John Evon - Motors and Drives Specialist

Energy Savings August 2018

MAYER

Energy Consumption

Total electrical energy is 100% of the total

63% of the electrical energy use is for motors[1]	**- 63% of the total**
60% of the motors are on pump and fans	**- 38% of the total**
50% of pumps and fans are potential for drives	**- 19% of the total**
50% of energy can be saved in these with drives	**- 9.5% of the total**

Drives can save 9.5% of Total Electrical Energy Use!![2]

[1] Source: US Department of Energy
[2] Not counting 40% not on pump and fans

Why Are Drives Used?

ENERGY SAVINGS!!!

- Soft start = less stress
- Longer mechanical life of motor and driven load
- Improved power factor (0.95 to 1.0 range)
- Coordination between motors
- Improved control of process
- Reduced demand charge (15 min. moving window)
- Easy interface ability with automation systems

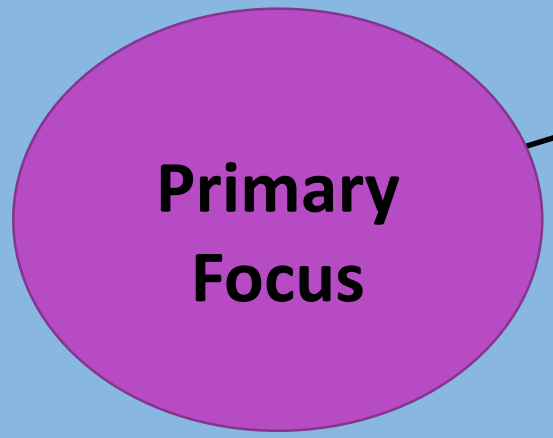
Why Are Drives Used?

- Improved speed regulation
  - 3 to 5% - 0.3 to 0.01% (With Encoder)
- Reduced maintenance relative to…
  - Other variable speed methods
  - Constant speed methods
- Ride-thru capability during power sags and outages (load inertia and drive type dependent)
  - Full output power at 80% line voltage possible!!!
- Electronic Reversing (= Contactor-less)
- Regeneration (for specific applications)

APPLICATION TYPES

What applications are best to cut energy cost?

- Constant Torque
- Constant Power
- Variable Torque



APPLICATION TYPES

Variable Torque Loads

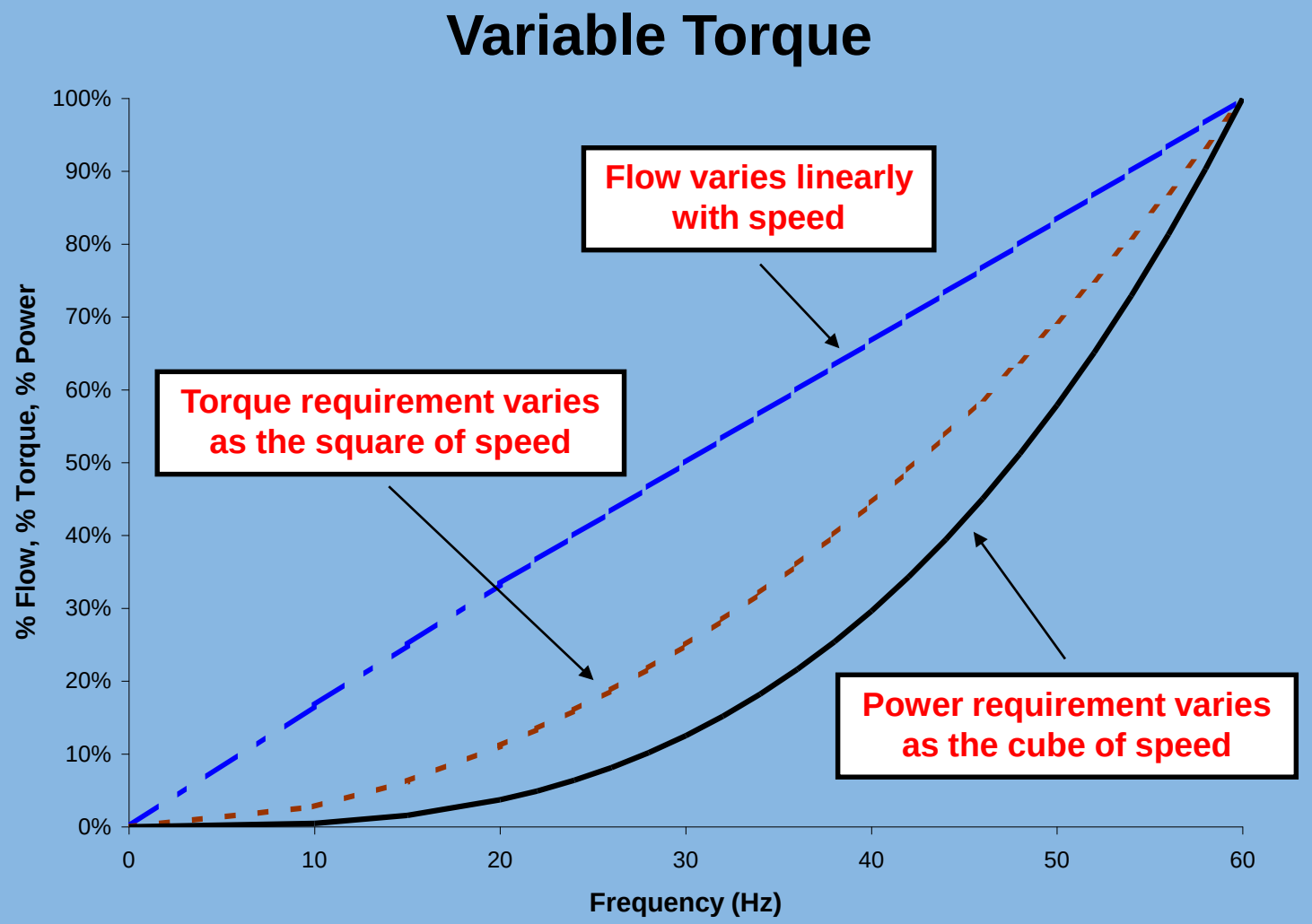
- Fans
- **Centrifugal Pumps**
- **Centrifugal Fans**
- Cooling Tower Fans
- Centrifugal Blowers
- Centrifugal Compressors

Your Best Friend – The Affinity Laws With Variable Torque

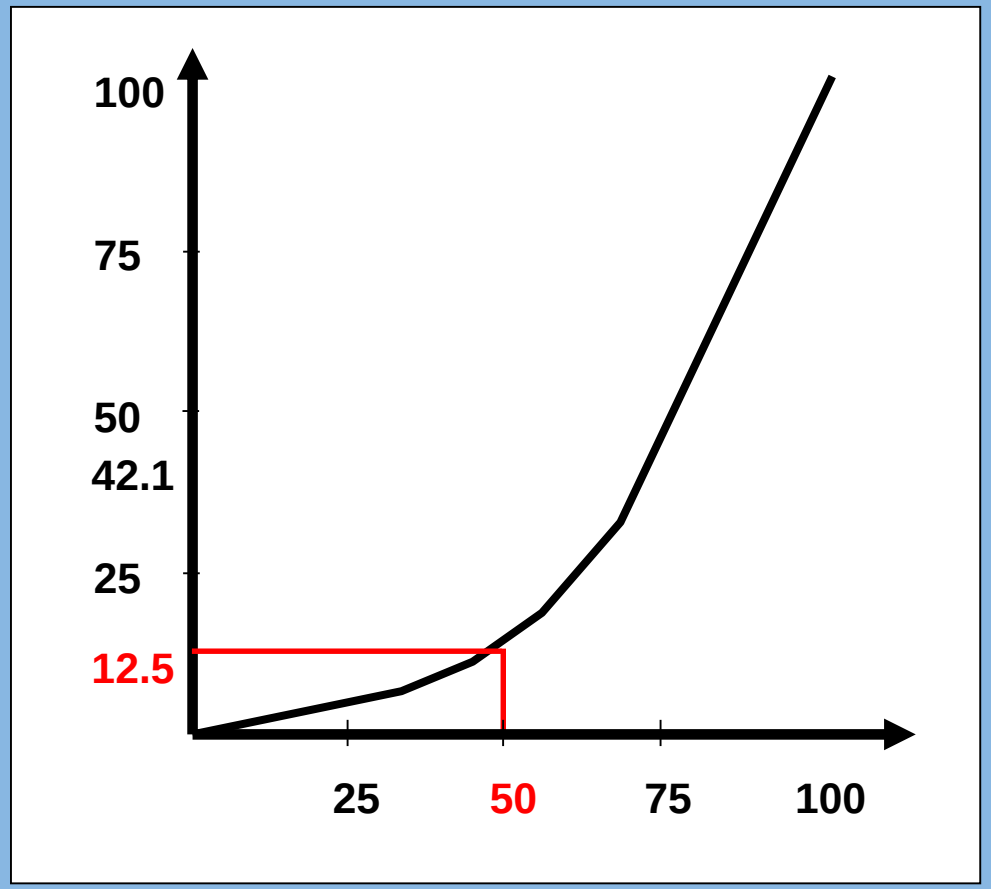
Affinity Laws

- $Q \propto N$
  - Flow rate proportional to rotary speed
- $H \propto N^2$
  - Head (pressure) proportional to rotary speed squared
- $P \propto N^3$
  - Power proportional to rotary speed cubed

Affinity Laws of Centrifugal Loads



Saving Energy by Changing Speeds



POWER

Power is Proportional to (Speed)^3

* 50% speed the horsepower required is (.50*.50*.50) = 12.5%.

