What's New in Irrigation Pumping?

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Irrigation Pumping

- In US over 34 million acres use pumping for irrigation
- Over 600,000 pumps on 154,000 farms
- Average of almost 4 pumps per farm
- Each pump covers an average of 56 acres
- 70% are from wells
- Spending over $4400 per pump to operate

2012 Census of Agriculture, National Agricultural Statistics Service

Pumping plant design

- Three parts to a pumping plant
  - Power Unit
  - Drive Type
  - Pump

Pumping Plant - Power Unit

- The power unit could be from a number of different energy sources
  - Electric - 71%
  - Diesel - 21%
  - Natural Gas - 5%
  - Propane - 2%
  - Gasoline - 1%

Pumping Plant - Drives

- Pump Drives
  - Direct – motor is directly connected to the pump, 100% of power gets to the pump.
  - Right angle drive – used for attaching power unit to the pump. Can have right angle and be used for speed adjustment. Estimated efficiency is 95%
  - Multiple V Belt – Fairly inexpensive but does require more maintenance. 90% efficiency for this type of drive
  - Flat Belt – used a lot in the past where older tractors were used as the power source. Efficiency of 85%

Direct Drive

Right angle drive w/ diesel power unit

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V Belt Drive

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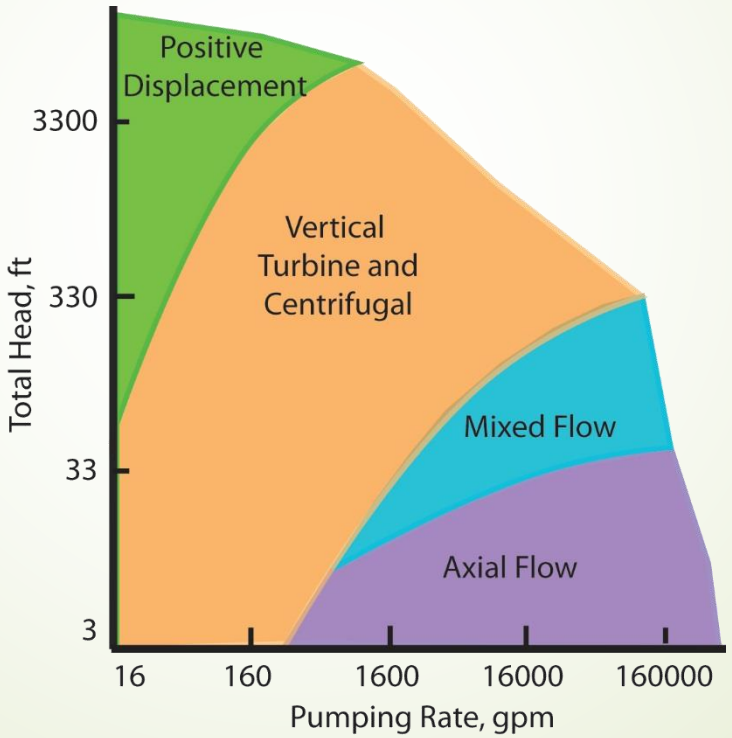
Pumping Plant

- Types
  - Centrifugal – commonly used, has a fairly level head vs flow, so good for various flow rates, must have water vertically within 20-30 ft. of pump
  - Deep well turbine – power unit at surface and pump in well connected with a shaft. Pump bowl, shaft and discharge pipe under ground and water is lifted to the surface. Generally used where the water level is greater than the level a centrifugal pump operates. Can be very efficient, can add more bowls to get more lift, may be placed very deep under ground (over 500 ft.) Very flexible where it can be used but harder to work on.
  - Submersible – a turbine pump used in wells. The motor is located under the water so no shaft. Can be small diameter and generally lower horsepower and smaller applications.
  - Propeller – Similar to a deep well turbine but designed for low head, high discharge. Power unit at the surface and with shaft below water level, propeller forces water up the column to the surface.
  - Positive Displacement – delivers a fixed amount of liquid for each cycle of pump operation. Good for chemigation into an irrigation system and high pressure, low flow systems such as stockwater.

What type of pump do I use?



