



# **Introduction to Physics of Liquids, Centrifugal Pumps Systems, and Pump Operation**

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**Colorado Environmental  
Council for Training Inc.**

**Delta Marriott Thornton/Northglenn Hotel  
10 E. 120<sup>th</sup> Ave.**

**Northglenn, CO 80233**

**November 6, 2025**

**by**

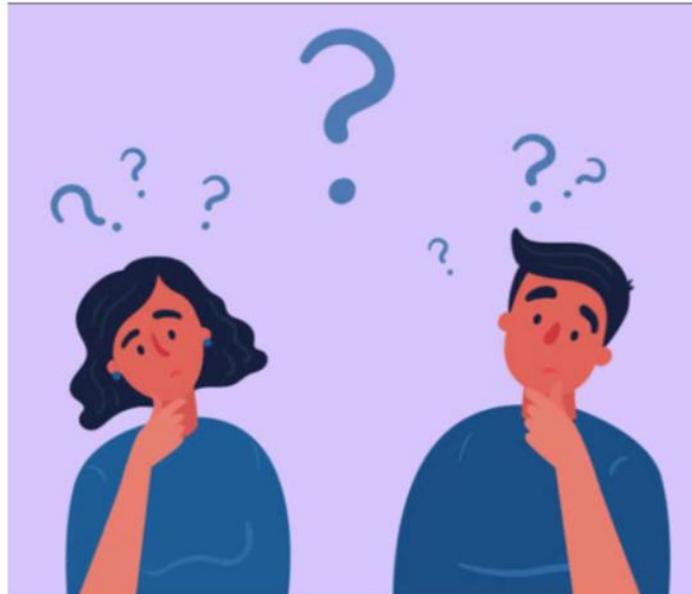
**Arvada Pump Company**

# Welcome –

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**Why are you here today ?**

**(Other than “my boss said I had to” .....?)**



**What do you expect or want to learn about?**

**Do you have any specific questions yet?**

# DIHYDROGEN OXIDE & SELECTED SDS INFORMATION

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- **Chronic Effects on Humans:**
  - No determined negative effects.
- **Other Toxic Effects on Humans:**
  - Non-corrosive for skin. Non-irritant for skin. Non-sensitizer for skin. Non-hazardous in case of ingestion. Non-corrosive to the eyes. Noncorrosive for lungs.
- **Lethal Dose 50** – Approximately 6 liters for 75 kg (165 lb.) person (immediate)
- **Toxicity to Animals:**
  - Not available.

# DIHYDROGEN OXIDE & SELECTED SDS INFORMATION - CONTINUED

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- **Taste:** Varies depending on source
- **Color:** Colorless.
- **Odor Threshold:** Not available.
- **pH (1% soln./water):** 7 [Neutral.]
- **Boiling Point:** 100°C (212°F)
- **Specific Gravity:** 1 (Water = 1)
- **Vapor Pressure:** 2.3 kPa (@ 20°C)

# DIHYDROGEN OXIDE -

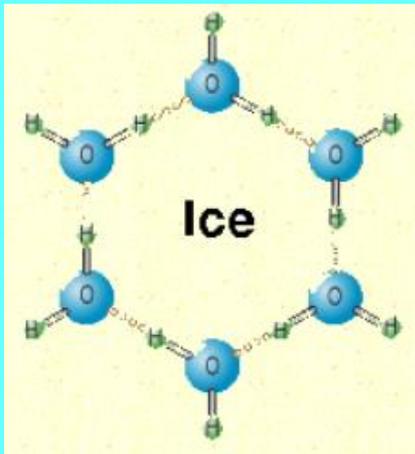
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- **Solid** below 32 degrees F
- **Gas** above 212 F @ Sea Level
- **Liquid:** above 32 degrees F
- **Density:** Lower as solid than liquid
- **Crystalline Structure Solid** – 6 sided
  
- ***WHAT IS THIS SUBSTANCE?***

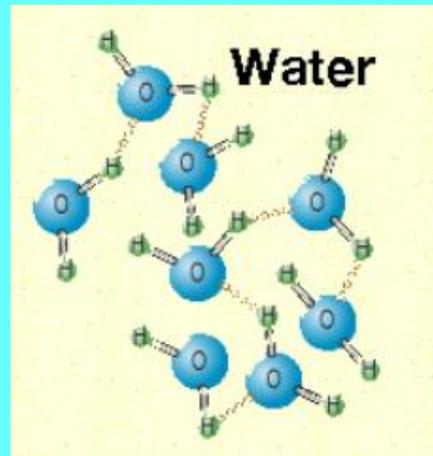
# What is It?

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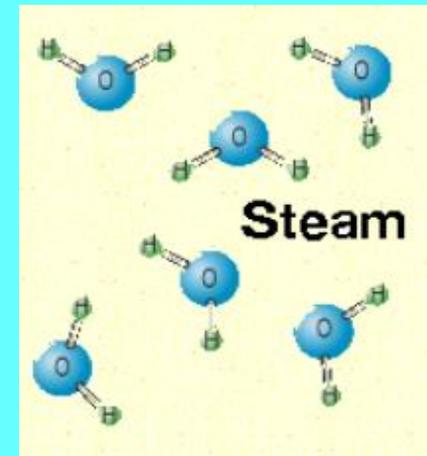
- H<sub>2</sub>O - or WATER !!
- SG = 1.0



SOLID



LIQUID



GAS

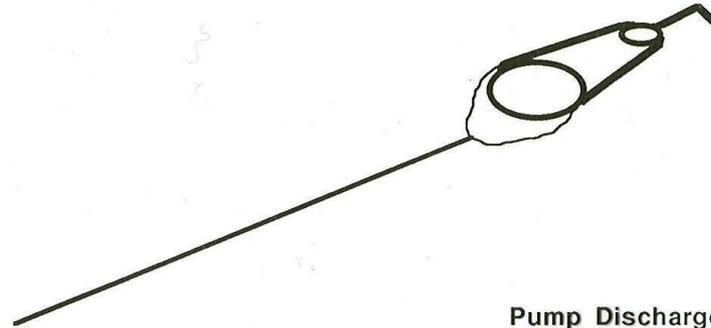


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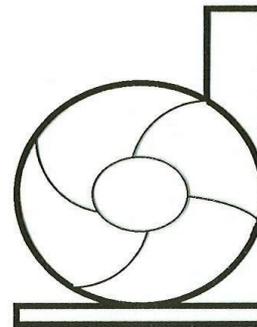
# CENTRIFUGAL PUMPS

# CENTRIFUGAL PUMP / BUCKET ANALOGY

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Pump Discharge =  
Hole in Bucket

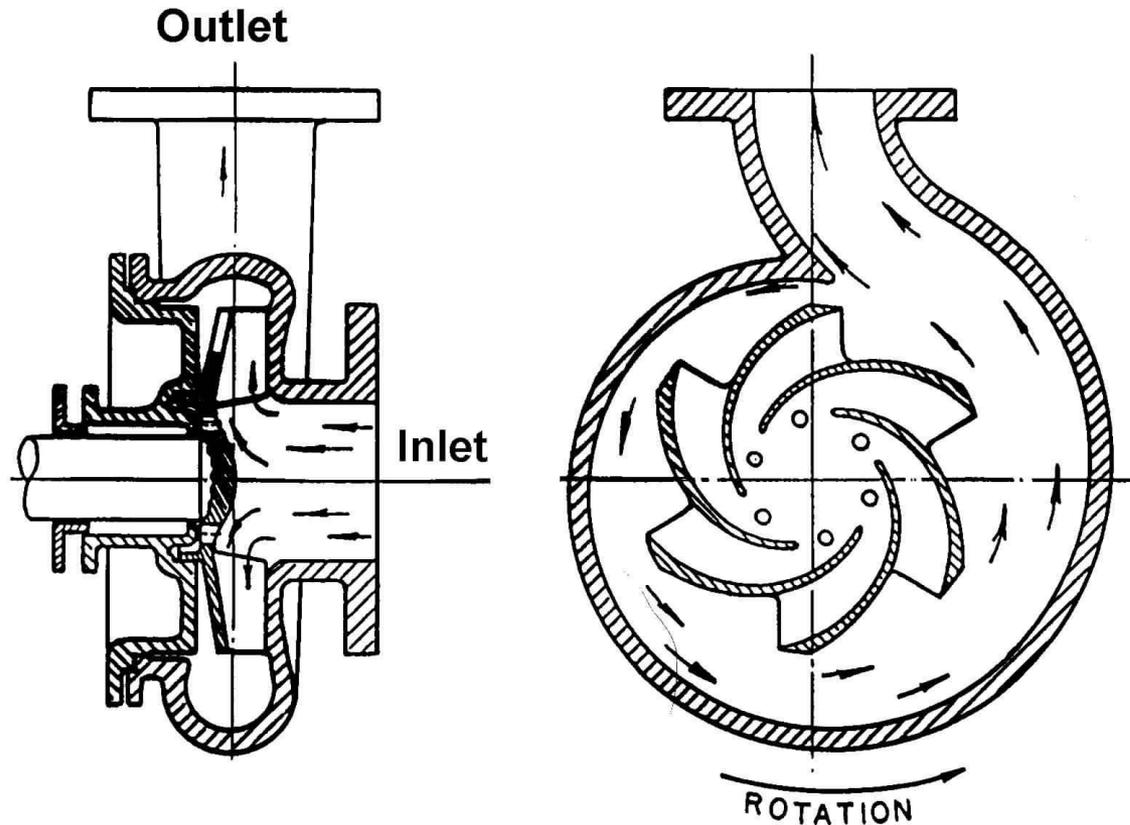


Case = Bucket

Impeller = Rope

Centrifugal Pump - "Bucket Theory"

# END SUCTION VOLUTE STYLE PUMP



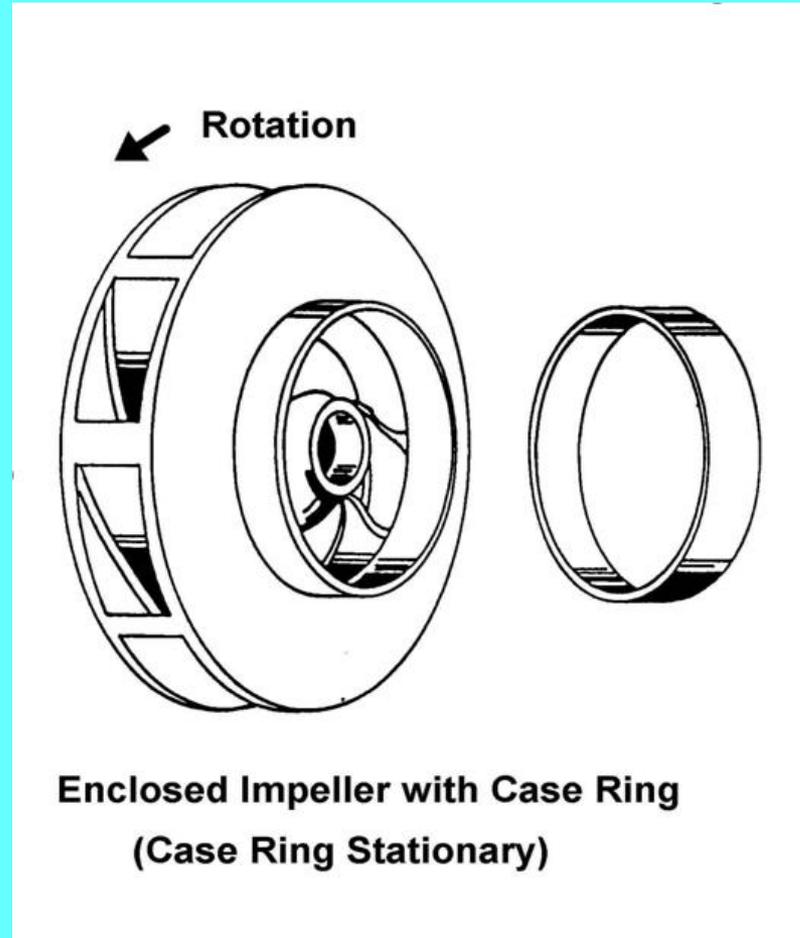
**End Suction Centrifugal Pump**

# PUMP IMPELLERS – OPEN VS. CLOSED

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Semi-Open Impeller



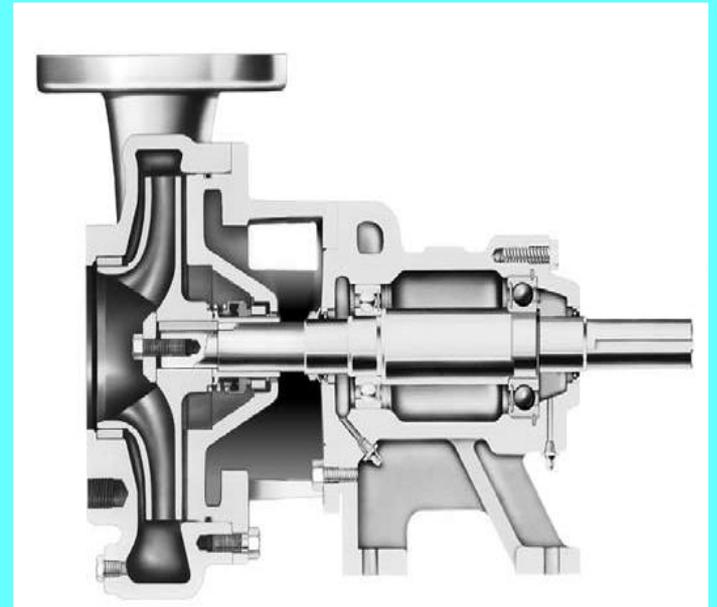
Enclosed Impeller with Case Ring  
(Case Ring Stationary)

# Centrifugal End Suction Pump

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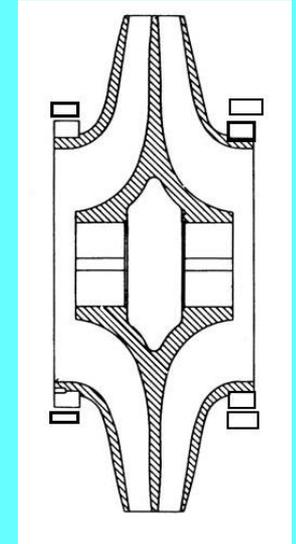
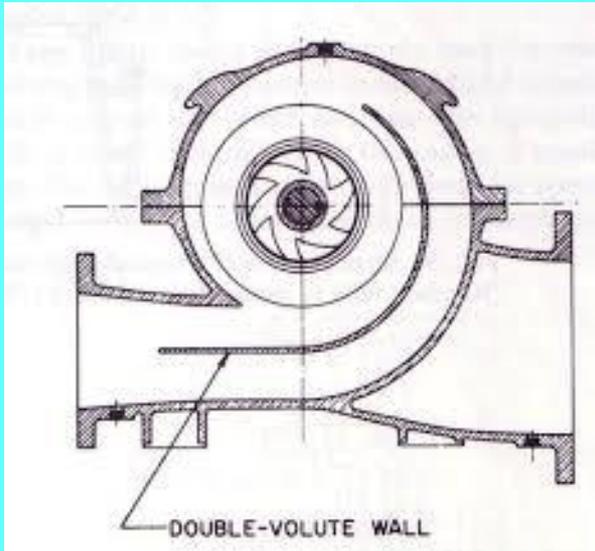
Close Coupled



Frame Mounted

# Centrifugal Double Suction Pump

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# What Makes Up A System Curve?

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- Elevation Change
- Friction Losses
  - Pipe, Valves, Fittings, Heads, Nozzles
- Incoming System Pressure
- Required Discharge Pressure
- Variation in Flow Requirements

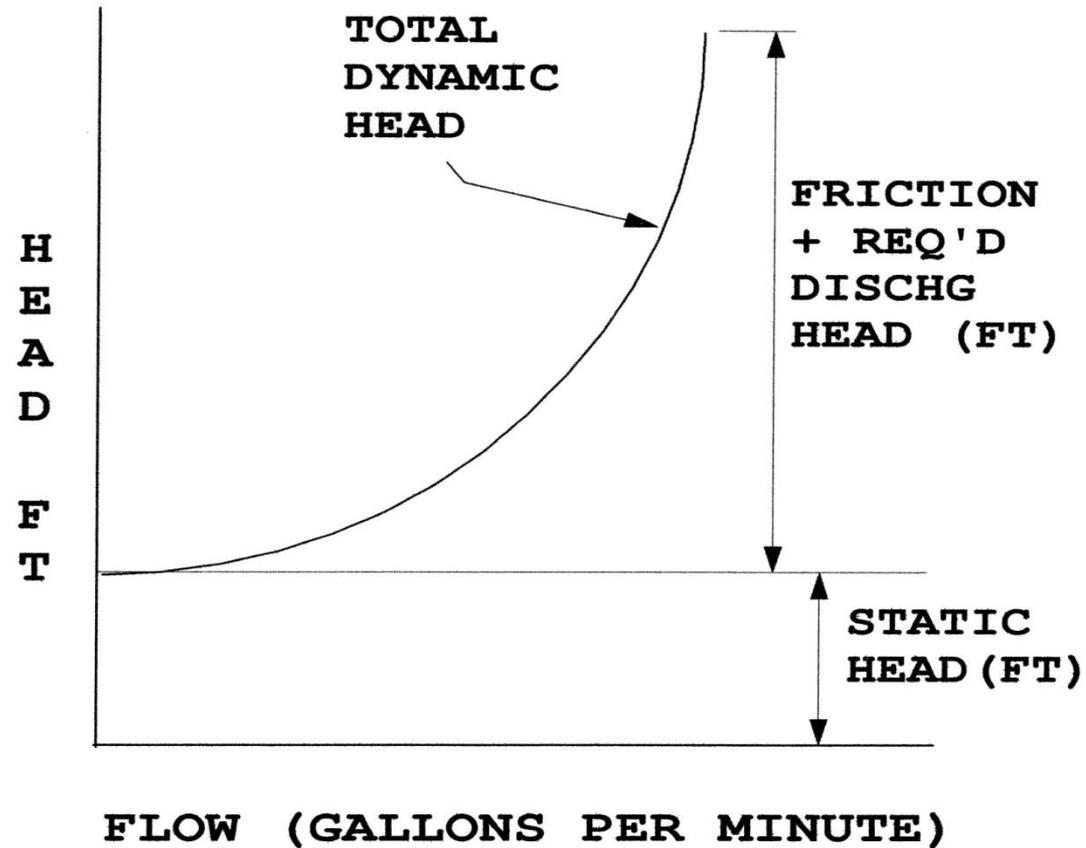


# Pump Selection & Operation

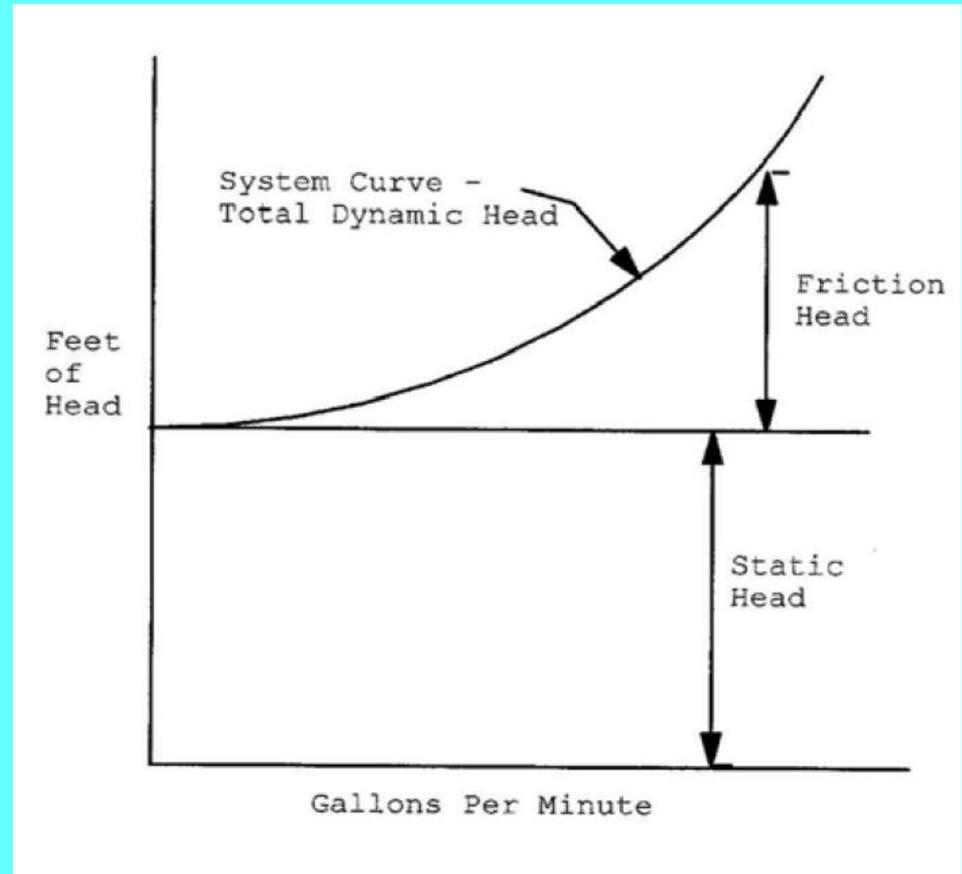
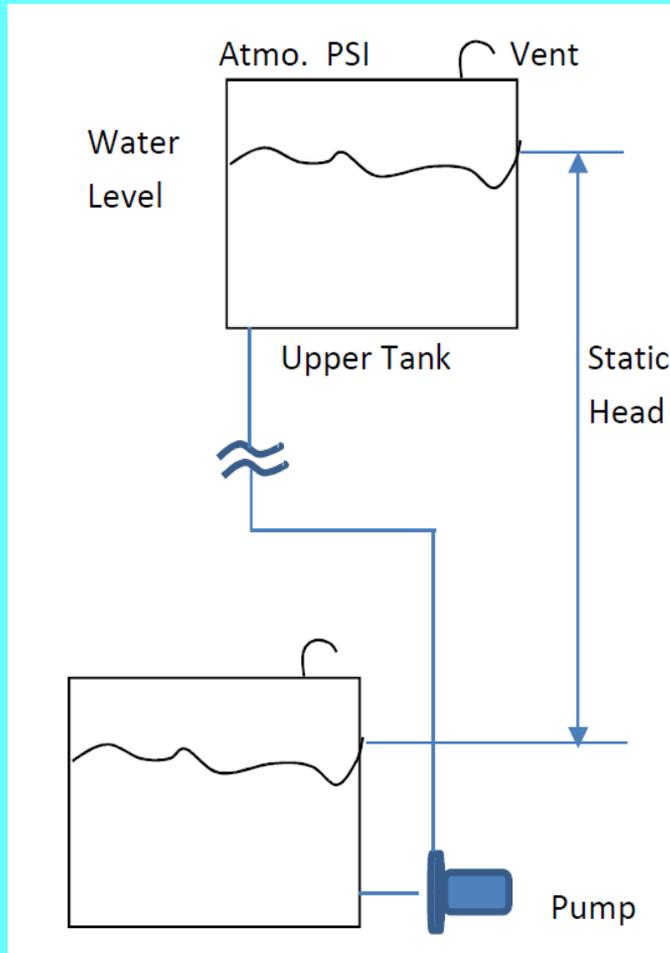
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- System Curves  
&  
▪ Pump Curves