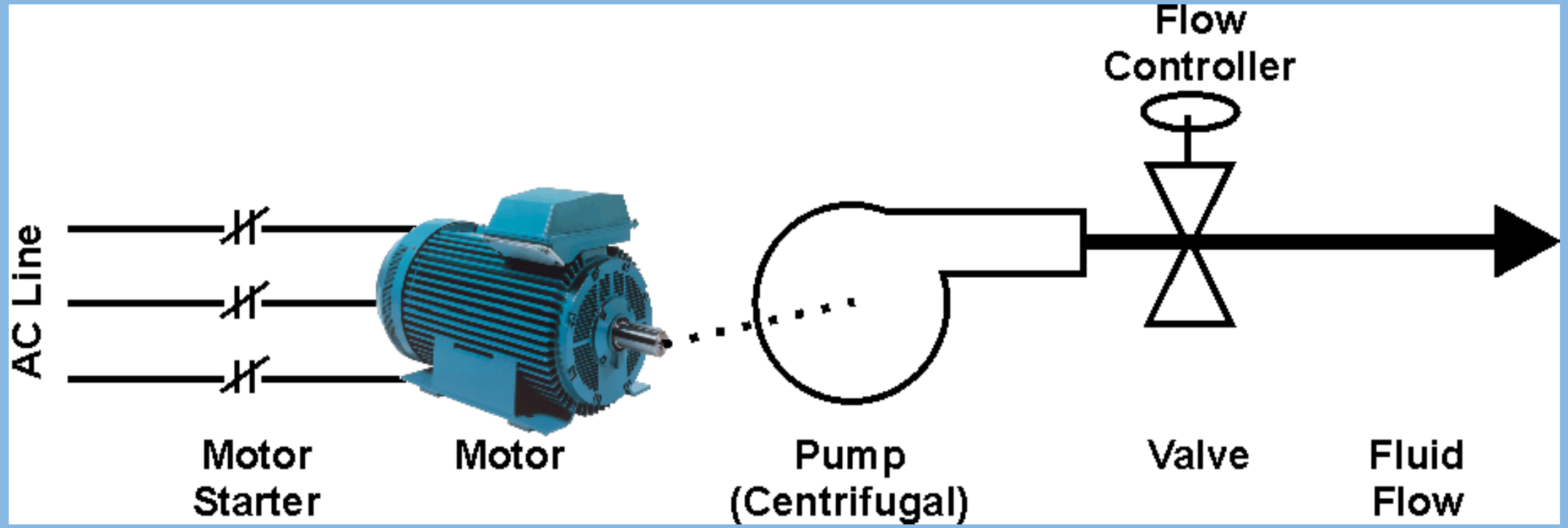
MAYER

Application, Types

Speed	Volume	Pressure/ Head	Horsepower Required
100%	100%	100%	100%
90%	90%	81%	73%
80%	80%	64%	51%
70%	70%	49%	34%
60%	60%	36%	22%
50%	50%	25%	13%
40%	40%	16%	6%
30%	30%	9%	3%