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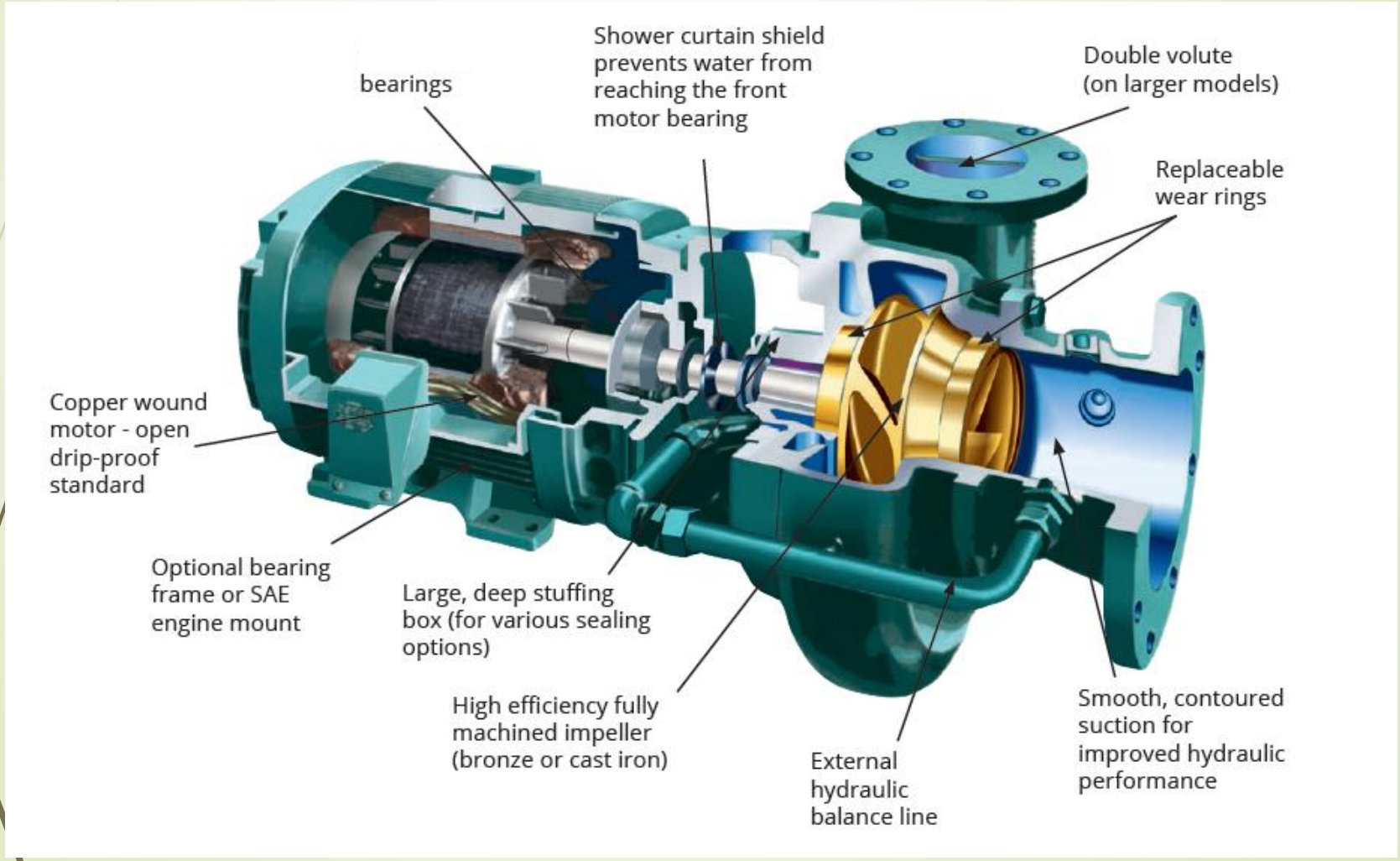
