**WWOA**

**Virtual Operator Training Series**

- **April 30th**  Activated Sludge  9am – Noon
- **May 6th**  Anaerobic Digestion  9am – Noon
- **May 14th**  Collection System Long-Range Planning  9am – Noon
- **May 21st**  WI DNR Updates  11am-1pm
- **May 26th**  Water Quality Trading  9am – Noon
- **June 4th**  Submersible Pump O&M  9am – Noon
- **June 10th**  Biosolids Handling Case Studies  9am – Noon
- **June 18th**  Process Control  9am - Noon
Webinar Meeting Details

Welcome from the WWOA, thank you for continuing your education with us during these historically unique times.

- Find the chat function, you will need that to answer simple questions designed to confirm that you are still participating.
  - This is necessary to get credits.
- Breaks will be 5 minutes, we will start promptly following each break.
- Questions can be asked through the Q&A feature, we will check in on them periodically.
- A short survey will be included at the conclusion.
  - We need feedback to improve this approach to continued educational opportunities.

The content of this presentation is intended for the sole purpose of educating WWOA members and is not to be downloaded, copied, used, shared, or otherwise transmitted without the prior consent of WWOA and the authors.
WWOA would like to thank our generous sponsors and partners for their support of our mission to provide training and education opportunities for our members and others working in the water and wastewater profession.

2020 WWOA Virtual Operator Training Series
Accessible ~ Affordable ~ Informative

Submersible Pump Operation & Maintenance
Virtual Operator Training ~ June 4, 2020

PRESENTING SPONSOR:

CONTRIBUTING SPONSORS:
Introductions

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Xylem Flygt
20 Point Service Checklist

Start-up and Trouble Shooting
FOUR SECTIONS OF A TYPICAL PUMP

- MOTOR COMPARTMENT
- JUNCTION CHAMBER
- SEAL CHAMBER
- HYDRAULIC WET END
“N” Technologies: 3170 and 3171

JUNCTION CHAMBER

MOTOR COMPARTMENT

SEAL CHAMBER

WET END

INSPECTION CHAMBER
4600 Series Mixer

- Junction Chamber
- Seal Chamber
- Motor Compartment
- Wet End
JUNCTION CHAMBER

1. Terminal Board
2. Power Cable Connections
3. Stator Leads Connections
4. Thermal Connections
5. Ground Connections
FLYGT NITRILE “O”RING

Nitrile Rubber (NBR) - This is the standard type “O” ring that you will find in Flygt pumps & mixers. It has good mechanical properties, such as tear resistance and elasticity and is not affected by oil or water. The NBR material has temperature limitations of (70 Degrees C) and a restricted ability to withstand strong acids.
Viton / Fluorocarbon (FPM) - FPM is most often selected as the alternative when the NBR is not feasible. FPM maintains its properties up to 180 Degrees C and will not degrade in most acids and alkalies. FPM is more sensitive to mechanical damage than the NBR material.
“O” RING SEALING

“O” Ring Notes!

“O” rings are under a compression fit, and will form flat spots after being under this compression. The “O” rings should not be used over again after they have been removed, other than in an emergency situation.

The use of Silicone Rubber, RTV, and other material of this type should not be used to assist the sealing of the “O” ring. In many cases, this material will interfere with the proper sealing of the “O” ring.
“O” RING SEALING

Always make sure you have the correct “O” ring for the area you are sealing off. A small amount of clean oil or silicone spray on the “O” ring before installation, will help to assure that the”O” ring slides onto the sealing surface rather then rolling, which can lead to possible damage to the “O” ring when two surfaces are mated together.
All “O” rings are made with a certain hardness or softness. If the “O” ring is too soft, it will flow too much. If the “O” ring is too hard, it won’t flow enough. In either case, the proper sealing may not take place, thus allowing leakage. Using original Flygt parts will assure you always have the correct “O” ring to do the job.
TERMINAL BOARD

Use Care When Tightening To Avoid Cross Threading Or Over Tightening Of Lug Causing It To Break Off.