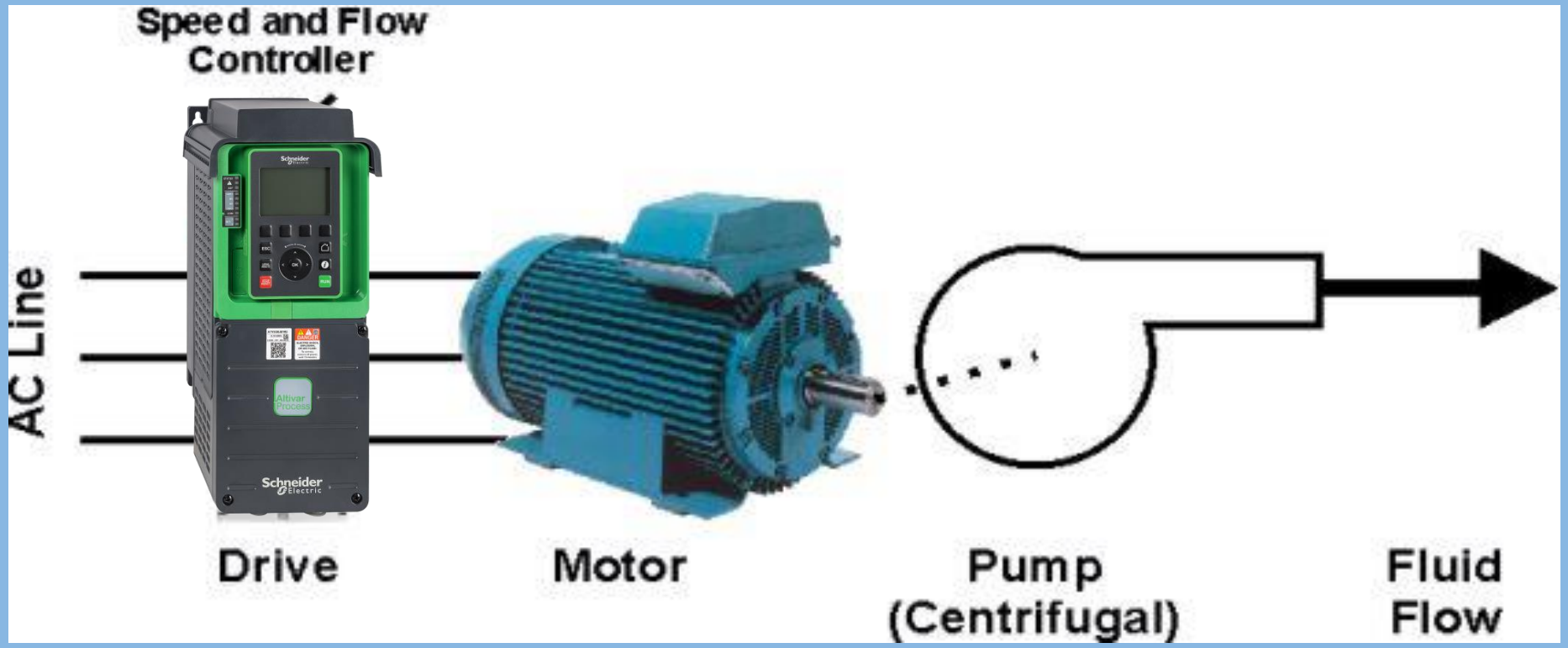
Application Types; Pumps

Fluid Flow Control of Pump With Valve



Application Types; Pumps

Flow Control of Pump With Drive



AUDIT

In Real Estate it's…

LOCATION

LOCATION

LOCATION

MAYER

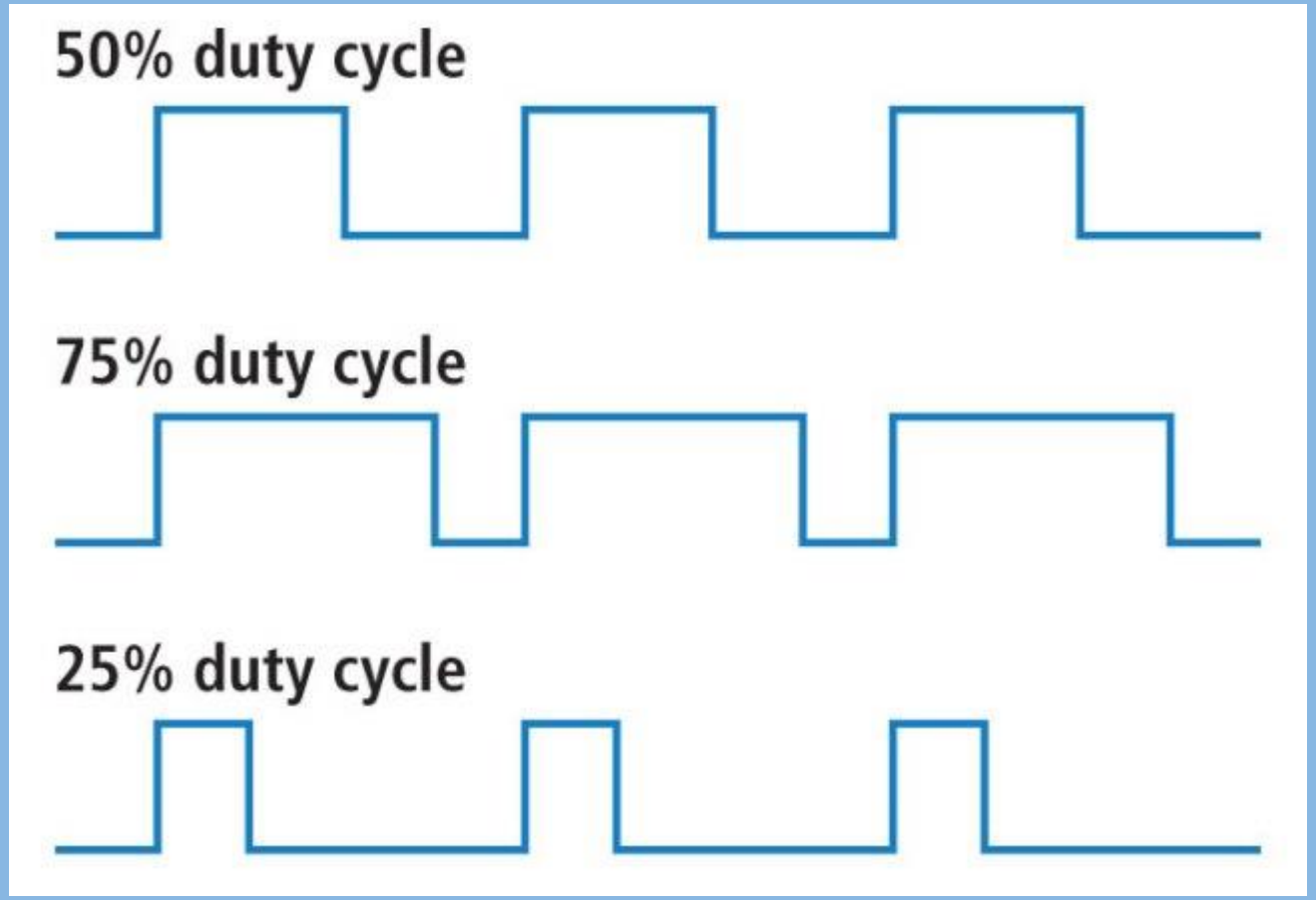
AUDIT

In Energy Savings it's…

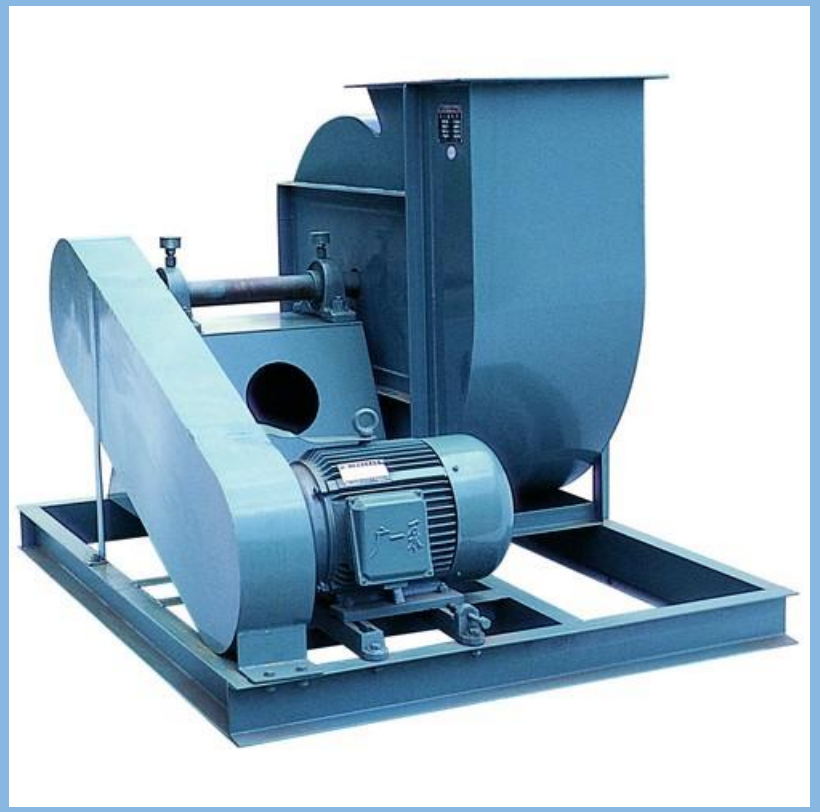
Duty Cycle

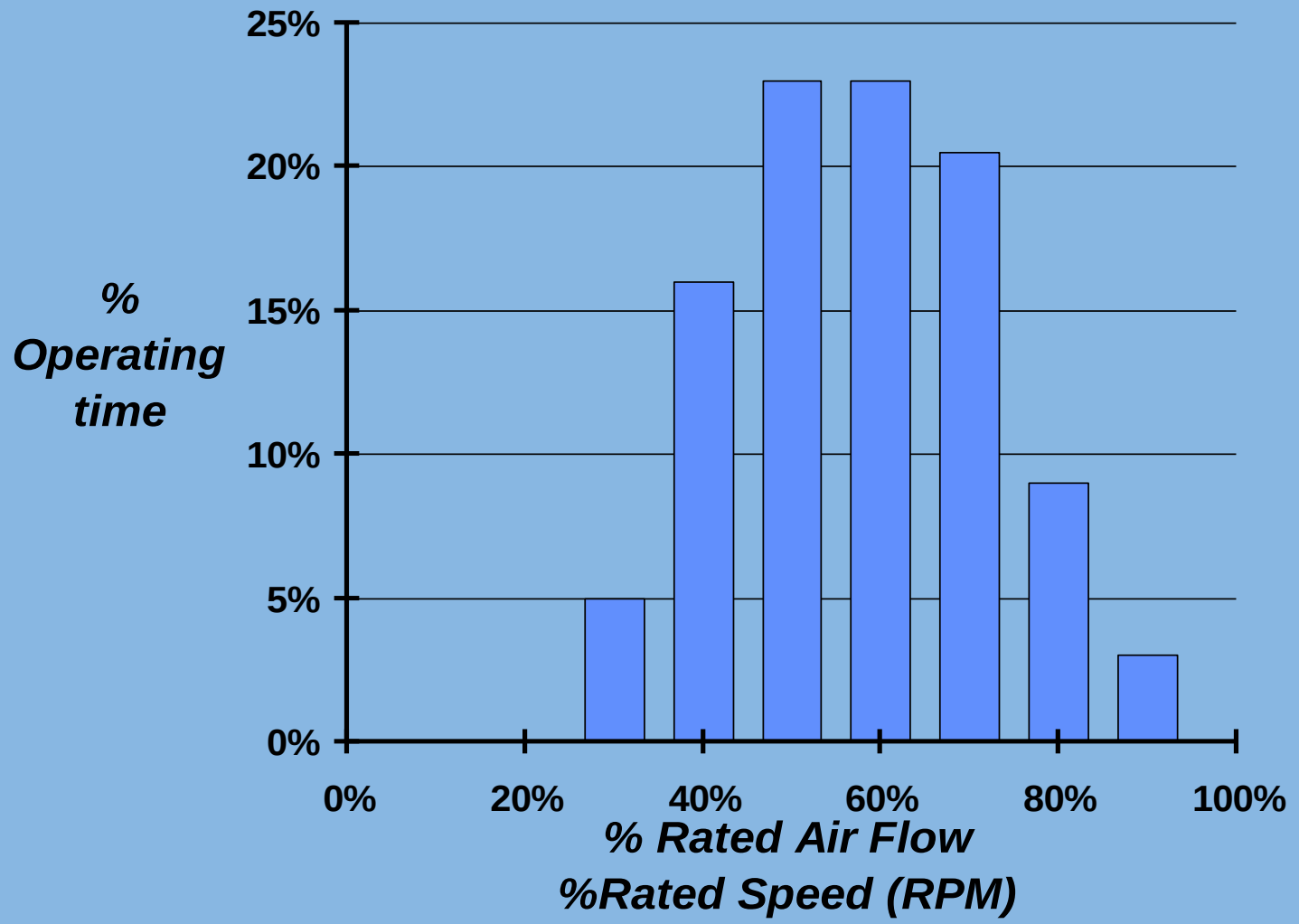
Duty Cycle

Duty Cycle



Typical Fan System Duty Cycle

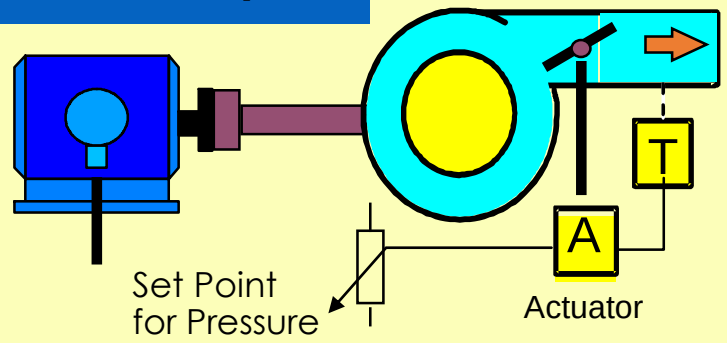




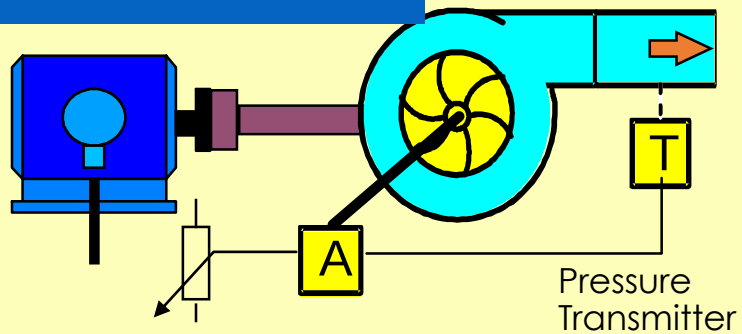
Typical Fan System Duty Cycle

Air Volume Control of a Centrifugal Fan

