Common Problems and Operational Tips - Submersible Sewage Pumps

Tricks of the Trade

Outline

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2. Recommended Maintenance
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   - ❑ Mechanical Components
   - ❑ Electrical Components

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   - ❑ Submergence
   - ❑ Clogging
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   - ❑ Grit

4. Summary and Questions

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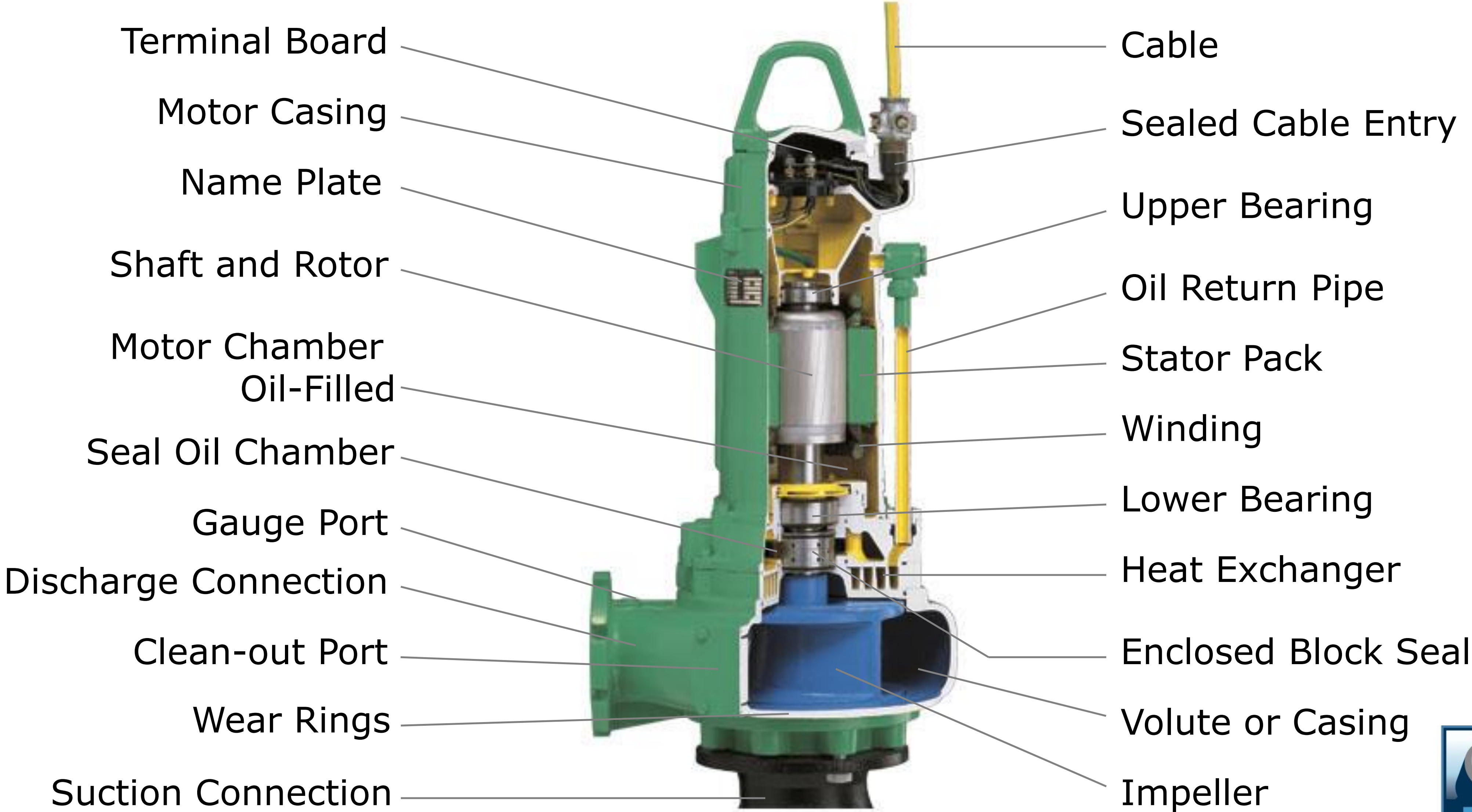
Part 1 – Parts of Submersible Sewage Pump

Parts of a Submersible Pump



Part 2 – Recommended Maintenance

Each model has their own requirements, these are meant as general information; severe duty applications will require more maintenance than listed (usually double)

Recommended Maintenance

Fluids and Lubricants

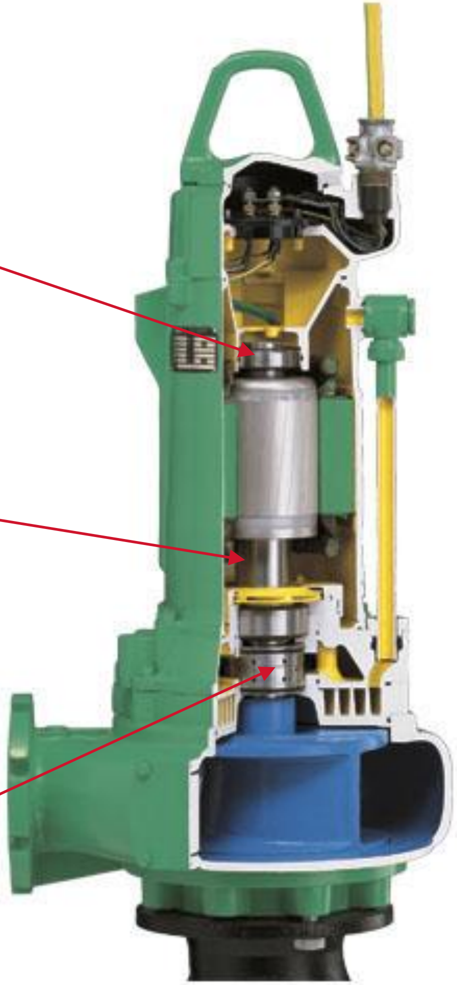
Recommended Maintenance-Fluids and Lubricants

<u>Fluids and Lubricants</u>

- **Bearings: Grease bearings if pumps have fittings once per year (pretty rare on newer pumps; most bearings are sealed for life or running in oil now)**

- **Coolant: FK motors have mineral oil coolant, change every 3 years. For HC or FKT model motors have water/glycol coolant, change every 3 years. Check levels and fluid quality every year and top up if required.**

