Pumps and Motors

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Presentation Outline

- Energy Efficiency and Motors
- Energy Efficiency and Pumps

Energy Efficiency and Motors

Motor Efficiency Defined

% of electrical input power the motor turns into mechanical output power

NEMA standards dictate how this is measured & calculated

First Cost vs. Life Cycle Cost

Lifetime electrical costs could be as much as 75 times the initial purchase price of the motor.

Premium Efficient Motor Upgrade

High motor energy – replace ‘standard’ motors with premium efficient motors. Savings depends on:

- Difference in motor efficiency
- Motor size
- Equipment run time
- Cost of motor
- Cost of energy

Rewind or Replace

Reliable repair shops

- Lose 1% or 2% efficiency

Replace if:

- motor is less than 40 hp
- cost of the rewind exceeds 65% of the price of a new motor
- motor was wound before 1980

Evaluate Payback

50 HP Pump Motor

- Efficiency = 87%
- Duty Cycle = 22 hrs/Day * 365 days
- kWh charge = $0.082/kWh
- kW charge = $14.00/kW

New 50 HP Motor

- Efficiency 93%
- Total cost (installed) = $7,200.00

Evaluate Payback

(50 HP X .746 kW) ÷ efficiency =

37.3 ÷ .87 = *42.8 kW*

(50 HP X .746 kW) ÷ efficiency =

37.3 ÷ .93 = *40.1 kW*

42.8 – 40.1 = 2.7 kW Savings

Evaluate Payback

Demand Savings:

2.7 kW X $14.00 X 12 Months = $453.60 (annual demand)

kWh Consumption Savings:

2.7 kW * 22 hrs/Day * 365 = 21,681 kWh/yr

21,681 X $0.082 = $1777.82 annual savings (kWh)

$1777.82 + $453.60 =

$2,331.42 Total Annual Electric Savings

Evaluate Payback

$7200 Installed Cost

$2331 Annual Savings

3 Years

Motor Master+

- Developed by US Department of Energy.
- Free download from DOE website.
- Database of motors, efficiencies, pricing.
- Calculates simple payback periods of motor replacement projects.

Energy Efficiency and Pumps

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Energy Audits – Pumping Sytems

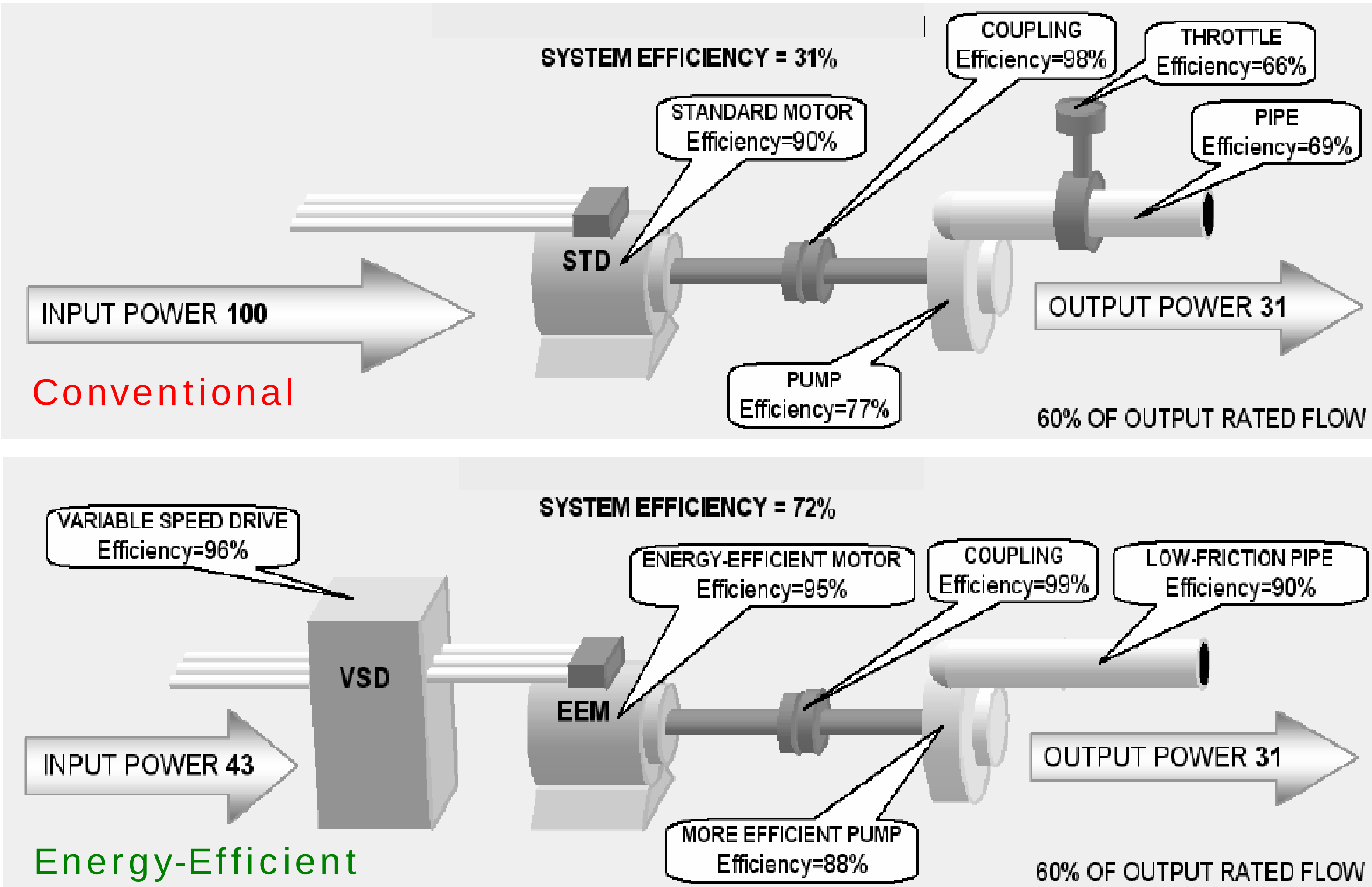
- Don’t Throttle Pump Discharge!
- Evaluate existing pump efficiency
- Install variable speed device
- Install pump controllers tied to level and/or process controls.