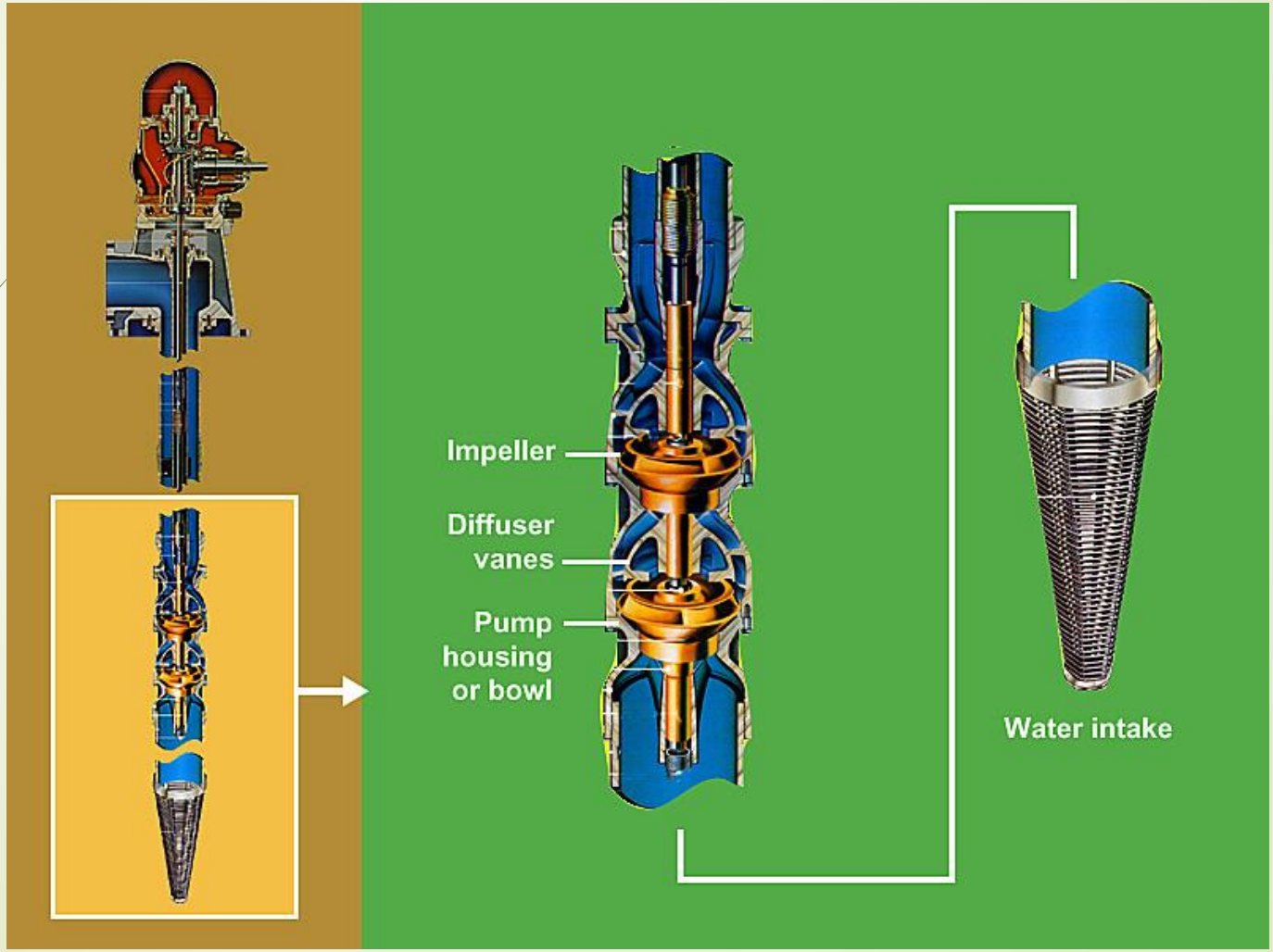
Centrifugal Pump