Split Lugs
“C” PUMP TERMINAL BOARD

NOTE! Always check to see if Buss Bars are to be used dependent upon the voltage configuration. Stator lead changes are still necessary.
TERMINAL BOARD

NOTE!
Always Make Sure Leads Are Connected For Proper Voltage And Phase

- Power Cable Connections
- Stator Lead Connections
When moisture has entered the terminal board area, you may need to disassemble the terminal blocks and clean.
Tighten Allen Screw To Compress Grommet
Stator Leads And Power Leads Are Crimp Connected And Secured To Stator Turns
3085 STATOR/POWER CONNECTIONS

Stator Leads And Power Leads Are Crimp Connected And Secured To Stator Turns

Plastic Tie Wrap

Plastic Insulator Sleeve
3085 GLAND NUT CABLE ENTRY
3085 COMPRESSION GLAND NUT

Internal Strain Relief Clamp

Threaded Gland Nut
3085 COMPRESSION GLAND NUT

Serrated Edges Grip The Cable Jacket

Always Make Sure You Have The Correct Clamp For The Cable You Are Using.
CABLE ENTRY ASSEMBLY

- Strain Relief Clamp Assembly
- Cable Grommet & Washers
- Machined Area For Location Of Cable Grommet & Washers
Always Make Sure You Have The Correct Grommet And Washer. Compare Size Indicated On Grommet To Cable I.D.
EXTERNAL STRAIN RELIEF CLAMP
Most of the conductor strands were removed during the stripping of the insulation. Ground lead should be redone to maintain as many bare strands as possible.
IMPROPER GROUND CONNECTION

Insulation under ground clamp.
This should be redone, with no rubber insulation under ground clamp.
Proper ground connection with all of the conductor strands under the ground clamp and no insulation under the clamp.
Ground Conductors Should Always Be Longer Than Power Conductors To Assure A Good Ground
Stray stands of conductors not inside of split lug connection could cause arcing and a possible short circuit. All strands should be between spilt lugs.
Conductors are stripped back too far and are extended too close to other terminal posts. This could lead to arcing and a short circuit.
Proper termination should have all bare strands of conductors between split lugs, and bare strands should not extend too far through the split lug connection.

Try to avoid dropping bare wire strands on the terminal board.
SUBCAB CABLE
14/7 Subcab Cable Conductor Identification

- Thermal Lead / Orange
- Thermal Lead / Blue
- Power Conductor / White
- Power Conductor / Red
- Power Conductor / Black
- Ground Check / Yellow Lead
- Ground Lead / Yellow Green Stripe
By bending the cable at the area to start the cut, it will allow the utility knife to make a clean cut in the insulation. This will allow you to see the conductors under the jacket and avoid cutting the insulation on the conductors.
Once the cable jacket begins to separate, you can easily see the conductors and this will allow you to make a clean cut of the jacket without doing damage to the conductors.
DAMAGED CONDUCTORS DUE TO IMPROPER STRIPPING OF JACKET

Conductors cut while stripping cable jacket. Cable should be redone.
GROMMET & STRAIN RELIEF SET

Strain Relief “Set”
Don’t over tighten as damage can be done to inner power conductors.

Compression Grommet “Set”
Do not use this area again when installing new grommet, as it will not seal properly.
Dual cables are used on large horsepower, high amperage pumps to split the amperage between two cables.
Never Lift Pump By Power Cable
Always Assure That The Cable And Grommet Are The Proper Size
“O” Rings Keep Water Out Of Terminal Board Area
Always Make Sure Of A Good, Solid Ground Connection

High Point In Lifting Bale Always Faces Toward Discharge
Make Sure Terminal Board Is Connected For Proper Voltage And Phase
“O” Ring Under Terminal Board Keeps Water Out Of The Dry Motor Compartment
The List

