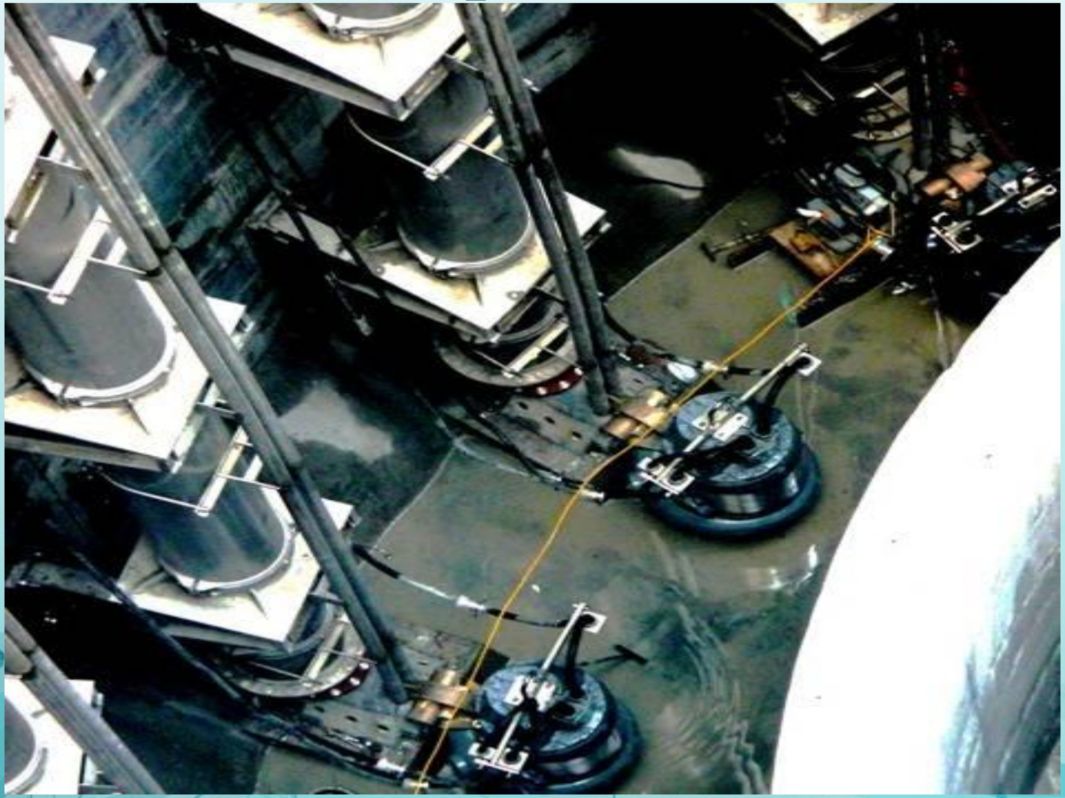
Variable Frequency Drive (VFD) benefits with Pumps



Energy Efficiency in Pumping Systems

- Motor costs

Energy Efficiency in Pumps

- Energy wastes

How your **money** is **wasted**!

Car example :

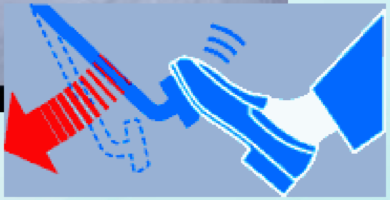
…try to regulate the speed of your car

- keeping one foot on the accelerator
- the other on the brake.

Pump example :

… try to adjust the pump output

- running the motor at full speed
- control the flow with a throttle valve



Still one of the most common control methods in industry with a considerable waste of energy!