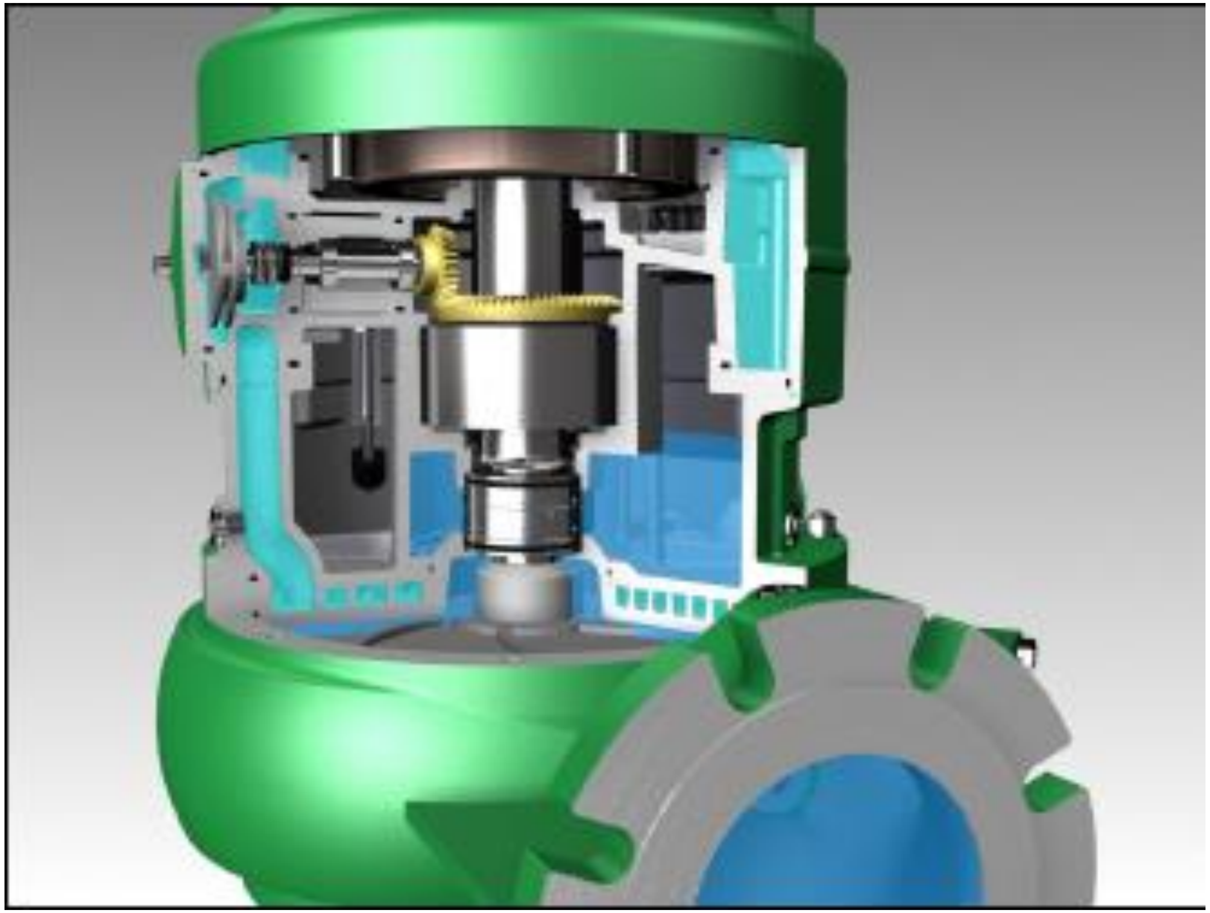
- **Seal Chamber: Non-conductive oil Change annually or every 8000 hours.**



Fluids and Lubricants (cont'd) – Water/Glycol cooling system

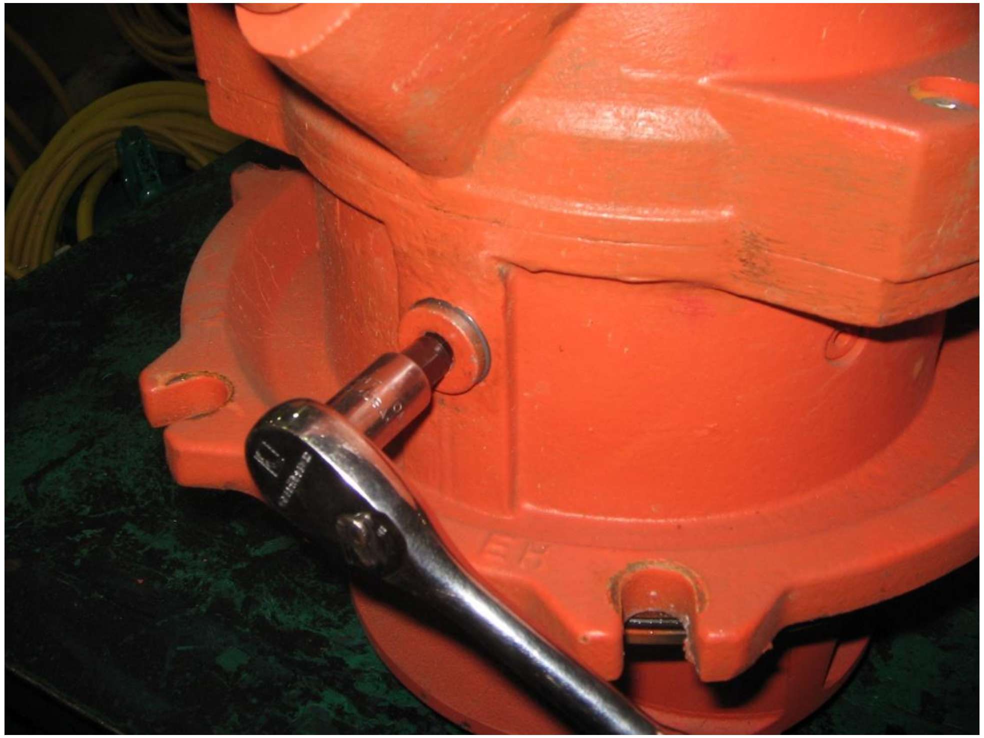
Coolant

Air-filled motor with internal cooling system; change coolant every 3 years. Check every year.



Fluids and Lubricants (cont'd) – Small Pump Example

Seal Chamber for smaller pump with air-filled motor (drain and fill plug are same)



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Fluids and Lubricants (cont'd) – Larger Pump Example

Separate plugs for fill and draw in larger motors.

Must always wait for motors to cool to room temperature and must be disconnected from electrical power before beginning service. Oil or coolant might be pressurized.

