Industrial Seminar Series

Making Energy Savings Count

Presenter (on behalf of EMANZ and EECA)

Ross Tunmer– Energy NZ

Session 1

Energy Performance Improvements for Industrial Plant Technologies

Session Outline

- ❑ Thermal Systems
- ❑ Compressed Air
- ❑ Fans & Pumps
- ❑ Refrigeration
- ❑ Power Factor Correction
- ❑ Industrial Lighting

Introduction

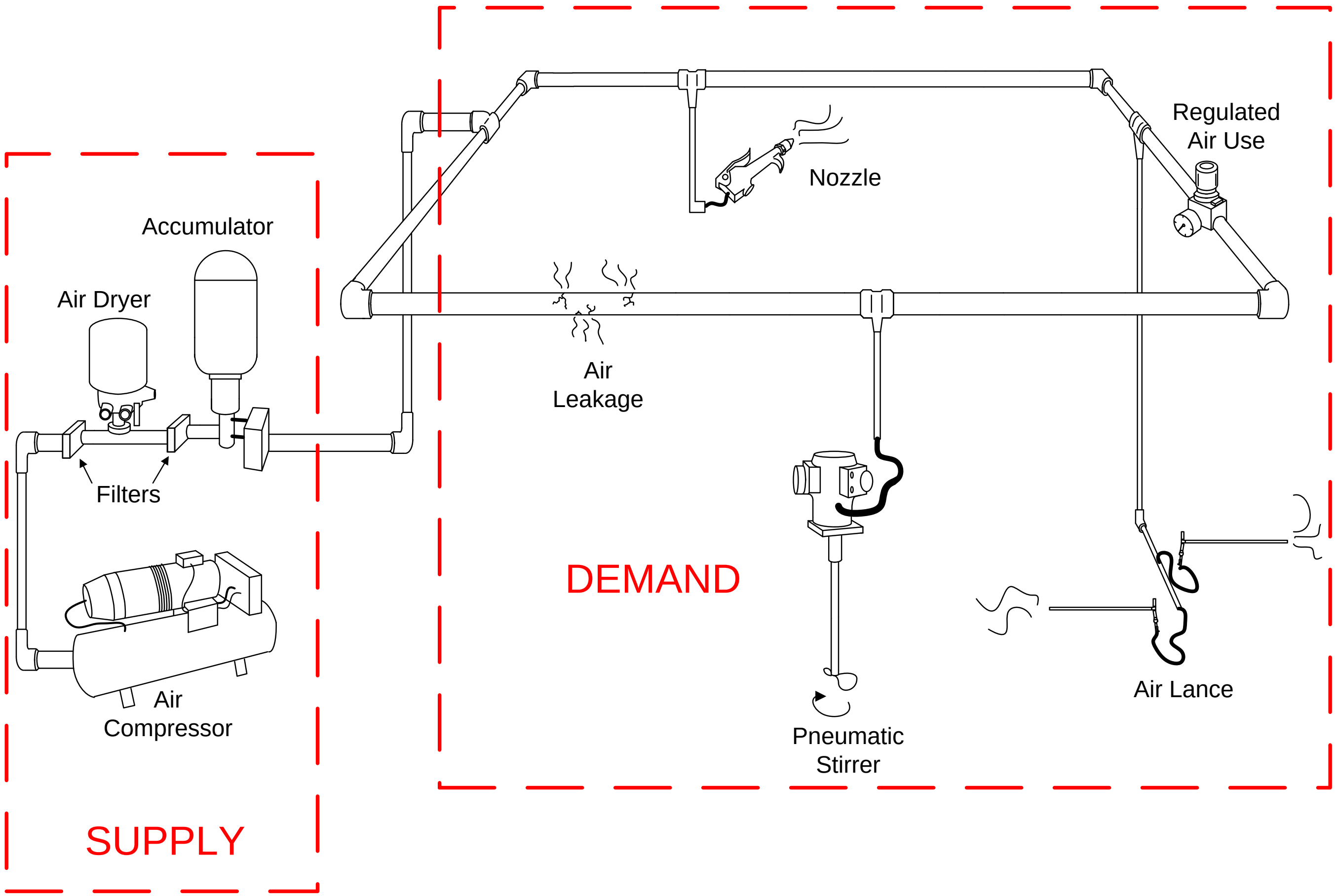
For each of these system categories first assess; in this order, the

- ❑ DEMAND SIDE

then…

- ❑ SUPPLY SIDE

Introduction



Thermal Systems

- The Basics

1. **Isolate Thermal System Users:** isolate from heating system when not in use
2. **Maintain Heat Exchangers:** ensures effective heat transfer and minimises losses
3. **Repair Leaks:** repair fluid leakage, steam trap leakage, etc.

