Wastewater Pump Intake Designs

Conventional and Self Cleaning Wetwells
Topics

• Clear liquid intake design review
• Solids-bearing liquid intake design
  • Self Cleaning designs
• Effective Operation and Control
Clear Liquids – HI 9.8.1 & 2

- Limit Surface Vortices
- Limit Approach Velocity
- Generalized Dimensions

“D” = f(Flow)
Clear Liquids – HI 9.8.1 & 2

- Limit Surface Vortices
- Limit Approach Velocity
- Generalized Dimensions
- “D” = f(Flow)
- “S” = f(Flow)
Bell Sizing – HI 9.8.25B

- V = 2.0 ft/s
- V = 3.0 ft/s
- V = 5.5 ft/s
- Recommended
- V = 8.0 ft/s
- V = 9.0 ft/s
Submergence – HI 9.8.26B

Bell D for 2.0 ft/s
Bell D for 3.0 ft/s
Bell D for 5.5 ft/s
Bell D for 8.0 ft/s
Bell D for 9.0 ft/s

S = Submergence, inches

Q = Flow, gpm
Duplex Circular Wetwell – HI 9.8.4A

• Limit Surface Vortices
• Limit Approach Velocity
• Generalized Dimensions
  • “D” = f(Flow)
  • “S” = f(Flow)
Duplex Circular Dry Pit – HI 9.8.4C

- Limit Surface Vortices
- Limit Approach Velocity
- Generalized Dimensions
  - “D” = f(Flow)
  - “S” = f(Flow)
Solids-bearing Liquids - Considerations

- Where possible, adhere to clear liquid layout
- Add features to minimize solids accumulation
  - Minimize horizontal surfaces
Duplex Circular Dry Pit – HI 9.8.15

- Steep and large corner fillets
- Minimized horizontal surfaces
- Suction bell clearance at tight end of range (.30 to .40 x D)

Figure 9.8.15 — Circular wet pit with sloping walls and minimized horizontal floor area (submersible pumps shown for illustration)
Cleaning Cycle Description

• “Removal of settled solids is effected each time a pump is activated, but removal of floating solids can only be accomplished when the liquid surface is at a minimum and the pump intake submergence is low enough to create a strong vortex.”
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• Do we think it really works?
‘Cleaning Cycle’ Reality

- Example - 1000 GPM at 40’ (6” Sub Non-Clog)
- Db = 22” Volute
- Ds = 72” Wetwell ID
- Cf = 8”
- Assume constant speed fill and draw at 800 GPM inflow (dV/dt = 200 GPM)
- Level above fillet top – 204 Gallons per foot, or approximately 1 foot per minute drawdown
‘Cleaning Cycle’ Reality

- Example - 1000 GPM at 40’ (6” Sub Non-Clog)
- Db = 22” Volute
- Ds = 72” Wetwell ID
- Cf = 8”
- Assume constant speed fill and draw at 800 GPM inflow (dV/dt = 200 GPM)
- Level half way down slope – 72 Gallons per foot, or approximately 1 foot drawdown every 21 seconds
‘Cleaning Cycle’ Reality

- Example - 1000 GPM at 40’ (6” Sub Non-Clog)
- Db = 22” Volute
- Ds = 72” Wetwell ID
- Cf = 8”
- Assume constant speed fill and draw at 800 GPM inflow (dV/dt = 200 GPM)
- Level approaching vortex break – 30 Gallons per foot, or approximately 1 foot drawdown every 8 seconds.
‘Cleaning Cycle’ Reality

- Example - 1000 GPM at 40’ (6” Sub Non-Clog)
- Db = 22” Volute
- Ds = 72” Wetwell ID
- Cf = 8”
- Assume constant speed fill and draw at 800 GPM inflow (dV/dt = 200 GPM)
- Level approaching vortex break – 30 Gallons per foot, or approximately 1 foot drawdown every 8 seconds.
- Due to varying section, drawdown rate accelerates rapidly
‘Cleaning Cycle’ Reality

• Sloped wetwells in general do not provide effectively cleaning action as the high velocity mode of operation is transient in nature.
‘Cleaning Cycle’ Reality

• Confined Inlet style wetwells suffer from same limitations
• Baffle wall results in solid settling in lag pump basin, ‘slugging’ lag pump when lead / lag control alternates
Trench Wetwell for Solids-bearing liquids

**Trench-Type Wet Well**

- Transition from circular to rectangular recommended, see Section 9.8.3.2.3.1
- Anti-rotation baffle (protude as far as practical)
- 0.3 m/s (1.0 ft/s) max velocity above trench
- \( r \geq 2.33 \times \text{head on sluice gate (2D min)} \)
- \( \varepsilon \geq 45^\circ \) for smooth surface (plastic lining)
- \( \varepsilon \geq 60^\circ \) for concrete
- \( s \geq (1+2.3F_b)D \)
Trench Wetwell for Solids-bearing liquids