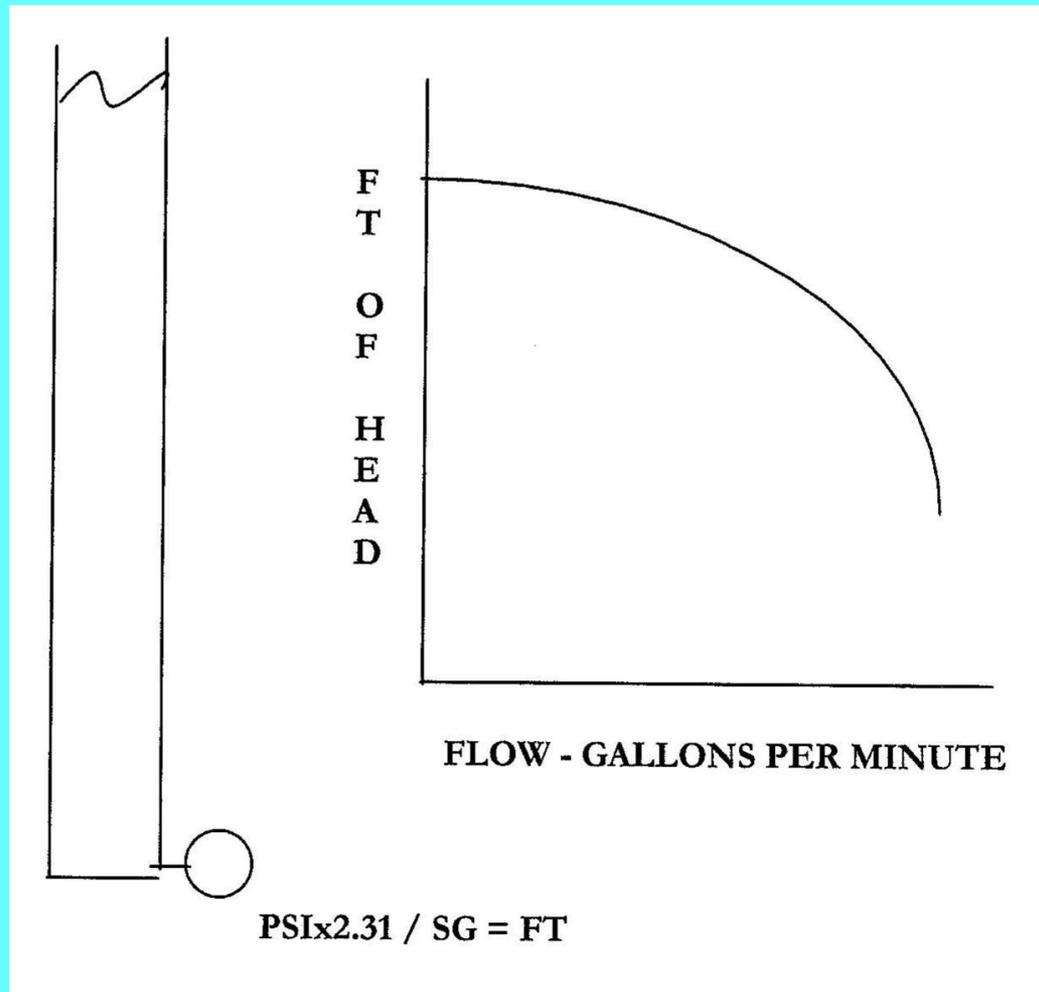
# BASIC PUMP SYSTEM CURVE



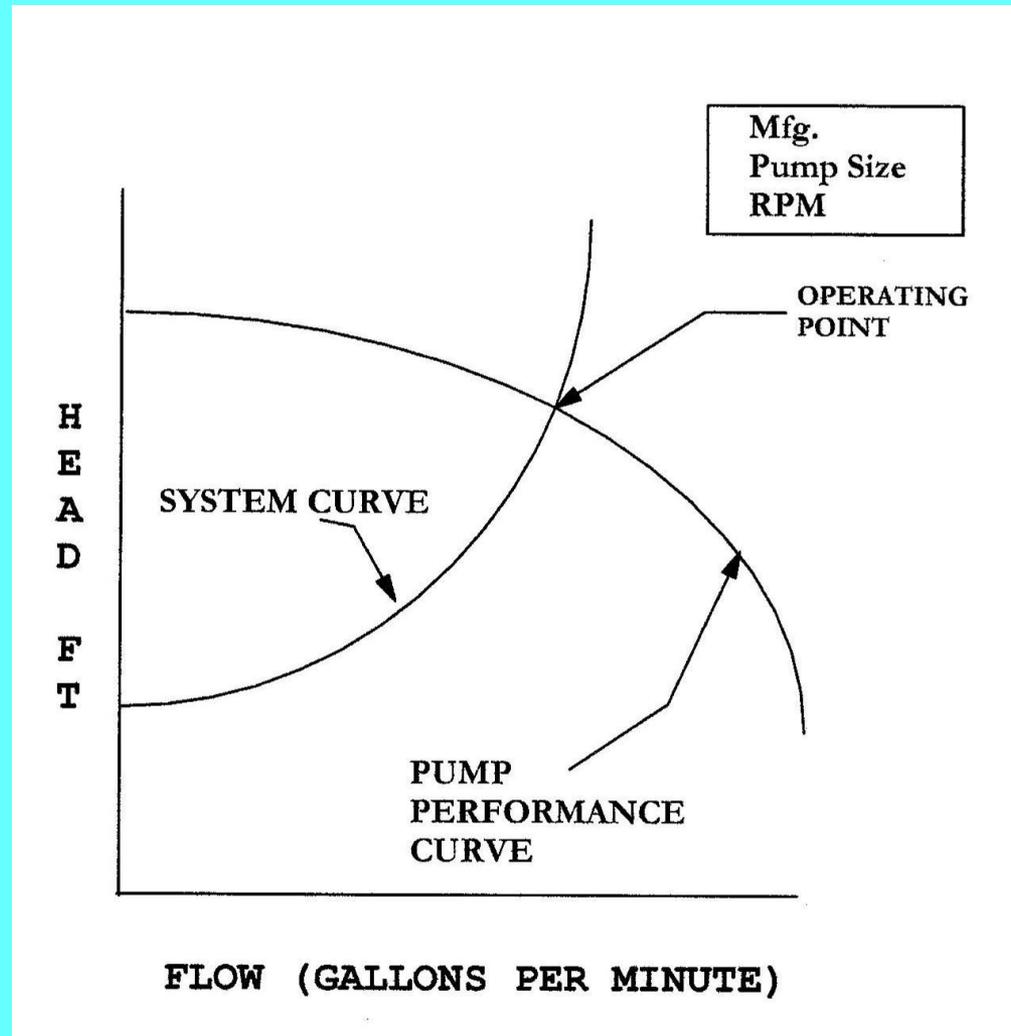
# BASIC SYSTEM & SYSTEM CURVE



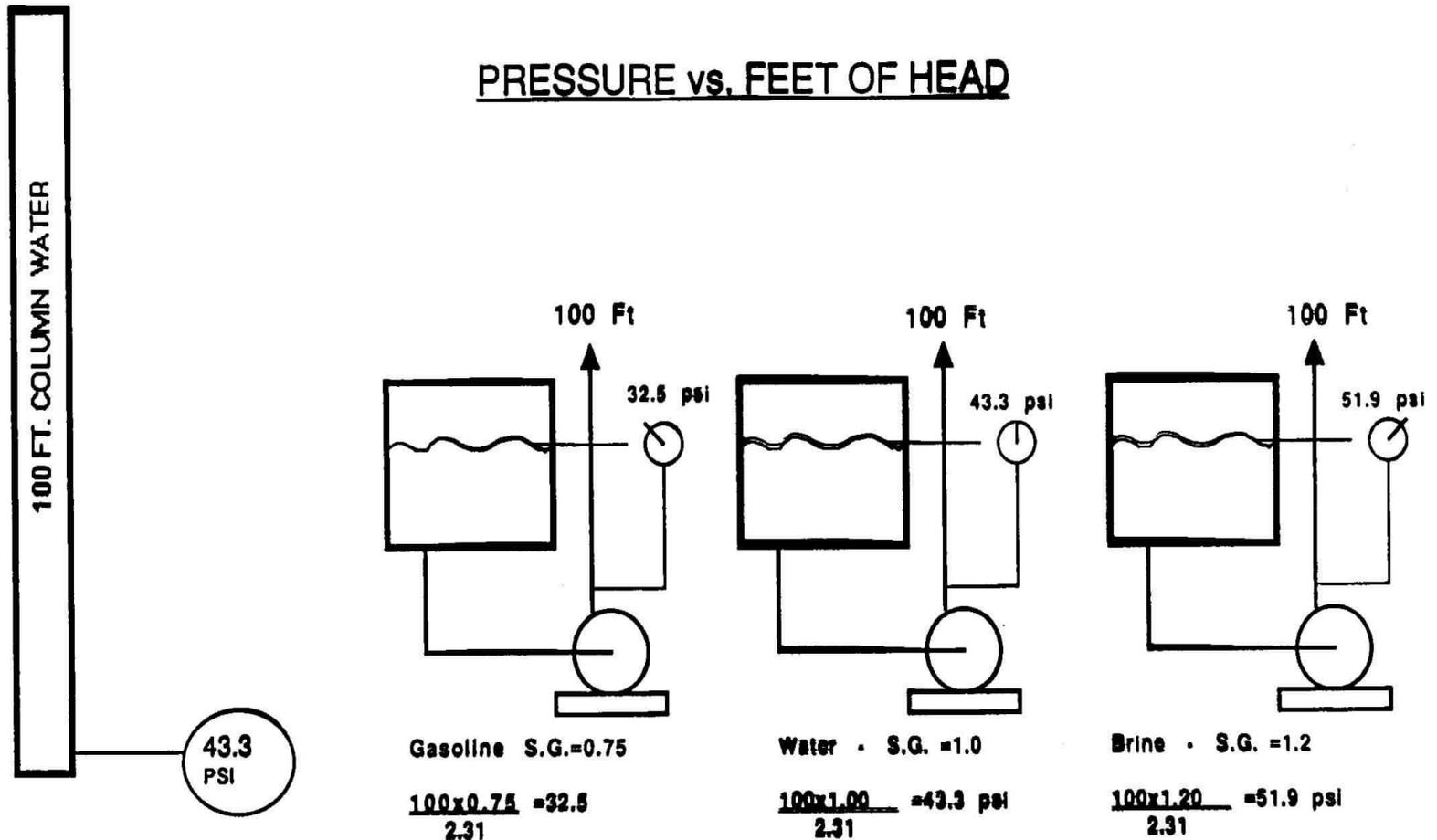
# BASIC PUMP PERFORMANCE CURVE



# PUMPS OPERATE WHERE SYSTEM & PUMP CURVES INTERSECT



# PRESSURE (PSI) / FEET OF HEAD EFFECTS OF SPECIFIC GRAVITY



# CONVERTING TO “LIKE” UNITS

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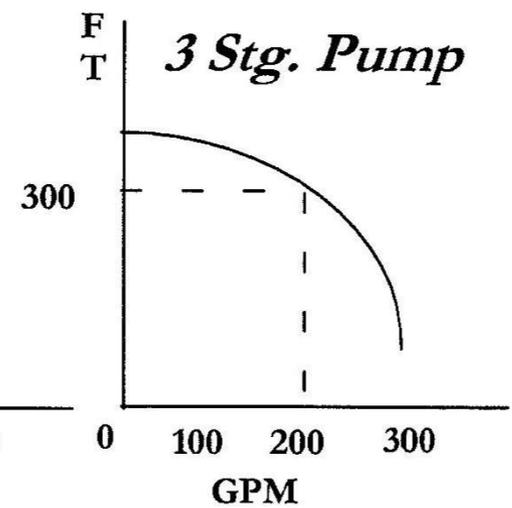
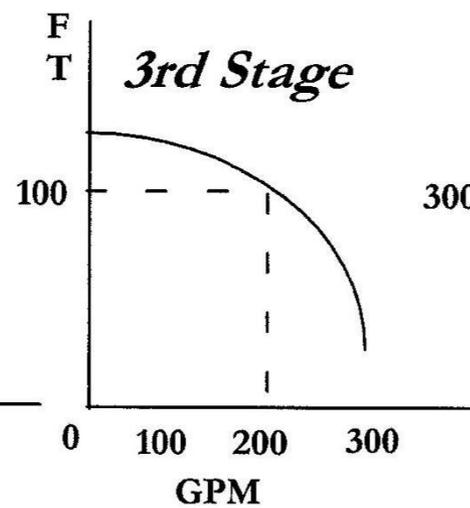
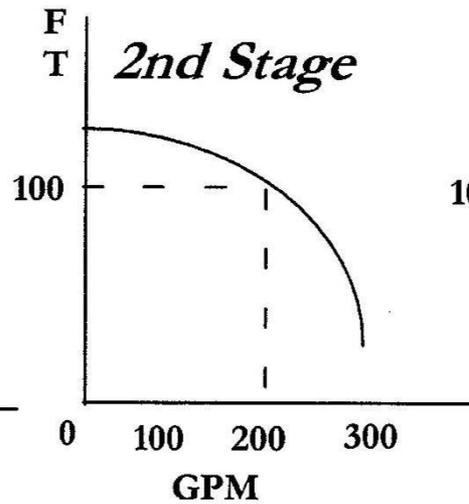
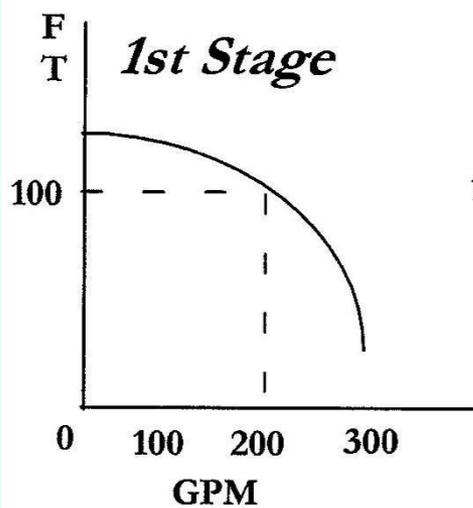
- WATER – S.G. 1.0
- STATIC HEAD (Elev. Change) = **21 FT.**
- CONVERT PSI TO FEET:
  - FRICTION LOSSES = 5.35 PSI
  - REQ'D PSI @ DISCHARGE = 80 PSI
  - $(\text{PSI} \times 2.31) / \text{S.G.} = \text{FEET OF LIQUID}$
  - $\text{HEAD} = (5.35 + 80) \times 2.31 / 1.0 = \underline{\underline{197 \text{ FT.}}}$
- TOTAL HEAD REQUIRED = **218 FT.**

# Large Municipal Raw Water Irrigation Station



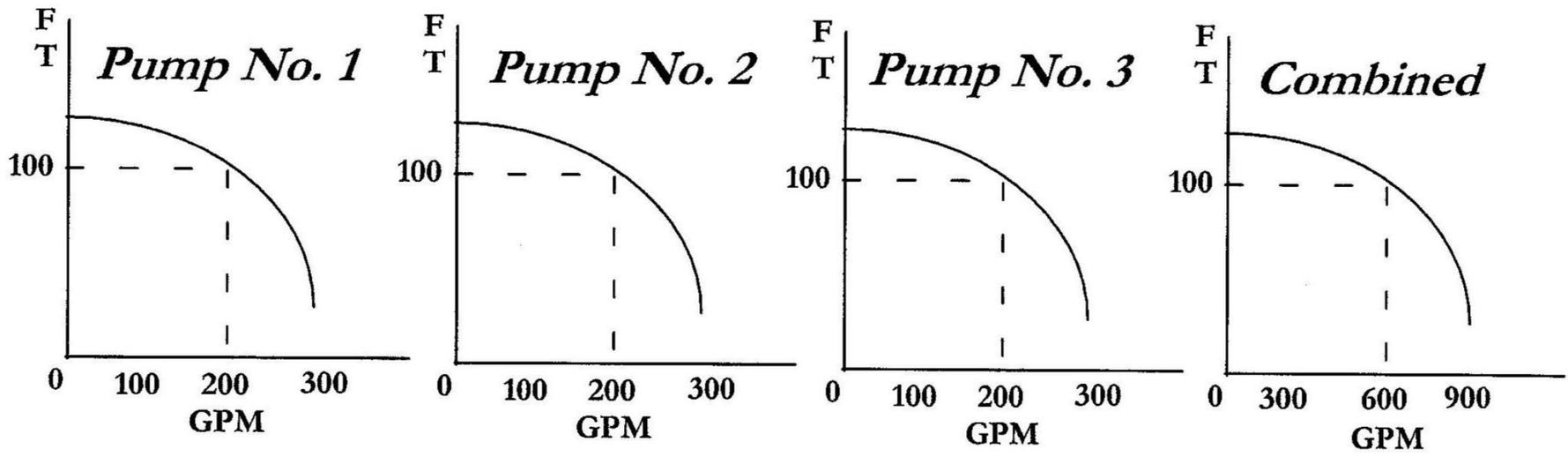
# MULTIPLE STAGES INCREASE PRESSURE – FLOW CONSTANT

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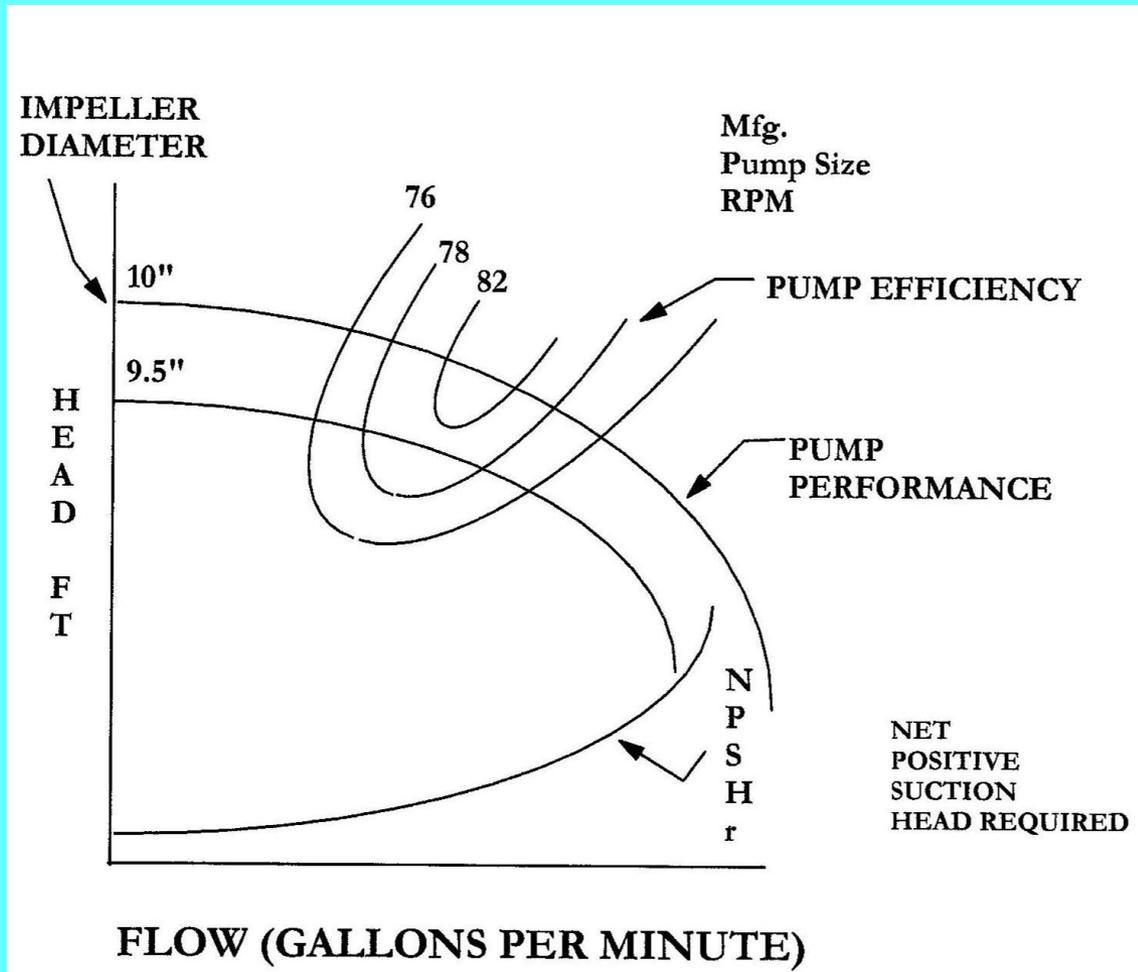