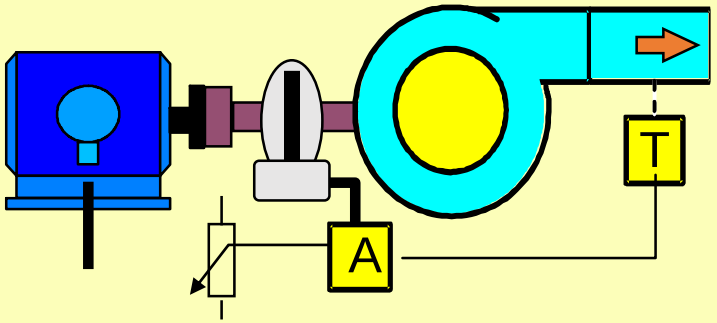
Outlet Damper



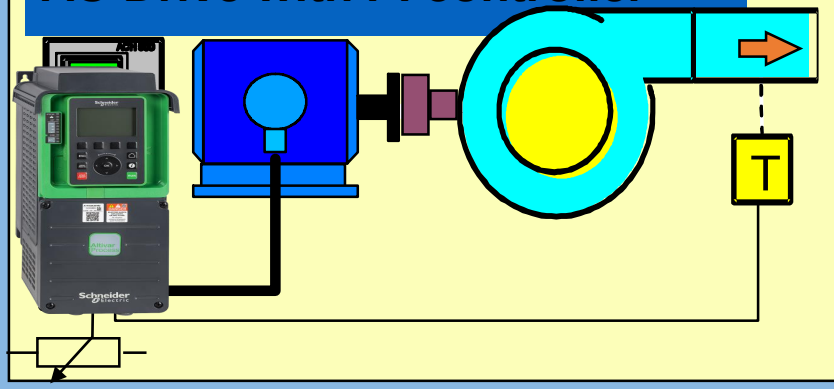
Inlet Guide Vane



Hydraulic coupling



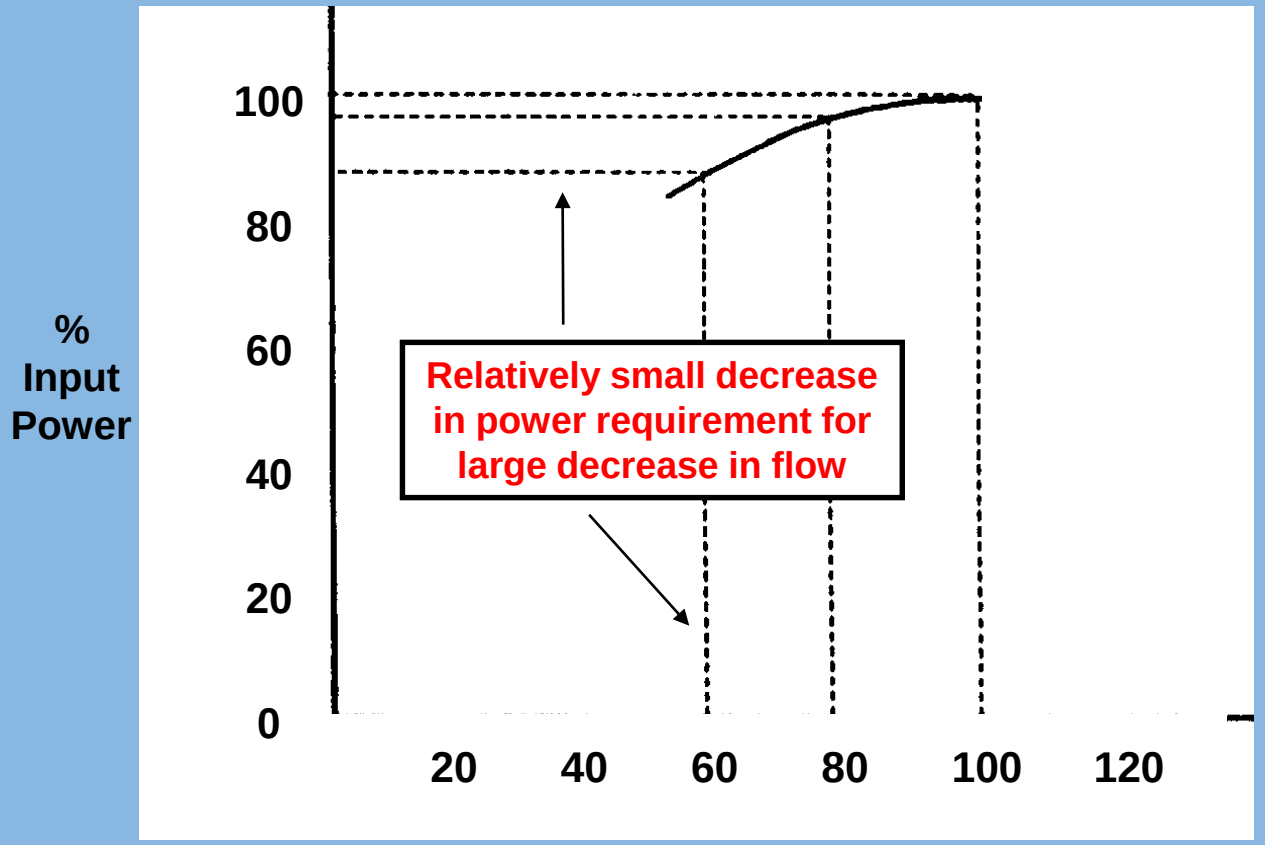
AC Drive with PI controller



MAYER

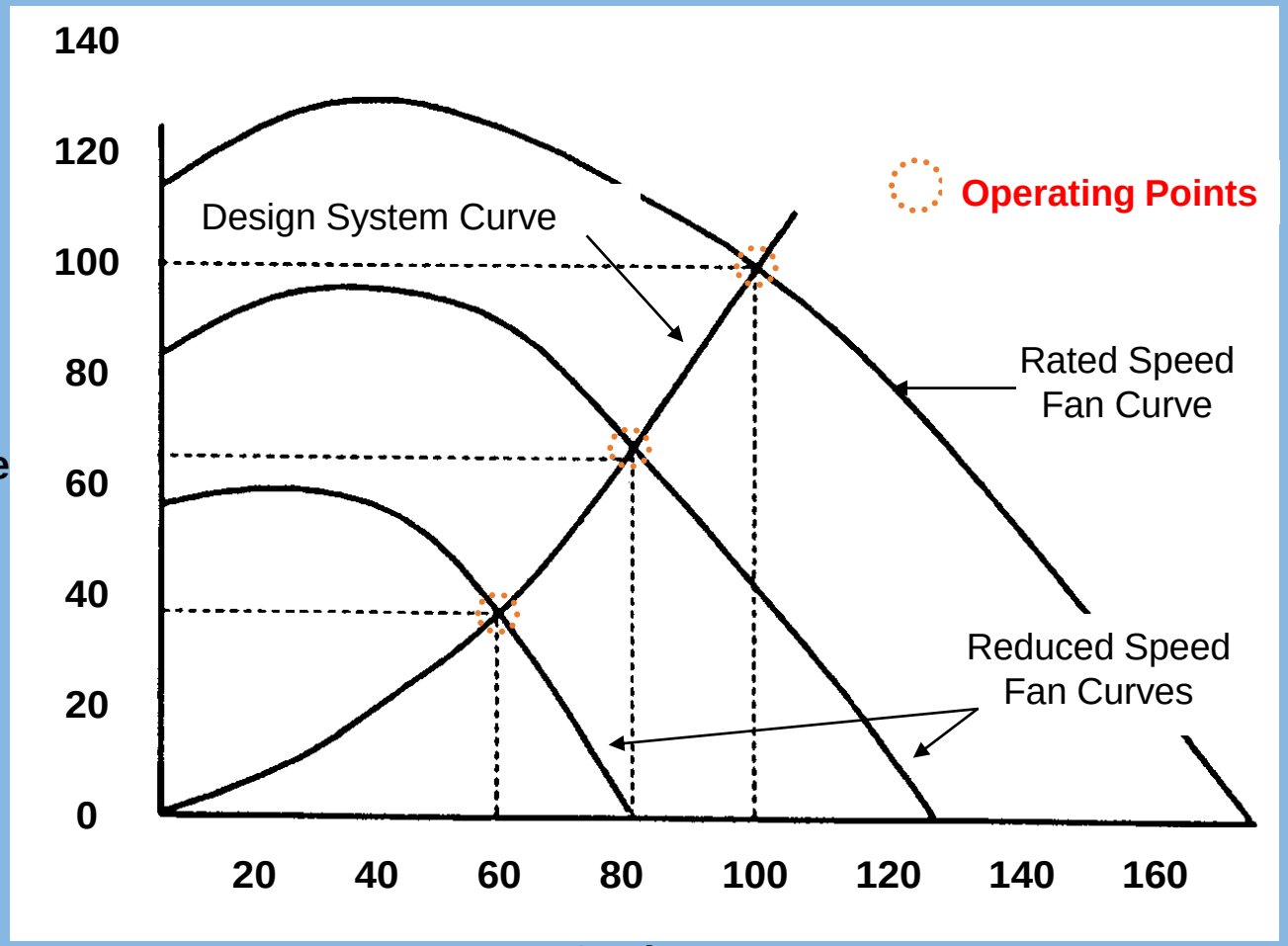
Applications; Fans and Blowers

Outlet Control - Power Requirements

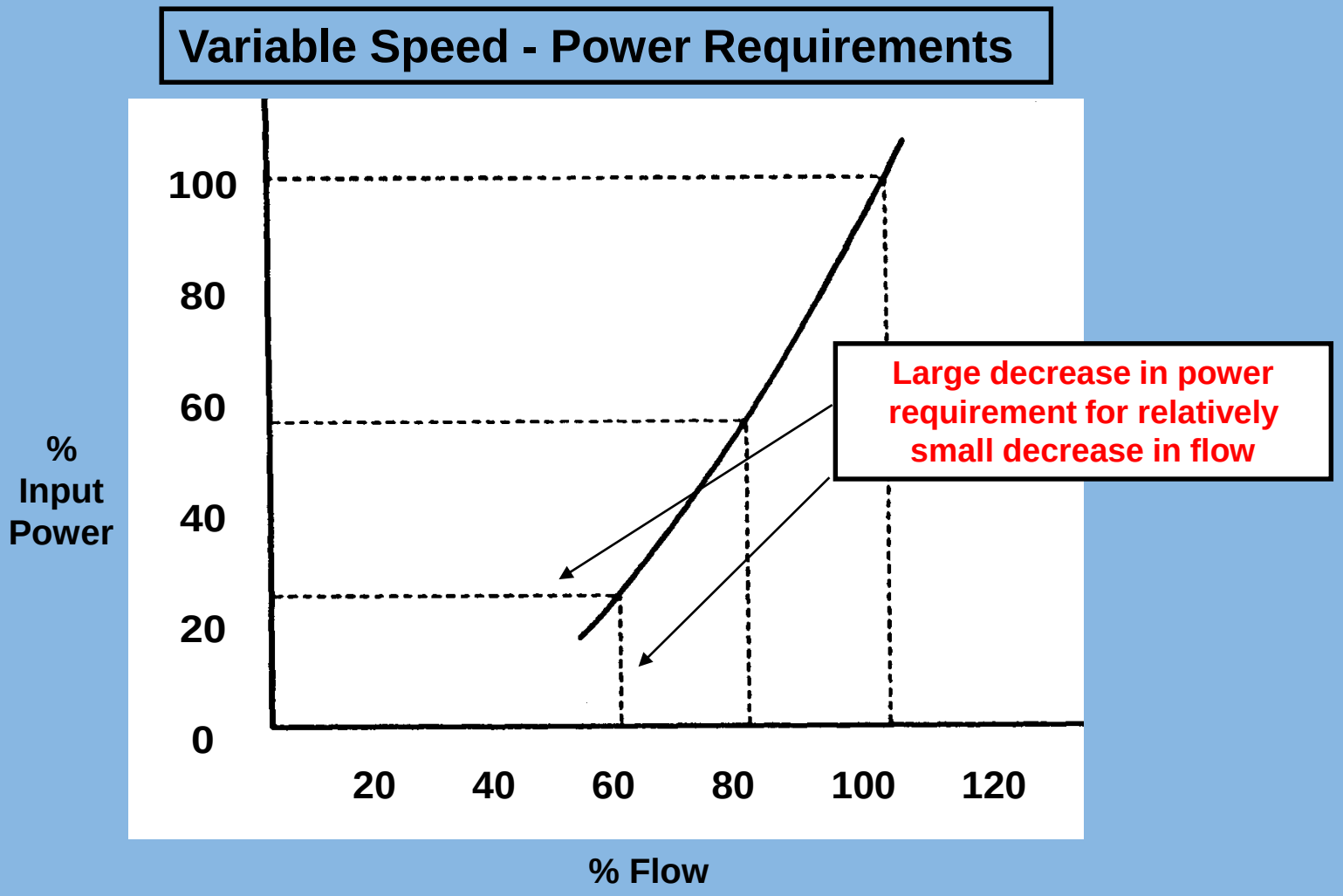


Applications; Fans and Blowers

Variable Speed - Operating Points



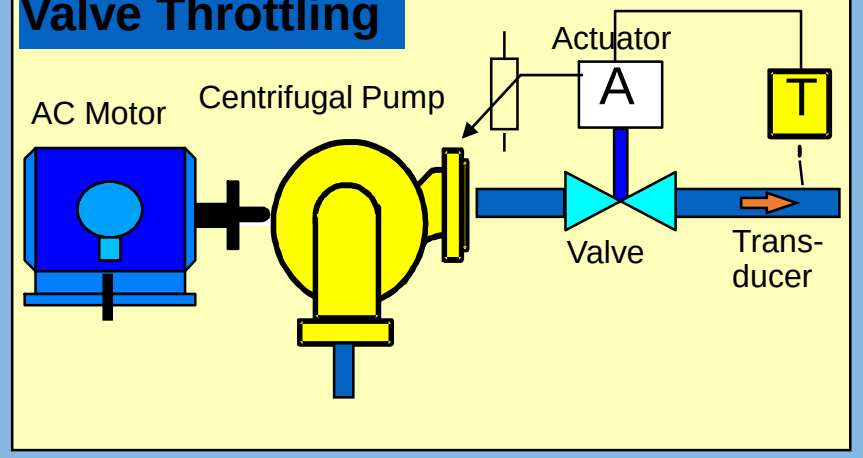
Applications; Fans and Blowers



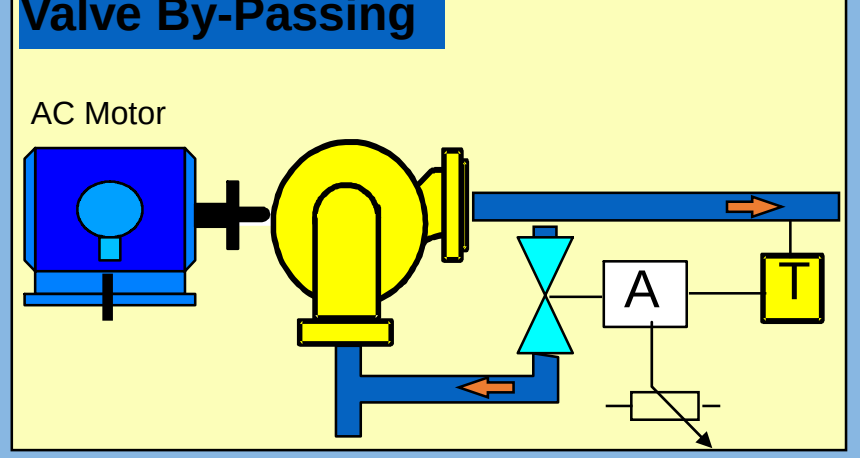
Applications; Pumps