- High velocity flow down ogee
- Floatables are entrained into flow stream
- Solids pushed to cleaning pump
Trench Wetwell for Solids-bearing liquids

Fluid momentum allows cleaning pump to maintain prime continuously while wetwell operates in high velocity mode.
Trench Wetwell for Solids-bearing liquids

Hydraulic jump formed

Cleaning pump still operating
Trench Wetwell for Solids-bearing liquids

• Ideally suited for vertical column solids handling pumps
  (Fairbanks Morse VTSH, etc)
Trench Wetwell for Solids-bearing liquids

• Pull up submersibles with suction extension
• Dry pit / Wet pit with suction bells
Trench Wetwells - Cautions

• For very high capacity installations, follow updated intake design guidelines, or specify a hydraulic model study
• Do no underestimate control challenges
• Manual cleaning is always superior
What is the WEMCO-Hidrostal Prerostal System?

• A self cleaning, flow matching waste water intake/wetwell system

• Prerostal performance is achieved when an immersible screw centrifugal non clog pump is utilized within an engineered tangential intake wetwell

• Provides a passive self cleaning intake system, which effectively eliminates both floating scum/grease blankets and heavier solids which settle to sump bottom.
WEMCO-Hidrostal Prerostal

- Prerostal Video
How Does The Prerostal Work?
Hidrostat pumps incorporate the unique screw centrifugal impeller designed to deliver real benefits to pump users

- Viscous handling for pumping thick & viscous liquids
- Low shear pumping for sensitive liquids
- Delicate handling for pumping delicate materials
- Solids handling for pumping solids laden liquids without blockages
Solids Handling Centrifugal Impeller

- Single or two vane impeller
- Large port passages
- Thick rounded vanes
- Still prone to ragging at vane tip and shroud intersection (no escape path)
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- Large port passages
- Thick rounded vanes
- Still prone to ragging at vane tip and shroud intersection (no escape path)
Current Generation Solids Handling Centrifugal Pumps

• Lower shroud is omitted, resulting in a semi-open impeller configuration

• Impeller and lower liner are designed to push rags and stringy material outward to end of impeller vane tips, and through to volute

• Passage of stringy material is improved, but vane tip wear results.
WEMCO-Hidrostal Screw Centrifugal Impeller
System Components

- Tangential Flow Inlet Basin
- Submersible/Immersible Hidrostal Screw Centrifugal Pump with Inlet Bell
Benefits

• Self cleaning action
• Floatables are gently folded into the suction of the pump
• Reduced odor and gas
• Eliminates difficult and costly cleaning of wet wells
• **Passive** flow matching maximizes self cleaning cycle time
Principle of Operation

- The tangential inlet well design changes the intake flow characteristic based on wet well level.
- At lower wetwell levels, increased tangential channel velocity and potential energy transfer increases rotation, and cleaning action.
- At higher rotational speeds, impeller inlet angle changes, altering the flow rate of the pump.
1. No pre-rotation
2. Pump operates on published curve
3. No virtual head

Delta H = 0
Excellent Power & Industrial Solutions

Weir Specialty Pumps

WEMCO PREROSTAL
Maximum Inflow

Pump operates at published design
1. Flow forced through entrance channel
2. Virtual head creates rotation of fluid
3. Partial pre-rotation
4. Pump capacity decreases
WEMCO PREROSTAL
Medium Inflow
WEMCO PREROSTAL
Minimum Inflow

1. Maximum virtual head in pre-rotation basin
2. Maximum rotation of fluid
3. Maximum reduction in pump capacity
WEMCO PREROSTAL
Minimum Inflow

Graph showing the relationship between RPM and capacity.
WEMCO-Prerostal Configurations – Wet Pit Pull Up

- **Liquid Level Probe** (by others)
- **Pump Removal Hatch**
- **Control Cable Motor Leads**
- **Upper Bracket**
- **Lifting Cable**
- **Guide Rails**
- **Discharge Piping** (by others)
- **Discharge 4" Class 150 Flange**
- **Low Water Elev.** to be set at pump start up by authorized field rep.
- **Pre-Rotation Basin**
WEMCO-Prerostal Configurations – Dry Pit
WEMCO-Prerostal Configurations – Enhanced Trench

**Trench-Style Enhanced With Prerotation**

This enhanced design uses the trench and ogee ramp, but completely eliminates the need to store fluid in the inlet system. It avoids the cost of the sluice gate/valve, any automation or electronics, and the trained operator to run it through its “self-cleaning” cycle. Instead, the Prerotation system automatically cleans the wet-wall, at least daily, without any costly equipment or operator attention.

In this system, the last pump is replaced by a “prerotation basin” and HiDrastal screw centrifugal pump. This system both automatically cleans the wet-wall every time there is a low flow cycle, and matches the flow of the sump when in its Prerotation cycle.
Thank you

Questions…