# MULTIPLE IDENTICAL PUMPS – PUMPING IN PARALLEL

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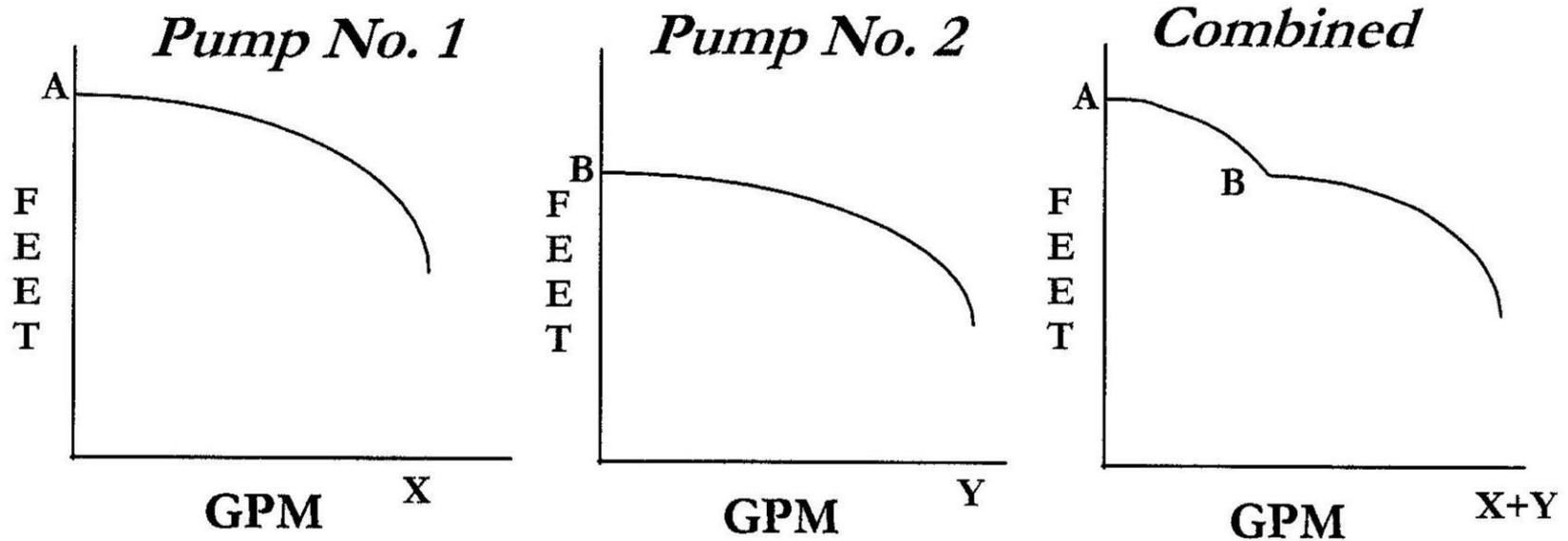


# ELEMENTS OF MANUFACTURER'S PERFORMANCE CURVES



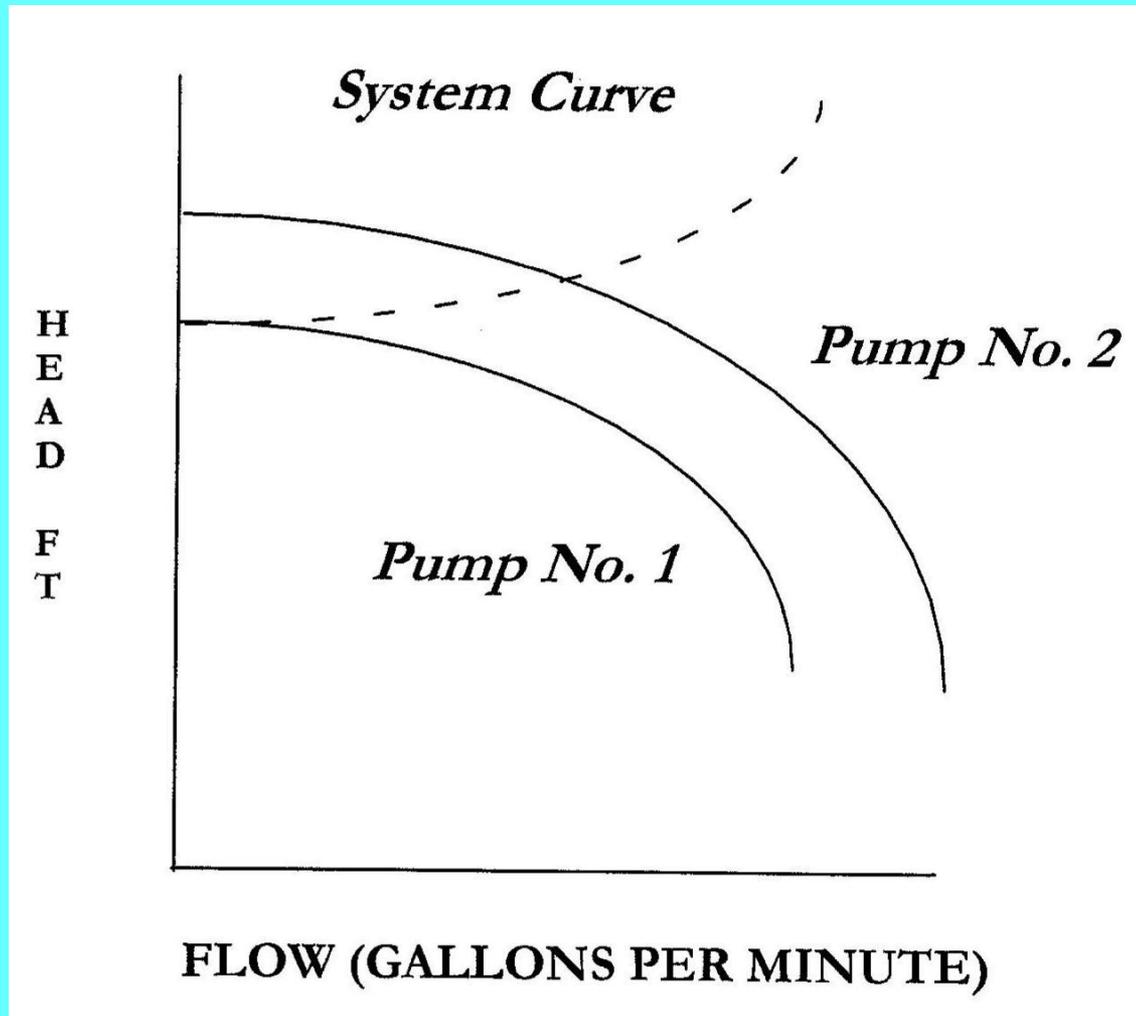
# COMBINED PERFORMANCE OF TWO DISSIMILAR PUMPS

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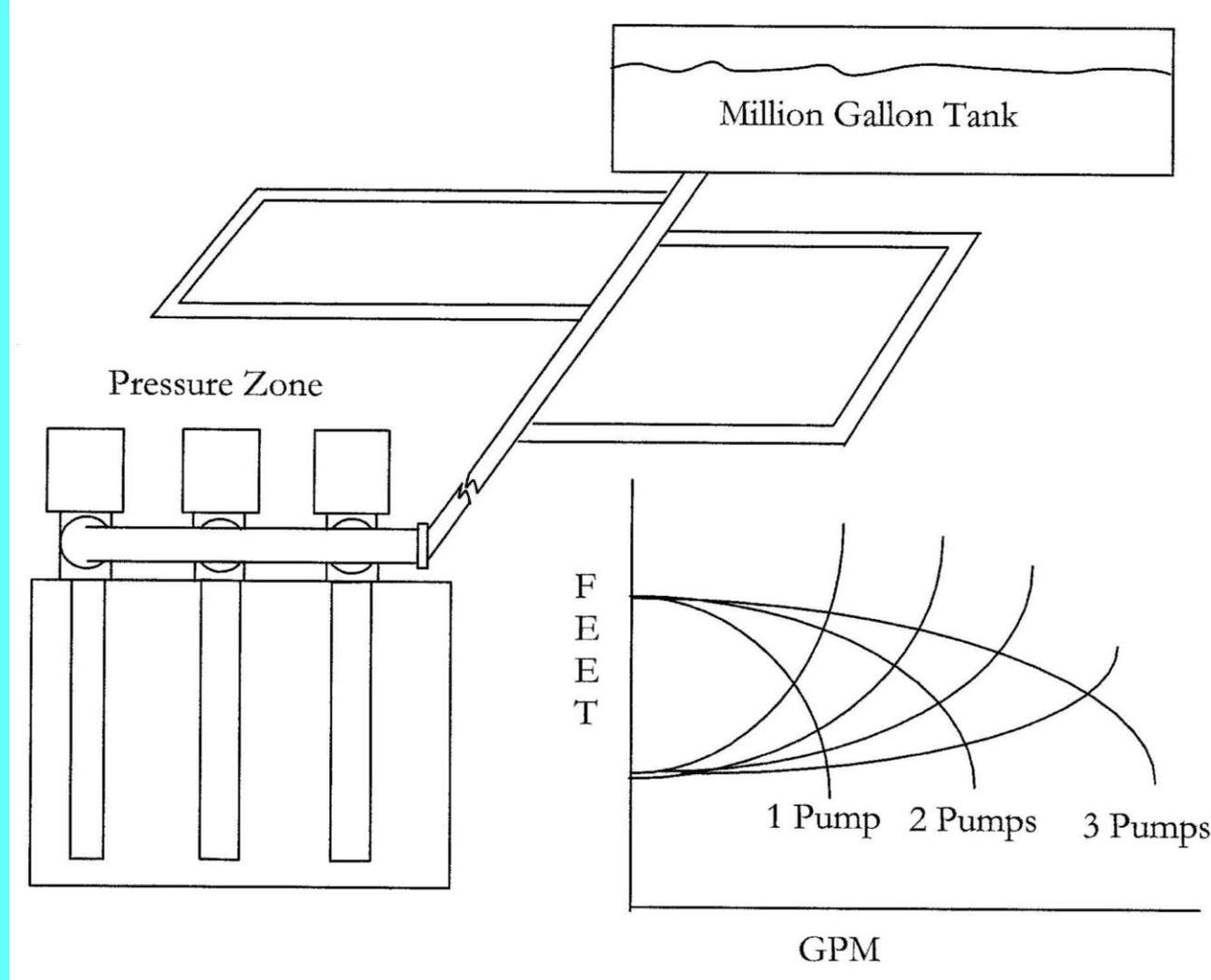


# DANGER OF OPERATING DISSIMILAR PUMPS IN PARALLEL

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# LARGE SYSTEM SCHEMATIC + PUMP & PUMP PERFORMANCE CURVES



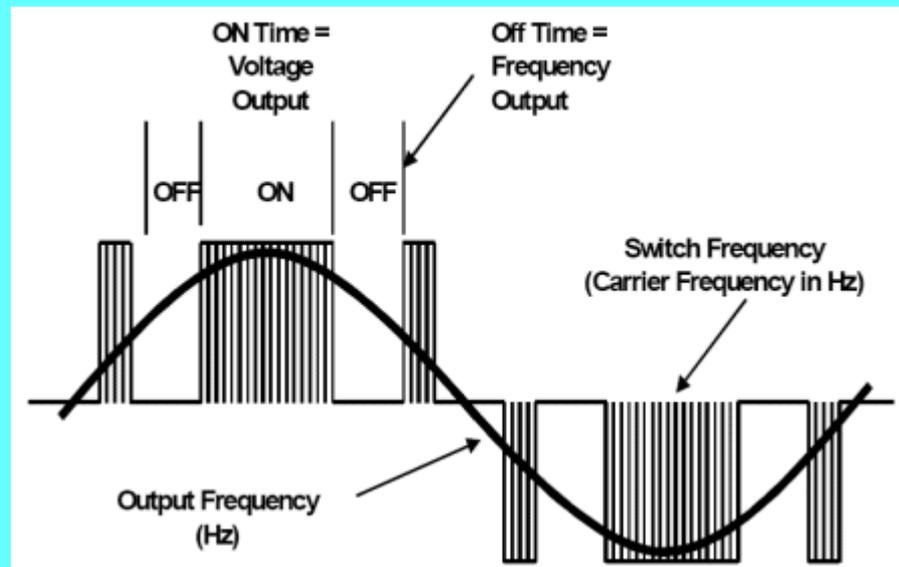
# Variable Speed and Variable Frequency Drives

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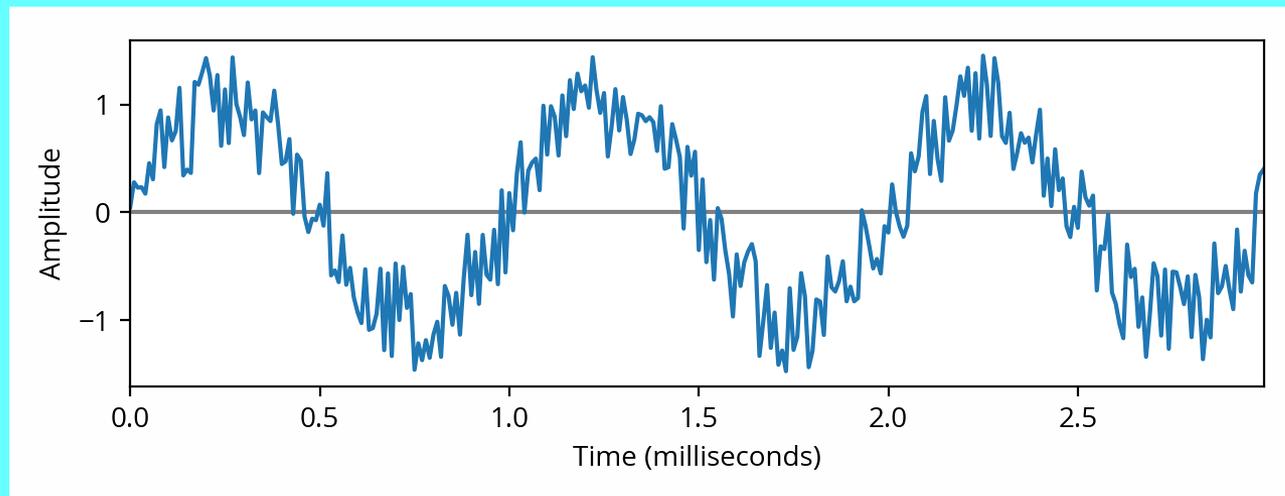
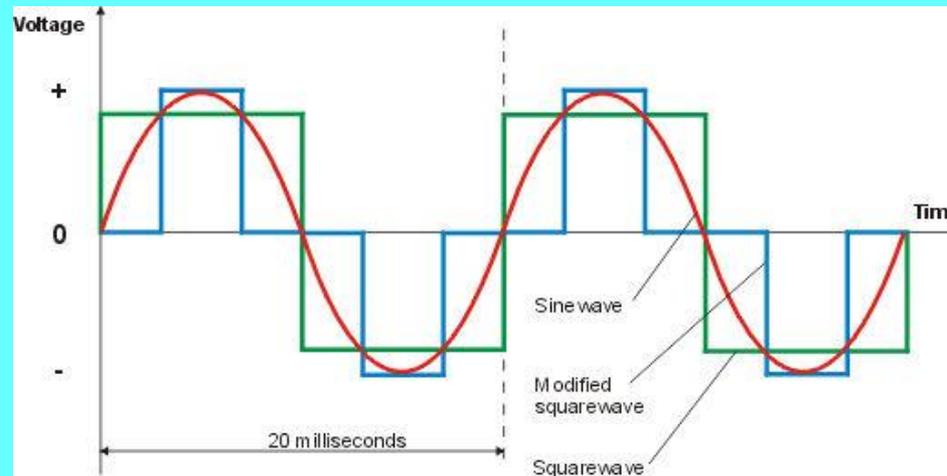
# How Does a VFD Work?

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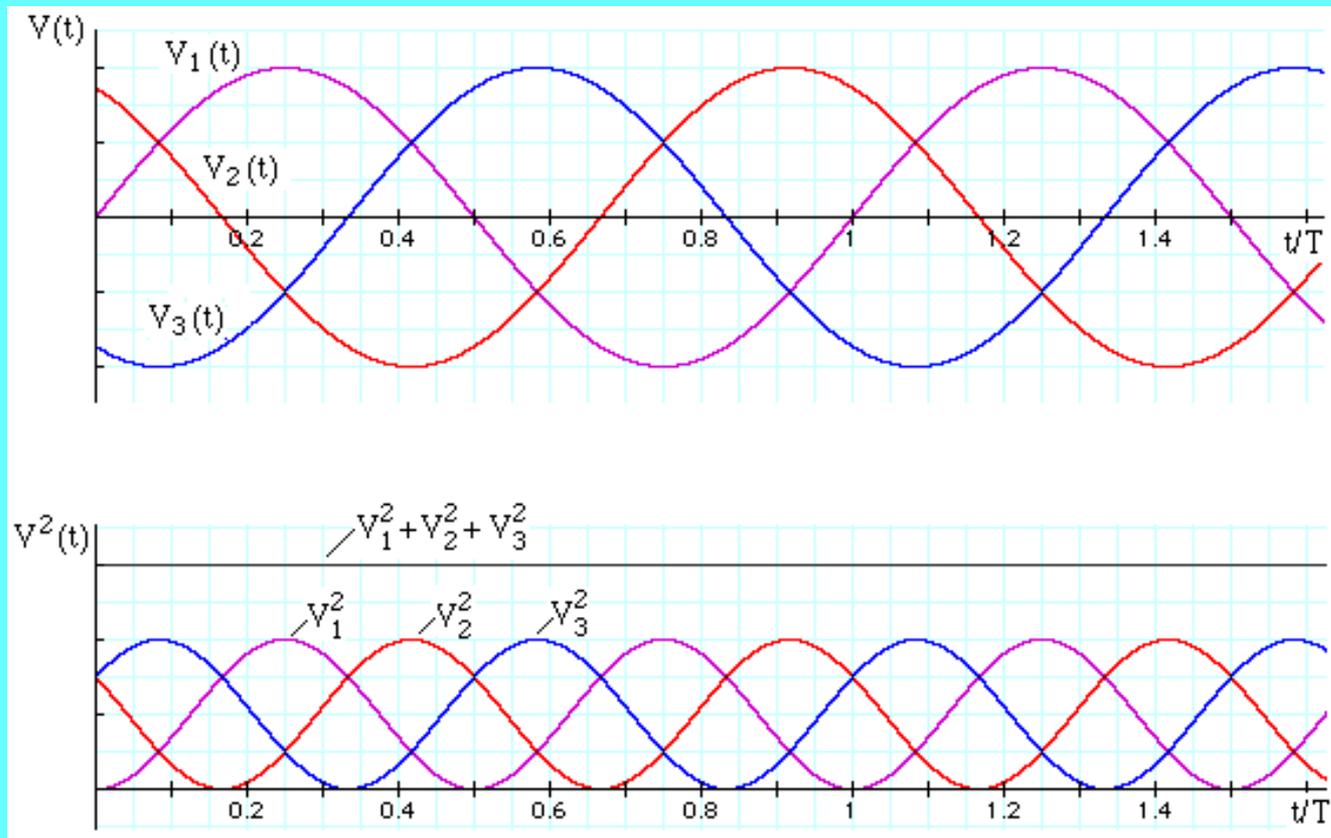


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# Simulated Sine Wave Output