Water Flow Control of a Centrifugal Pump

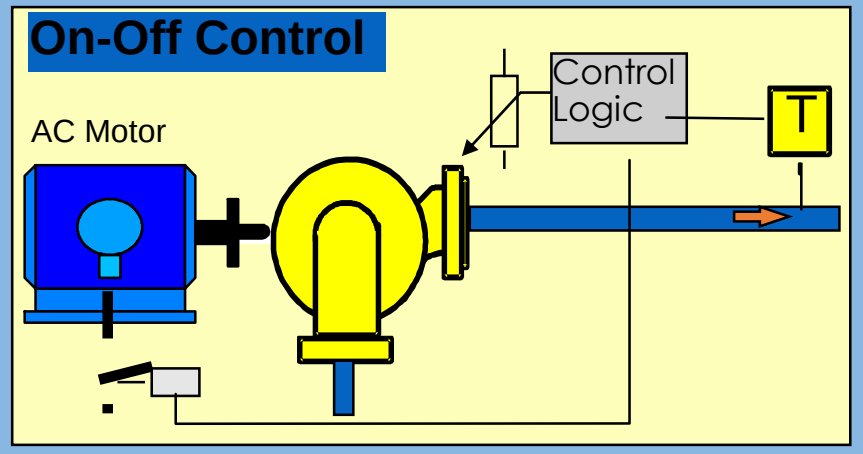
Valve Throttling



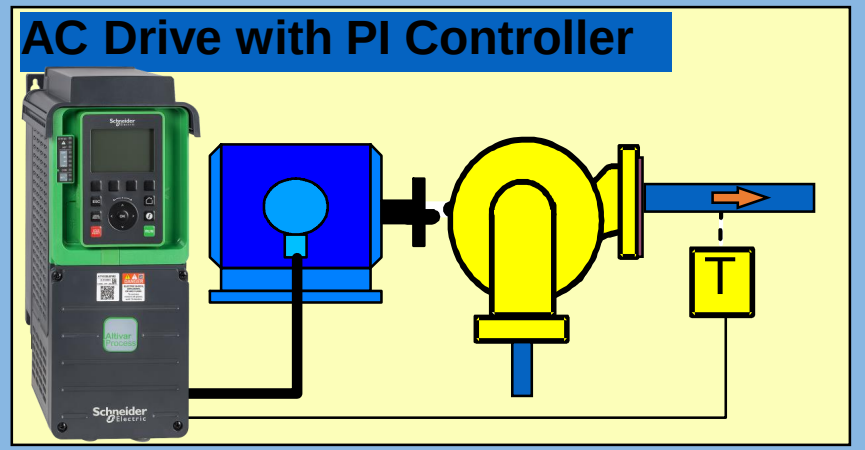
Valve By-Passing



On-Off Control

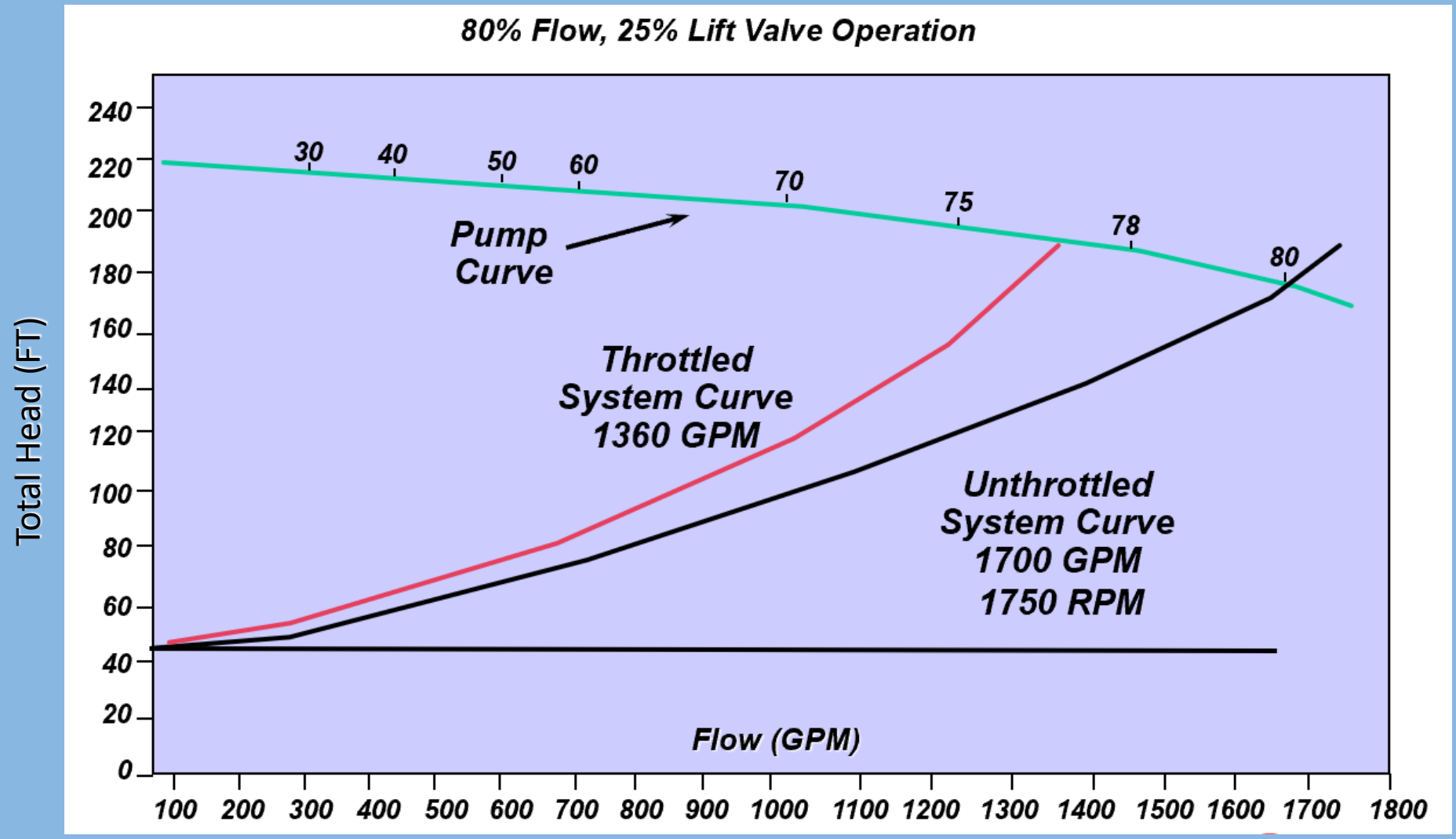


AC Drive with PI Controller



Applications; Pumps

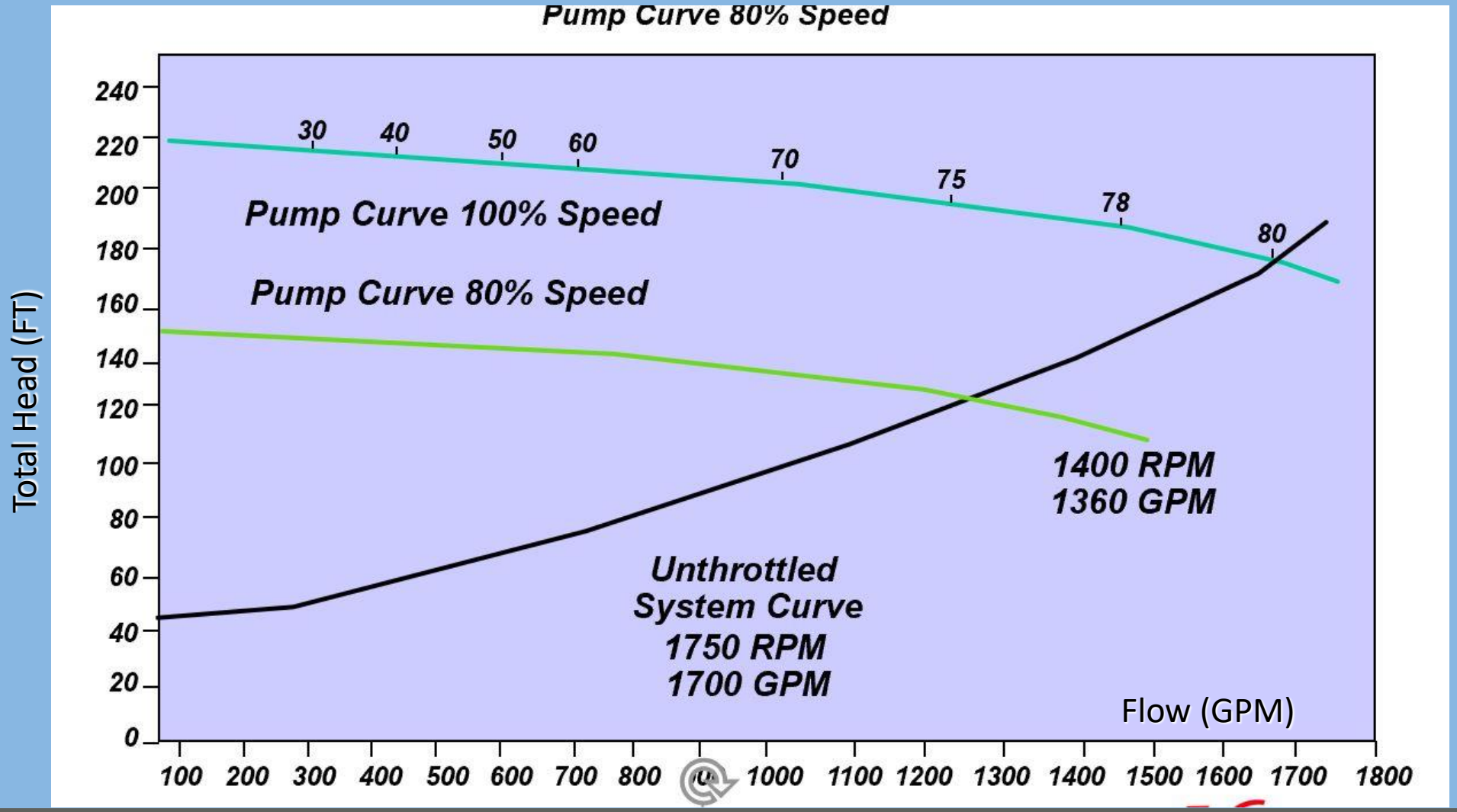
Pump Power Consumption



MAYER

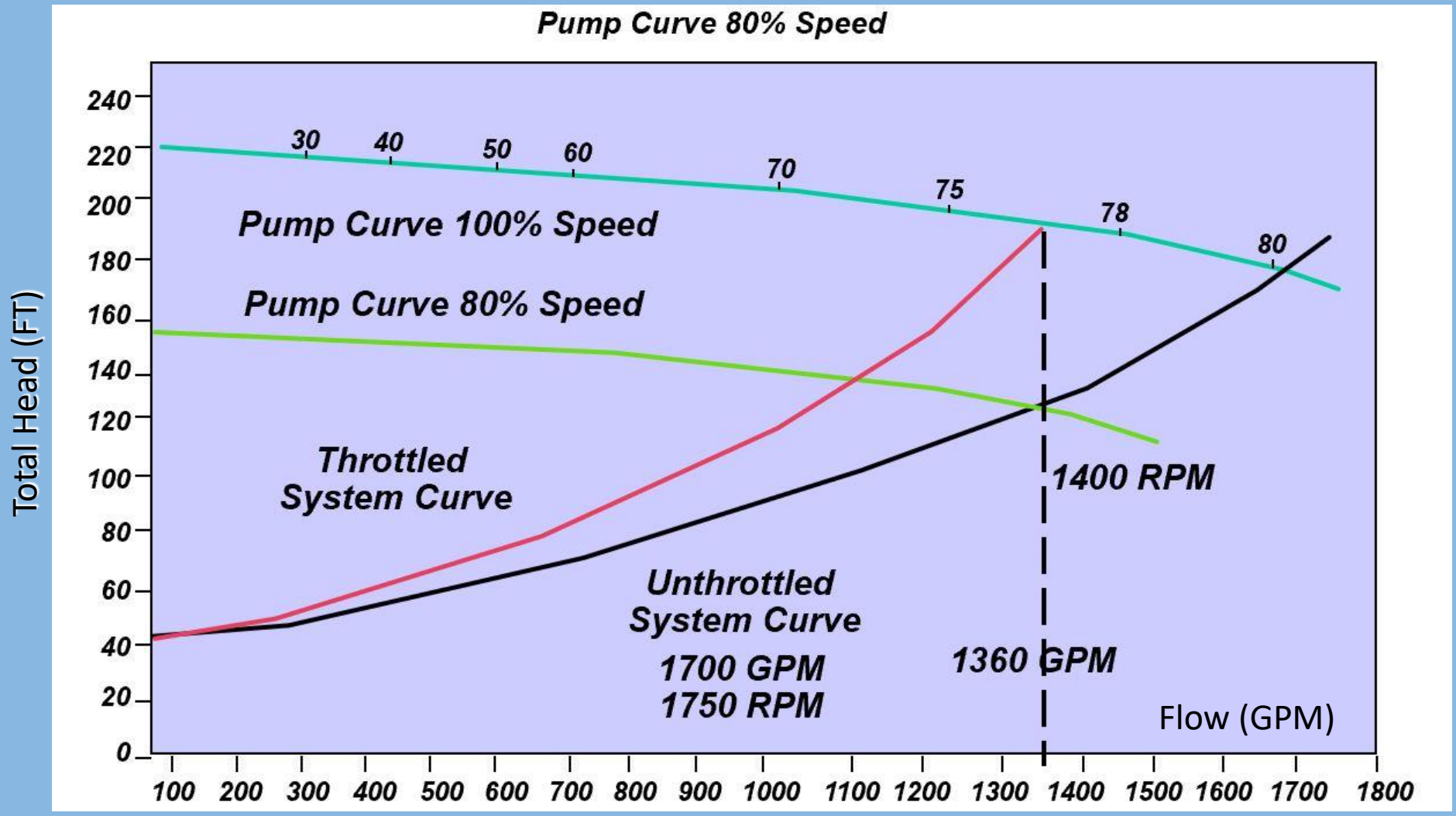
Applications; Pumps

Pump Power Consumption



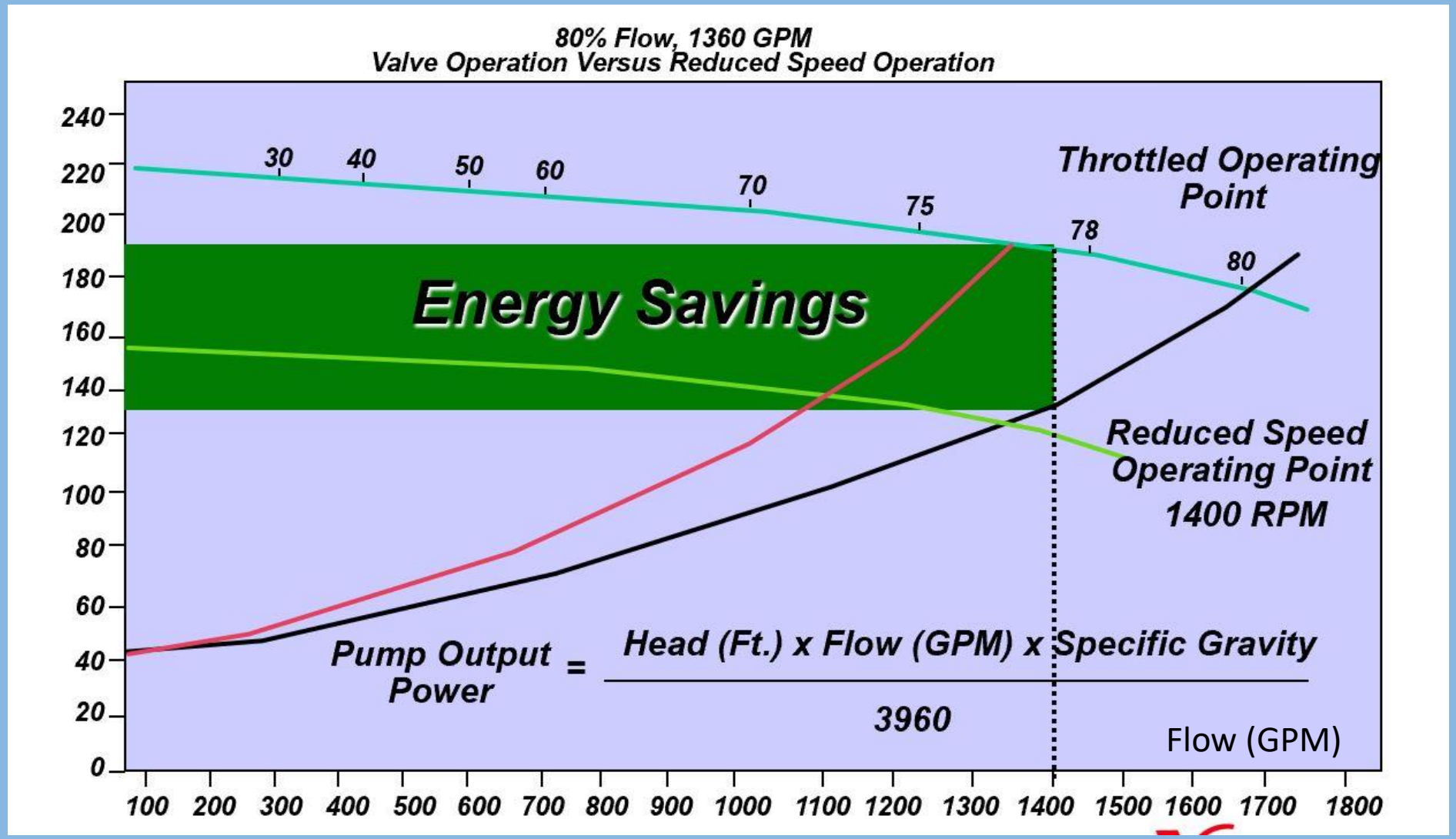
Applications; Pumps

Pump Power Consumption



MAYER

Application: Pumps



Energy Savings, Economics

Economic Justification