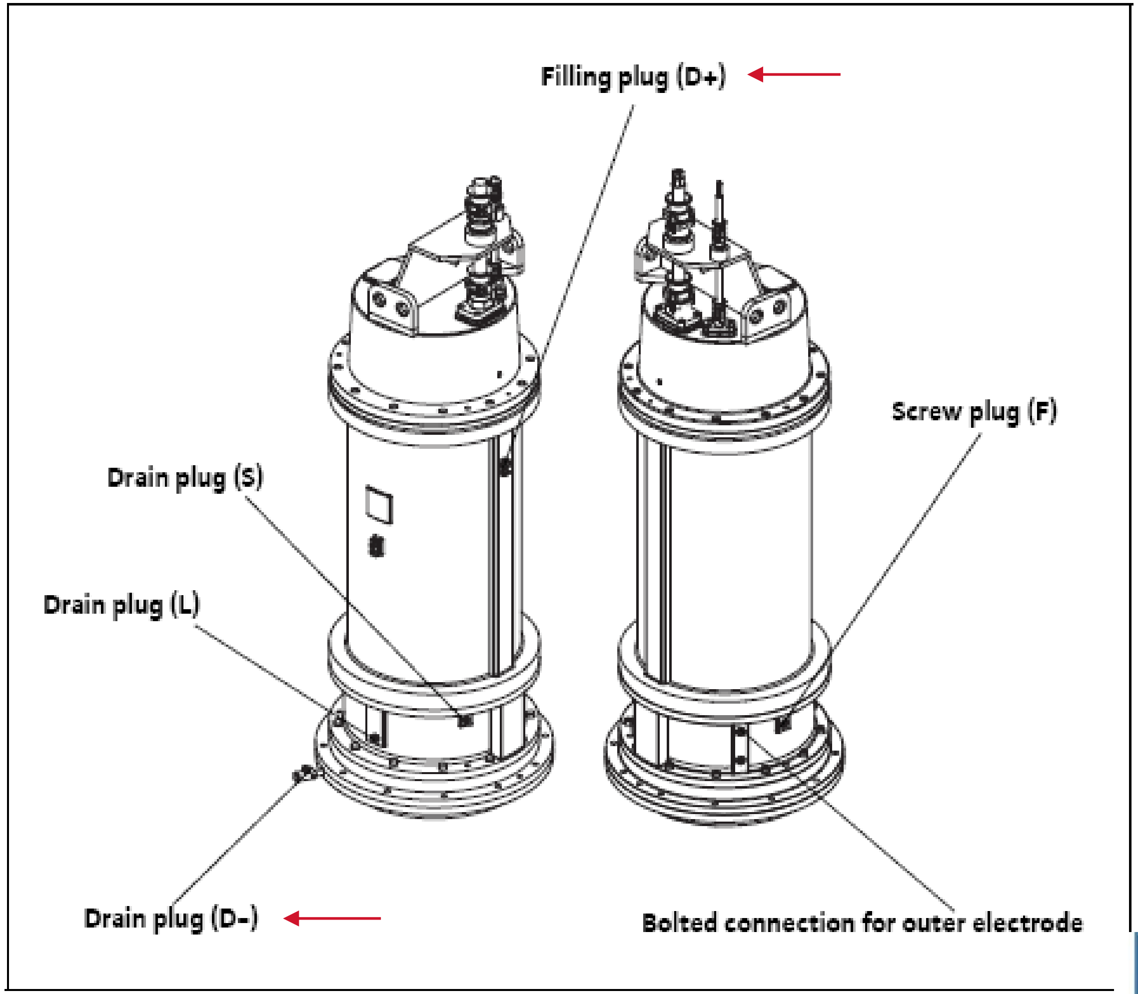


Fig. 7-1: Position of the screw plugs

Fluids and Lubricants - Summary

Application	Fluid or Lubricant	Recommended Fluid Replacement
Bearings	Most are sealed and do not require re-greasing Larger pumps still require use external grease	None Once per year
Coolant or Motor Filling	-White Medical Oil -Transformer Oil (models prior to year 2001?)	Once every 3 years; check every year Check every year
Seal Chamber	-White Medical Oil Or other non-conducting oil	Once per year

Mechanical Components

Recommended Maintenance – Mechanical Components

Annual Inspection (Disconnect power):

- Visually inspect power cable and cable holders, especially where cable flexes
- Visually inspect external pump components
- Visually inspect wear ring clearance if pump has wear rings
- Visually inspect impeller for wear
- Check and adjust clearances for all grinder pumps

Mechanical Components - Cables

- Make sure cables are free of strain, well supported and in conduit where possible. Keep power cables away from control wiring (especially 4-20 mA circuits)

- Cables should not hang from a sharp bend

Mechanical Components – Exterior Inspection

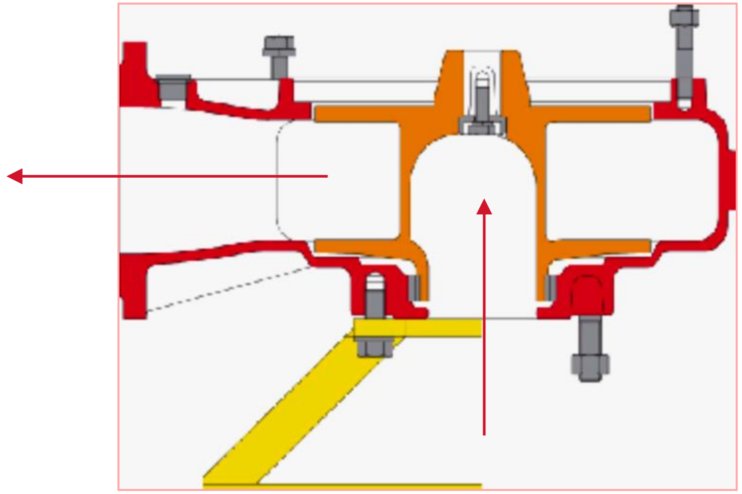
Inspect for the obvious first: corroded metal, lost coatings, etc.

If it is a wet pit submersible, watch how it comes up the rails and then re-seats on elbow when re-installed. Check for "blow by" by running level down to a foot above the volute.

If it is a dry pit submersible, watch for any patterns of leakage between the volute and motor and the volute and suction elbow

Mechanical Components - Wear Rings

- Wear ring clearance for our pumps is .040 when new and they are to be changed when that distance becomes .080



- Wear rings ensure maximum flow through the impeller

Mechanical Components - Impellers

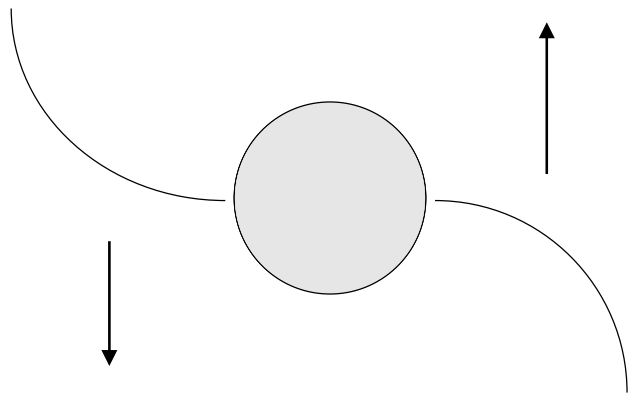
Inspect impeller for wear: pitting, holes and missing material (cavitation)

Damaged water pump impeller

Consider a ceramic coating or hardened impeller at first signs of wear

Mechanical Components - Impeller

Whenever you disconnect power, make a record of wire numbers for re-connection



If you forget, you will need to check impeller rotation. Remember that sewage pump impellers "fling" water and the vanes bend backwards in direction of rotation

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Summary – Mechanical Components

Examine the exterior of the pump, the cables and the wet end once per year.

Consider dropping the volute and inspecting the impeller more closely once the pump is 3 or more years old.

Wet end

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Electrical Components

Electrical Components – Monthly Checks

Record the running amps and voltage (A to B, B to C, C to A) every month. Keep these on file and review

1. Amps give an indication of possible hydraulic issues—as wear increases, amperage will change.

2. Voltage gives an indication of the quality of power and possible phase imbalance.

-Voltage must be +/-10% rated voltage or warranty invalid for most (5% for some manufacturers)

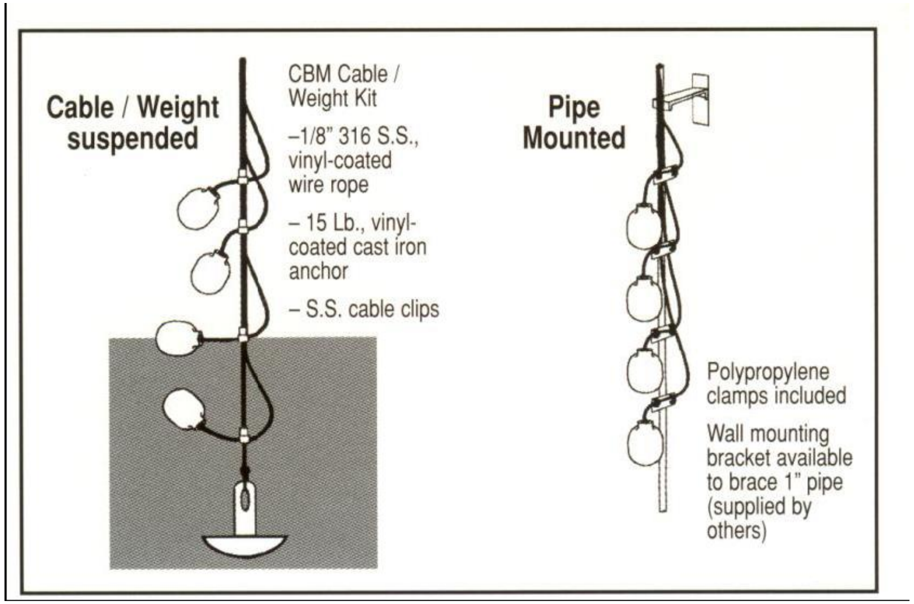
-Voltage phase to phase should be 1% top to bottom or motor life compromised. For example, an imbalance of only +/- 2% causes a power loss of 5%

Electrical Components – Monthly Checks

Consider running your level control system through a brief test on a monthly basis

-Make sure pumps come on and turn off at correct level

-Make sure alternation works



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Electrical Components-Annual Checks

Once per year, check the following:

1. **Motor insulation value (some O and M manuals recommend twice per year)**

1. **Moisture sensor circuit**

2. **Over-temperature sensor circuit**

3. **Full test of level control system**

Annual Electrical Checks – Moisture Sensors

For our electrode type, measure resistance.

