- Increases coverage efficiency
- Allows dust control automation
- Side slope leaching option
- 3/4" NPT male base, nozzle #9 (9/64")

The best and most flexible option to leach side slopes or keep dust under control when coupled with a portable pipe system.

NOTE: Pressure regulator recommended @ 40 psi (2.76 bar). Flow: 3.65 gpm (829 L/hr)

IMPACT SPRINKLERS

Available in copper, gold/silver
Low flow models
3/4" M NPT, 1 1/4" M NPT, 1 1/2" M NPT, 1 1/4" M BSPT connections

SUPER SPRAY

For evaporation
3/4" NPT Connection

PRESSURE REGULATORS

PRU-Ultra Flow
- 20 to 100 gpm (4543 to 22712 L/hr)
- 2" NPT or BSPT connections

PRHF-High Flow
- 10 to 32 gpm (2271 to 7268 L/hr)
- 1" or 1 1/4" NPT or BSPT connections

PMR-MF-Medium Flow
- 2 to 20 gpm (454 to 4543 L/hr)
- 3/4" and 1" NPT or 1" BSPT connections

PRL-Low Flow
- 0.5 to 8.0 gpm (114 to 1817 L/hr)
- 3/4" NPT or Hose connections

PRMP-Mining Prospector
- 0.5 to 7 gpm (114 to 1590 L/hr)
- 3/4" NPT or Hose connections
**QUICK-CONNECT RISER ADAPTER**

1. Place the riser adapter in the desired location
2. Support it with either 1/2” or 3/4” PVC pipe or 5/16” plastic stake (PL/1000093)
3. Cut Polyethylene tubing to desired length
4. Insert Super Barb tubing into both ends of tubing
5. Press fit one tapered end into riser adapter
6. Using a 7/16” drill and tap to bore a 1/4” hole in HDPE lateral where the bushing will fit
7. Insert the threaded bushing into the tapped hole
8. Press fit the tapered end into the threaded bushing

Friction loss through the entire assembly (including 3 ft (0.9 m) of 0.270” PE tubing) is 6.1 psi at 2.0 gpm (0.43 bar at 454 L/hr).

* Consult factory for friction loss on flows greater than 2 gpm (454 L/hr) or tubing longer than 3 ft (0.9 m).

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**RISER ADAPTER**

1. Place the riser adapter in the desired location
2. Support it with either 1/2” or 3/4” PVC pipe or 5/16” plastic stake (PL/1000093)
3. Cut Polyethylene tubing to desired length
4. Push one end of tubing approximately 1/2” into riser adapter
5. Insert Super Barb Fitting (with barbed end) into other end of tubing
6. Using the proper punch tool, cut hole in lateral where the tubing will attach
7. Insert barb into the hole

Friction loss through the entire assembly (including 3 ft (0.9 m) of 0.345” PE tubing) is 1.6 psi at 2.0 gpm (0.11 bar at 454 L/hr).

* Consult factory for friction loss on flows greater than 2 gpm (454 L/hr) or tubing longer than 3 ft (0.9 m).

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Tubing punch tools sold separately:
- TUPTAP51 for 0.345” barb fitting and press-fit bushing (red handle).
- TUPTAP41 for 0.270” barb fitting (green handle).
Senninger Riser Adapters make irrigation easier in hard to reach places. It is ideal for temporary and portable systems. Sprinklers connect to the adapter, which then connects to low pressure laterals. This makes it easy to relocate or remove sprinklers for installation in other locations.