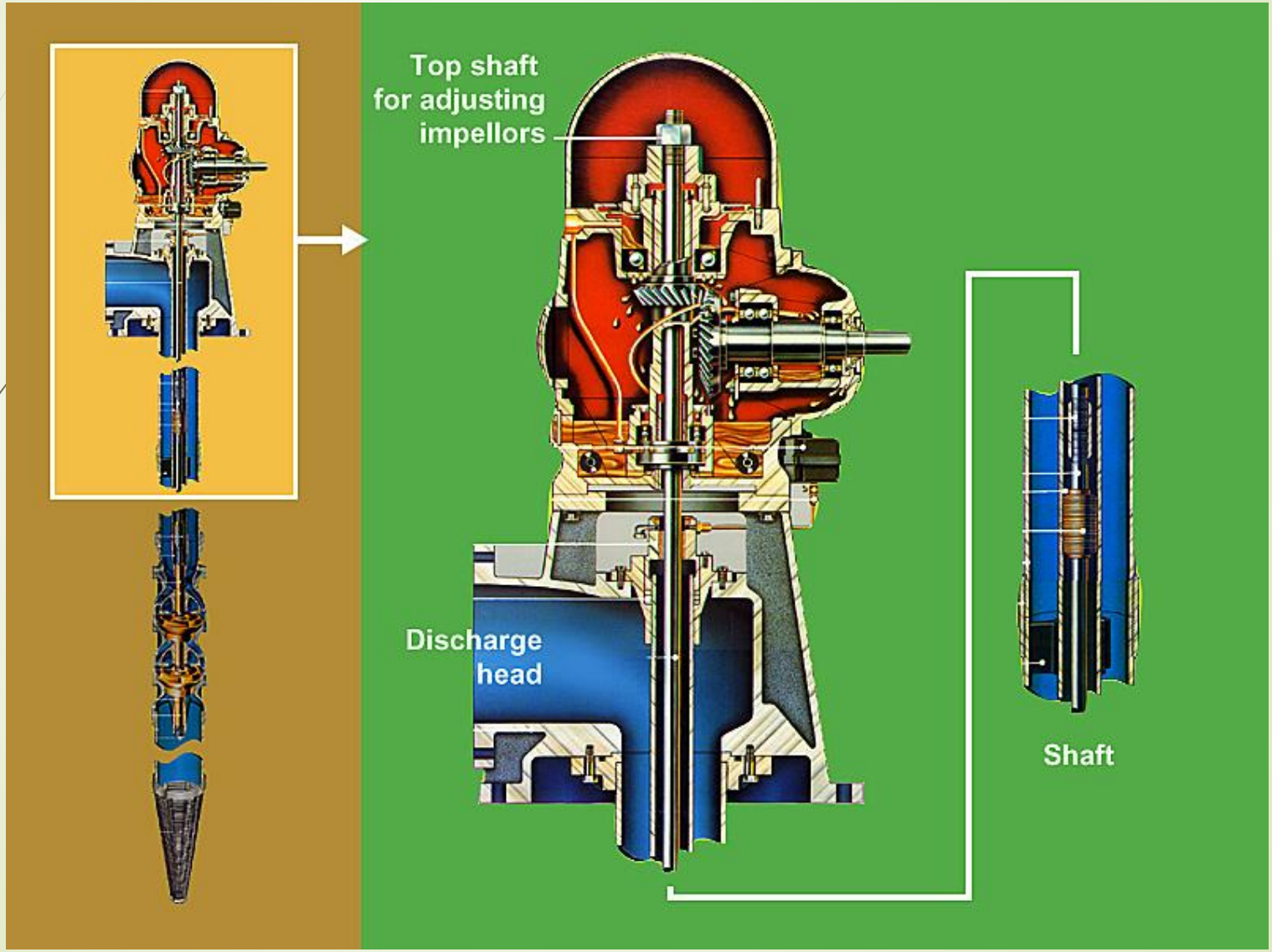


Vertical Mount Centrifugal Pump

Deep Well Turbine



Deep Well Turbine