VFD Benefits with Pumps

- Physical laws for centrifugal loads

It’s pure physics: Due to the laws that govern centrifugal pumps, the flow of water decreases directly with pump speed

Affinity laws of centrifugal loads:

Flow = f (motor speed)

Pressure = f (motor speed)^2

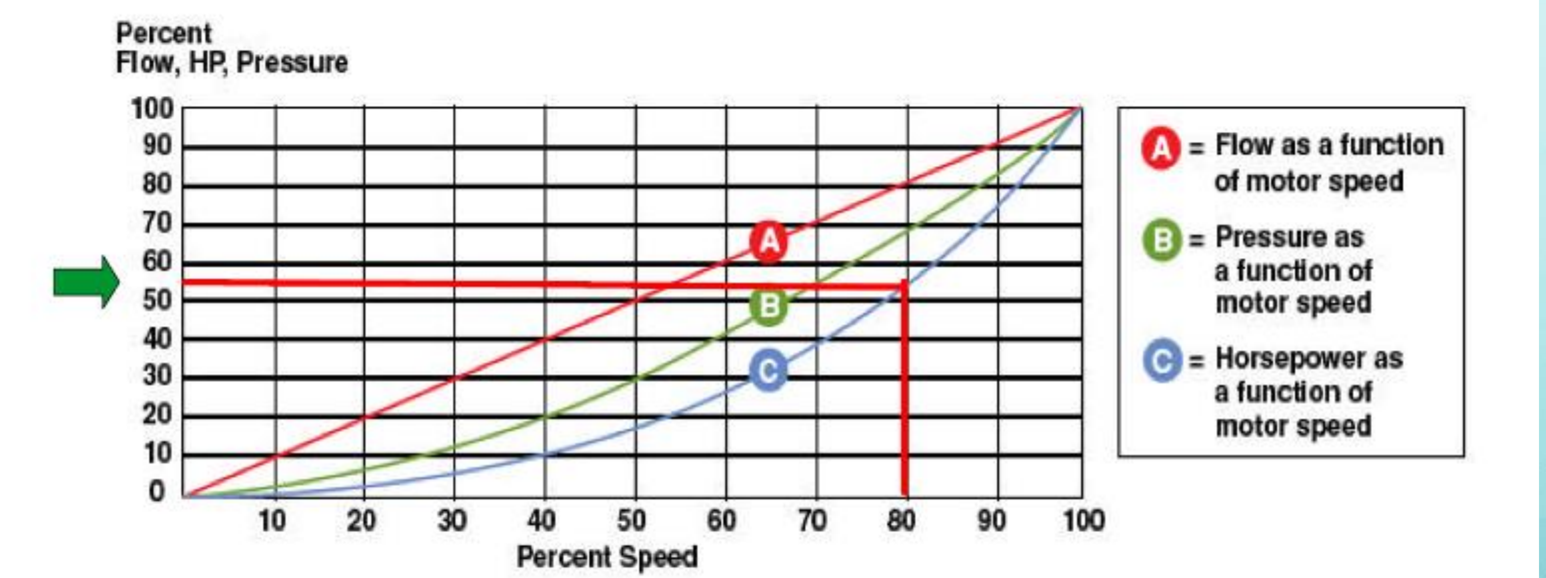
Power = f (motor speed)^3

VFD Benefits with Pumps

- Physical laws for centrifugal loads

A motor running at <u>80%</u> of full speed requires <u>51%</u> of the electricity of a motor running at full speed.

✍ (.8 x .8 x .8 = .512)