### FEATURES
- No gluing or fusing required
- Suitable for sprinkler or spray nozzles with a 1/2" NPT male base connection
- Components available for 0.345" and 0.270" PE tubing
- Riser adapter suitable for 1/2" PVC, 3/4" PVC, or 5/16" steel rod

### LOWER FLOWS
(Use with 0.270" tubing)

<table>
<thead>
<tr>
<th>Assembly Part #s</th>
<th>RSASM2TC3QCA</th>
<th>RSASM23C3</th>
<th>RSAD270 1/2&quot; F x 0.270&quot; Tubing</th>
<th>RSAD345 1/2&quot; F x 0.345&quot; Tubing</th>
<th>RSAD345 1/2&quot; F x 0.345&quot; Tubing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Riser Adapters</strong></td>
<td></td>
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</tr>
<tr>
<td>Fitting</td>
<td>FTA1B2T 0.270° Super Barb x #2 Taper*</td>
<td>FTA15B2T 0.345° Super Barb x #2 Taper*</td>
<td>FTA15B2T 0.345° Super Barb x #2 Taper*</td>
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</tr>
<tr>
<td>PE Tubing</td>
<td>TU15T3 3 ft (0.9 m) 0.270° I.D.</td>
<td>TU15ST3 3 ft (0.9 m) 0.345° I.D.</td>
<td>TU15ST3 3 ft (0.9 m) 0.345° I.D.</td>
<td>TU15ST3 3 ft (0.9 m) 0.345° I.D.</td>
<td>TU15ST4 4 ft (1.2 m) 0.345° I.D.</td>
</tr>
<tr>
<td>Barb Fittings</td>
<td>FTA1B1B 0.270° Super Barb x Hose Barb Insert Adapter</td>
<td>FTA1SB2T 0.345° Super Barb x Hose Barb Insert Adapter</td>
<td>FTA1SB2T 0.345° Super Barb x Hose Barb Insert Adapter</td>
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<td>Bushings</td>
<td>FTHS2T Winged Hose Barb Bushing #2 Taper</td>
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<td>FTHS3T Winged Hose Barb Bushing #3 Taper</td>
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### HIGHER FLOWS
(Use with 0.345" tubing)

<table>
<thead>
<tr>
<th>Assembly Part #s</th>
<th>RSASM24C3QCA2T</th>
<th>RSASM24C3QCA3T</th>
<th>RSASM24C3</th>
<th>RSASM24C4</th>
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<tr>
<td>Fitting</td>
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<td>FTA15B2T 0.345° Super Barb x #2 Taper*</td>
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<td>PE Tubing</td>
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<td>TU15ST3 3 ft (0.9 m) 0.345° I.D.</td>
<td>TU15ST3 3 ft (0.9 m) 0.345° I.D.</td>
<td>TU15ST4 4 ft (1.2 m) 0.345° I.D.</td>
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<tr>
<td>Barb Fittings</td>
<td>FTA1B1B 0.270° Super Barb x Hose Barb Insert Adapter</td>
<td>FTA1SB2T 0.345° Super Barb x Hose Barb Insert Adapter</td>
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<td>FTA1SB2T 0.345° Super Barb x Hose Barb Insert Adapter</td>
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<tr>
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<td>FTHS3T Winged Hose Barb Bushing #3 Taper</td>
<td>FTHS3T Winged Hose Barb Bushing #3 Taper</td>
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### Additional Options
- FT4HSC2T Barb Bushing Clamp for 1" Hose #2 Taper*
- FT1M2T Winged 1/4" M NPT Threaded Bushing #2 Taper*
- FTPLUG2T #2 Taper* (Red)
- FTPLUG3T #3 Taper** (Maroon)

Friction loss through the entire assembly:
- including 3 ft (0.9 m) of 0.270° ID PE tubing - is 6.3 psi at 2.0 gpm (0.43 bar at 454 L/hr).
- including 3 ft (0.9 m) of 0.345° ID PE tubing - is 1.7 psi at 2.0 gpm (0.117 bar at 454 L/hr).

Consult factory for friction loss on flows greater than 2 gpm (454 L/hr) or tubing lengths greater than 3 ft (0.9 m).
We strive to create the best low pressure, high performance agricultural irrigation products in the world while maintaining the highest level of quality and reliability. In every instance we will back our innovations with the unwavering support our customers need to succeed.

James E. Burks, President of Senninger Irrigation