- Check electrical condition of insulation on power cable(s) and on all phases of the motor.
- Check for any loose or faulty electrical connections within the control panel.
- Check voltage supply between all phases of the electrical control panel.
- Check voltage between all phases on the load side of the pump / mixer control panel with pump / mixer running.
- Check amperage draw on all phases of the motor.
- Check condition and operation of the motor thermal protection control system (if equipped).
- Removal of pump / mixer from the tank for physical inspection.
- Check condition of inner shaft seal (inspect condition of motor / stator housing).
- Check condition and operation of leakage and bearing sensors (if equipped).
- Check outer shaft seal (inspect condition of oil in oil housing).
- Change oil or coolant.
- Check for worn or loose impeller or propeller.
- Check impeller wear rings (rotating & stationary).
- Check for any unusual noise in the upper and lower bearings.
- Clean, reset and check operation of the level control system (if equipped).
- Check for physical damage of power and control cables.
- Check for correct shaft rotation.
- Reinstall the pump / mixer and check operation (if liquid level in the tank permits).
- Test the pump / mixer operating cycle, under load (if liquid level in the tank permits).
- Check operation of valves and associated equipment.
What Is POR?

- POR (Permissible Operating Region)
  - Determined by ANSI/HI 9.6.3 - 1997
  - The range where hydraulic forces in the volute are well controlled (uniform & free from separation)
  - Between 70% and 120% of BEP (centrifugal pumps)
What is AOR?

• AOR (Allowable Operating Region)
  – Determined by pump manufacturer
  – Between 50% and 125% of BEP flow as defined by manufacture
  – The range where there is no significant reduction in component life
1. Check electrical condition of the insulation

- Is there any burn marks in the wire
- Any wire deformed
- Is insulation braking down
- Check for loose or faulty connections
1. Check for loose or faulty connections
   • Check all voltage on all phase
2. Check voltage supply between all phase
3. MEGGER READINGS

- less than 100 megohms
  unserviceable
- 500 me ohms
  moisture present
- 1000 megohms
  serviceable
- 2K megohms
  new condition
Which wires do you hook your megger up to?
Motor Insulation Test
4. WHAT IS VOLTAGE DROP?

When we speak of Voltage Drop we are concerned about the voltage at the pump / mixer terminal board. The published voltage limits are (+/- 10%) and this is measured at the terminal board.

The voltage check should always be taken as close to the pump or mixer as possible.

If the pump or mixer is located some distance from the control, voltage drop in the power cable must be calculated and subtracted from the panel voltage to determine the true voltage that the pump or mixer is seeing.
5. Check the amperage between the phases

- Where do you check for a 3 phase pump?
- Where do you check for a single phase pump?
TROUBLESHOOTING EQUIPMENT

CHECKING 3–PHASE AMPERAGE

On a 3-Phase system, the amperage readings should always be taken on the load side or motor side of the control to get a true and accurate reading of the actual amperage that the pump motor is seeing.

The use of an Am probe requires in most case for the control or circuits to be live or energized and **CAUTION** should be used.

Before applying power, it is often a good idea to check connections for tightness.
CHECKING 1 – PHASE AMPERAGE

On a 1 Phase or Single Phase control, the amperage readings should always be taken on the line side or incoming power side of the control, to get an accurate reading. With the capacitors in the control, readings taken on the load side of the control will not be accurate.

The use of a Am probe requires in most cases for the control or circuits to be live or energized and **CAUTION** should be used.

Before applying power, it is often a good idea to check connections for tightness.
OVERHEATED MOTOR
Damage Due to Overload
Single Phase Damage
Damage Due to Unbalanced Voltage
Winding Grounded at Edge of Slot
Winding Grounded in the Slot
Shorted Phase to Phase
Damage Due to Voltage Surge
6. Check the sensors in the pump

- Thermals
- FLS
- PT100
MOTOR WINDING RESISTANCE

- Measured with a low ohm meter
- Should be equal between power leads.
- May increase slightly over a long period of time
Resistance Check Through Cable
Three (3) Switches Wired In Series, Placed In The Stator End Turns When The Stator Is Wound, With Two Leads Coming out of The Stator.
THERMAL PROTECTION
FLS - 518 8902
( Flygt Leakage Sensor )

Leakage detector for
- stator housing
- junction box

Critical alarm that requires immediate stop and service before restart
Flygt Leak Sensor
Tripped leak Sensor
The type of PT-100 sensors that Flygt uses, are of the linear type. This type of sensor respond to temperature change in a linear manner, increasing its resistance in equal proportion to increasing temperature. Temperature can be read by taking the resistance value, and converting the resistance to temperature. These type sensors are used in both the stator and bearing locations for heat detection.
The Flygt Mini-CasII unit is used in the monitoring the temperature sensing devices in the smaller Flygt pumps and mixers in the range of the 3085 thru 3300.
7. Lifting Device