Thermal Systems

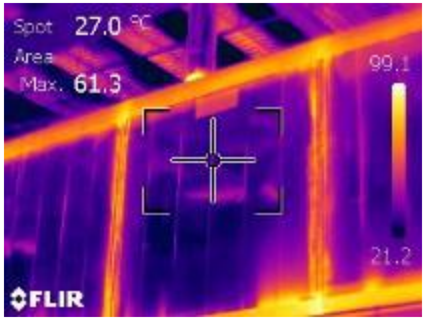
- Process Heating Optimisation

1. Analysis of current processes to minimise heating energy: Reduce water content, change of materials, etc.
2. Especially when process requires heating and cooling Pinch Analysis may be worthwhile

Thermal Systems

❑ Heat Loss / Insulation:

1. **Direct Heating:** e.g. oven – ensure adequate heat containment.

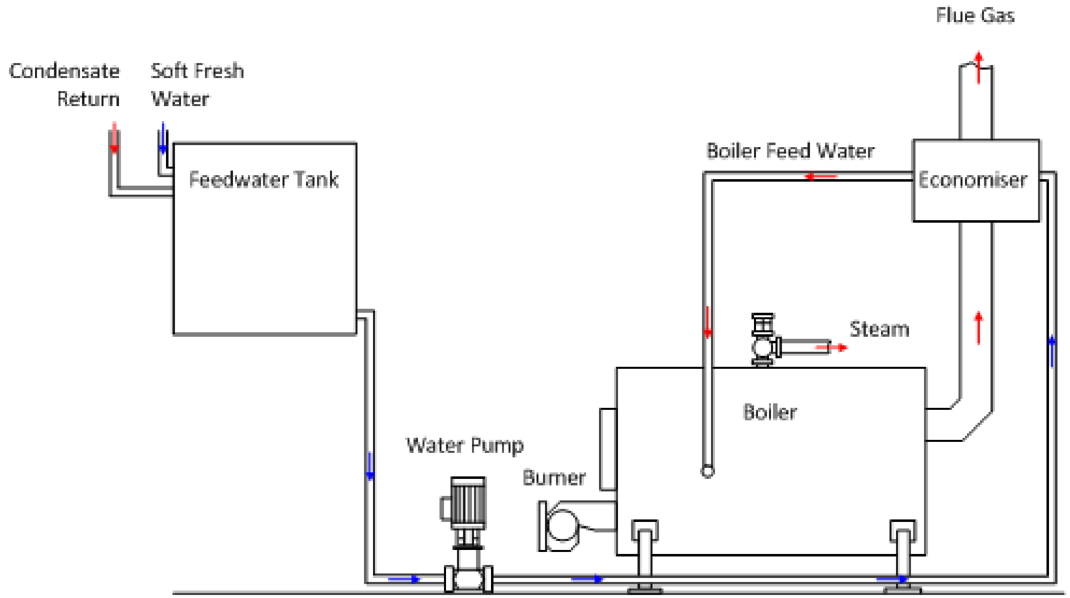


2. **Indirect Heating:** e.g. steam network – removable jackets on valves, flanges, heat exchangers.

Thermal Systems

- ❑ Heat Recovery:

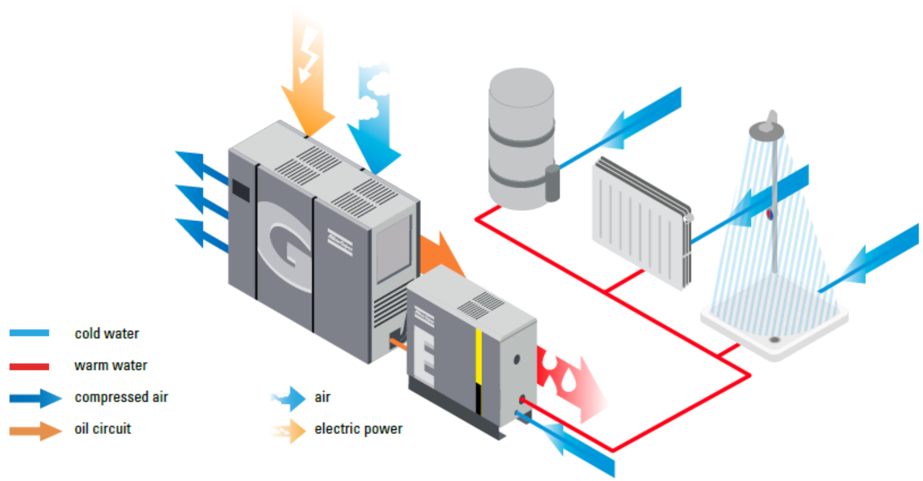
1. **Thermal Process Heat Recovery:** condensate return, flash steam, economiser, etc.