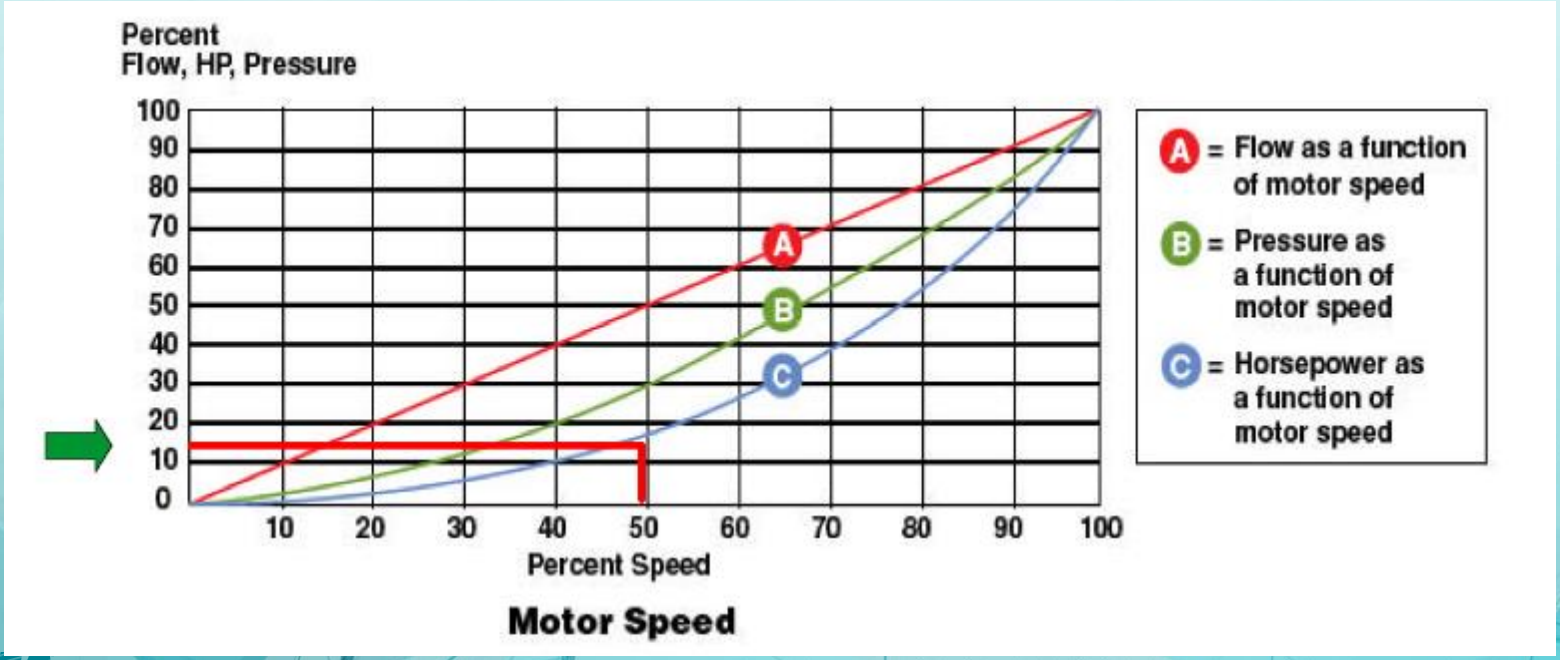
Motor Speed

VFD Benefits with Pumps

- Physical laws for centrifugal loads

A motor running at <u>50%</u> of full speed requires <u>12.5%</u> of the electricity of a motor running at full speed.

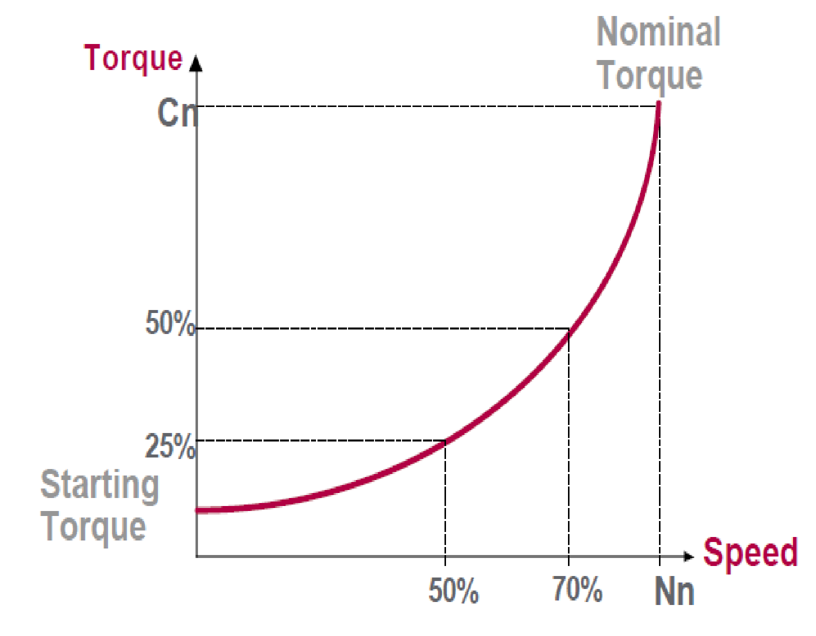
(.5 x .5 x .5 = .125)