- **For single probe type (Wilo standard), value should approach infinity**

- **For dual probe option, value across probes should be very high (300,000 + ohms)**

You need to know if seal failure alarm shuts down pump or only lights indicator light. Either is acceptable with electrode type sensor

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Annual Electrical Checks – Temperature Sensors

<u>Temperature Sensors – Measure Resistance across them</u>

1. Bi-Metallic which gives "ON/OFF" – reading should be near zero

2. PTC type which gives "ON/OFF" – reading should be 20 - 100 Ω (3 in series would be 60-300 Ω).

3. PT 100 (Platinum resistance type: optional) which can give a varying signal indicative of temperature – reading should be 100 Ω at 0 degrees C (32 degrees F) and increased by 0.385 Ω/degree C (108 Ω at 68 degrees F).

Electrical Components – Preventative Sensors

Vibration switches can shut down equipment that experience abnormal vibration on a temporary basis

Active vibration sensors can quantify and record vibration history and show trends prior to a catastrophic mechanical failure

OPTIONAL

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Conclusion of Recommended Maintenance

1. Maintenance for submersible pumps is dependent on the manufacturer and impeller type. Non-clogs have least maintenance.

2. Replace seal oil and do a visual inspection once per year. Perform a system check on each station once per year.

Part 3 - Most Common Operational Problems

Common Problems and Operational Tips

Inlet to the wet well

Most Common Operational Problems – inlet on top of pump

You must avoid dumping sewage via free fall; especially on top of a pump

- Free fall will entrain air
- Pumping on pump also causes unstable flow pattern into pump
- Problems worst at low water levels
- Common indicator is if the one pump being dumped on gives more trouble than the other(s)

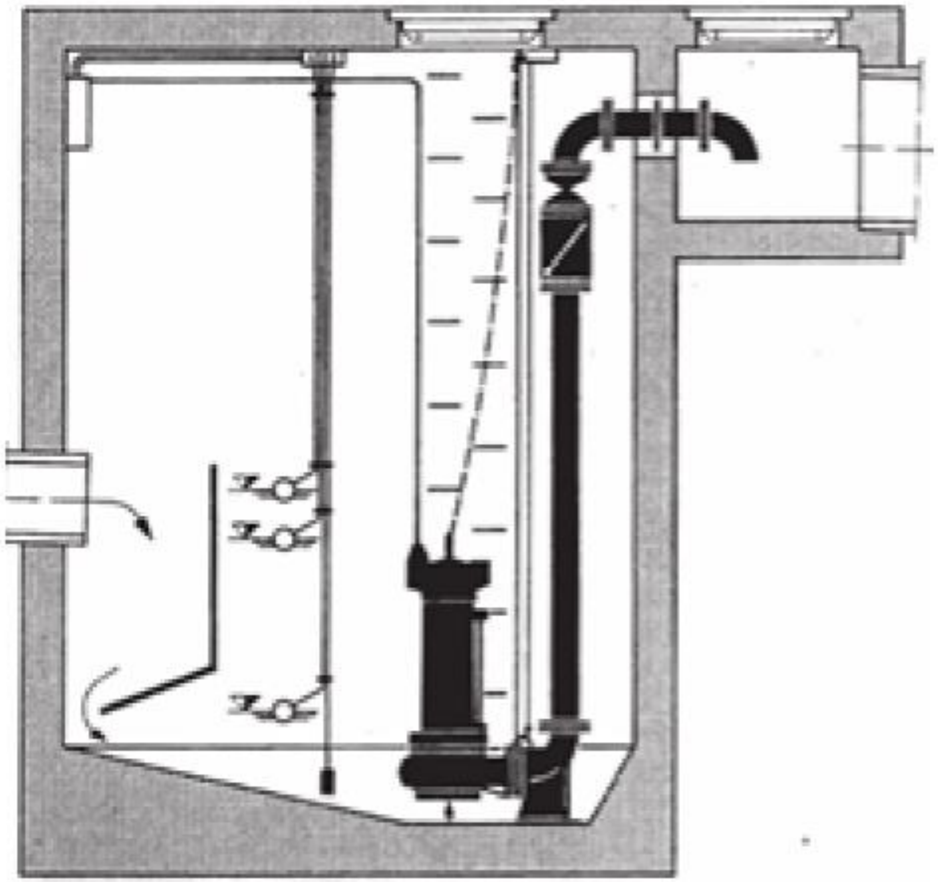
Most common problem we see

Larger Example – High slope, aimed at pump

Inlet on top of pump (cont'd)

Add a baffle (or other solution like piping) instead

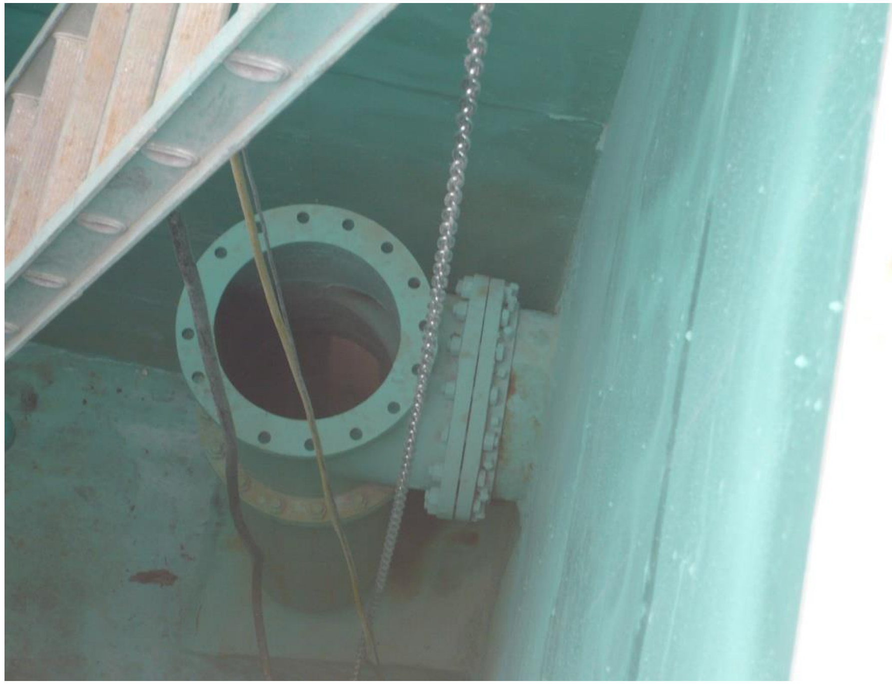
- Prevents air entrainment
- Reduces possibility of swirling flow into the pump
- Controls high approach velocity
- Still allows line to be cleared if jammed



Preferred approach is along the floor at low velocity (1-2 fps) to the pump

Common Problems and Operational Tips

Pump Spacing



Most Common Operational Problems – Pump Spacing

Pump spacing too tight

In this example, the middle pump will have low flow and more mechanical issues (especially vibration)