# Three Phase Variable Frequency Drive Output



**Zero to About 400 Hz – Motor Speed**

# Variable Speed Operation

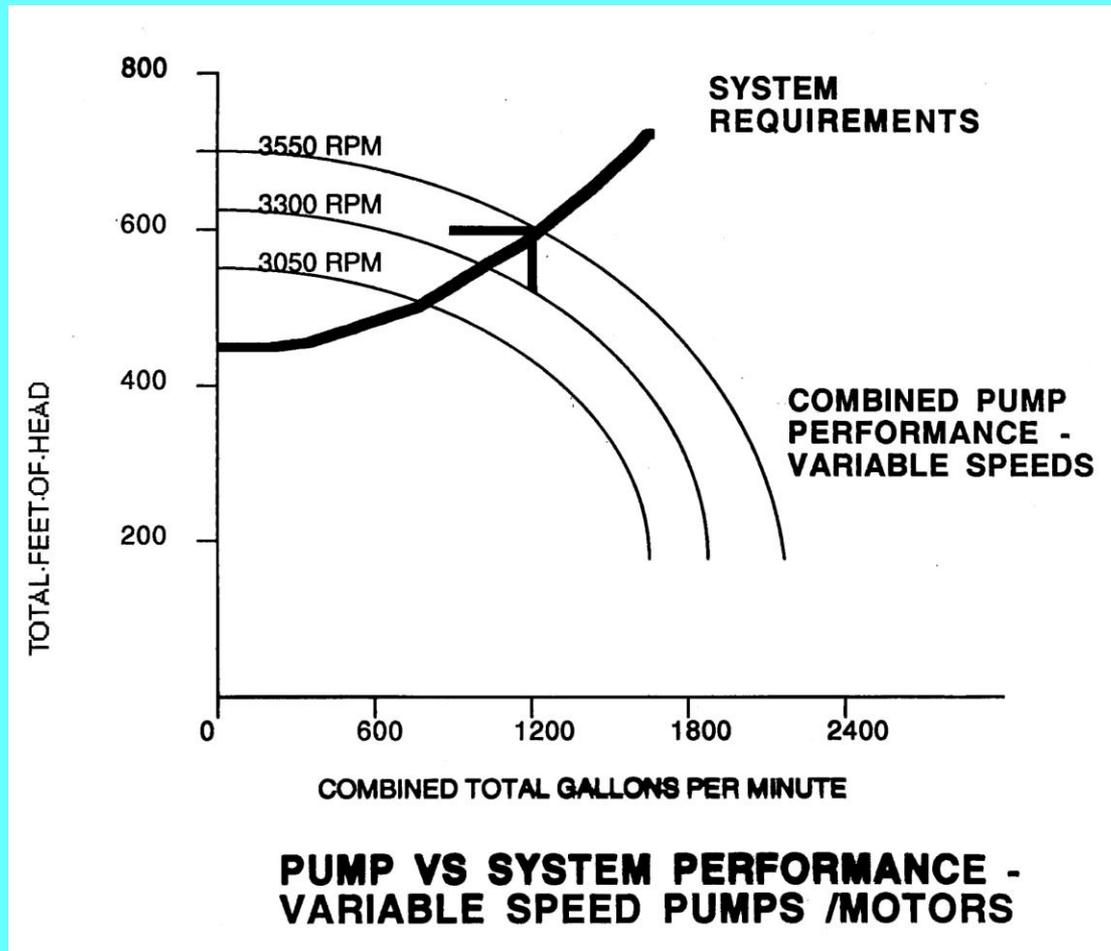
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## ○ Pump Selection

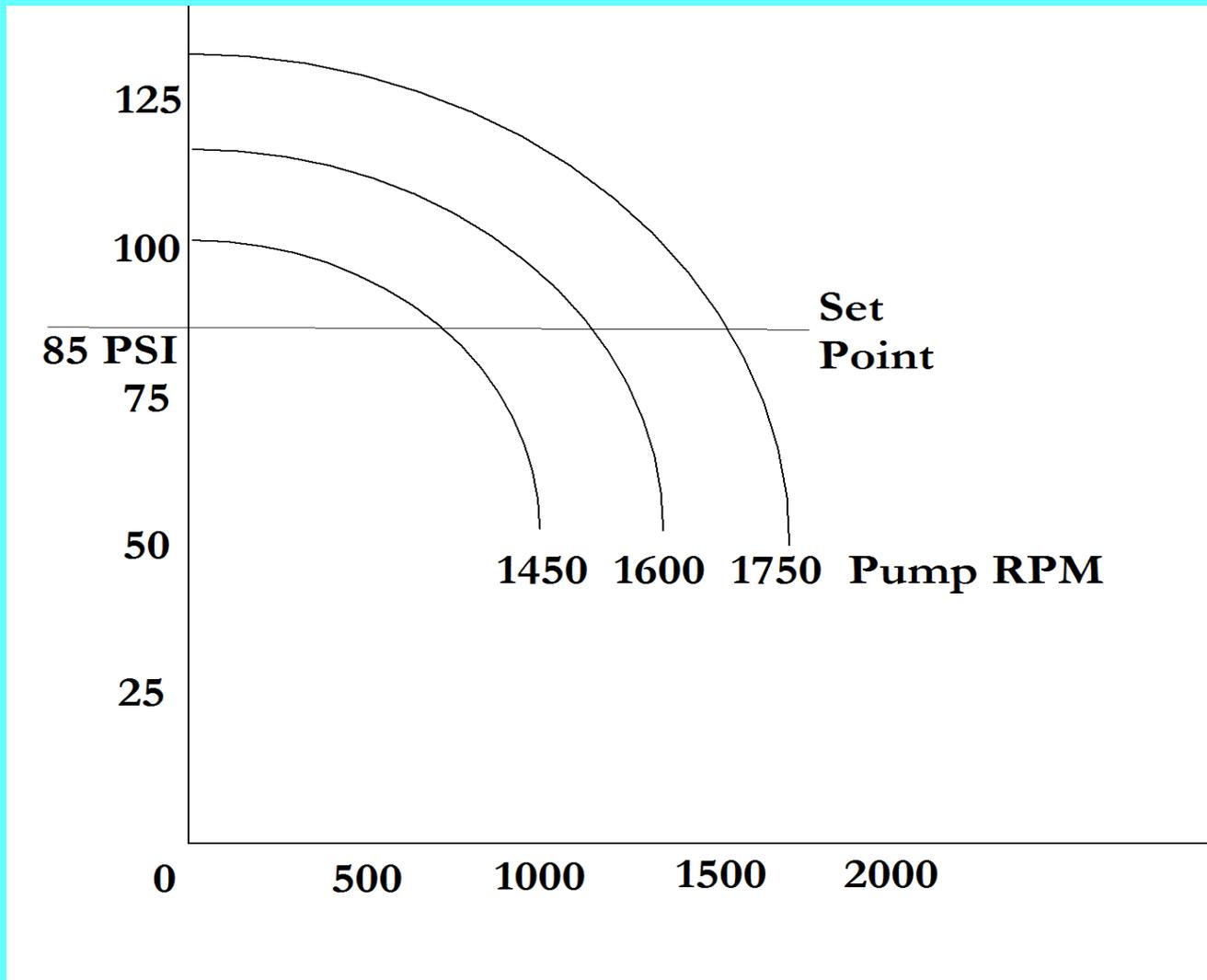
- Does the System Have Varying Flow or Pressure Demands?
- Steeply Rising Pump Curve?
- What Are the Horsepower Limitations?
- Are There NPSH Problems?

# VARIABLE SPEED PERFORMANCE

- Note: The pump operates where the system curve intersects the pump curve, but with variable speed, the pump can match the system curve.



# Variable Speed - Maintaining Constant Pressure / Varying Flow



# Predicting Variable Speed Performance\*

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- Capacity – GPM       $GPM1/GPM2 = RPM1/RPM2$
- Head – FT               $TDH1/TDH2 = (RPM1/RPM2)^2$
- Brake HP – BHP       $BHP1/BHP2 = (RPM1/RPM2)^3$

\*Trimmed Impeller Performance Follows Same Relationships with DIA1 Replacing RPM 1 and DIA2 Replacing RPM 2

# VARIABLE SPEED FULL SPEED + VALVE VS. LOWER SPEED

## VARIABLE SPEED PERFORMANCE

DESIRED PUMP OUTPUT  
LIQUID

315 GPM @ 200 FT (86.5 PSI)  
WATER

Original Impeller Diameter

8

Inch

Final Impeller Diameter

8

Inch

Performance Curve RPM  
S.G. 1.00

3550

Reduced Operating RPM

3200

### Pump Performance at 3500 RPM

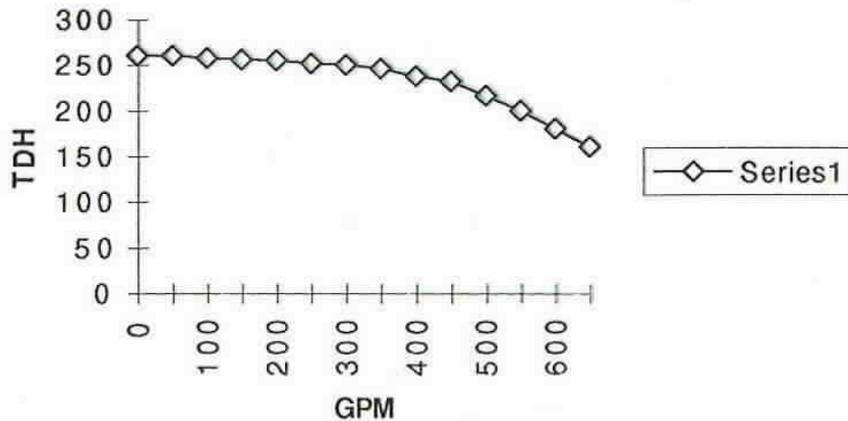
GPM	TDH	Effic	BHP
0	260	20%	0.0
50	260	35%	9.4
100	258	45%	14.5
150	256	54%	18.0
200	255	60%	21.5
250	252	64%	24.9
300	250	70%	27.1
350	246	74%	29.4
400	238	78%	31.0
450	232	80%	33.2
500	216	80%	34.2
550	200	78%	35.6
600	180	75%	36.2

### Pump Performance at 3200 RPM

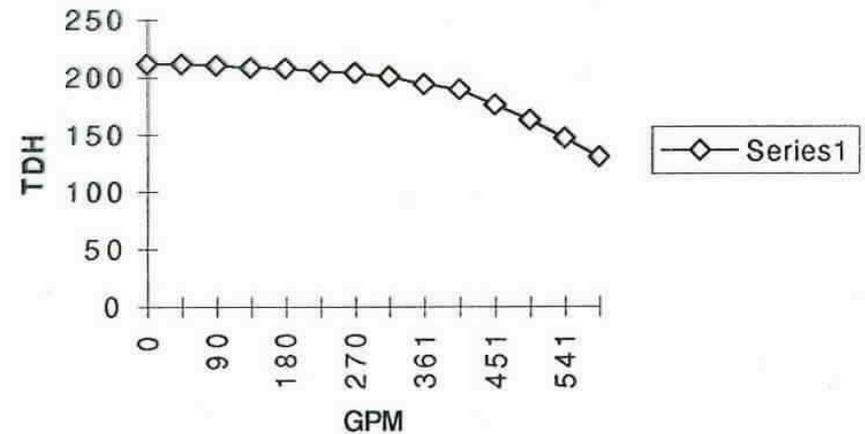
GPM	TDH	Effic	BHP
0	211		0.0
45	211	35%	6.9
90	210	45%	10.6
135	208	54%	13.2
180	207	60%	15.7
225	205	64%	18.2
270	203	70%	19.8
315	200	74%	21.5
361	193	78%	22.7
406	189	80%	24.3
451	176	80%	25.0
496	163	78%	26.1
541	146	75%	26.5

# VARIABLE SPEED PERFORMANCE CURVES

## ORIGINAL PUMP PERFORMANCE



## REDUCED SPEED PERFORMANCE



# COST ANALYSIS – VFD CONTROL VS. THROTTLING VALVE

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- HP - 315 GPM @ 250 FT **27.06** BHP
- HP - 315 GPM @ 200 FT **21.50** BHP
- Savings - VFD over Valve 5.56 BHP
- **12 Hrs./Day x 135 Days/Yr. x 5.56 = 9007.20 Horsepower Hours / Year**
- 746 Watts/HP x 9007.2 = 6719.4 KWH
- At \$0.0815/kwh Savings = \$547.62/yr.
- **Over 20 years, savings = \$10,952.57**



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# What Damages Pumps?

Diagnosing and  
Correcting Operations

# Pumping Success vs Pumping Failures

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- Centrifugal Pumps only work because liquid is not compressible – i.e. hydraulic brake system in a car.
- What happens when water boils?
- What is Vapor Pressure?
- What's the difference in entrained air and vaporizing bubbles?

# PUMP OPERATIONAL CONCERNS

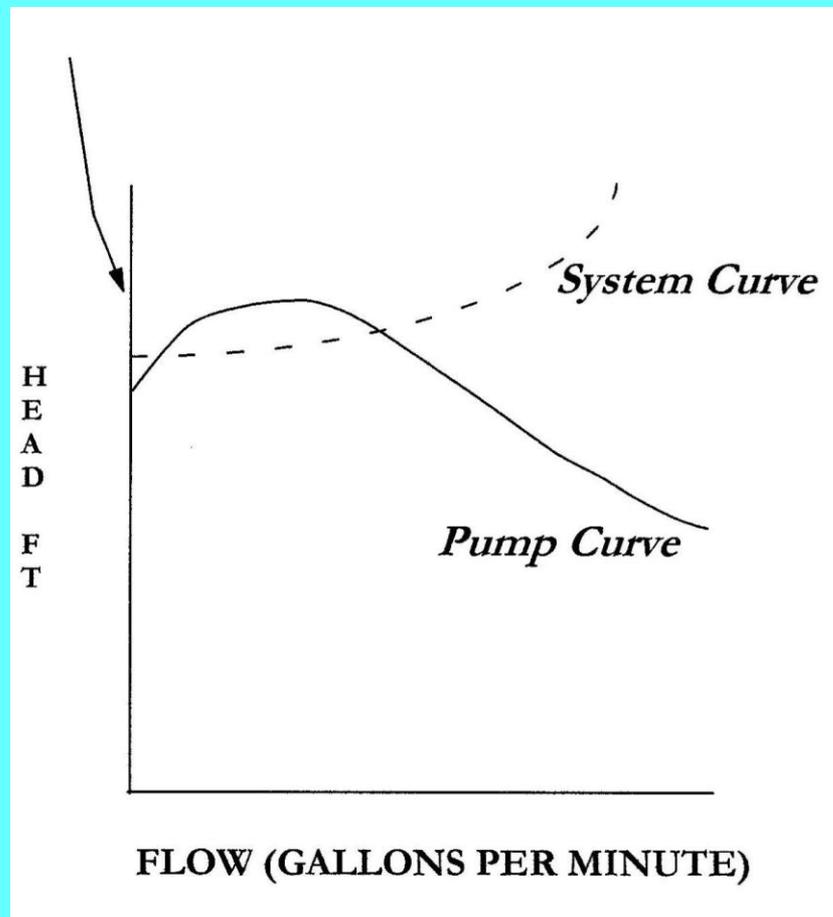
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- Is the Pump Properly Selected for the Application?
- Cavitation
- Air Entrainment
- Recirculation
- Stability of Flow
- Variable Speed Operation

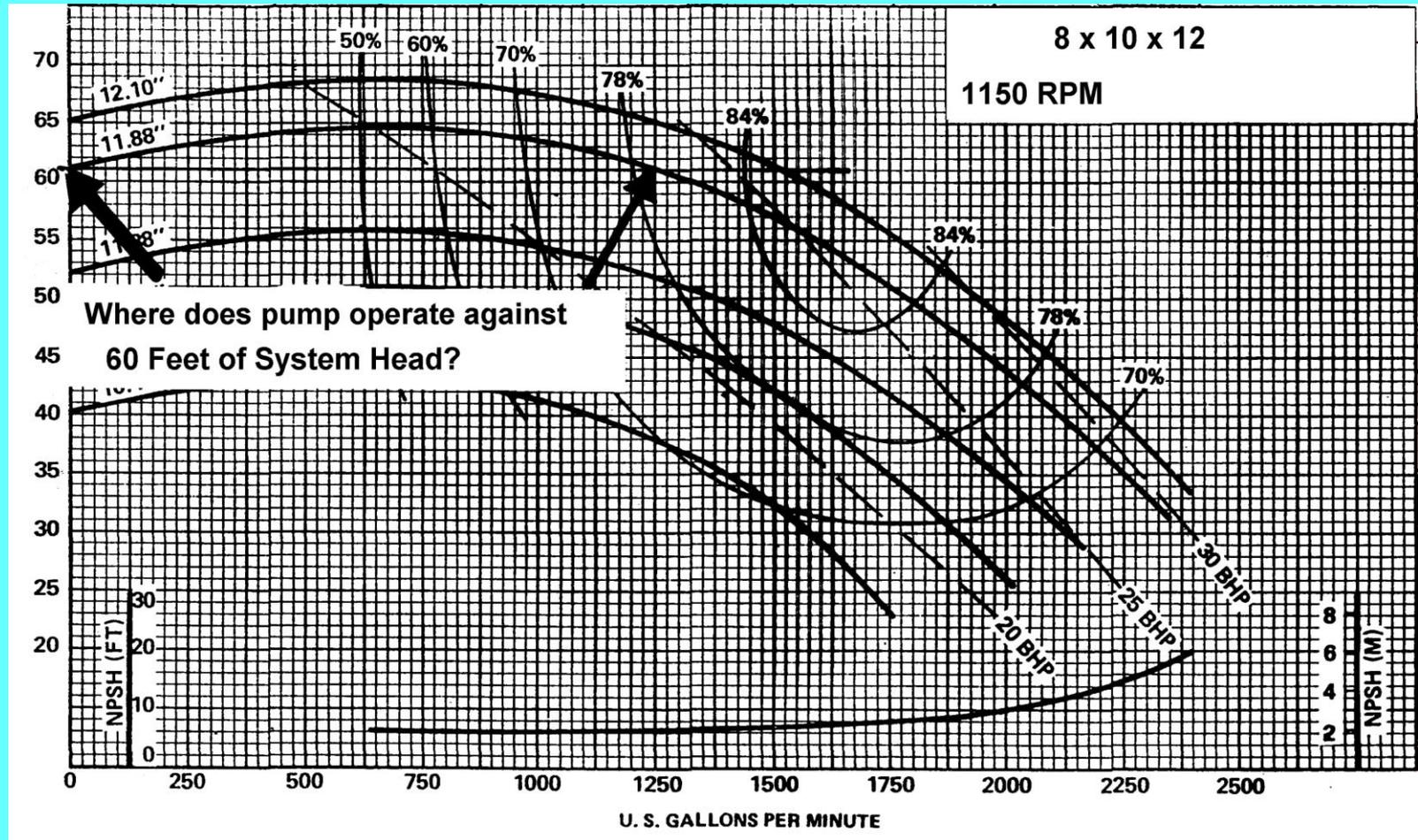
# NON CONTINUOUSLY RISING CURVES & UNSTABLE PERFORMANCE

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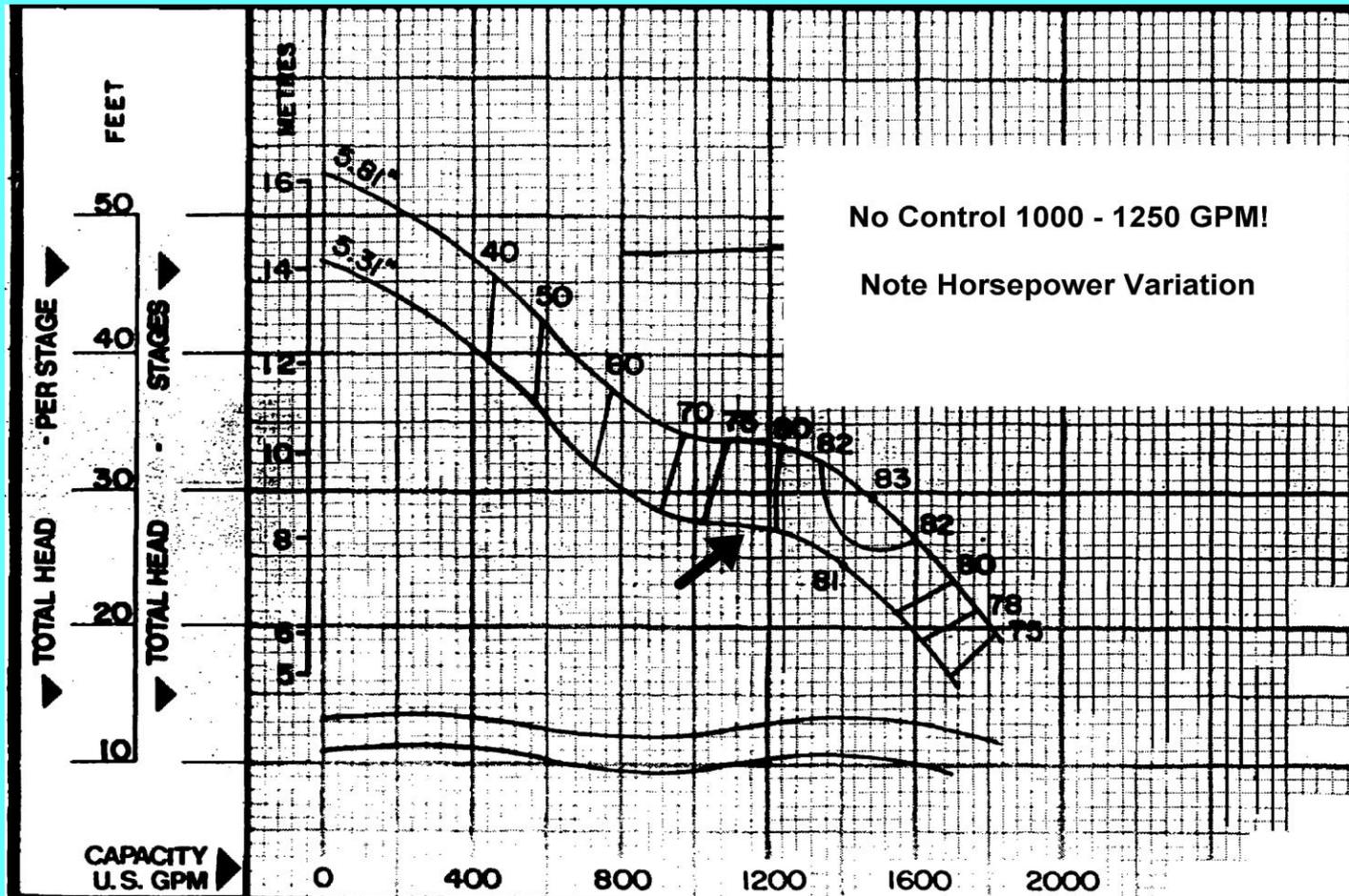
(Hint – Where Does System Curve Cross the Pump Curve?)