Thermal Systems

❑ Heat Recovery:

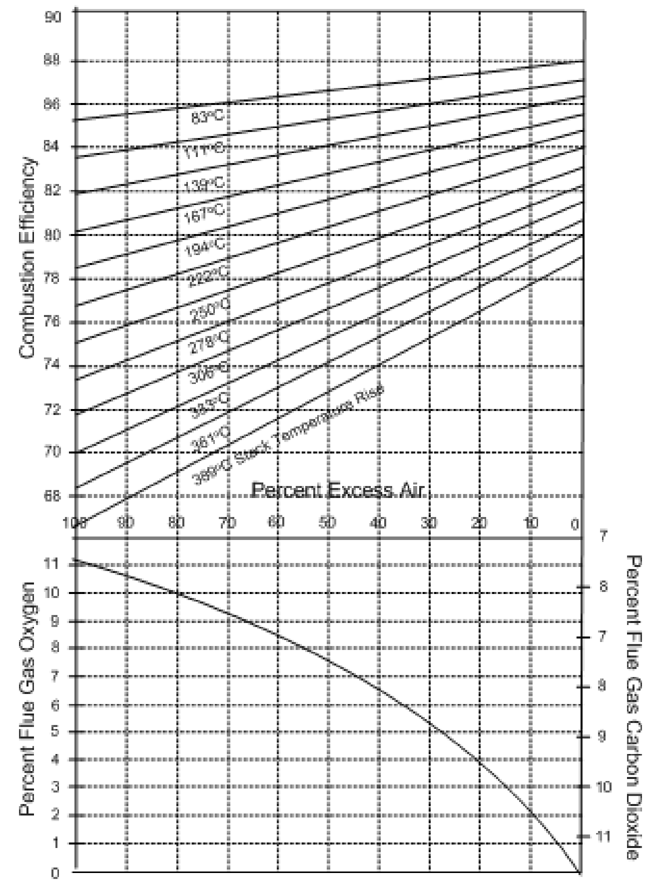
2. **Utility Heat Recovery:** compressed air exhaust, refrigeration system desuperheater, combustion air preheat, etc.



Thermal Systems

- Combustion Efficiency:

1. **Combustion Efficiency of Thermal Systems:** e.g. oven burner efficiency, excess oxygen control optimisation.



Combustion Efficiency Chart for Natural Gas

Compressed Air

- Air Leaks

20% - 50%

Compressed Air

- Inappropriate Uses:

- Compressed air is 10-12% efficient at point of use!

1. Direct Blowing
2. Product Propulsion
3. Vacuum Generation
4. Sparging
5. Aspirating

Compressed Air

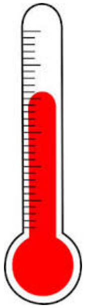
- ❑ Supply Pressure:

1. Regulate users and reduce losses.
2. Can reduce pressure setpoint of compressor(s) (important: may need to increase receiver size if capacity is an issue).
3. 7% efficiency penalty every 1.0 bar of pressure.

Compressed Air

- Compressor Temperature:

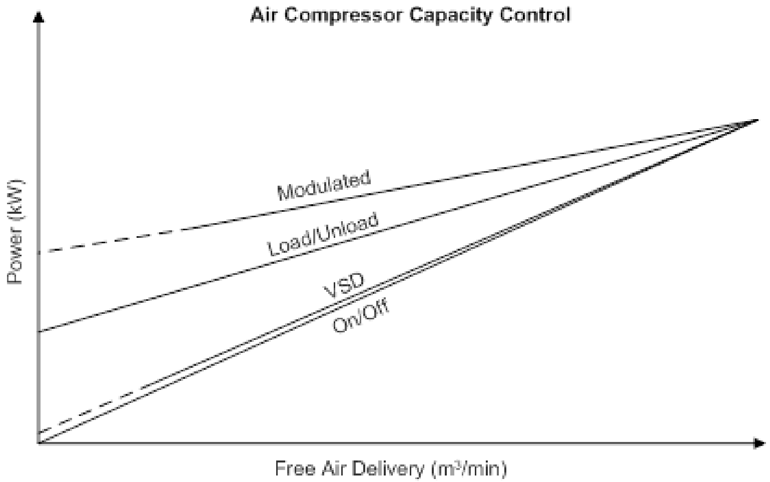
1. Ensure intake is ambient and compressor room is ventilated.
2. 1% efficiency penalty every 3 °C over ambient.



Compressed Air

❑ Single Compressor Control:

1. Load/Unload rotary screw common but not efficient at lower loads.
2. Modulated is very inefficient.
3. VSD and on/off (typically reciprocating) are most efficient.



Compressed Air

- Multiple Compressor Control:

1. More than one compressor providing supply.
2. Cascade control is common but can have issues.
3. ‘Trim’ compressor should be the most efficient at part loads.