VFD Benefits with Pumps

- Physical laws for centrifugal loads

- A small reduction in speed produces a significant reduction in power
- Relevant applications : Pumps
- The resisting torque of centrifugal pumps varies with the square of the speed **:** $T = kN^2$
- Power is a cubed function $P = kN^3$



EX 50HP 10Hrs/day, 250 days @$.08

With 15% average speed reduction

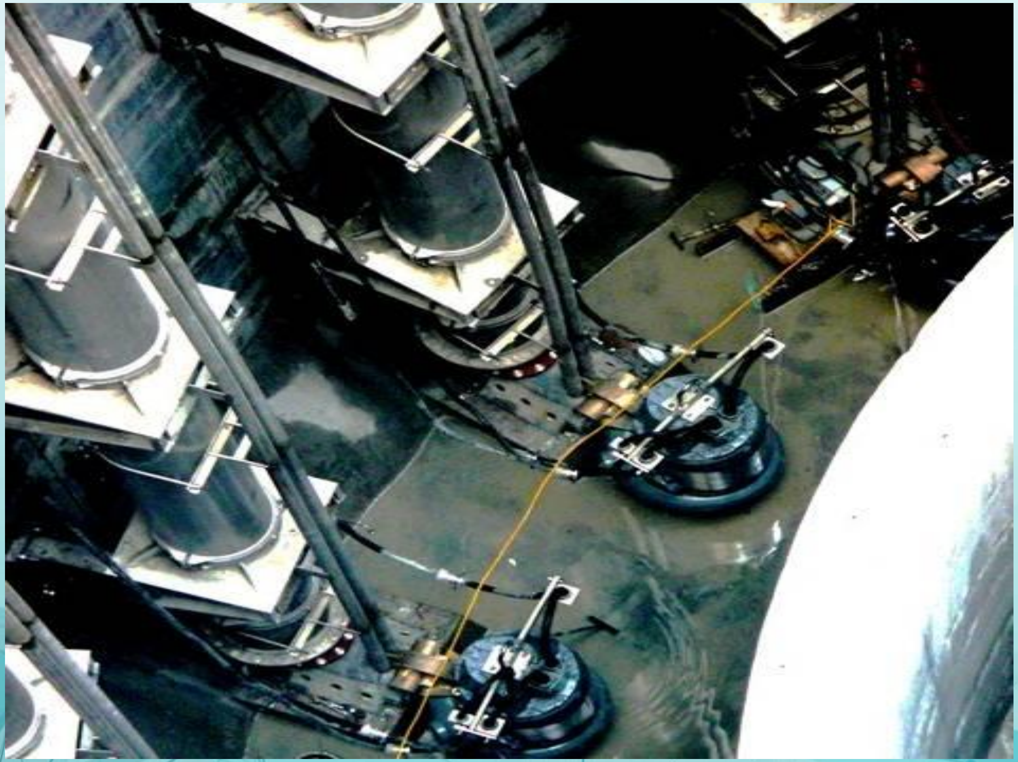
ATL = $7,460

VFD = $4,188

Savings = $3,272

Today, less than 10% of these motors are controlled with variable speed drives

Efficiency of pumping systems



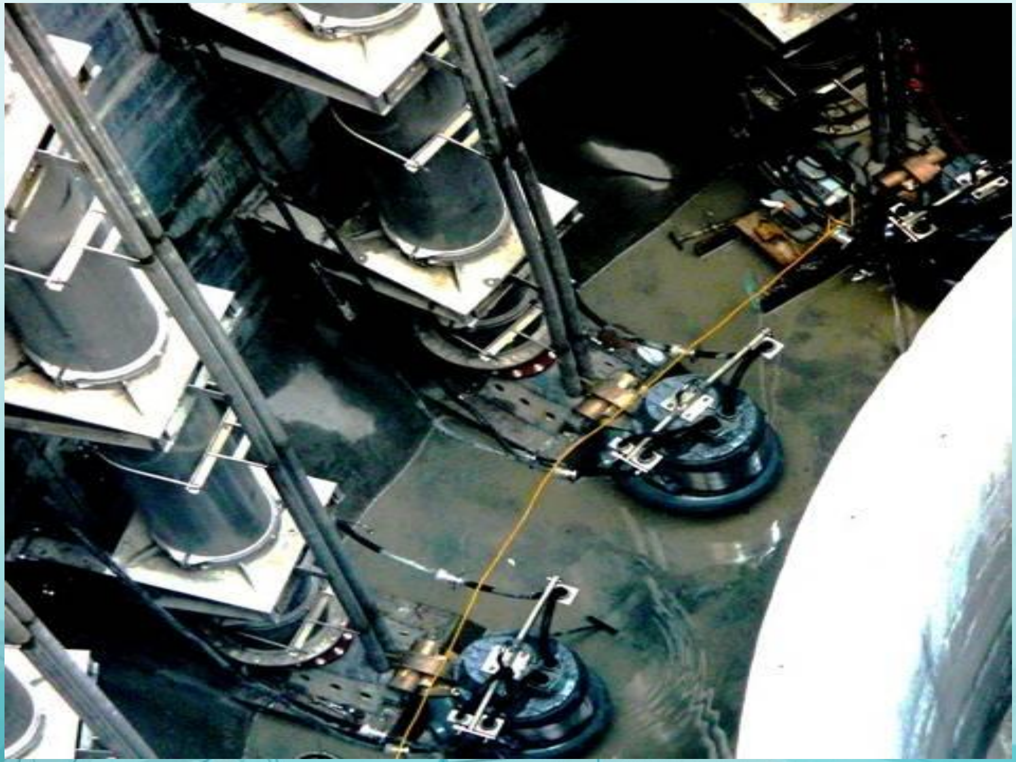
VFD Benefits with Pumps

Other Benefits

In addition to energy savings, using a VFD has many other advantages:

- Less mechanical stress on motor and system
- Less mechanical devices - Less maintenance
- Process regulation with PID regulators, load management functions
- Reduce noise, resonance avoidance
- Performance and flexibility, range settings, above base operations
- Easier installation and settings, drive mechanics
- Can be controlled with automation, communication networks

Steps to obtain pump optimization



Pump Optimization

Complete a detailed Pump Assessment

Pumps are usually consuming more energy than necessary:

- The pump is oversized and has to be throttled to deliver the right amount of flow. Energy is lost in the valve.
- Pumps that are not running close to their best efficiency points (BEP) operate at lower efficiency. Throttled pumps usually fall into this category.
- Pumps are running with by-pass, or recirculation, lines open.
- Pumps are running although they could be turned off.
- The pump is worn and the efficiency has deteriorated.