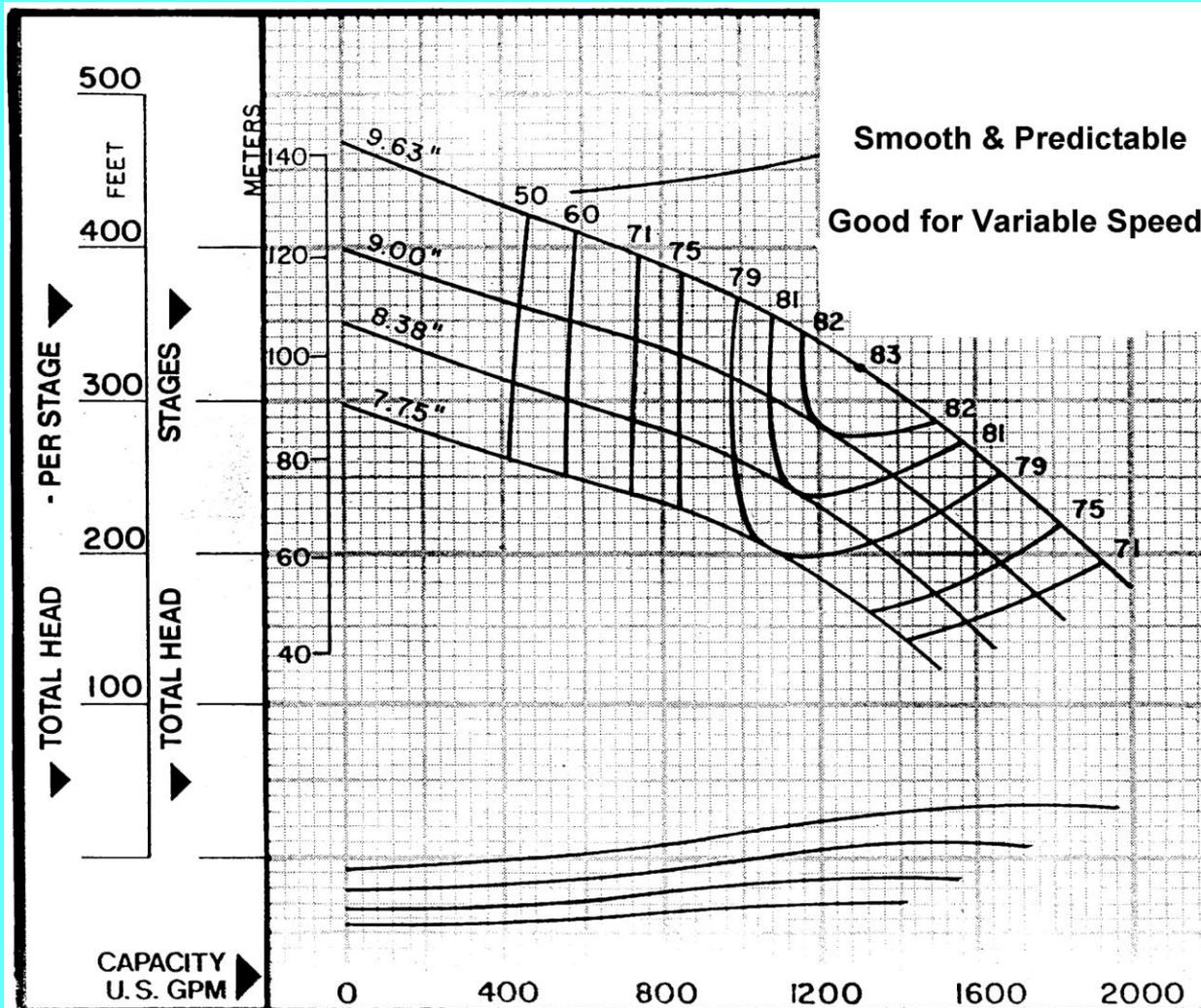
# PREVENT UNPREDICTABLE PUMP PERFORMANCE - PROPER SELECTION!



# Flat Unstable Performance ....

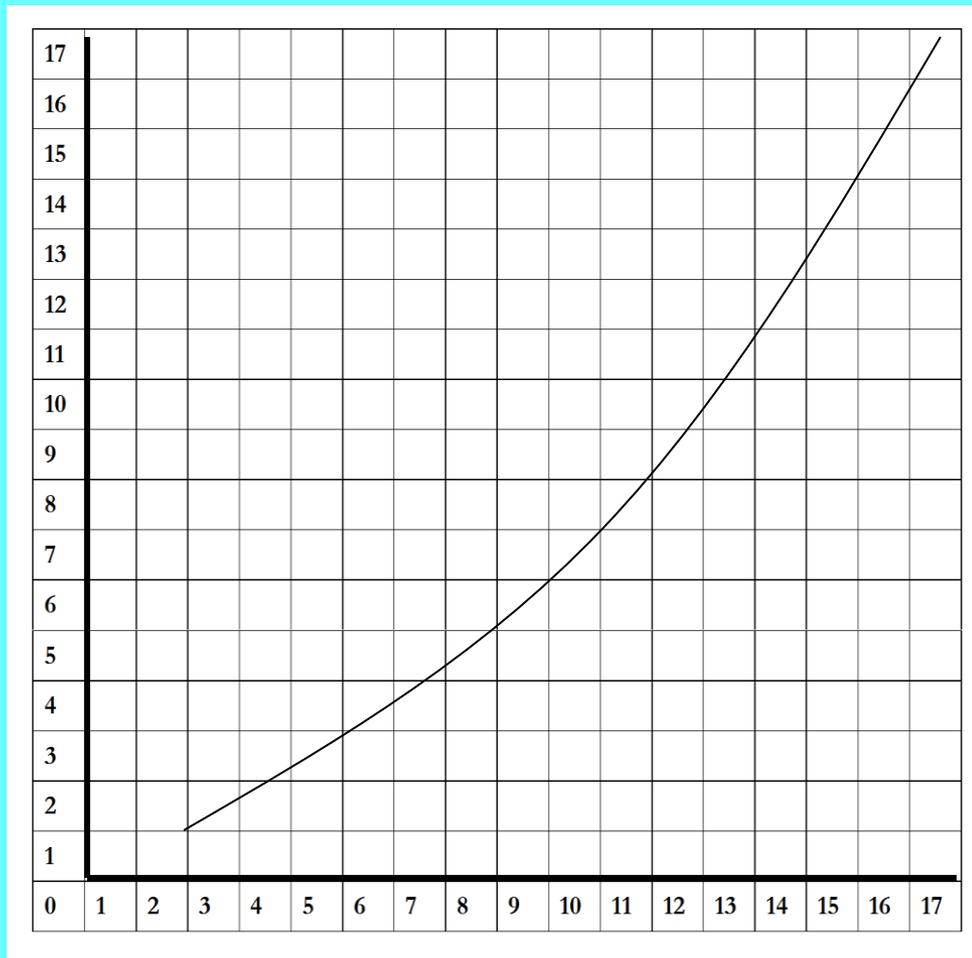


# Continuously Rising /Smooth Curve – Predictable & Stability



# MINIMUM SUBMERGENCE – PREVENTS VORTEX FORMATION

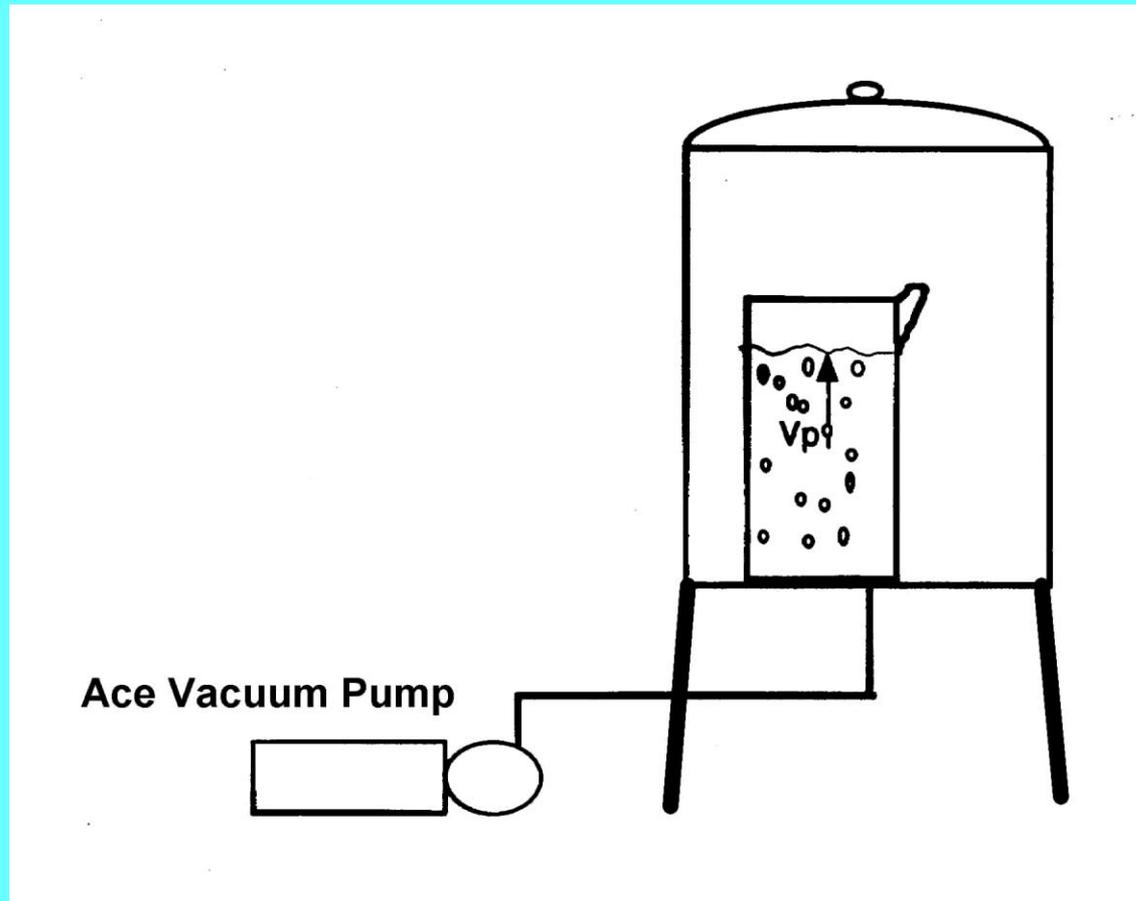
Submergence  
In Feet (Min.)



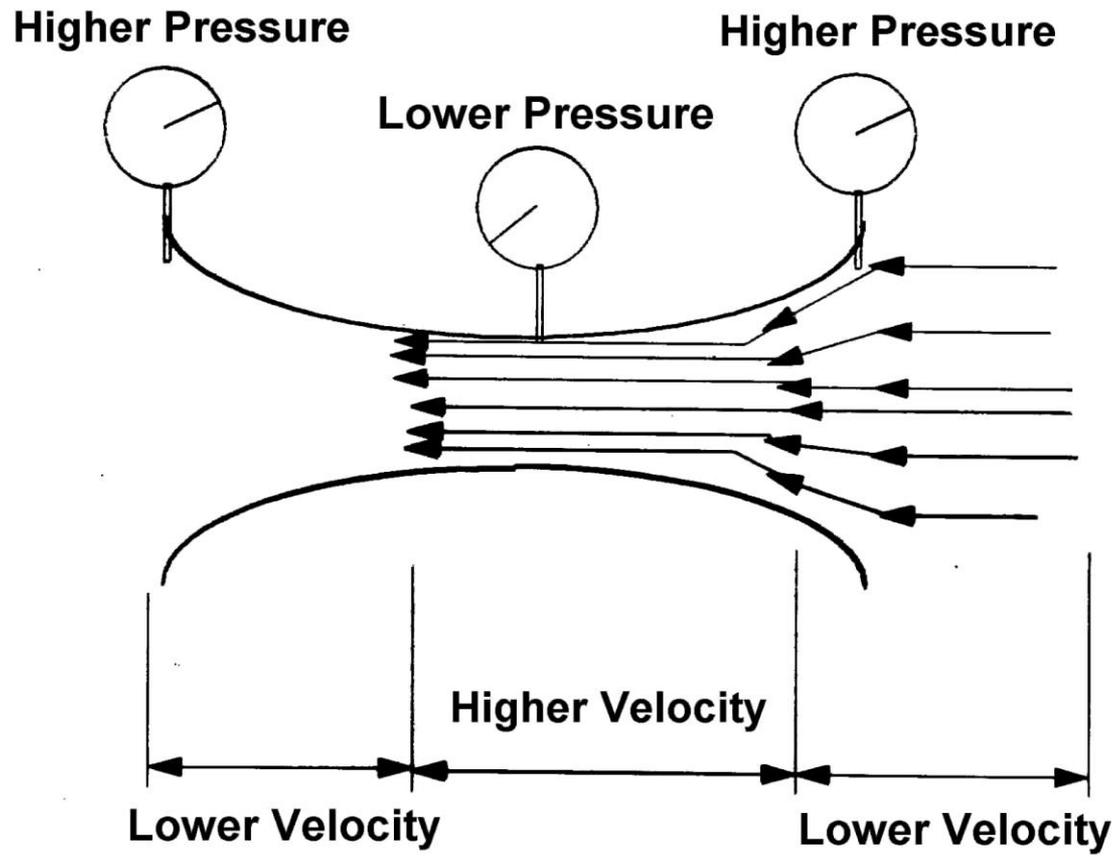
$$\text{Velocity (Ft/Sec)} = \text{GPM} \times 0.321 / \text{Area} \text{ or } \text{GPM} \times 0.4085 / \text{D}^2$$

# LOWER PRESSURE OR ADDED HEAT - LIQUID VAPORIZES (BOILS)!

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# PRESSURE VS. VELOCITY



# CAVITATION AND VELOCITY

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- Narrowing Passage = Increased Velocity
- “Throttling” Valves Reduces Pressure
- Reduced Pressure Increased Chance for Liquid to Flash to a Vapor = Cavitation
- Therefore - **DO NOT throttle pumps on suction side!**

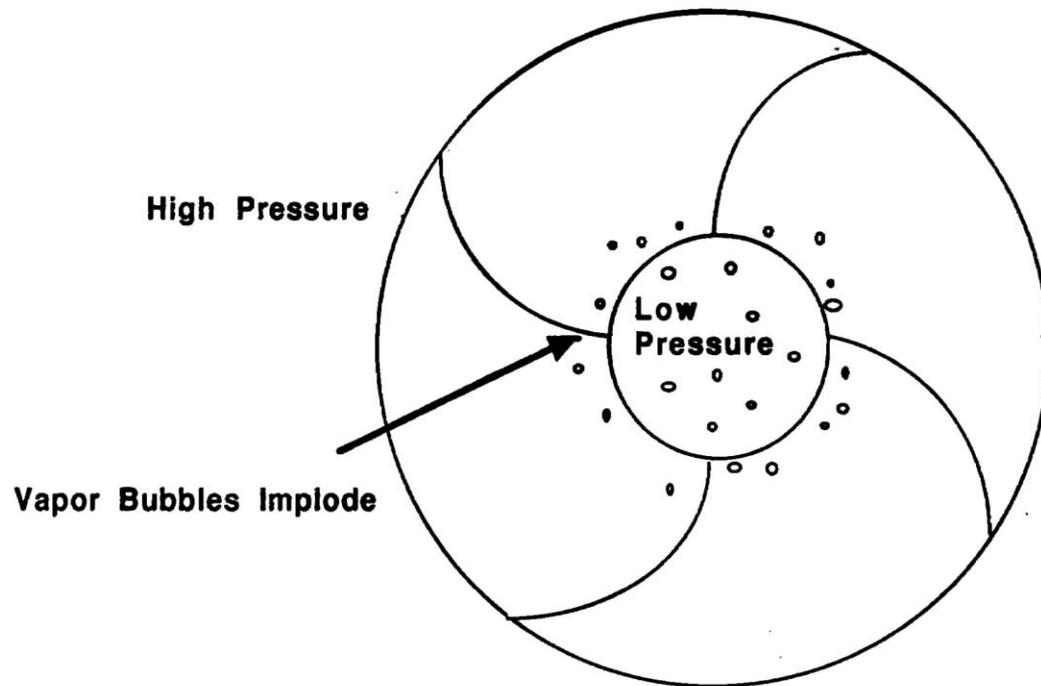
# WHAT IS CAVITATION ? (SOUNDS LIKE GRAVEL)

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- Absolute Pressure Drops
- Vapor Bubbles Form in Liquid
- Velocity Decreases / Pressure Increases
- Bubbles Collapse
- Energy (Heat of Vaporization) Released
- Localized Damage – Metal Surfaces Appear “Peened”) By A Hammer

# CAVITATION IN PUMP IMPELLER .....

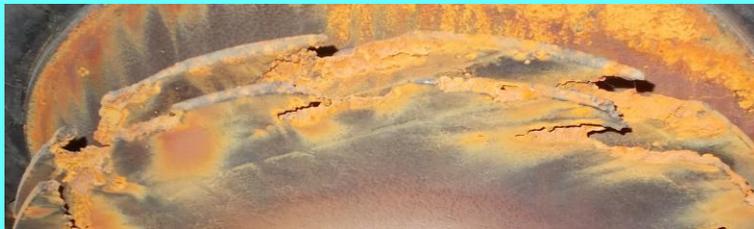
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**The Eye of an Impeller Is Just Like A Vacuum Pump**

# Cavitated End Suction Impellers

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# Cavitation

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# Turbine Pump Cavitation



# Corrosion vs Cavitation

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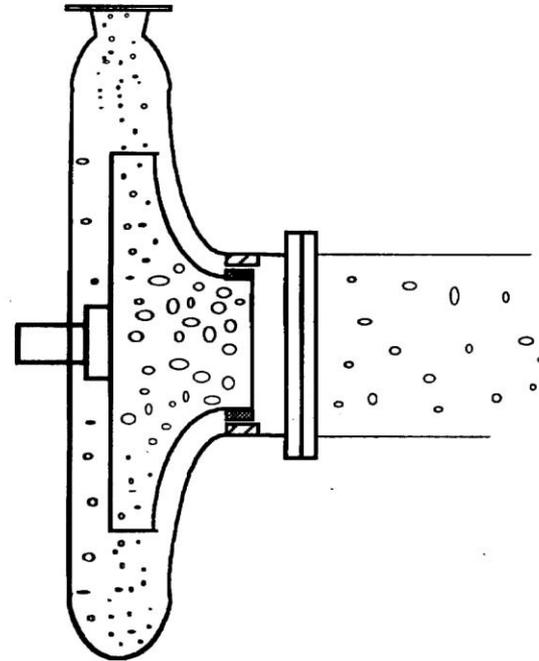
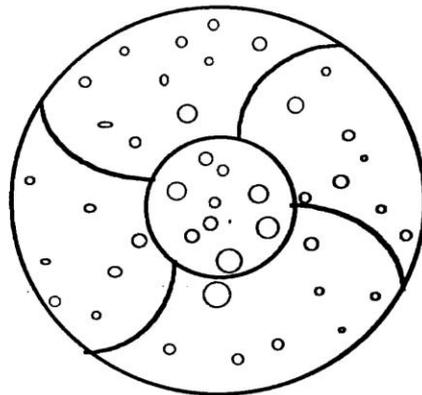
Corrosion