How to Justify the Money Spent

MAYER

Applications, Economic Justification

100% Speed

100% Load

100 HP Induction Motor

$$(100\ HP)x\left(\frac{1}{95\%\ eff}\right)x(.746\ kw/HP)x(.08\ \$/kWh)x(12\ H/Day)x(360\ D/Year) =$$

$27,139 per year!

MAYER

Applications, Economic Justification

60% Speed

22% HP

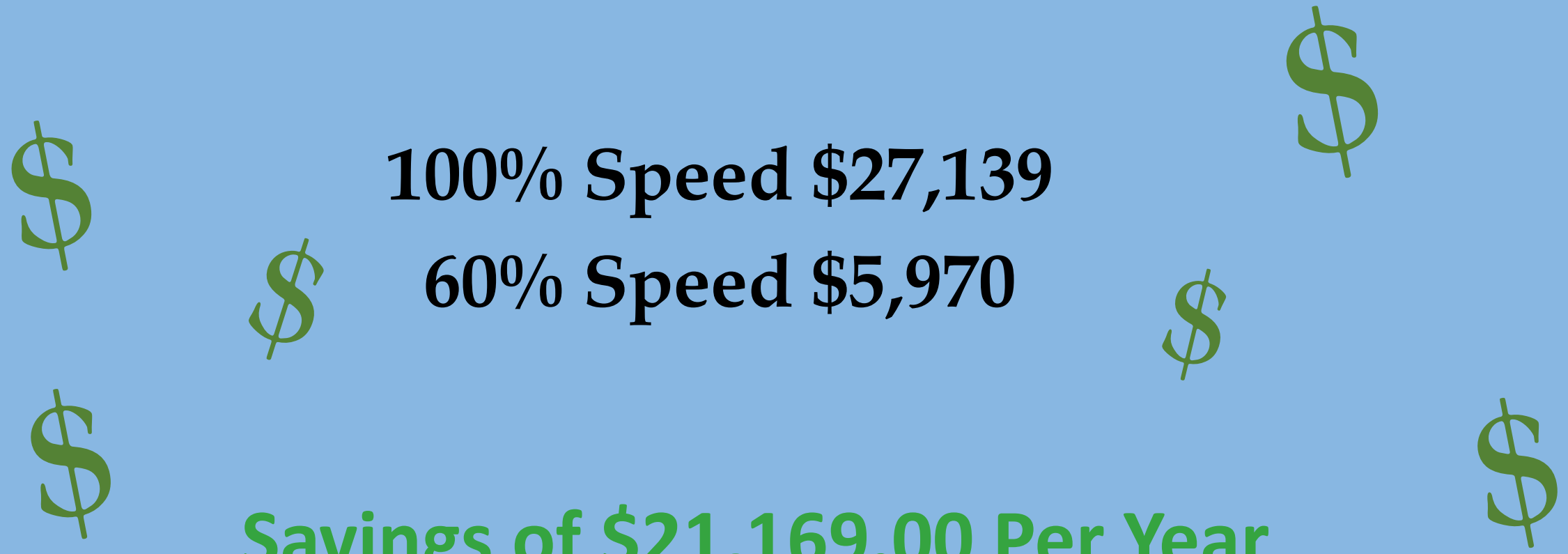
100 HP Induction Motor

$$(100\ \text{HP} \times 0.22) \times \left(\frac{1}{95\%\ \text{eff}}\right) \times (.746\ \text{kw/HP}) \times (.08\ \$/\text{kWh}) \times (12\ \text{H/Day}) \times (360\ \text{D/Year}) =$$

$5,970 per year!