Submersible Pump

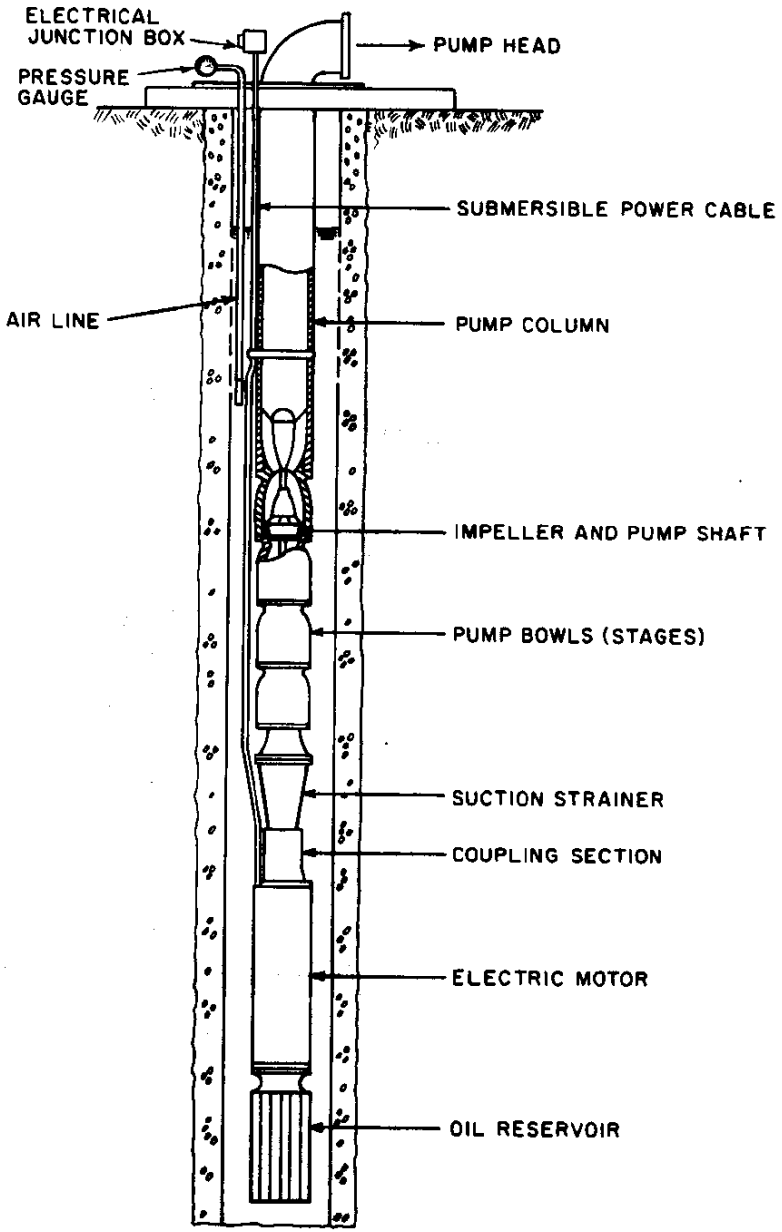
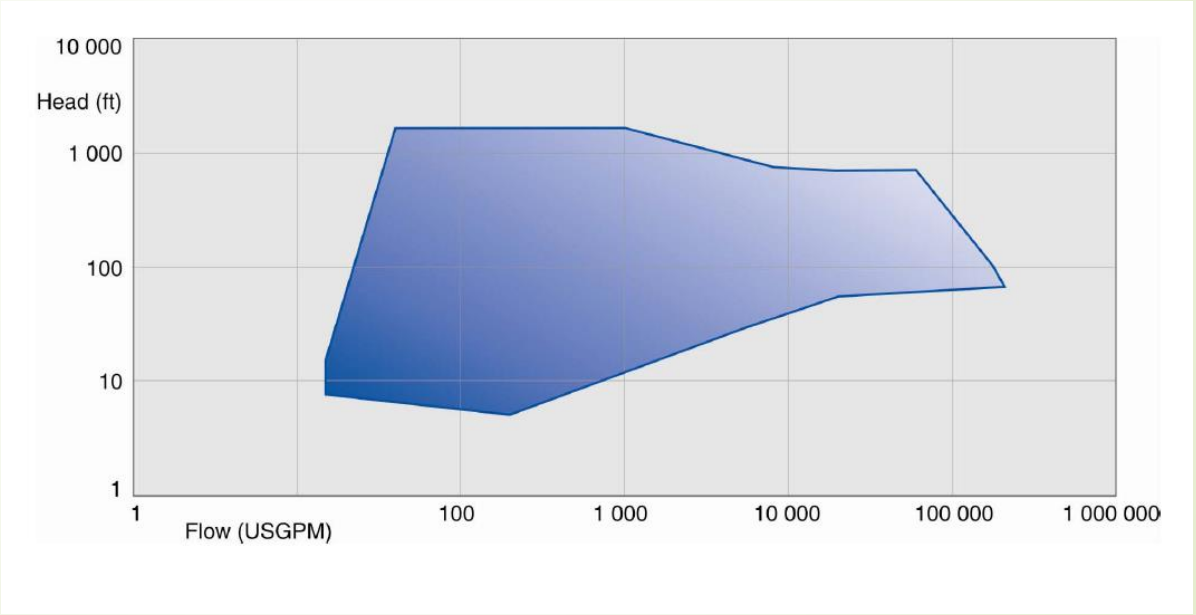


Fig. 5.3. Submersible pump.