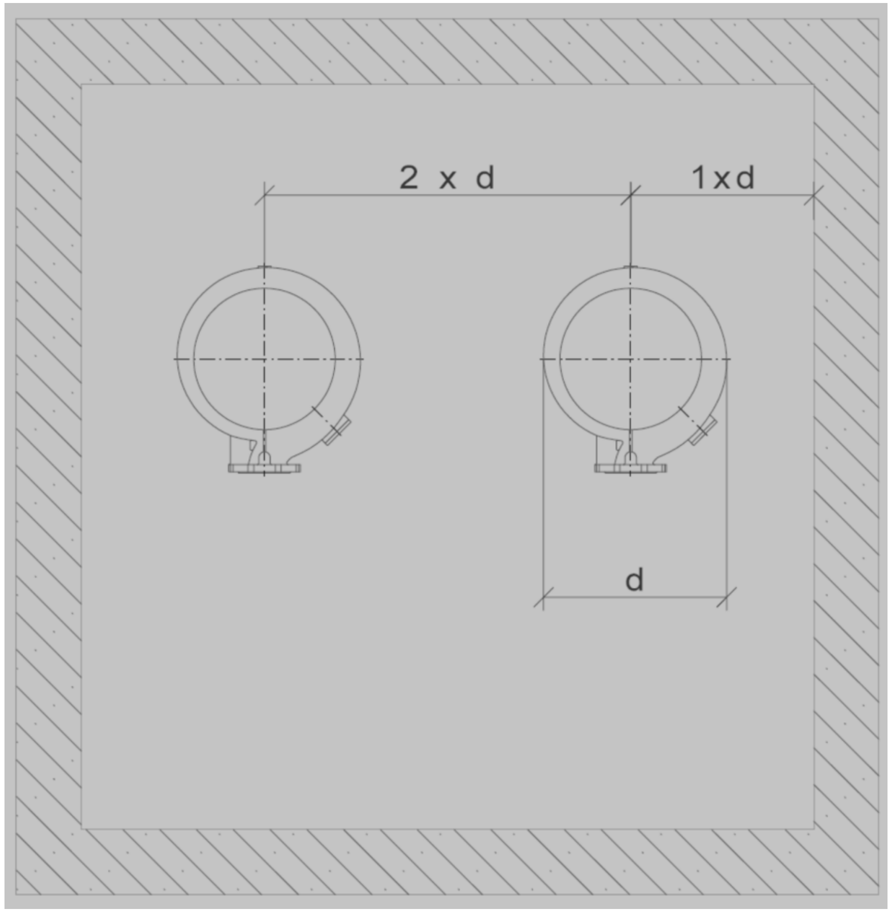
Possible Fixes

1. Change the control sequence to avoid running the center pump in combination with the others.

2. Add anti-vortexing devices, like knee walls between the pumps or a vertical plate on the pump inlet

3. Best: Move the center pump to the other side of the wet well

Pump Spacing (cont'd)



General spacing for wet pit pumps with both pumps in the control sequence

- For a submersible pump, the "D" distance from Hydraulic Institute is the volute diameter.
- Spacing is one "D" from the edge of one pump to the edge of the next pump (2D from centerline to centerline).
- Spacing to the wall is ½"D" (one D from centerline to wall). You need a pump to be close enough to the wall to prevent vortexing
- **Resist the temptation to use a single manufacturer's design criteria if it conflicts with Hydraulic Institute – limits the Owner's future options**

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Pump Spacing (cont'd)

- Do not forget about vertical spacing

- Many pumps, especially larger ones at 1800 RPM, may need to be elevated to reduce the influence of the floor—otherwise flow will be lower than expected and more "noise" will be heard

Proper pump arrangement

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Common Problems and Operational Tips

Grease

Most Common Operational Problems – Grease

This is a major way that grease ends up in wet wells:

1. Restaurants use water for dish washing that is hotter than allowed by code. When they wash dishes, that water melts the grease in the grease trap (even if it was working correctly), and this grease-laden sewage ends up in your lift station

2. They wash the majority of dishes later in the evening when there is lower flow coming into the station—fewer pump cycles . Also, liquid grease is lighter than water anyway.

3. The grease re-forms on the top of liquid with the lower temperature sewage in the pump station

Grease (cont'd)

3 common solutions for grease:

Mix/Flush Valve

- Uses entire pump HP for mixing/can cavitate pump
- Does not operate at night when pumps are OFF
- Does not need another starter or much control logic

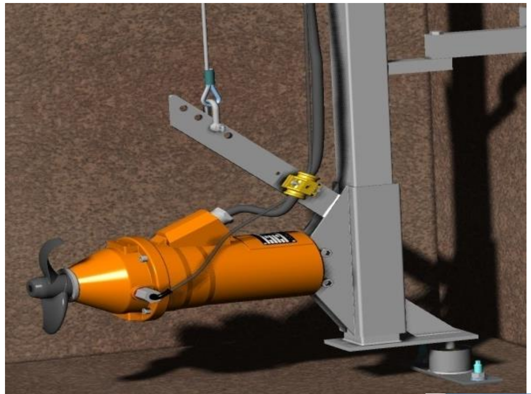
Wet well mixer

- Most efficient and low HP
- Operates in low flow when pumps are OFF
- Requires another starter and 3 relays

Aerating the wet well

- Usually a blower/coarse bubble diffuser(s)
- Can help keep fresh/can increase odor problem if septic
- Requires starter and a little more in the control realm

Mix Flush Valve



Wet well mixer

Common Problems and Operational Tips

Submergence

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Most Common Operational Problems – Submergence

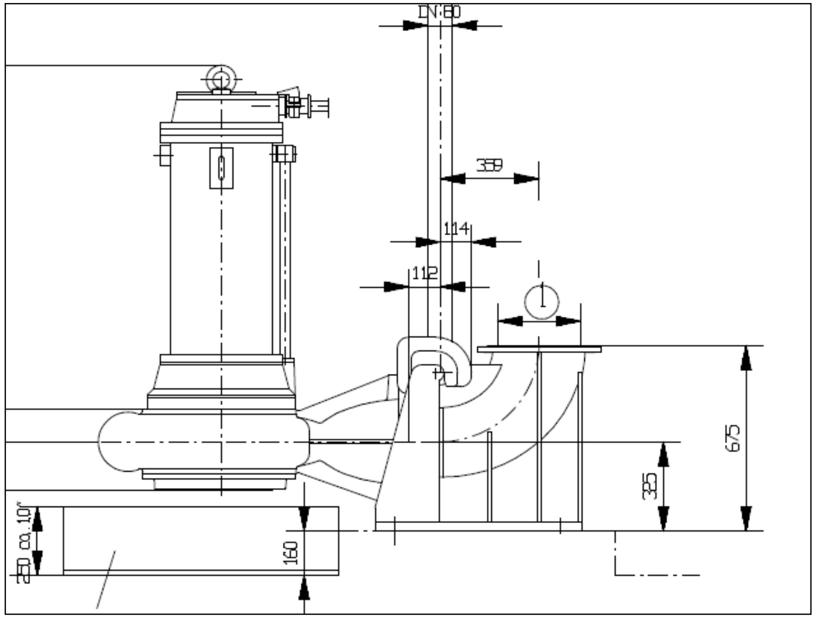
<u>Low Submergence</u>

- Keeps odor down (more cycles)
- Can cause vortexing – devices can help
- Easier to entrain air
- NPSH considerations (especially for dry pit pumps)

<u>High Submergence</u>

- Prevents vortexing
- Keeps motor cool
- Better hydraulically-increasing submergence can cover up for many deficiencies

Must cover the top of the volute!



Submergence (cont’d)

Whenever you are trying to diagnose a pump problem, increase the level in the wet well prior to starting the pump—higher submergence will lessen any sump design problems and pump application problems, but not greatly improve a broken pump.