Variable Speed vs. Valves

- Uses less energy to meet pumping needs
- Run pumps at lower speeds

- Mechanical devices to control flow
  - flow-restricting valves
  - moveable air vanes
- Hard on mechanical equipment

Problem: Pump Inefficiencies



Pump Efficiency Equation

$$Pump_{eff} = \frac{Q \times H \times SpGr}{c \times kW \times Motor_{eff}}$$

PARAMETER	DEFINITION
$Pump_{eff}$	Pump efficiency
Q	Flow
H	Head
$SpGr$	Specific Gravity
kW	Kilowatts
$Motor_{eff}$	Motor efficiency of pumps in specific application
c	Unit Conversion Factor

Affinity Laws for Centrifugal Pumps and Fans

1. $$\frac{Q_2}{Q_1} = \frac{n_2}{n_1}$$

2. $$\frac{H_2}{H_1} = \left[\frac{n_2}{n_1}\right]^2$$

3. $$\frac{P_2}{P_1} = \left[\frac{n_2}{n_1}\right]^3$$

Q = Flow (gpm)
n = Pump Speed (rpm)
H = Total Head (ft)
P = Power

If you can reduce the speed by 10%:
-You reduce your flow rate by 10%
-You reduce the system head by 19%
-You reduce your P by 27%

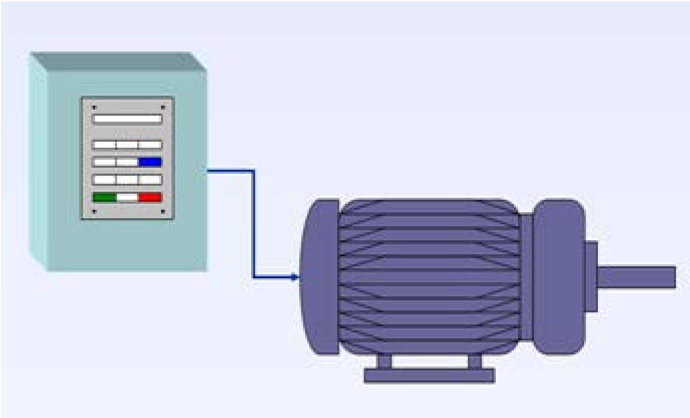
Variable Frequency Drives

Electronic controller that adjusts motor speed by modulating AC power frequency

Matches motor speed to load requirement

Work best with fluctuating demand

Lower wear on motor with soft start



Process & Energy Audits

Systems for controlling the rotational speed of an electric motor

A variable frequency drive (VFD) controls the frequency of the electrical power supplied to the motor

Others:

- Eddy Current Drives
- Liquid Rheostats

VFD – other (non-energy) benefits

Lessens mechanical & electrical stress on motor

Reduces maintenance & repair costs

Extends motor life

Precise control of processes

- Pressure in water distribution systems can be maintained to closer tolerances
- DO concentrations consistently maintained
  - automated controls linking DO sensors to vfd on blower

Energy Audits Tools

Pumping System Assessment Tool

- Developed by US Department of Energy.
- Returns actual pumping system efficiency vs. potential system efficiency.
- Utilizes input of simultaneous pumping system data:
  - Influent/effluent pressure
  - Flow
  - Pump speed
  - Power.

Questions?