## Cavitation



# AIR ENTRAINMENT IN PUMPS .....

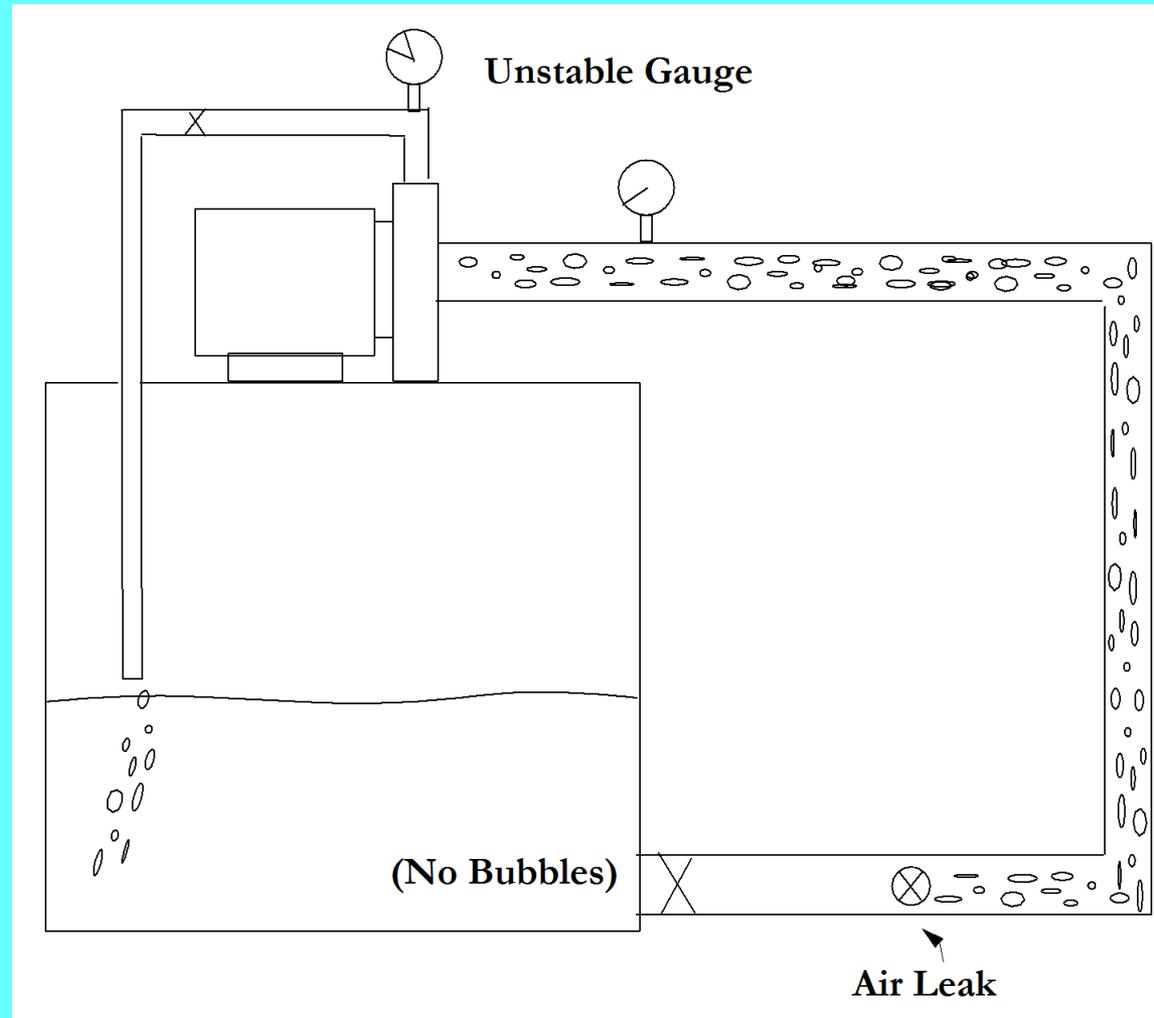
- **Air Entrainment** does not cause the same damage as cavitation. However, air occupies space that should be filled with fluid and air entrained liquid is compressible – i.e. reduced pump performance.



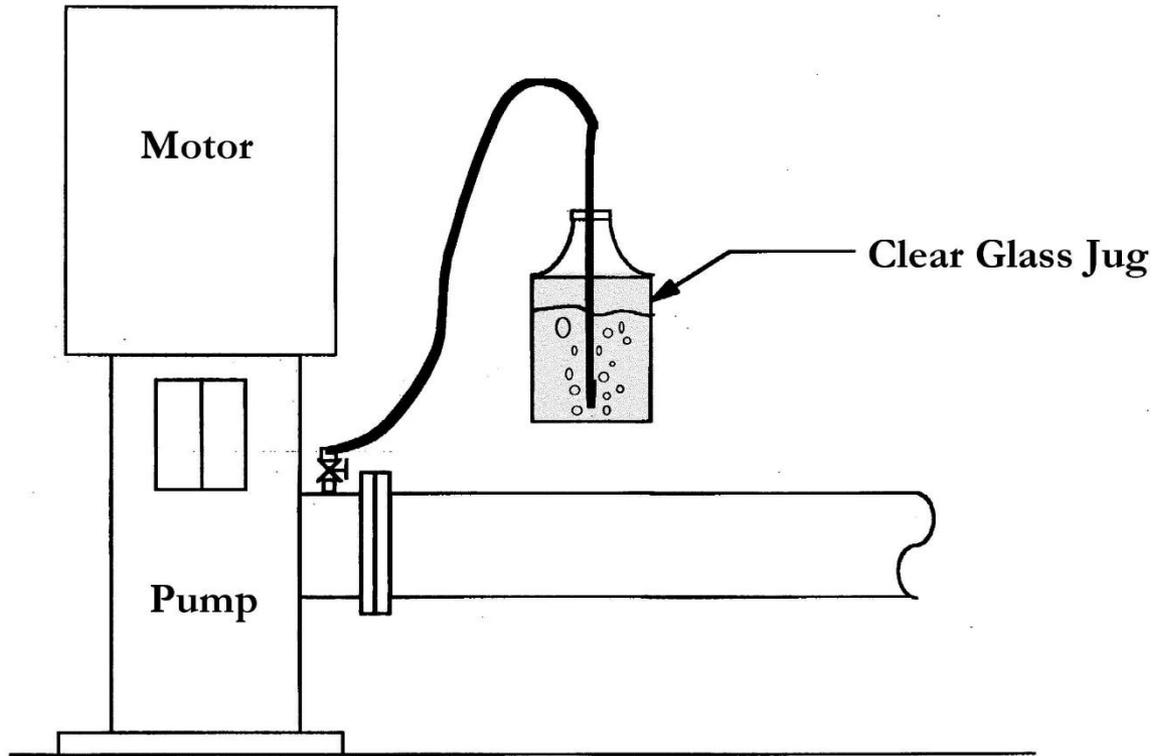
2% AIR CAN DECREASE PERFORMANCE BY 2-4%

4% AIR CAN DECREASE PERFORMANCE BY 50%

# INLET AIR LEAKS DON'T NECESSARILY DRIP – JUST ALLOW AIR IN!



# TESTING FOR AIR ENTRAINMENT



# PROVIDING FOR FLOW STABILITY

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- Prevent Air Pockets Caused by Reducers and High Points in Piping
- Eliminate Elbows / Straighten Piping on Double Suction Pumps
- Eliminate Air Pockets in Discharge Piping
- Prevent Sudden Changes in Flow Rates

# Shaft Sealing – Packing vs Mechanical Seals

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## PACKING

### PROS –

- INEXPENSIVE
- WORKS GREAT ON WATER
- EASIER TO CHANGE
- CAN STILL RUN IF LEAKING
- “LOW TECH”

### CONS –

- MUST LEAK TO LUBRICATE SHAFT
- CAN MAKE A MESS!
- FREEZING CONDITIONS CAUSE ICE
- NOT FOR EXPLOSIVE OR TOXIC LIQUIDS
- CAUSES WEAR ON SHAFT / SLEEVE
- NEEDS TO BE PERIODICALLY ADJUSTED

## MECHANICAL SEAL(S)

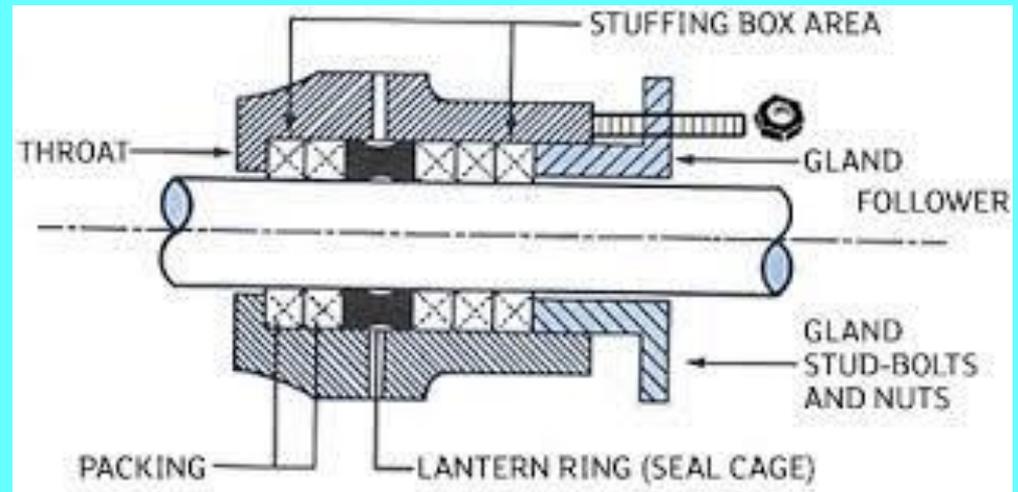
### PROS –

- NO LEAKAGE WHEN RUNNING
- CAN WORK WITH TOXIC FLUIDS
- CAN WORK WITH FLAMMABLES
- ENGINEERED FOR APPLICATION
- VARIETY OF MATERIALS
- NO ADJUSTMENTS REQUIRED

### CONS –

- “HIGH TECH”
- EASILY BROKEN OR DAMAGED
- CAN BE EXPENSIVE
- DISASSEMBLE PUMP TO REPLACE
- CAN'T RUN IF LEAKING

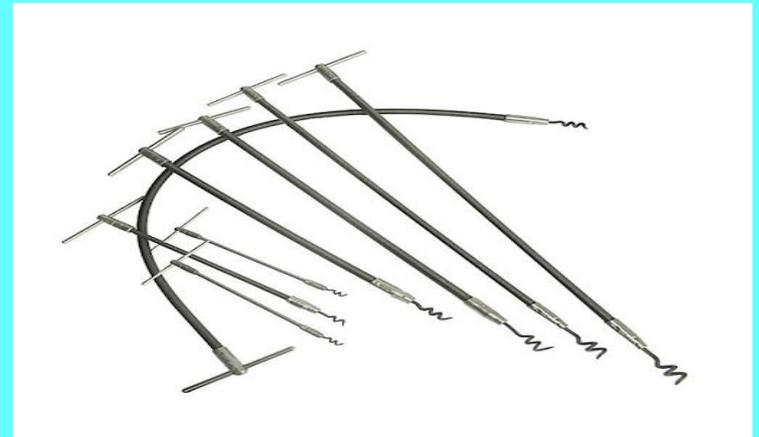
# Stuffing Boxes & Packing



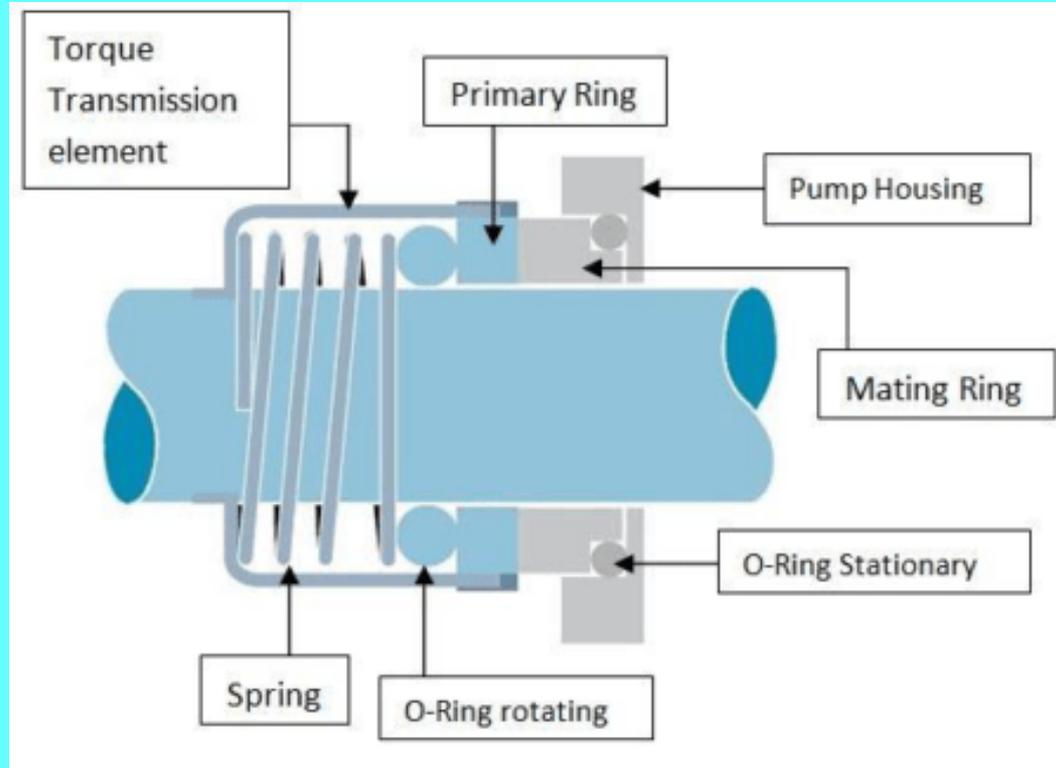
Packing **MUST** leak about 60 drops per minute to lubricate and cool the shaft / sleeve!

# Packing, Lantern Rings & Packing Tools

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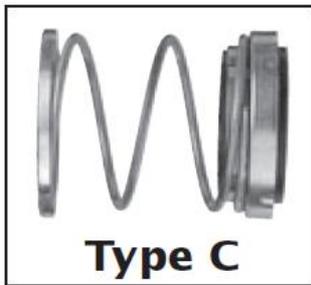
# Mechanical Seals



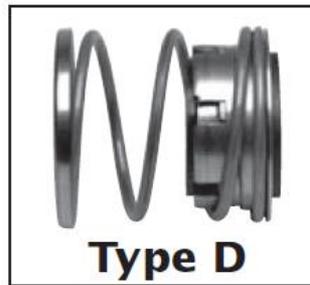
Pumps with seals should have no visible leakage. DO NOT run seals dry!

# U. S. Seal – Basic Components

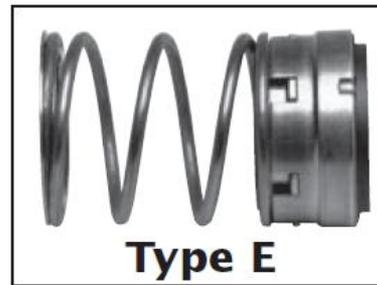
## U.S. SEAL MFG. HEAD TYPES



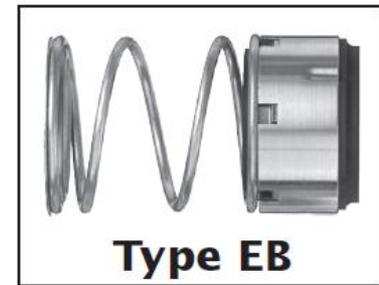
Equal to:  
John Crane  
Type 21



Equal to:  
John Crane  
Type 2



Equal to:  
John Crane  
Type 1



Equal to:  
John Crane Type 1  
Balanced

## U.S. SEAL MFG. MATING RING DESIGNS

(Available in a wide variety of materials)



# AESSEAL Cartridge Mechanical Seal

---



# John Crane Multi-spring Seals



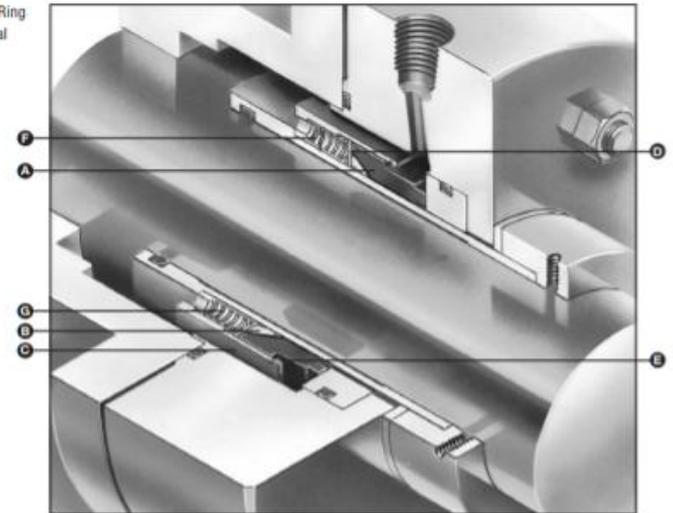
## TYPE 8-1/8-1T Elastomer O-Ring Seals

- A - Face/Primary Ring
- B - Seat/Mating Ring
- C - Spring
- D - O-Ring
- E - Retainer
- F - Disc
- G - Anti-X-Ring
- H - Snap Ring
- I - Set Screws



## TYPE 9/9T PTFE Wedge Seals

- A - Face/Primary Ring
- B - Secondary Seal
- C - Retainer
- D - Disc
- E - Snap Ring
- F - Set Screws
- G - Spring





---

Maintenance

Considerations

# SAFETY FIRST

---

- **Before Working on Equipment**
  - **Isolate ALL Energy Sources**
    - **Isolate ALL Electrical Sources**
      - **Lockout / Tagout & Test**
  - **Isolate ALL Pressure Sources**
    - **Double Block and Bleed Pressure**
      - **Lockout / Tagout & Test**
- **DO NOT Enter Confined Space Without Proper Training, Equipment and Personnel**

# Use Your 5 Senses Every Day at Work!

---

- **Get to KNOW Your Pump(s) System**
  - **Smell - Know What is Normal**
    - **Any Unusual Odors – Hot, Burning, Fumes, Etc?**
  - **Look –**
    - **Pressure Gauges, Unusual Leaks, Smoke, Critters?**
  - **Listen –**
    - **Does the Equipment Sound Normal or Strange**
  - **Feel It! – Is Equipment Hot or Vibrating?**
    - **(It's not Sexual Harassment, if it's not alive!)**
  - **Taste – Don't Lick the Equipment!**
    - **If you sense strange tastes – get out / get help!**

# USE SOME COMMON SENSE ?

---

- **IS THIS HOW THEY MAKE "CLEAN ENERGY?"**
- **WHICH CAME FIRST – THE ELECTRICAL PANEL OR THE IRRIGATION SYSTEM?**
- **TIME FOR AN IMMEDIATE CHANGE – HEAD / PANEL RELOCATION OR XERISCAPE**
- **GET LOCATES FOR UNDERGROUND WIRES AND PIPING BEFORE DIGGING.**



# Locked Out / Tagged Out - LOTO

---

- Identify All Energy Sources
- Notify Affected Personnel
- Disconnect / Close (Valves)
- Tag It
- Lockout
- TEST IT!