- The pump/system was installed or designed incorrectly (piping, base plate etc.)

Pump Optimization

Complete a detailed Pump Assessment

To determine whether these reasons apply, some basic information is needed:

- Actual system demand (flow and pressure)
- Operational flow rate as a function of time (the duration curve)
- Flow controls
- The pump curve
- Where the pump operates on the curve

Process Energy Optimization

Automation is the key

- Develop consistent and appropriate milestone and deliverable expectations
- Standardize program schedule tracking requirements
- Establish key energy management performance metrics
- Produce meaningful reports that allow for clear and concise decision-making
- Install additional monitoring equipment as needed

VFD Application Considerations

- Keep motor lead lengths as short as possible
- VFD environment (0-40ºC), clean and non-condensing
- Enclosure rating (NEMA 1, NEMA 12, NEMA 3R)
- Ensure 3 metallic conduits are used (motor, power, and controls) Be careful with underground runs!
- Dedicated ground wires from motor to VFD and from power source to VFD
- Use line reactors for harmonic distortion control and enhanced protection from AC line transients
- Size VFD based on amp rating (6-pole motors and up)
- Disconnect Issues
- Harmonic calculations

Quiz

- For a centrifugal pump load, a motor running at 80% of full speed requires __% of the electricity of a motor running at full speed
- For a centrifugal pump load, a motor running at 50% of full speed requires __% of the electricity of a motor running at full speed
- True of False: in spite of the above physical relationships, throttling a pump's output remains the best way to adjust flow rate

- 51%
- 12.5%
- False