Propeller Vertical Pump

- **High flow**
- **Lower head**
- **Can be BIG!**



Positive Displacement Pump

- Piston
- Diaphragm

- Accurate flow per stroke for accurate injection of chemicals/fertilizer.
- Adjustable
- High pressure
- Low flow

E-Z Meter Chemical Injection Pump Features

1. Pumping cylinders can be mounted in parallel for large volume applications or for injection of two non-compatible products.
2. A simple change of stoke length sets the precise flow to be injected.
3. Maximum pressure 150 psi.

Photo from CDS John Blue Company, Irrigation Injection Pumps

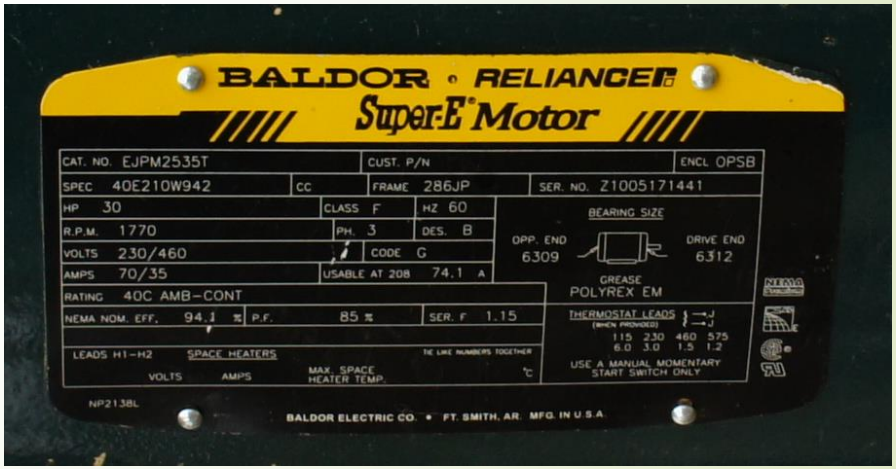
Turbine with centrifugal booster

Multiple pumps in series

Portable Pump station for drip system

Pumping Plants – What's New?

- Pumping has been done for 4000 years so what else could be fixed, upgraded or changed to make it better??
  - Power Units -
    - Premium duty electric motors
      - Heavier – can handle heat better
      - More efficient - saves energy and money
      - Can handle variable frequency drives – flexible operation
      - Cost more and have to ask for them
    - Diesel
      - More efficient engines
      - Less air pollution



Electric Motors

- A great web site to find all of the electric motors is at the Dept. of Energy
- Motor Master + 4.01.01 - there is a CCE version we can have loaded on the NRCS computers.

- http://energy.gov/eere/amo/articles/motormaster

Pumps

- Almost unlimited choice - thousands of different speeds, sizes, efficiencies of pumps are available
- Can use any of the power sources (except for on the submersible) to operate
- A great share point site where pump curves can be found is at-

ftp://ftp.wcc.nrcs.usda.gov/wntsc/Pump%20Curves/

Pump name plate – Manufacturer, Model, Impeller diameter

Variable Frequency Drive or Variable Speed Drive (they are the same)

- Converts AC current to DC and adjusts to condition needed then back to AC
  - Can be used where only single phase power is available
    - Maximum horse power for single phase motor is 10 hp
    - Can use to convert single phase power to three phase (still requires wire large enough to handle the motor amps)
  - Adjust speed of motor based on monitored condition. For irrigation this is usually pressure but could be flow, temperature, or whatever else needs control
  - Can be controlled/monitored manually or on the web