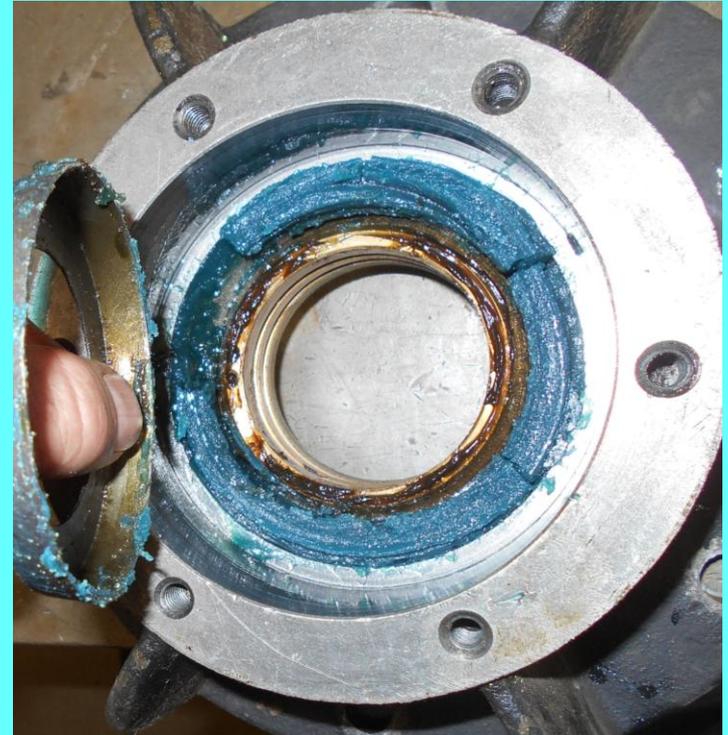






# Grease Incompatibility

---



# UNPOWERED MOTOR CHECKS – QUALIFIED PERSONNEL ONLY!

---

- **Change Oil – Drain and Refill**
  - **Check Viscosity & Oxidation Inhibitors**
- **Megger Check Motor Insulation**
- **Check for Free Rotation**
- **Open Junction Boxes / Check Splices**
- **Clean Vents & Screens**
- **Remove Dirt & Oil Buildup**

# Unpowered Electrical Checks – QUALIFIED PERSONNEL ONLY!

---

- **Electrical Panels -**
  - **General Clean-up**
  - **Vacuum - Dirt And Carbon Tracking**
  - **Use Plastic Safe Electrical Cleaner**  
**To:**
    - **Remove Carbon Tracking**
    - **Disassemble / Clean Contactors**  
**(DO NOT File Contacts)**

# Unpowered Electrical Checks – QUALIFIED PERSONNEL ONLY!

---

- **Electrical Panels – Continued**
  - **Lockout / Tagout**
  - **Check Overload Settings**
  - **Tighten All Connections**
  - **Phase Failure / Over-voltage  
Under-voltage Protection**
    - **Check Function And Settings**
  - **Lightning Protection**
    - **Check To See If Still Protected**

# General Equipment Checks -

---

- **Motor / Pump Couplings**
  - **Check Pump / Motor Alignment**
  - **Clean , Remove Rust, Check Bolt Torque**
  - **Insure Coupling Guards Intact**
- **Seals And Packing Should Be Checked Frequently. Packed Pumps - Repack Annually**
- **Lubricate Pump Bearings**

# SYSTEM CONCERNS –

---

- **Water / Pumpage Must Be Free of Dirt, Weeds, & Large Debris**
- **Sewage – Grease Removal**
- **Sewage Pumps – Sanitary Products, Diapers, Wipes**
- **Clean – Inlet Structures, Screens, Settling Ponds, Strainers**
- **Repairs – Start Early / Off Season Rushed Repairs May Be More Expensive!**

# SYSTEM CONCERNS – Cont.

---

- **Gauges / Transducers**
  - **Prevent From Freezing**
  - **Check and Calibrate Annually**
- **Valves**
  - **Fully Open / Fully Close**
  - **Shutdown – Ball Valves @ 45**
- **Flush Lines / Ports Periodically**



# STATION CONCERNS

---

- **Paint And Clean – Rusty / Dirty Equipment Is Hard To Service and Operate. Remove Corrosion And Paint During Warm Summer Months (w/o Condensation).**
- **Maintain Backup Equipment – Reduce Callouts / Emergency Repairs! Alternate Operation to Insure Backup Capability.**

# Powered Electrical Testing

---

- Qualified Personnel
- Safe Area & Working Clearances
- JSA – Job Safety Analysis
  - Identify Hazards
  - Arc Flash Information
  - Discuss with all personnel
  - Identify Emergency Services / Phone
  - Muster Point Identified
  - Sign and Save JSA

# RECOMMENDED MINIMUM TEST EQUIPMENT

---

- **Voltage Proximity Tester**
- **Quality Voltmeter – Rated in Excess of Highest Expected Voltage**
- **Clamp-on Amp Meter**
  - **Large Enough for All Motors in Service**
  - **If VFD's are in service, Meter must be "True RMS" for Accurate Readings**

# RECOMMENDED TEST EQUIPMENT – CONTINUED

---

- **Electricians Quality & Tested Rubber Protective Gloves**
- **Arc Flash Gear Is Required!**
- **Safety Glasses**
- **Flashlight**
- **Infrared Temperature Gun and/or Thermal Imaging Camera**
- **Pressure Gauges & “Snubbers”**

# POWERED ELECTRICAL CHECKS – QUALIFIED PERSONNEL ONLY!

---

- **DO NOT run pumps without water!**
  
- **Voltage Checks**
  - **Each Leg to Ground**
  - **3 Phase -Leg to Leg – A/B, B/C, A/C**
    - **Check Voltage Level**
    - **Note Consistency & Balance**
  - **Check Voltage Drop Across Starter**

# POWERED ELECTRICAL CHECKS – QUALIFIED PERSONNEL ONLY!

---

- **Check Amp Loads – Pump Pumping!**
  - **Check Each Leg vs. FLA of Motor**
  - **Check for Balance Between Legs**
- **Check for Vibration -**
  - **Anchor Bolting**
  - **Pump Vibration**
  - **Motor Vibration**
  - **Shaft Runout / Deflection**

# Types and Classification of Pumps

---

- Positive Displacement
  - Reciprocating
  - Rotary
  - Progressive Cavity
- Kinetic Pumps – Due to Velocity of Liquid
  - Centrifugal
  - Peripheral
  - Special

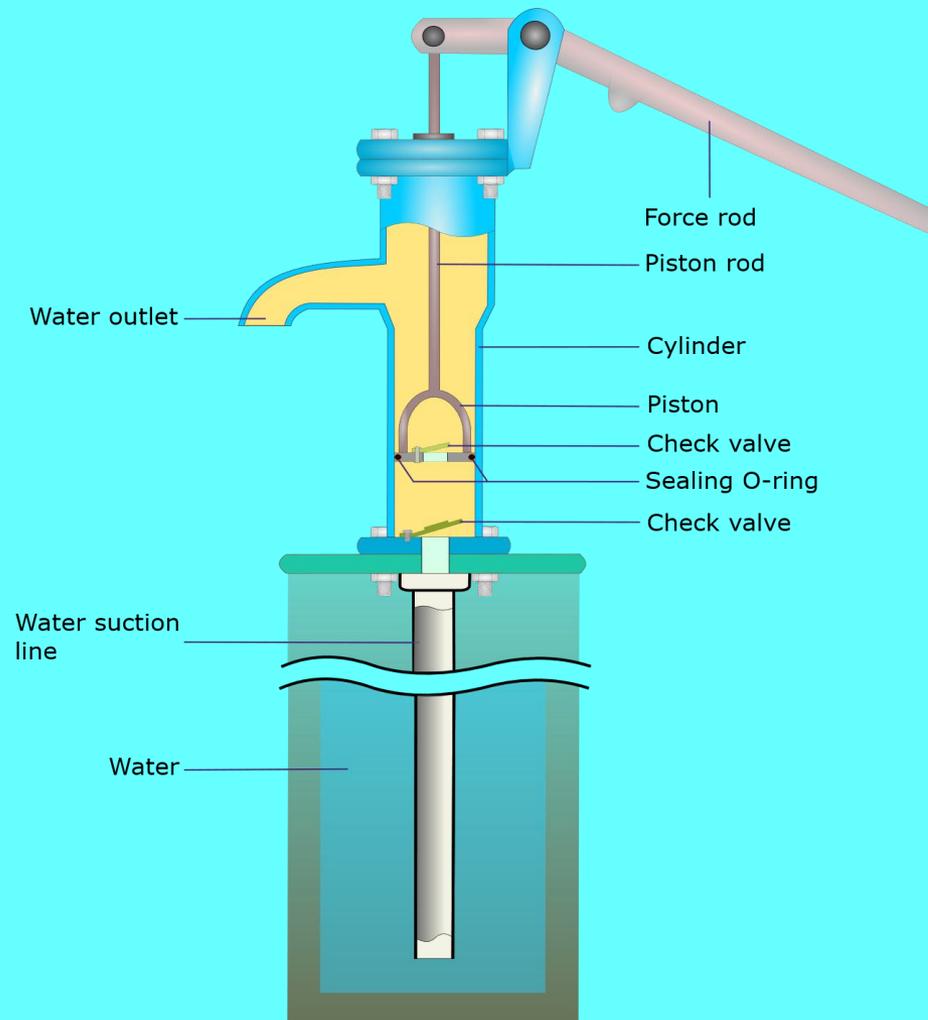


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# POSITIVE DISPLACEMENT PUMPS

# Hand-Operated Well Pump

---

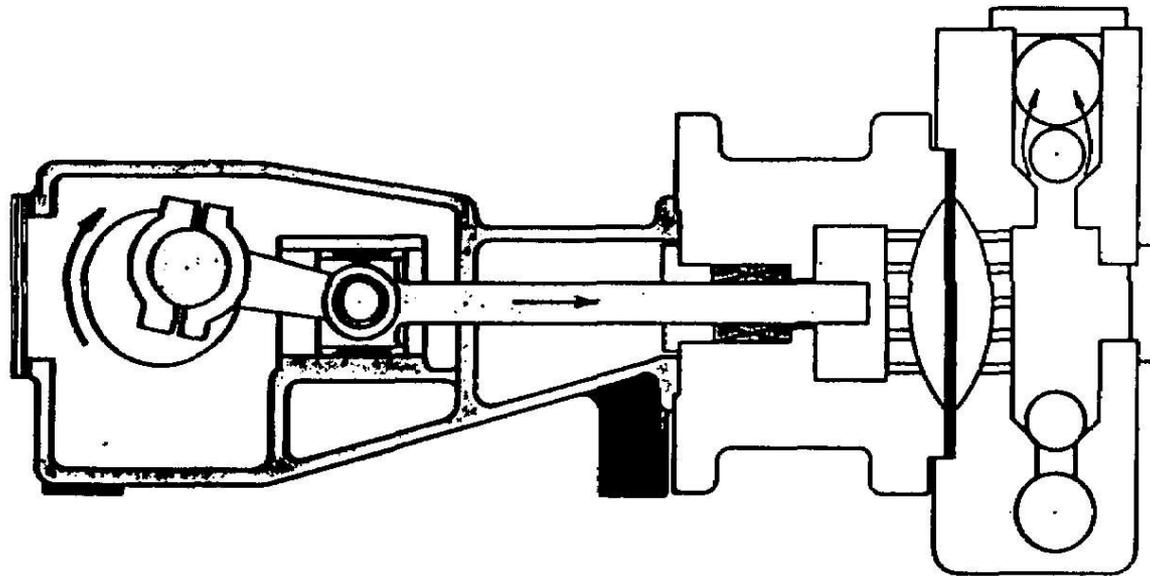


# Metering Pumps – Chem Feed



# Single Action Diaphragm Pump

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**Fig. 6 HORIZONTAL SINGLE-ACTING FLAT DIAPHRAGM PUMP**

# Cylindrical Diaphragm Pump

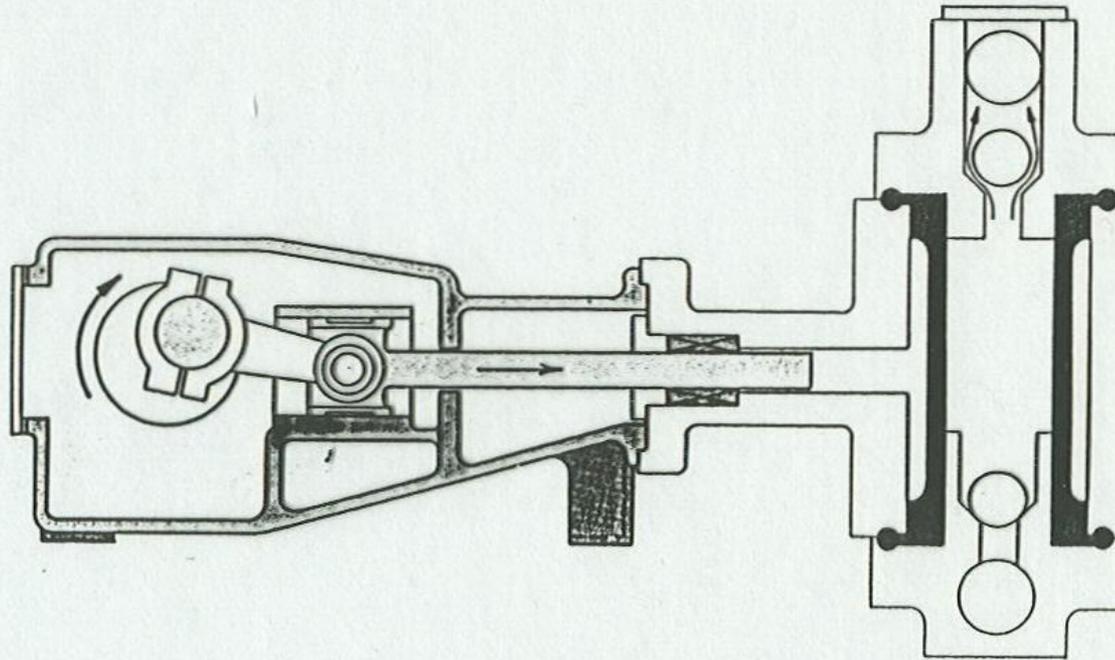
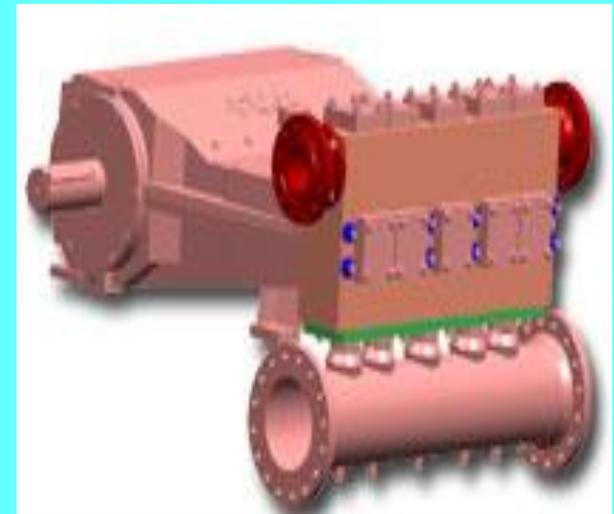
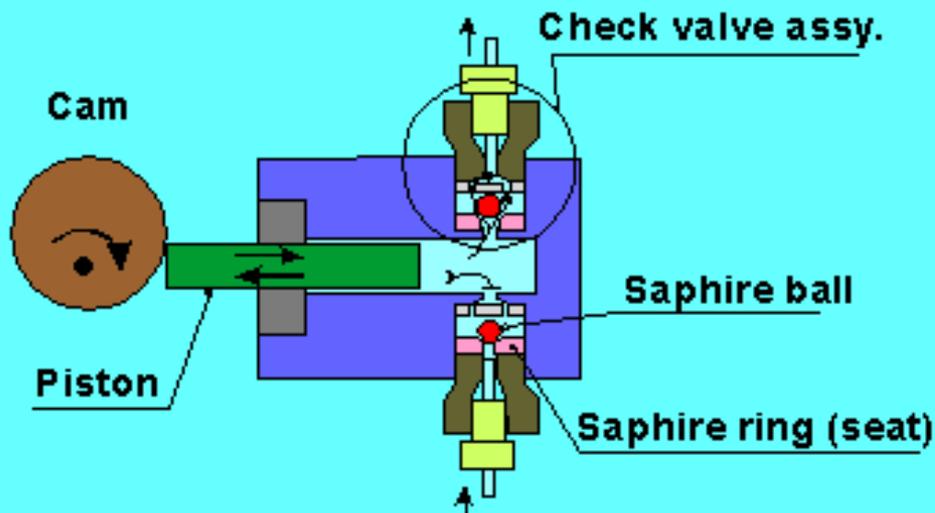


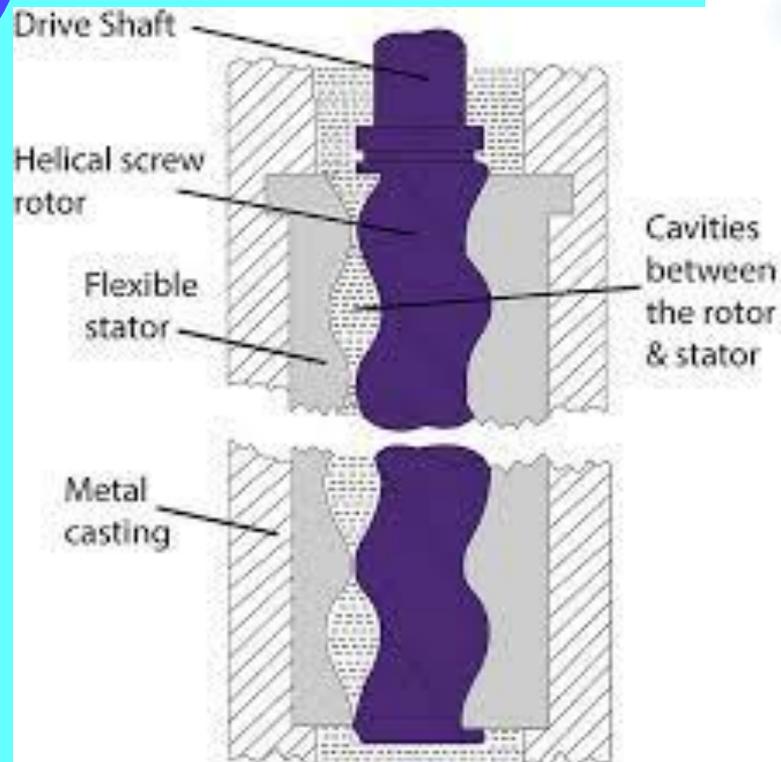
Fig. 7 HORIZONTAL SINGLE-ACTING CYLINDRICAL DIAPHRAGM PUMP

# Reciprocating Plunger / Piston

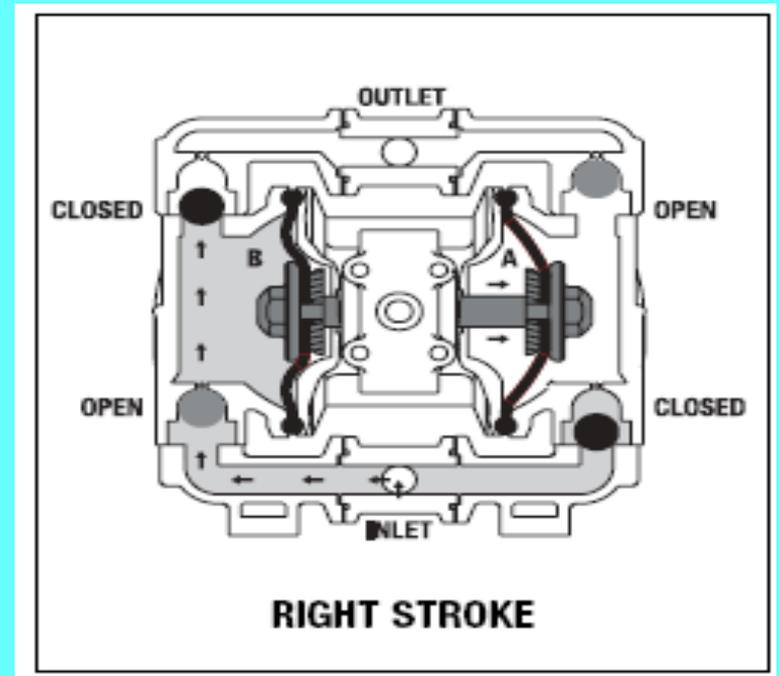
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# Progressive Cavity Pumps

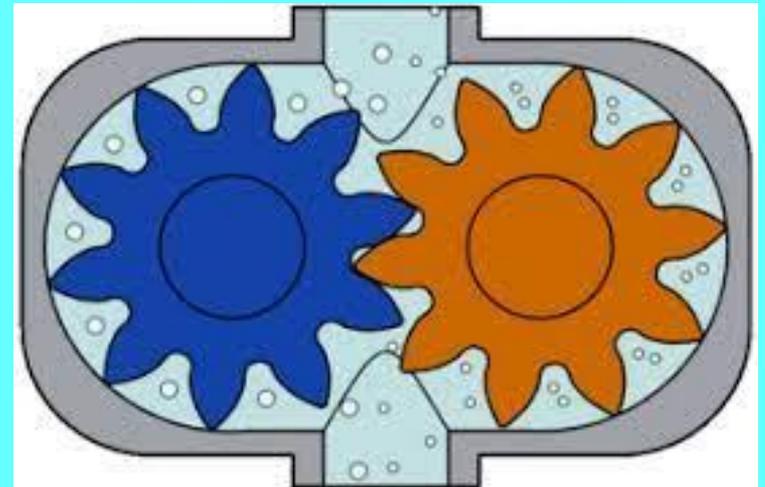


# Double Air Diaphragm or AOD



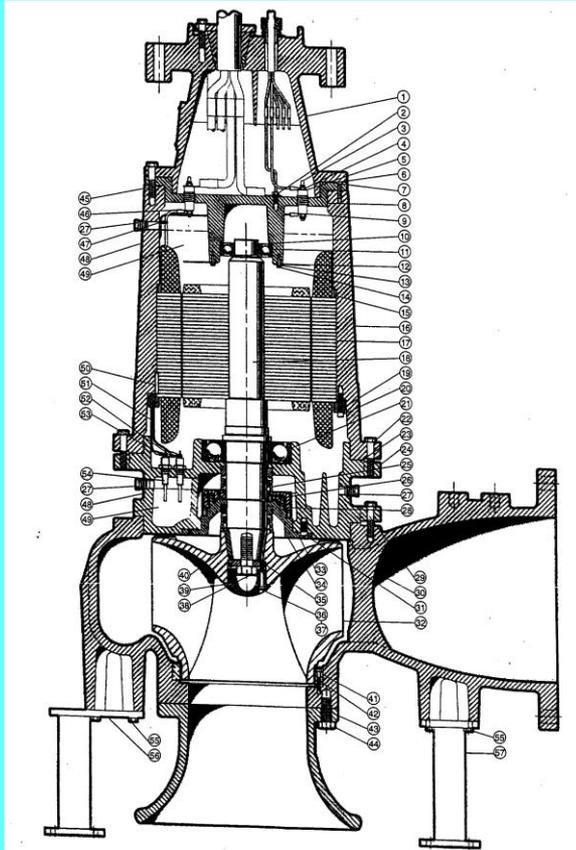
# Gear Pumps

---



# Single Suction Non-Clog Sewage

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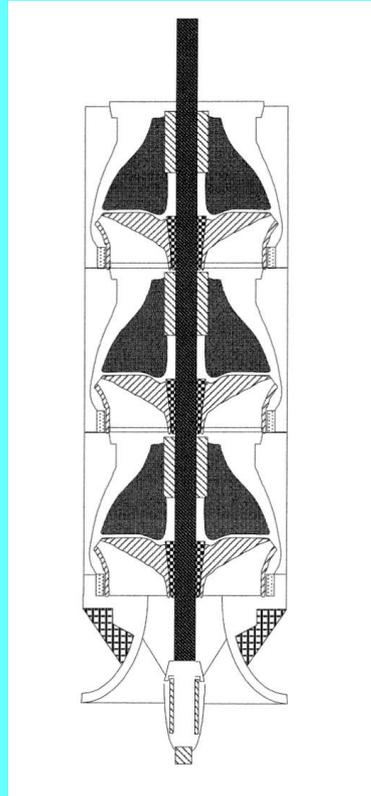