MAYER

Applications, Economic Justification



100% Speed $27,139

60% Speed $5,970

Savings of $21,169.00 Per Year

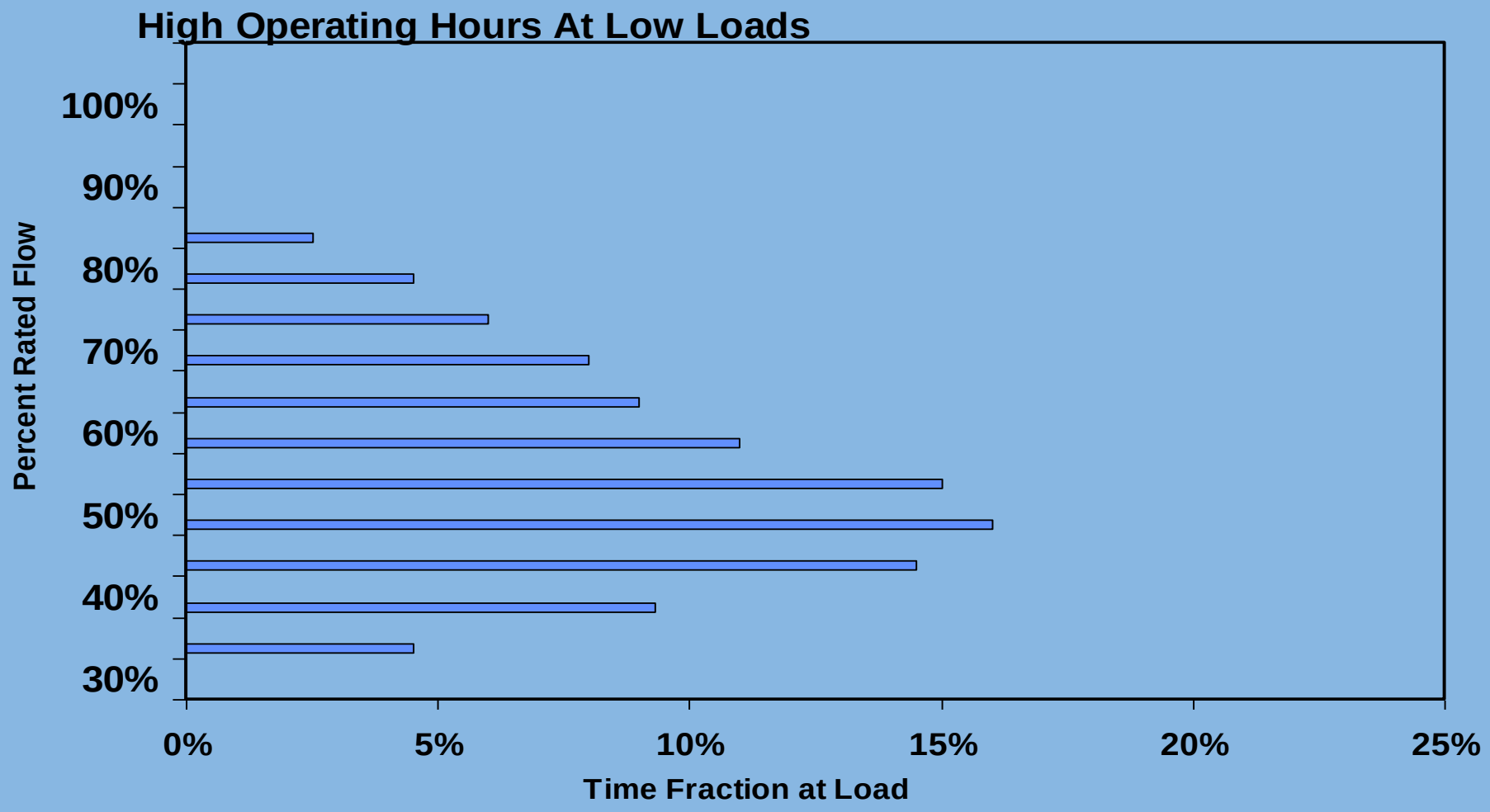
Applications, Economic Justification

Characteristics of a Good VFD Application

- High Annual Hours of Operation
- Moderate to High Horsepower
- Variable Load (high degree of throttling)
- Running at Low Speeds
- Process Improvement from Improved Control