VFD Benefits

- Lower energy costs
  - Can be used to lower system pressure rather than using a throttling valve
  - Soft start can reduce demand charges
- Safer system with less surge pressures at start up and shutdown
- Easier to control and operate entire system

VFD Controls

A VFD can be used to fit a pump to the site or to control multiple pumps

- Reducing RPM by 20% will save -
  - 50% of horsepower
  - Flow reduced 20%
  - Head reduced 38%
- Pump efficiency stays fairly constant with speed adjustment
- Need to keep VFD from getting to hot or cold
- Keep controls clean, dry and dust free
- Not sure on the long term effects on the motors

VFD

- The price of VFD's have dropped and they are getting smaller and better
- Some disadvantages are
  - Harmonics – the sine wave the VFD creates to control the motor speed can cause frequency on the power line. A filter may be required that adds to the cost of the system. This is a question to ask the local power company prior to installation
  - Cost – the VFD does require energy to operate. Be sure and do economic calculations prior to installing to justify purchase.
  - VFD do create heat and must be kept cool and free from dust. A separate room/office for this type of equipment does help protect it.

VFD Tech Note

- There is a TN for more information on how a VFD works. This can be downloaded from the NRCS Water Management Engineering share point site at -

https://ems-team.usda.gov/sites/NRCS_ST_WNTSC/coreteam/engineering/WME/SitePages/Home.aspx

A VFD spread sheet is also available to check the potential energy and $ savings at the Bonneville Power web site under the USDA VFD.

http://www.bpa.gov/EE/Sectors/agriculture/Pages/Variable-Frequency-Drives.aspx

Irrigation Controls

- With wireless technology it is now possible to monitor irrigation systems
  - Weather
  - Irrigation application amounts
  - Soil data
  - Chemigation applications
  - System status
  - Trespass

  - All of these and more can be sent to the base station for the irrigator to keep up to date on how the system is operating.

Irrigation and Energy Conservation

- There are many ways to conserve energy in irrigation. Some examples include -
  - Irrigation Water Management
    - Schedule water applications based on crop or soil moisture level to save water by monitoring and applying the correct amounts
  - Irrigation system
    - Repair leaks
    - Convert to lower pressure
    - Apply water as uniformly as possible with new sprinkler package
    - Off site monitoring for constant update of crop and system status
  - Pumping plant
    - Lower pressure/flow using a VFD to more accurately supply the correct amount and pressure
    - Install a more efficient motor/drive
    - Find a better more efficient pump

Table 8-A2. Pumping Plant Component Standard Efficiency Values

Component	Field Attainable Efficiency, %
PUMP EFFICIENCY	
Centrifugal	75
Vertical Turbine	75
Floating Tailwater	65
Submersible	65
DRIVE EFFICIENCY	
Direct Drive	100
Right Angle Gear Drive	95
Multiple V Belt	90
Flat Belt	85
POWER UNIT EFFICIENCY	
Internal Combustion Engine (Diesel)	31.7
Internal Combustion Engine (Gasoline)	23.6
Internal Combustion Engine (Natural Gas)	22.6
Internal Combustion Engine (Propane)	25.6
Electrical Motor, 3 Phase, Serving Submersible Pump	80.0
Electrical Motor, Single Phase, Serving Submersible Pump	75.0
Electrical Motor, Vertical Hollow Shaft, 10 - 100 hp rating	90.0
Electrical Motor, Vertical Hollow Shaft, 100 - 150 hp rating	91.0
Electrical Motor, Vertical Hollow Shaft, 150 - 300 hp rating	92.0
Electrical Motor, V-Belt Drive, 10 - 40 hp rating (motor only)	88.0
Electrical Motor, V-Belt Drive, 40 - 125 hp rating (motor only)	89.0
Electrical Motor, V-Belt Drive, 125 - 130 hp rating (motor only)	92.0
Variable Frequency Drive or Variable Speed Drive Assuming 3% energy loss and 5% loss for required cooling* Note: Efficiency shown is drive efficiency only. Motor efficiency must be considered separately. * ITRC Report No. R 06-004, Electric Motor Efficiency under Variable Frequencies and Loads	92.0

Thank you
Contact information

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Questions?

Advances in Lo- and Hi-Tec Irrigation Systems

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