# Vertical Turbine Pumps

---

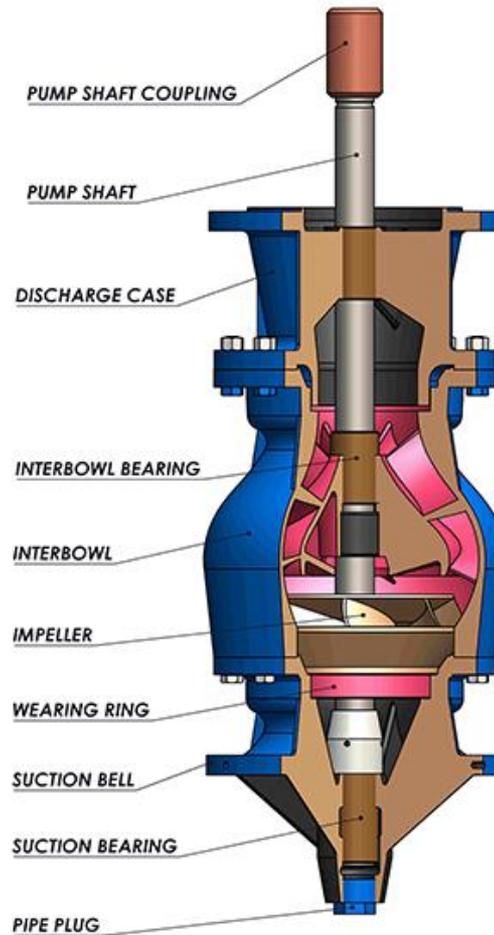


Vertical Lineshaft Turbine



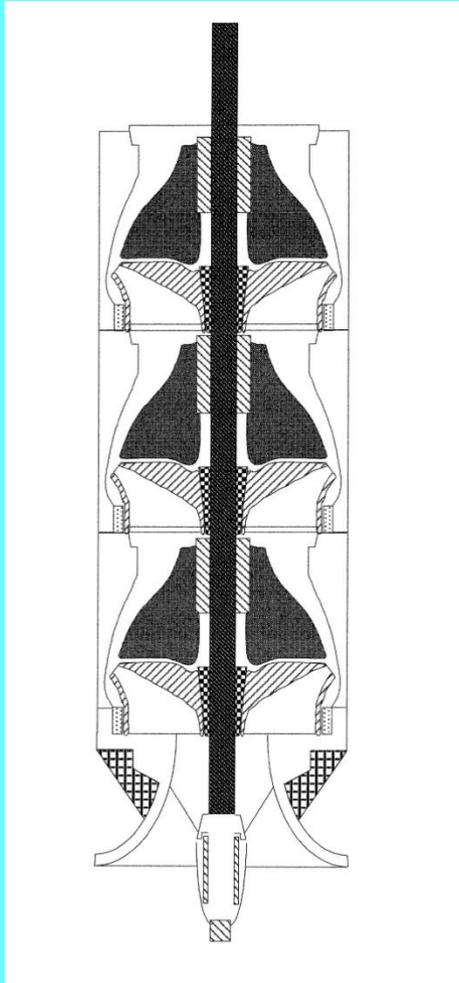
Submersible Turbine

# Vertical Turbine Bowl Assembly

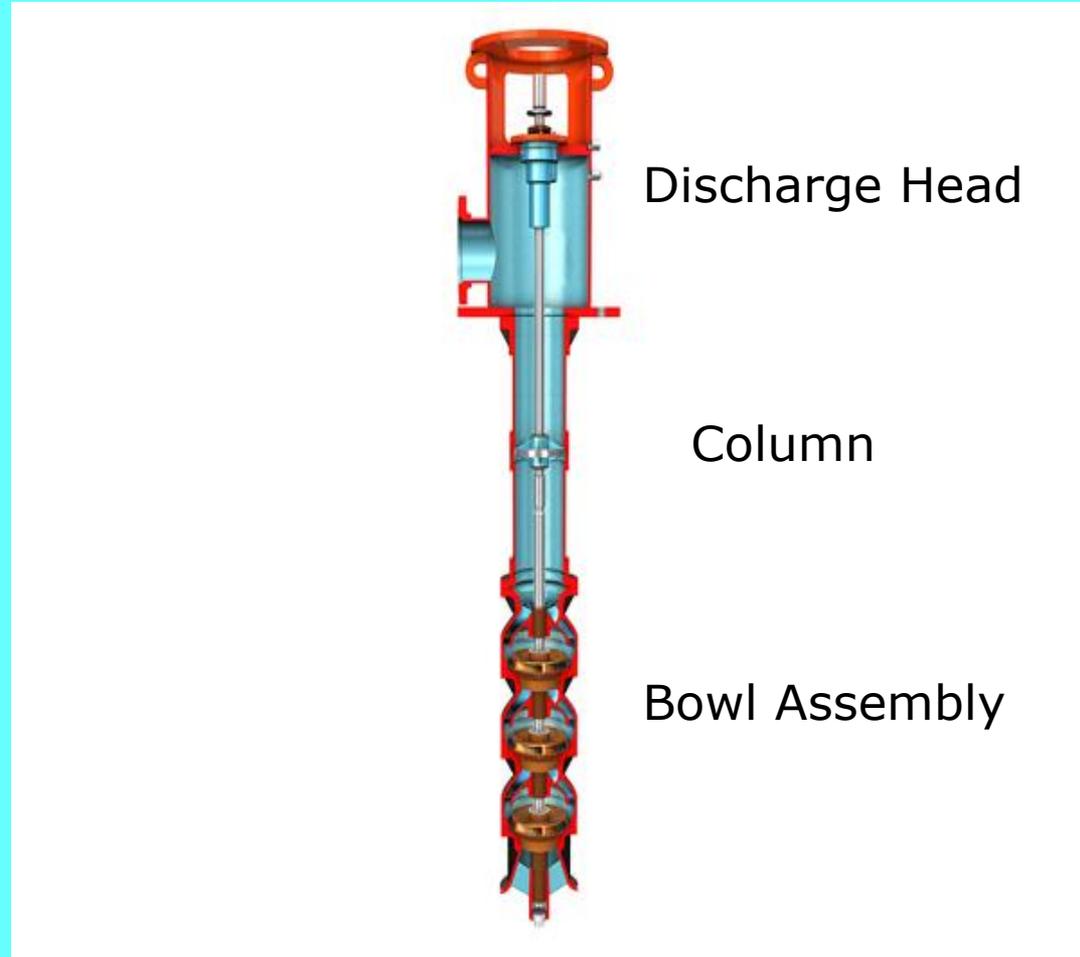


# Vertical Turbine Top Discharge

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Multiple Stages



Discharge Head

Column

Bowl Assembly

# Mixed Flow and Axial Flow Pumps

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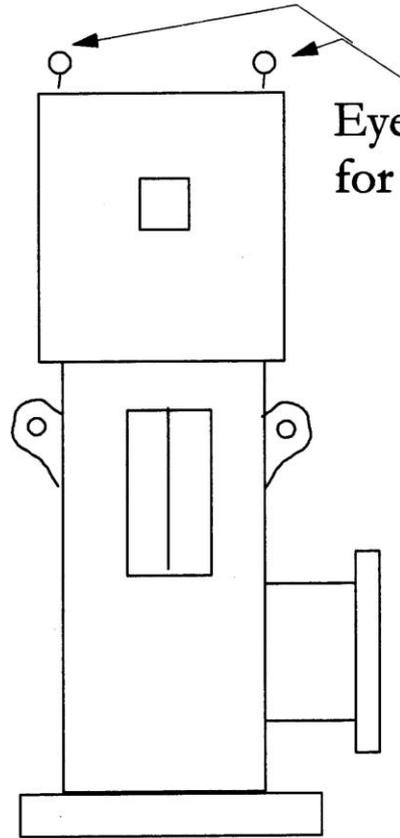


High Capacity / Low Head

- Axial Flow
  - 500 – 1,000,000 GPM
  - 2-80 Ft. TDH
- Mixed Flow
  - 600-250,000 GPM
  - 1.5-100 FT TDH
  -

# LIFTING & TRANSPORTING VERTICAL PUMP MOTORS

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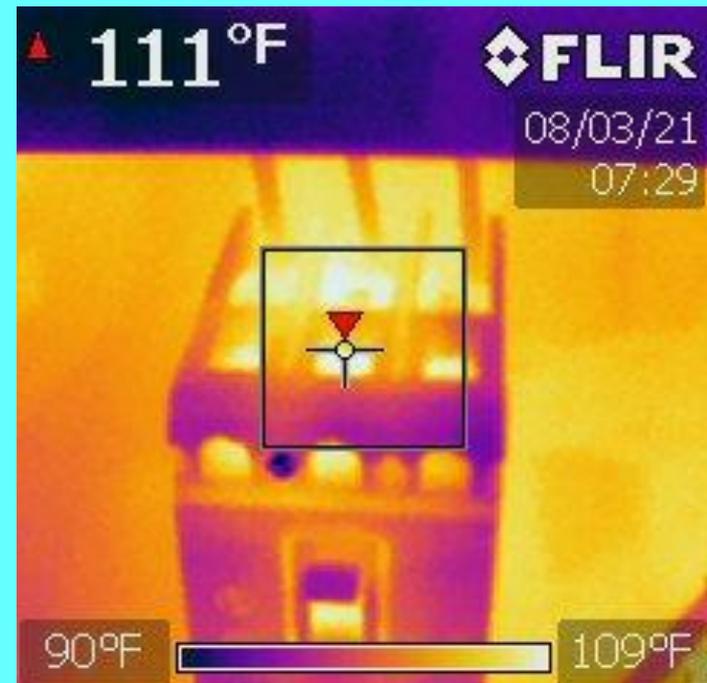
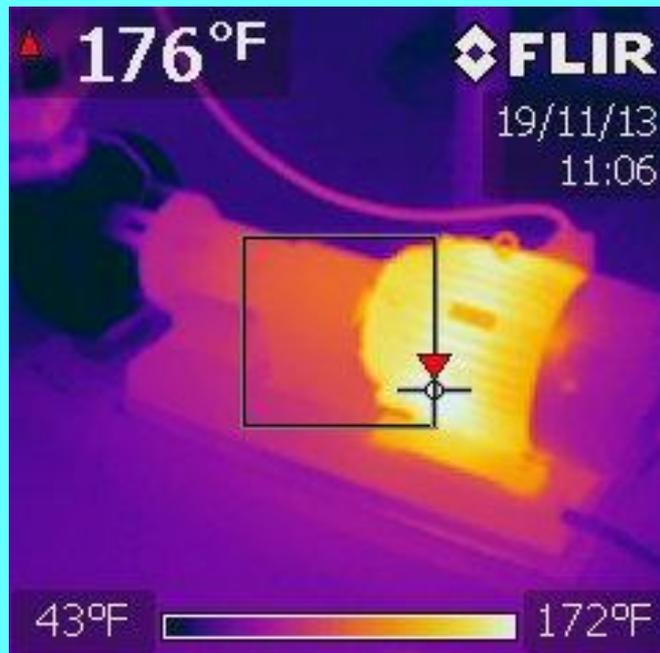


Eyebolts are **ONLY**  
for Lifting Motor

Vertical Motors **MUST**  
be Transported  
Vertically - **DO NOT**  
**LAY DOWN!**

# Specialized Testing – Thermal Imaging – Panels and Equipment

---

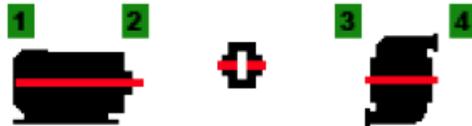


# Vibration Analysis

## 810 Vibration Tester Diagnostic Report

Device Serial Number : 1985001  
Machine Setup Name : ZOO P5  
Measurement Date/Time : 11/19/2013 11:34:06

### Drive Train



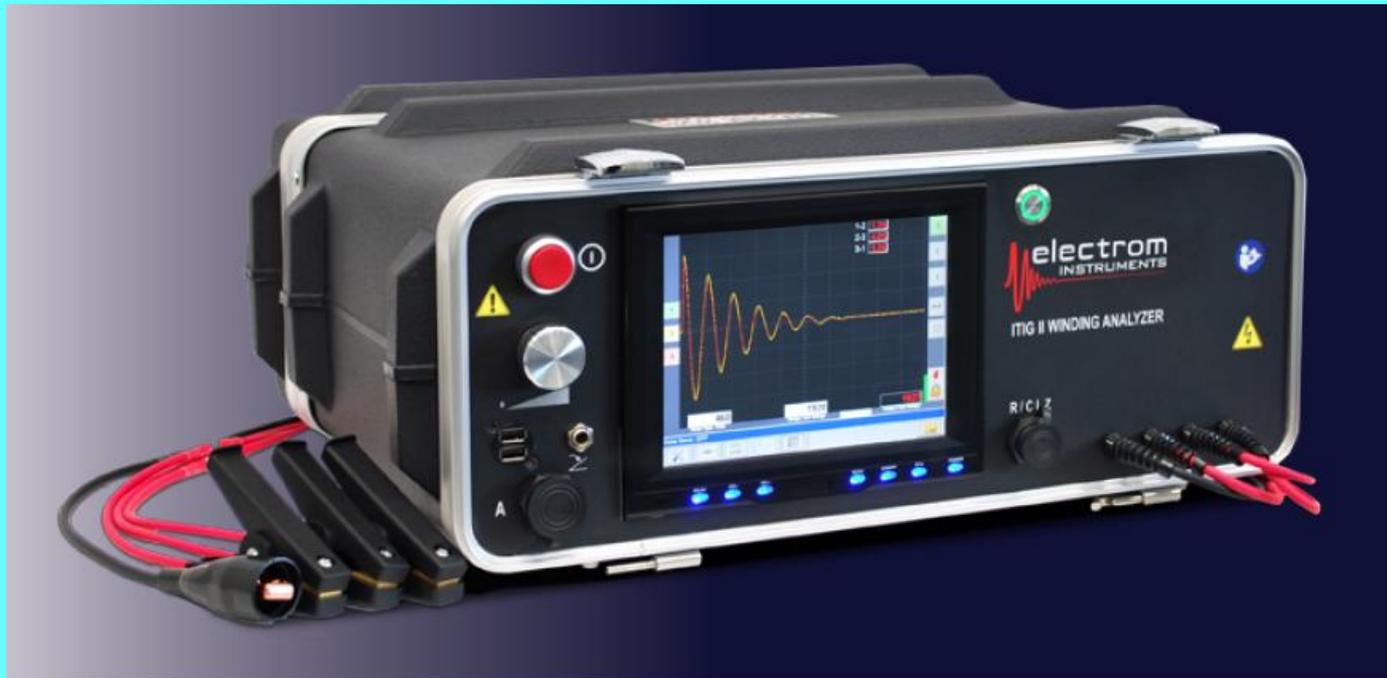
### Diagnosis

Fault description	Fault severity	Severity Score	Severity Scale
Motor Free End Bearing Wear	Moderate	28/100	

### Recommendations

Recommendations	Priority	Priority Description
Monitor Motor Free End Bearing For Increased Vibration	2	Desirable

# Electric Motor Winding Analysis



## iTIG II

**THE EASIEST TO USE TESTERS ON THE MARKET  
DELIVERING A NON-DESTRUCTIVE TEST SET  
THAT FINDS MORE FAULTS**

The iTIG II motor tester and winding analyzer combines multiple testing technologies from micro-ohm resistance to high frequency surge tests and partial discharge measurements into a single light weight portable instrument. From low voltage to high voltage, 20 different tests are available.

# Power Quality Analyzer

---

- Check and Record Incoming Power



# Keep Records / Review Changes

## Inspection Services Performed:

### Pump:

Manufacturer: Peerless M/N: 5AE12 S/N: 9927067941-10-A  
 Pump Size: 5x6x12 Impeller Trim: 10.78"  
 Rated Flow: 1270 Rated Head: 427  
 Pump Operated:  Y  N Pump Vibration:  Normal  Excessive  
 Anchor Bolts Tight:  Y  N  Adjusted Pump Noise:  Normal  Excessive  
 Bearing Temperatures:  OK (< 150° F)  Hot  Not Enough Operating Time to Test  
 Mech. Seal Leaking:  Y  X  N Flush Line Operable:  Y  N  N/A  
 Packing  Adjusted  Changed Size: \_\_\_\_\_ # Rings: \_\_\_\_\_  
 Pipe Supports / Condition:  OK  
 Lubricant:  Changed  Added Type / Weight: Mobil XHP 222

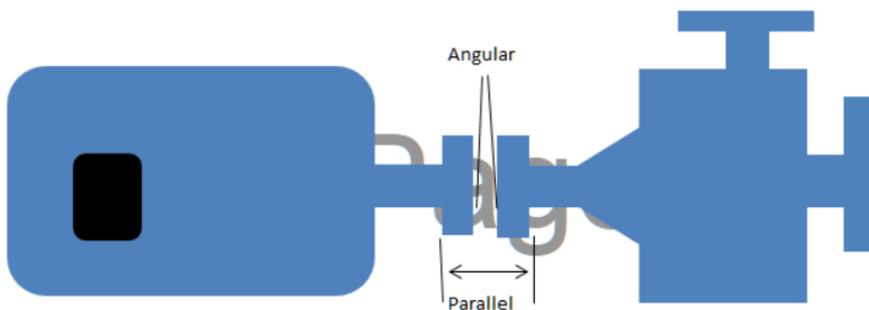
### Motor:

Manufacturer: Baldor/Reliance M/N: ECP84416T-4 S/N: A1309032002  
 Horsepower: 200 RPM: 3570  
 Rated Voltage: 460 Rated Amps: 213  
 Pump Operated:  Y  N Pump Vibration:  Normal  Excessive  
 Anchor Bolts Tight:  Y  N  Adjusted Pump Noise:  Normal  Excessive  
 Bearing Temperatures:  OK (< 150° F)  Hot  Not Enough Operating Time to Test  
 Lubricant:  Changed  Added Type / Weight: Polyrex EM  
 Voltage at Starter (Left to Right): 1: 482 2: 484 3: 480  
 Amperage Under Load: 1: 211 2: 213 3: 212  
 Winding Resistance: 1-2: 0.1 2-3: 0.1 1-3: 0.1  
 Megger Test Volts: 1000 Reading: >2.2 G  
 Conduit Box Opened:  Y  N Connections Checked:  Y  N  
 Ground Wire Tight:  Y  N  Adjusted

# Motor / Pump Shaft Alignment

## ○ Laser Accuracy & Printed Reports

Motor Data:  
Manufacturer: Baldor M/N: EL3609T S/N: \_\_\_\_\_ HP: \_\_\_\_\_ RPM: \_\_\_\_\_  
Pump Data:  
Manufacturer: Aurora M/N: 344A S/N: \_\_\_\_\_  
Coupling Data:  
Manufacturer: Woods Size: 5J Parallel Spec: 0.015 Angular Spec: 0.056



Vertical Parallel Before Adjustment: 0 Vertical Angular Before Adjustment: 15  
Horizontal Parallel Before Adjustment: 7 Horizontal Angular Before Adjustment: 20  
Vertical Parallel After Adjustment: \_\_\_\_\_ Vertical Angular After Adjustment: \_\_\_\_\_  
Horizontal Parallel After Adjustment: \_\_\_\_\_ Horizontal Angular After Adjustment: \_\_\_\_\_



ANY QUESTIONS?

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**THANK YOU FOR YOUR TIME AND  
ATTENTION!**

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