Applications, Economic Justification

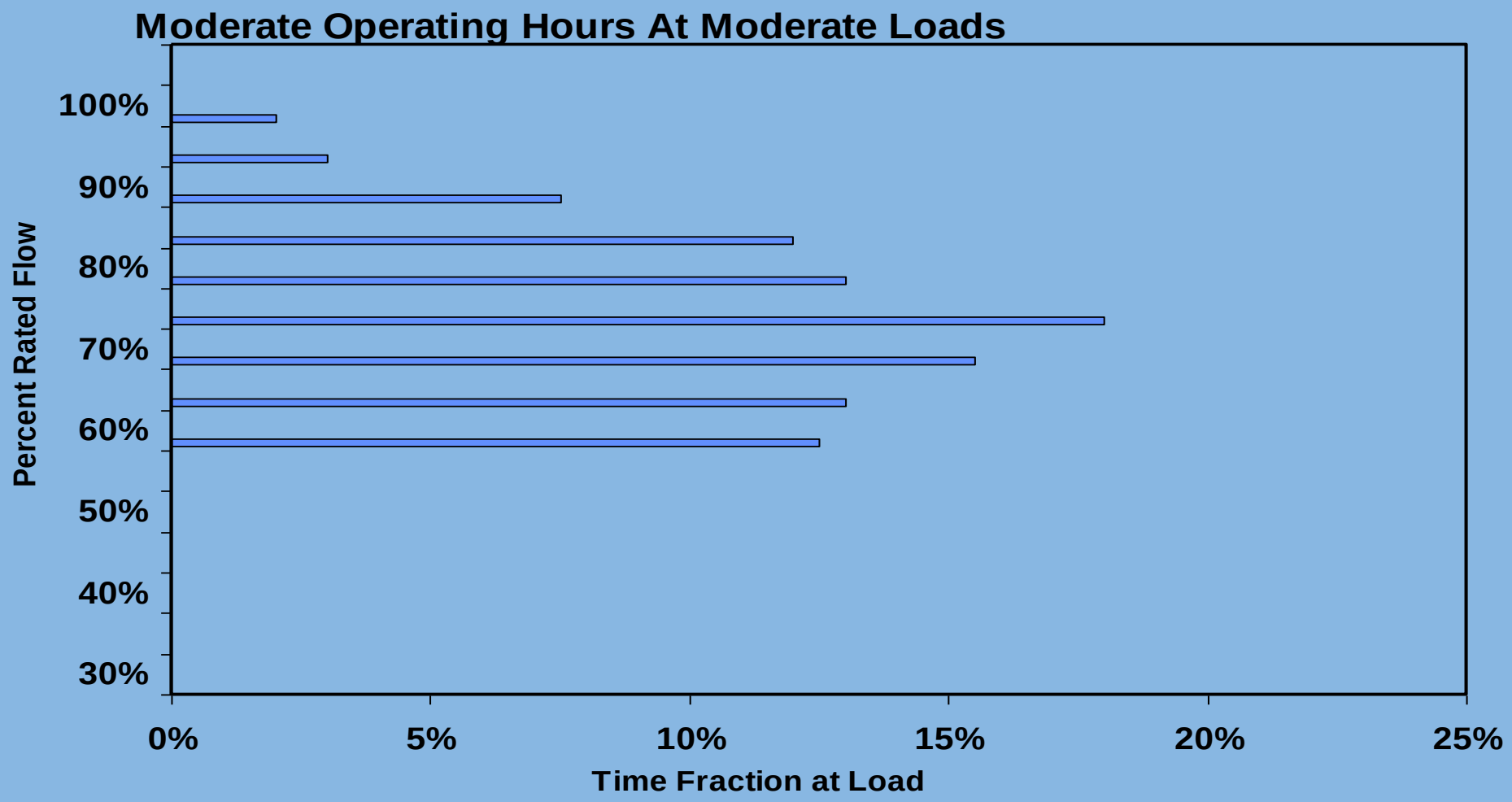
Load Profile - Excellent VSD Candidate



MAYER

Applications, Economic Justification

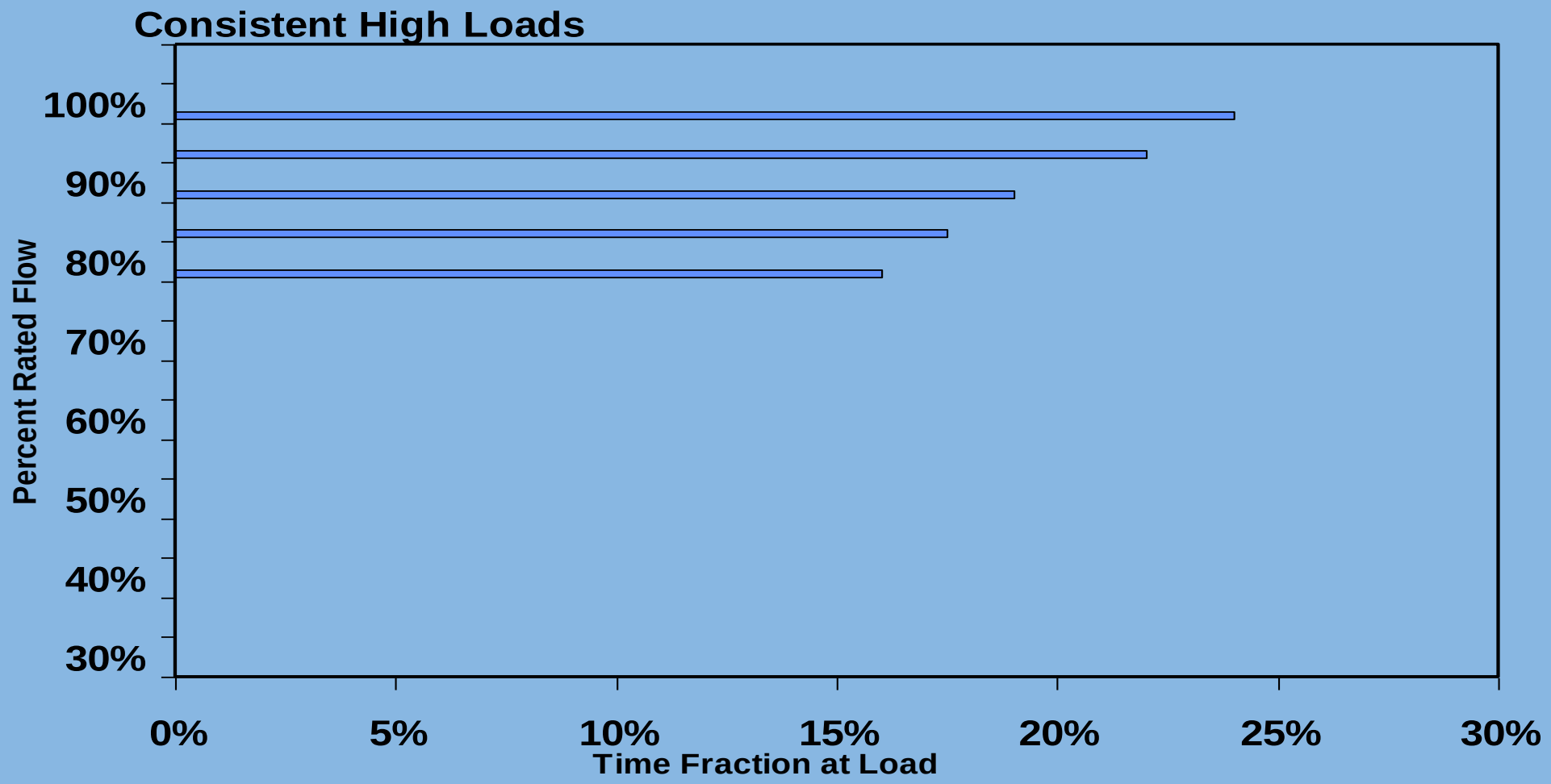
Load Profile – Average VFD Candidate



MAYER

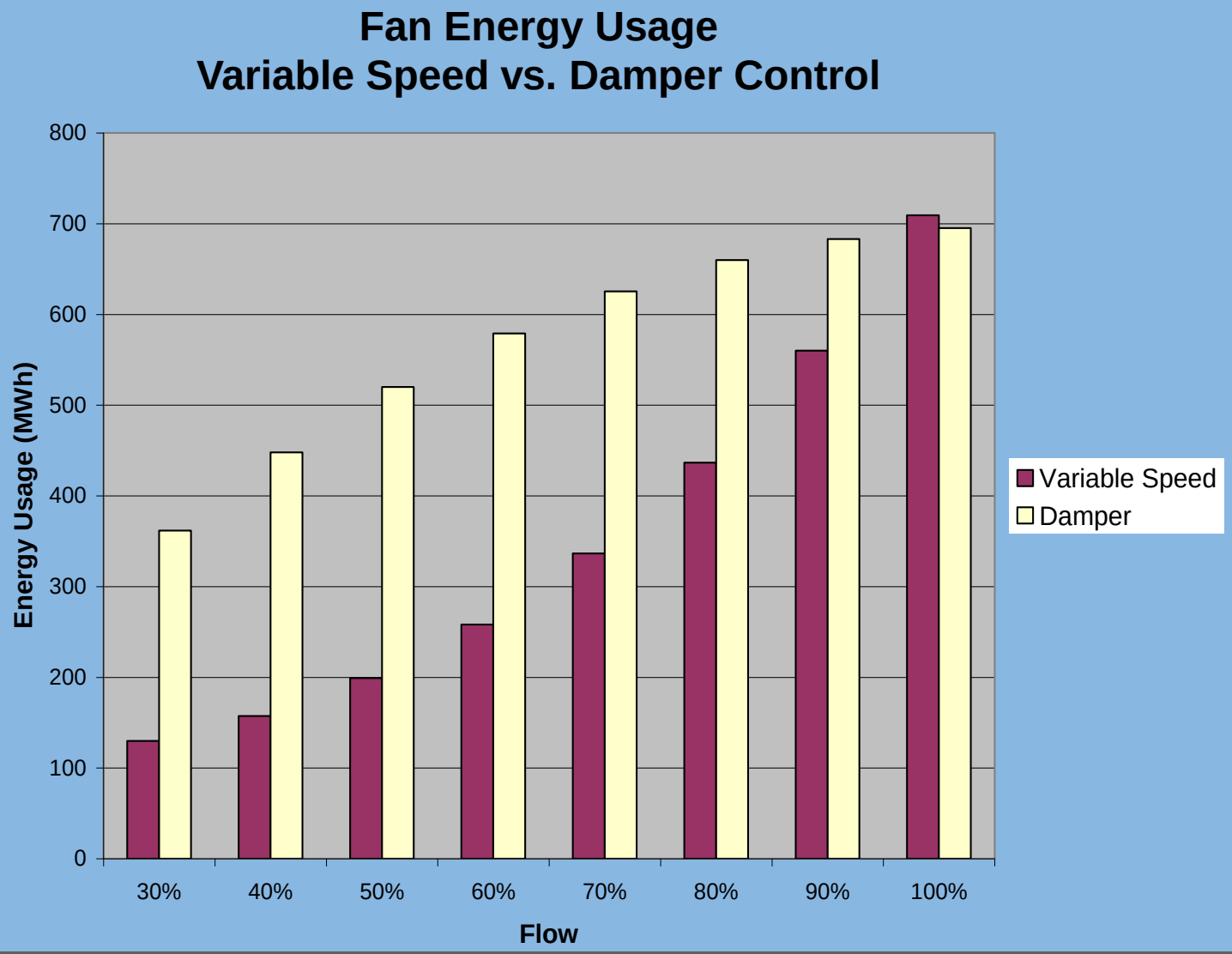
Applications, Economic Justification

Load Profile - Poor VFD Candidate



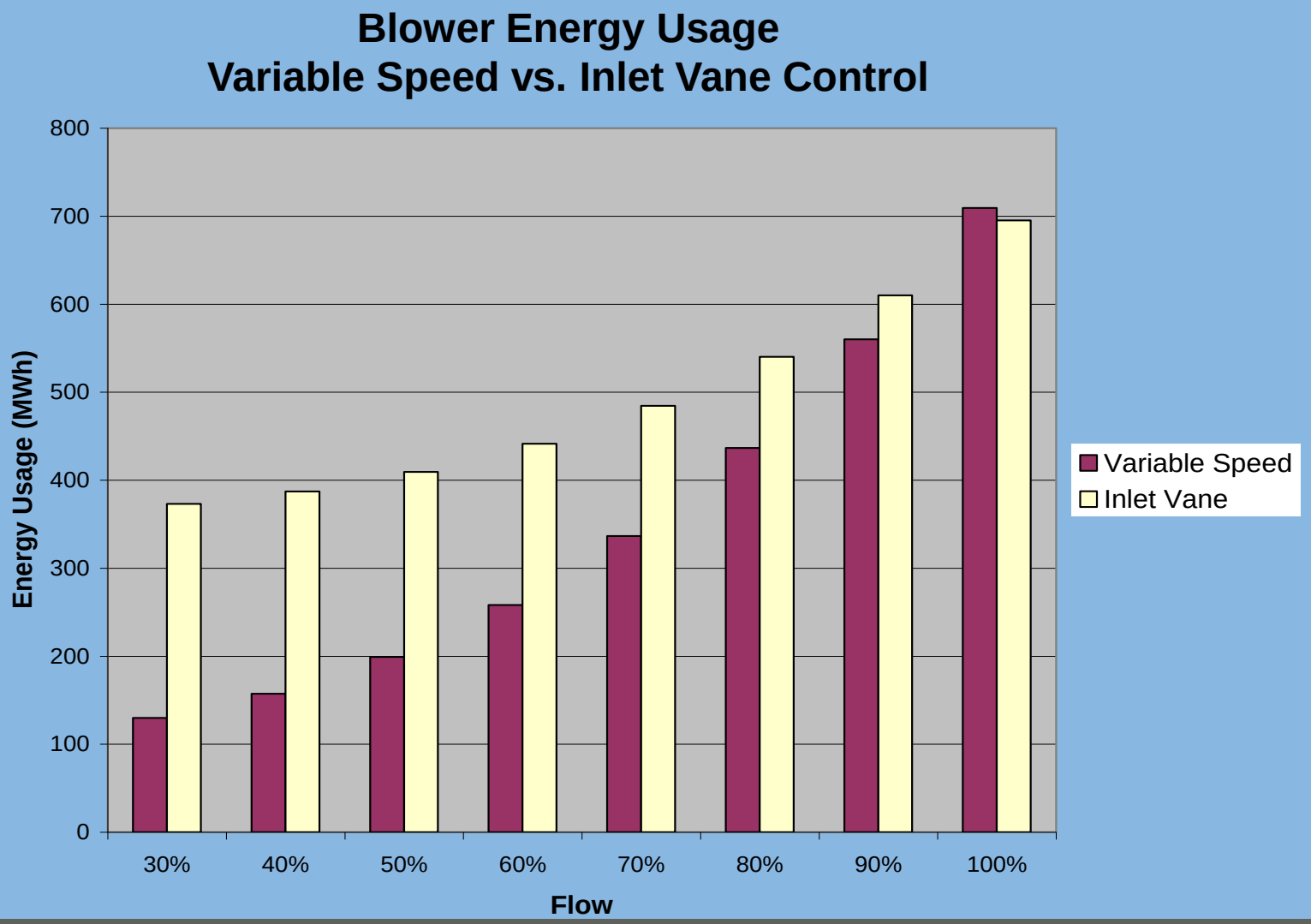
MAYER

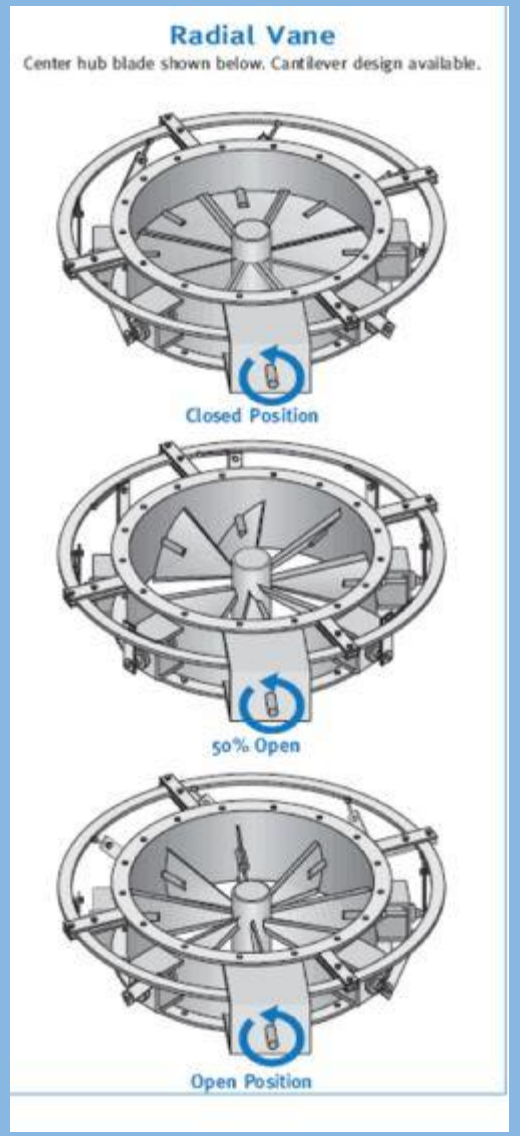
Applications, Economic Justification



MAYER

Applications, Economic Justification





Applications, Economic Justification

On line Tools

Variable Frequency Drive Energy Savings Calculator

The most common applications of using variable frequency drives are pumps and fans, suppose a 24/7 operate constant pressure water supply system's pump controlled by VFD may save as high as 30% electricity cost bills.

% Speed	% Hour
100%	10
90%	20
80%	25
70%	20
60%	10
50%	10
40%	5
30%	0
20%	0
10%	0
	100 %

Hours / Day 24
Days / Week 7
Hours / Week 168
Hours / Year 8,760

Motor size (HP):	30	Efficiency (%):	85
Input voltage (V):	380	Frequency (Hz):	50
Full load current (A):	36	Speed (RPM):	1500

Full load input power (kW): 20.1 kW

VFD Cost ($): 5000
Electricity rate ($/kWh): 0.09

Estimate annual operation cost without VFD: 15,860 $
Estimate annual operation cost with VFD: 7,988 $

Your Annual savings: 7,871 $
Payback time: 7.62 Months.

Calculate

MAYER

Questions??


MAYER