Also, consider plugging the inlet to the station if there is a visible swirl (vortex) or other problems which are caused by the station inlet

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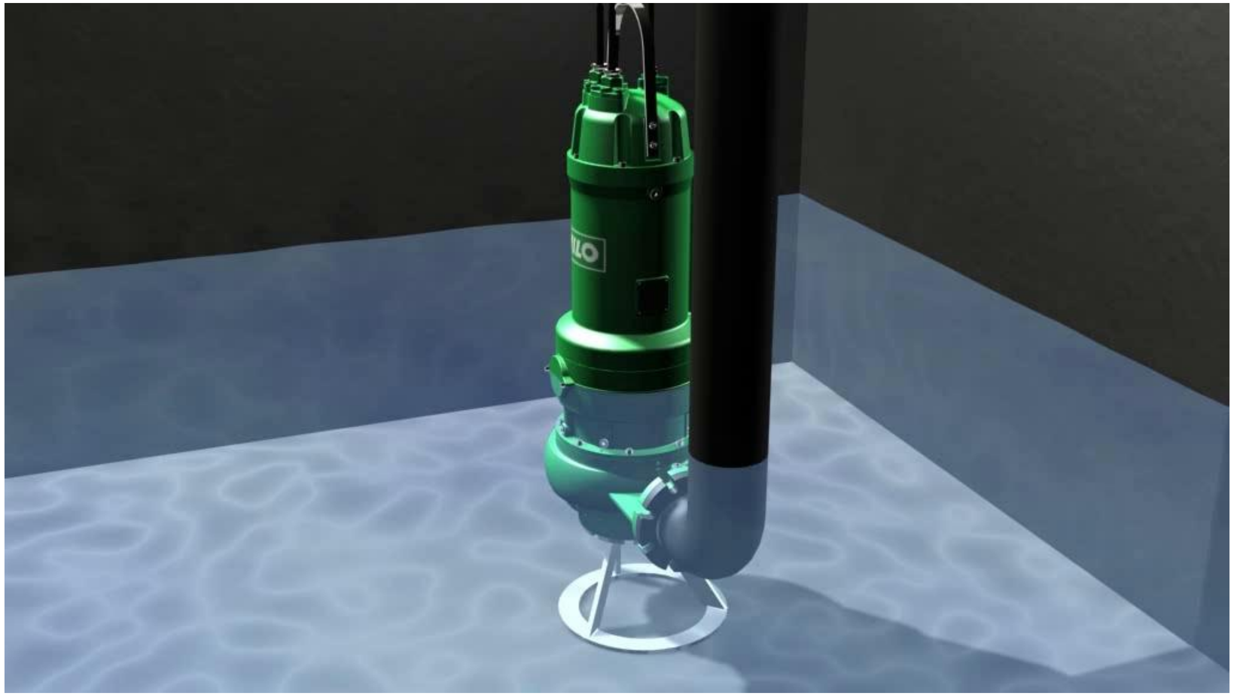
Submergence (cont'd)

Motor cooling becomes an issue with low submergence. Submersible motors keep water out and heat in.



Internal closed loop cooling system

Submergence (cont’d)

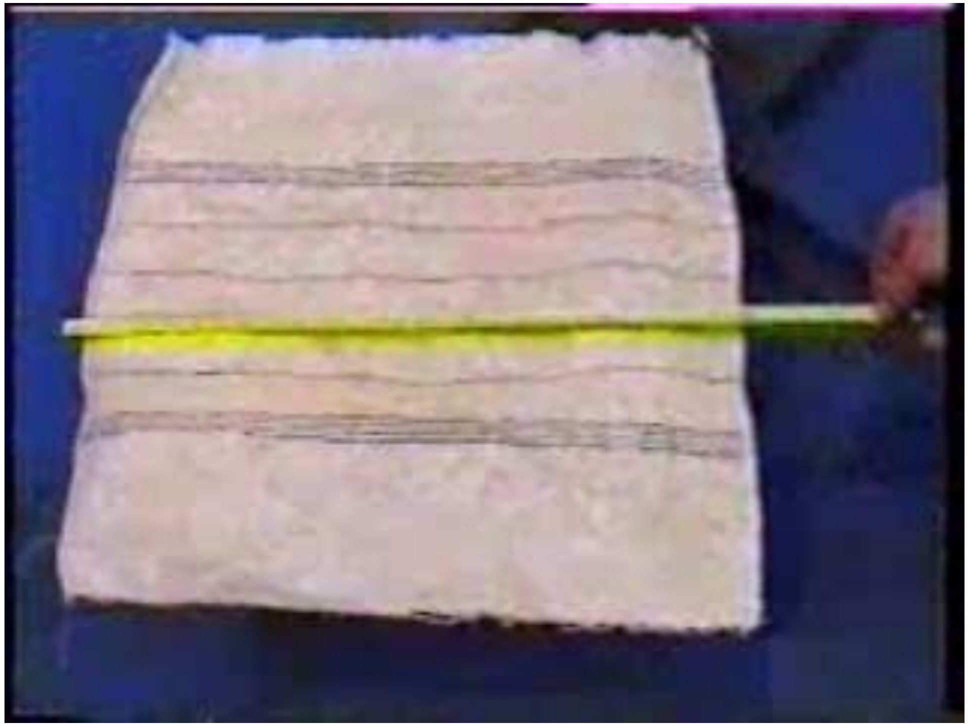
Motors without cooling systems rely on short cycle times and submergence for cooling.

Watch out for low submergence at lowest speed on VFD applications—slows down the coolant. Consider closed loop cooling system especially for VFD applications.

Open loop cooling system

Common Problems and Operational Tips

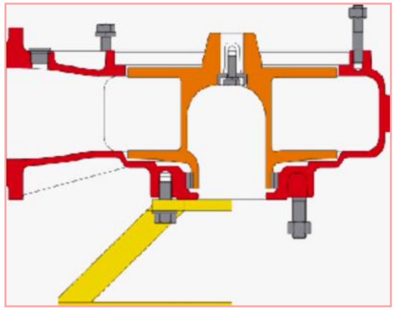
Clogging



Clogging

Avoid VFDs for stations that are prone to clogging—**must keep inlet velocity up**.

If you have VFDs, set min. speed higher as a test to resolve issue.



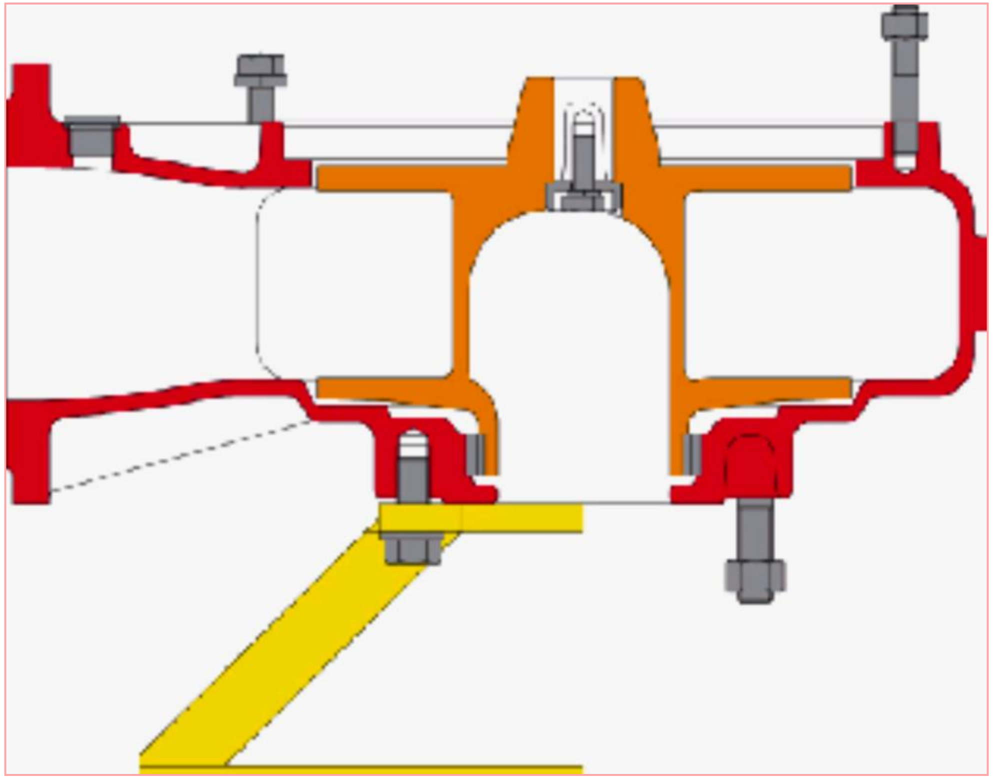
Sewage pumps are clog resistant, not clog proof