HOIST HOOK

NYLON LINE

GRIP-EYE

CHAIN SLING

FIG. 1

FIG. 2
8. Guide Rail

MOUNTING HARDWARE
14-59 00 00 (stainless steel)

3/8"-16 LATERAL NUT
14-46 37 05

HEX. HEAD BOLT (2),
3/8"-16 x 7/8"
14-46 20 25

3/8" PLAIN WASHER (2)
14-46 50 07

3/8" LOCK WASHER (2)
14-46 50 67

OPTIONAL:
NUT RAIL FEATURE

LATRAL NUT
NUT RAIL
BRACKET
9. Pump Information
The actual rotor or shaft speed is always somewhat less than the speed of the rotating magnetic field due to rotor slip. In other words, the rotor is always trying to “catch up” with the magnetic field.

**SYNCHRONOUS SPEED**

- 2 Pole Motor (1 pair of poles) = 3600 RPM
- 4 Pole Motor (2 pair of poles) = 3600 divided by 2 = 1800 RPM
- 6 Pole Motor (3 pair of poles) = 3600 divided by 3 = 1200 RPM

**SHAFT SPEED**

- 3300 RPM
- 1750 RPM
- 1150 RPM
10. Guide Claw
11. Stator Compartment
12. Oil
Oil/Lower Seal Evaluation
Mechanical Seals

Heat Marking
Mechanical Seals

# 1405
13. Impeller or Propeller
N impeller in good condition
Suction cover in good condition
Suction cover erosion
Impeller erosion
Inlet erosion
Inlet erosion
Leading edge and low pressure
Severe suction cover erosion
Long Jet Path & Smooth Deflection

Often a compromise!
Air Entrainment

Air entrainment is most frequently caused by turbulence in the suction line, or even at the suction source. For example, the kind of conditions identified here, will cause turbulence in the suction tank that will entrain vapor bubbles into the line leading from that tank to the pump suction.
What set do I need?

NP  NS  NT  NZ
Suction and Discharge Piping
Suction Piping

Suction Valve-First Obstruction

24" Suction Pipe X 10 Feet length

Supports
Suction Piping

RECOMMENDED

LONG RADIUS ELBOW

AIR POCKET

NOT RECOMMENDED
Incorrect Reducer
Reducer

Eccentric Reducer
14. Wear Ring
“C” PUMP WEAR RINGS

Pumps above 20 HP will have both a rotating as well as a stationary wear ring. The wear rings help to prevent wear to the cast parts, but also serve as a third bearing in the wet end section of the pump.
15. Bearings
Seal failure = washed out bearing
BEARING FAILURE
ROTOR DAMAGE
Winding Grounded in the Slot
16. Power Cable
17. Level Sensor
ENM-10 LEVEL FLOAT
Accessories

- Level sensor
- Overflow sensor
- DIN rail montage kit
- Battery backup
- Modem montage kit
18. Rotation
PROPER ROTATION OF A FLYGT PUMP

DETERMINING PROPER ROTATION

All Flygt Pump Impellers Turn *Clockwise* As Observed Looking Down At The Top Of The Pump.

1. Observe The Starting Kick or Starting Jerk. It Should Be *Counter-Clockwise* As Shown.
2. Connect And Observe : ( 3 Phase Only )
   A. Pumped Flow Out Of Hose Or Pipe
   B. Draw Down Rate Of Pit Or Sump.

Reverse Any Two Of The 3-Phase Leads and Compare Performance. Leave The Pump Connected In Best Of The Two. Vibration And High Amp Draw May Or May Not Occur With A Pump Running Backwards.
19. Discharge Connection
20. Draw Down Test

• Look in the book.
Sump mixing device benefits

1. No power is required
2. It is explosion-proof
3. It works automatically
4. It agitates wet well
5. Prevents build-ups
   - Re-suspends solids
   - Breaks-up sludge
   - Emulsifies grease