Innovative Technology: Development of the Self-cleaning Wet-well

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Innovative Technology: Self-cleaning wetwell

Overview

- Over the years, little investigative work has been attempted in advancing modern wet well designs
- The result: end-users have continued to endure poorly operating sumps
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Project introduction:

• Summary of an investigation into the optimum shape and performance of circular sumps with submersible solids-handling pumps in sewage applications

• Providing an in-depth look at the ability of circular sumps to deal with solids normally found in domestic sewage
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Project background:
• Simple circular, flat-bottomed wet wells have been employed for decades
• End-users have suffered with pump sumps that became fouled with trash, sludge and settled solids
• Owners routinely spend operating funds cleaning and maintaining wastewater pumps and wet wells
Project objective:

- Evaluate how effectively solids can be removed from wet-wells by pumps in two different sumps

  (a) A standard 5’-4” dia. flat-bottom circular wet-well
  (b) A wet-well having the geometry of the prototype typical IT station
  (c) The effectiveness of a sump mixing device was also tested in both sump examples.
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Driving force behind laboratory investigation:

• Fouled wet wells
• Sludge bank deposits
• Foul odor generation
• Choking of pumps
• Need for frequent station cleaning
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A view of the basic conventional pump sump
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Initial investigation:

Solids-handling pumps w/ 4” dia. suction inlet

• Test clearance dimensions between two pumps while in simultaneous operation
  - Pump clearances of 36-in down to 0-in were examined
  - No noticeable change in pump performance was measured
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Initial investigation:

Solids-handling pumps w/ 4” dia. suction inlet

- Test various pump inlet-to-floor clearance dimensions
  - Pump performance was measured as floor clearance was varied from 16-in through 1-in.
  - Floor clearance ratio (Clearance / Inlet dia.) of >= 0.4 delivered unaffected performance (>1.6” clearance)
  - For solids-handling pumps a 3” to 4” clearance is used
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The area of influence: 2-3 x Pump inlet diameter
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Modification 1:

Place one sloping wall, downstream of pumps

Result:
Power consumption increased 5% due to pre-swirl rotation
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Modification 2:
Two sloping walls, one downstream, one upstream from pump

Result:
Power consumption increased 10% due to pre-swirl rotation
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Modification 3:

Four vertical walls surround pump

Result:
Slight decrease in power consumption, higher $n_{hyd}\%$; no rotation around pump
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- **Cantilever type**
- **Submersible type**
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Cantilever type

Submersible type
Adapting circular sumps to sewage solids

Various densities of solids enter wet wells:

• Floating solids form surface blankets
• Sinking solids accumulate on sump floor in stagnant zones

• Solids can be removed from station if they come close enough to the influence of the pump intake
• The influence of the pump intake stretches only 2-3 inlet diameters for both floating and sinking solids
Adapting circular sumps to sewage solids
Development test #1 – Floating items

• Two wet well types are chosen for comparison
  - Conventional wet-well with 5’-4” diameter
  - TOP 100 wet-well

• Place 8 # of 2 types of plastic beads in each wet-well
  - Measure the mass of floating beads pumped out of a 5’-4” dia. sump and a TOP 100 sump
  - Fill each sump 12 x with 200 gal and empty the sump
  - Use pump-off level at the bottom of the volute

• Compare results from the two sumps
Adapting circular sumps to sewage solids

Bar graph showing dry mass (lbs.) comparisons:
- TOP 100:
  - PS: 90%
  - PE: 75%
- Conventional 5'-4":
  - PS: 23%
  - PE: 25%
Adapting circular sumps to sewage solids
Developmental test #2 – Sanitary items

• Two wet-well situations are chosen for comparison
  - TOP 100 wet-well
  - TOP 100 wet-well along with sump mixing device

• 200 gallons of water were introduced each cycle
  - Sump was filled / emptied in 12 cycles
  - Compare results of the tests
Adapting circular sumps to sewage solids

TOP sump, pumps w/o sump mixing device

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<th>Items</th>
<th>Initial</th>
<th>6 Cycles</th>
<th>12 Cycles</th>
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Adapting circular sumps to sewage solids

TOP sump, pumps with sump mixing device

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Adapting circular sumps to sewage solids
Developmental test #3 – Sand / grit settling solids

• Two wet wells are chosen and inter-connected
  - Conventional 5’-4” diameter wet well
  - TOP 100 wet well

• 110 pounds of sand and floating plastics are placed into each wet-well (220 total pounds)
  - The system is filled with 200 gallons of water
  - Each wet well is emptied back into the other a total of 10 times each
Adapting circular sumps to sewage solids

5’-4” dia. wet-well

TOP 100 wet-well

10 x
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Conventional wet-well

207 # of the sand remained in the conventional wet well
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TOP 100 wet well

Just 3 # of sand remained in the TOP 100 wet well
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- Conventional 5'-4" TOP 100 Sand: 98.6%
- TOP 100 Sand: 1.4%
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Program Conclusions 1

• TOP sump design proven to be more effective in transporting all types of tested solids than the conventional sump
• Difference was greatest for settling and floating solids
• Sump bottom was the most important characteristic to affect transport
• Pump stop level in also an important factor, lower levels provide greater floating solids transport
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Program Conclusions 2

• Repeated pumping cycles at lower pump-off levels proved most effective
• Sump mixing device was effective in enhancing the transport of settling solids (sand, grit and sludge), especially in the conventional wet-well
• TOP sump proved even more effective in handling solids than the conventional wet-well equipped with a sump mixing device
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Self-cleaning sumps: Installation types

• Retrofit applications
• Pre-engineered fiberglass pump stations
• Pre-engineered concrete pump stations
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TOPS utilization
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Retrofit application
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Upgrade an existing circular pump station

1. Remove station mechanicals.
2. Hose-clean and vacuum clean station interior
3. Lay leveling bed of fairly dry concrete
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4. Lower TOP station insert onto stiff concrete base
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5. Seat and level basin.

6. Restrained basin

7. Fill void area with grout.
   (~ 3 yds)
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8. Finish with grout at 45° to 60° to PS side-wall
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Completed station

9. Re-install piping and mechanical equipment
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Plan view: Typical completed self-cleaning lift station retrofit
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Before

Completed Retrofit
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Self-Cleaning
Current new construction, utilization methods
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Fiberglass pre-engineered pump station
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Concrete pre-engineered pump station
Conclusions 1

- The IT sump design has proven to be far more effective in transporting all types of solids and rags than the traditional circular sump.
- The IT sump exhibited the greatest sump improvement: removal of floating type and settling type solids.
- Sump diameter and bottom configuration are the characteristics that most affect the transport of solids.
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Conclusions 2

• Pump off levels are an important factor in maintaining a clean wet-well
• The lower the sump level, the greater the amount of solids that are transported
• Repeated cycles of low pump-off levels proved to be most effective
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Conclusions 3

• A sump mixing device was very effective in enhancing the transport of settling solids and the prevention of grease build-up in the station

• The benefits of sump mixing were greatest in the traditional large diameter, flat bottom design sump
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Conclusions 4

• The IT sump w/o sump mixing device was significantly more effective at handling solids than the traditional sump

• The IT sump was even more effective when the mixing device was employed
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Sump design recommendations for common circular concrete wet well
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Sump design recommendations for common circular concrete wet well

Plan view
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Design recommendations
For pump stations with midrange centrifugal wastewater pumps
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Question and Answer Period
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