Clogging (cont'd)

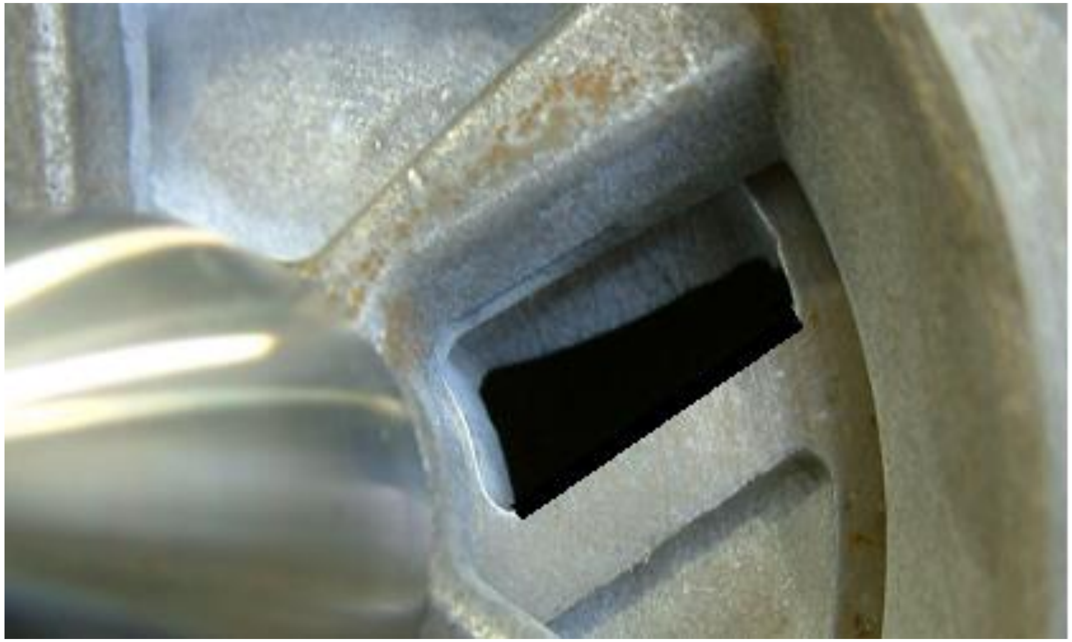
Check clearances for non-clogs:

Where is it clogging?

- 3" sphere passage
- Wear ring clearance
- Above the impeller



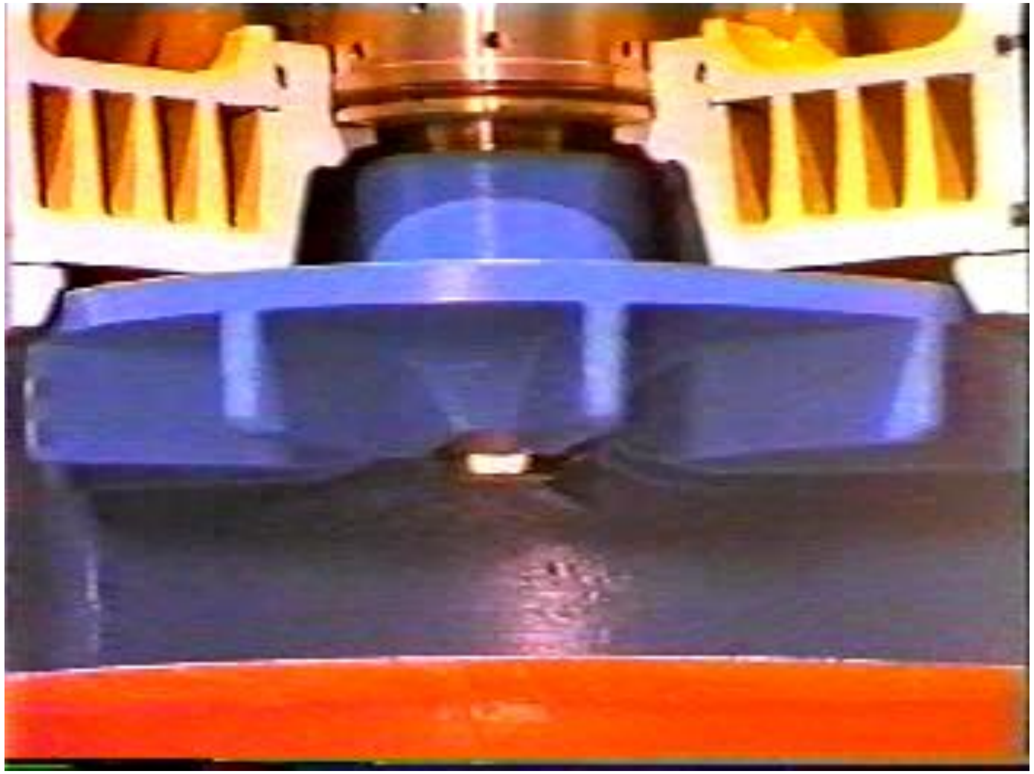
Clogging (cont’d)



Check tolerances between the cutting surfaces for cutting impellers

Clogging (cont’d)

Pick the correct impeller—might not be the most efficient (vortex or single vane).



Vortex also called recessed impeller

Common Problems and Operational Tips

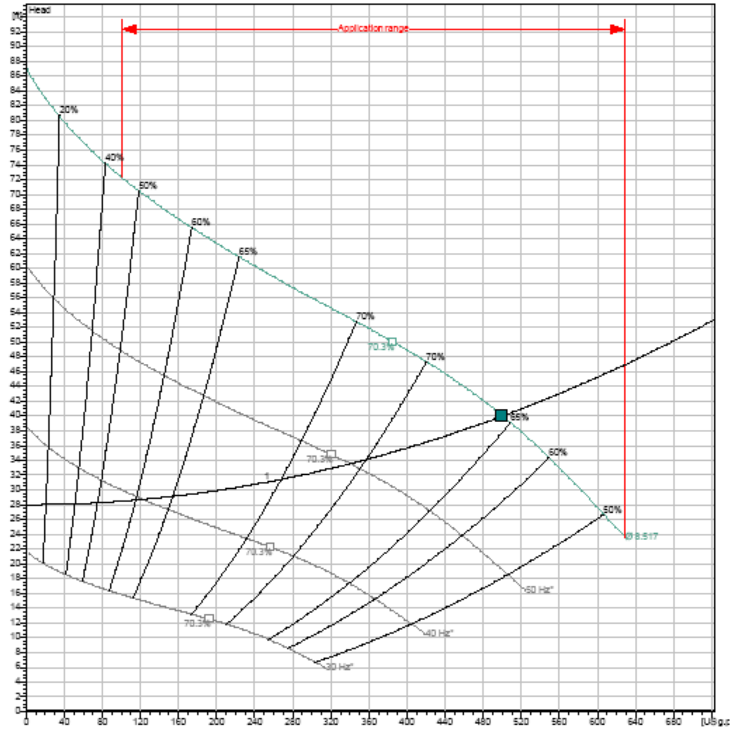
Variable Speed Applications

Project: VFD
Project number: 500 at 40
Created on: 2007-06-03
Created by:

WILO EMU

Performance curves
Submersible sewage pump FA 10.33E with motor FK 17.1-4/16K

Power data referred to: Water, pure [100%] ; 68°F; 62.315lb/ft³; 1.0768E-5ft²/s
Tolerance as per ISO 9906 / Annex A.2



Pump				Duty point data			
Impeller Ø	designed	8 1/2	inch	Volume flow		500	US g.p.m.
Nominal speed		1740	rpm	Head		40	ft
Frequency		60	Hz	Shaft power	P_2	7.7	hp
Impeller type		Single-channel		Pump efficiency		65.8	%
Motor				Power input	P_1	9.7	hp
Rated power		10.2	hp	Required pump NPSH		11.7	ft
Sel. explosion protection		--		Speed		1720	rpm

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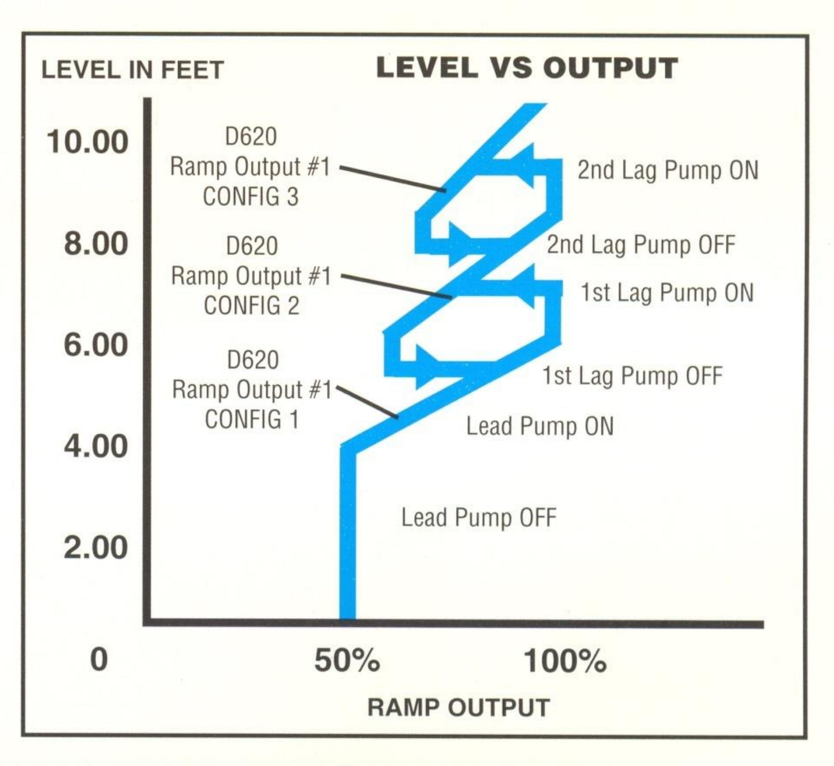
Standard VFD Programming

Vast majority of variable speed systems are set up with a linear ramp and a single PID loop, based on level, with the intention of matching the flow exiting the station with the station influent flow



PID: proportional-integral-derivative: hunts and seeks the correct level by calculating and correcting

VFD Applications – General Rules of Thumb

- Lowest minimum speed is 30 Hz (50%)
- Lowest flow should be 25% or more of BEP full speed flow (some pumps can go lower) to prevent impeller recirculation
- Pump motors are less efficient at lower speeds than their design speed.
- Select pumps right of BEP to slow down to better efficiency
- Consider a minimum flow that equates to 2 fps or have controls speed up to full speed to achieve scouring
- Minimum speed must be high enough to allow the pumps to shut off if the inlet flow is at or near zero

Common Problems and Operational Tips

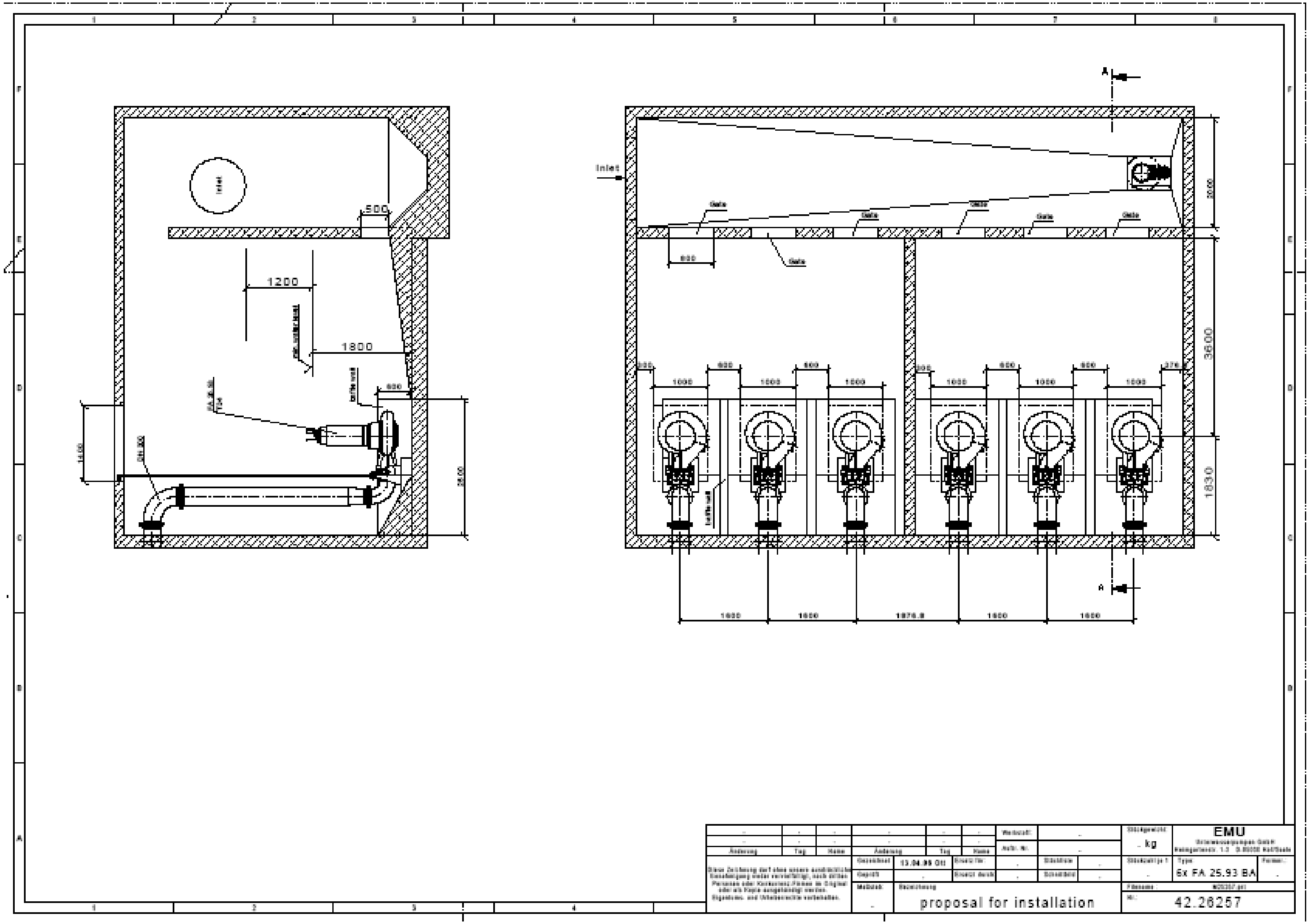
Grit (Raw Sewage)

Grit in sewage pump stations

Grit is in excess of 600 BHN

- **Cast irons are 100 to 200 BHN and are industry standard**
- **Cast stainless steels are 130 to 450 BHN and are expensive**
- **High chrome irons are 600 to 700 BHN, but are hard to cast (brittle and hard to machine) and are very expensive**
- **Ceramic coatings can be an inexpensive solution**

Consider selecting where the girt will settle out



Part 3 - Summary and Questions

Conclusion

1. If you have a problem installation, consider the possibility that there is a inherent problem – a pump is only a tool .

2. When looking at a design, use a competent independent third party for design advice (Hydraulic Institute, for example).

3. Communicate—design to operations and vice versa

- Design decisions
- Operational needs
- Potential problems
- Preferences

Any Questions?

Thank you very much!