Fans & Pumps

- ❑ Flow or Pressure Requirement

1. Minimise flow requirement to reduce pump/fan energy consumption
2. Minimise pressure requirement to reduce pump/fan energy consumption

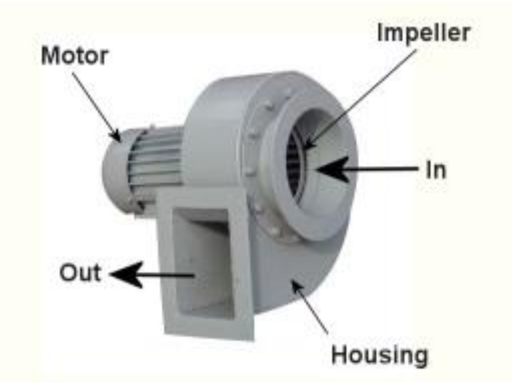
- ❑ Network Effectiveness

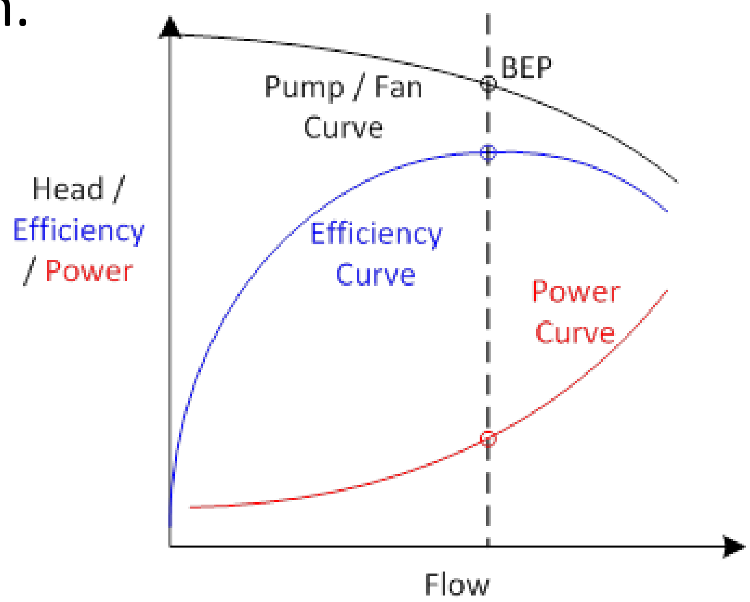
1. Ensure piping or ducting network is adequately sized and arranged
2. Ensure valves or dampers are suitable for their application

Fan & Pumps

❑ Pump / Fan Supply:

THE GOAL is: ensure that each pump or fan within a system is operating as close as possible to its Best Efficiency Point (BEP) as dictated by its design.

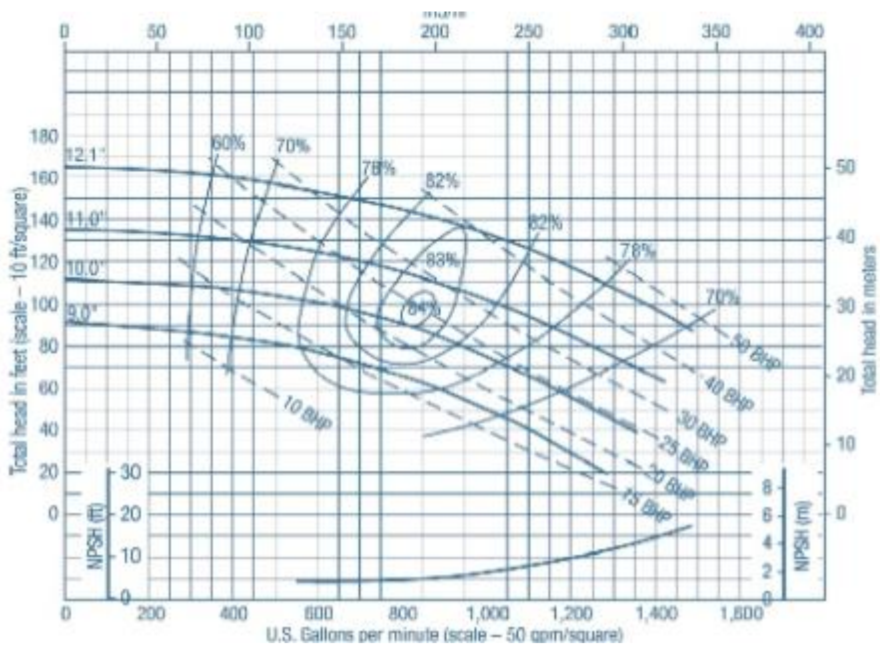


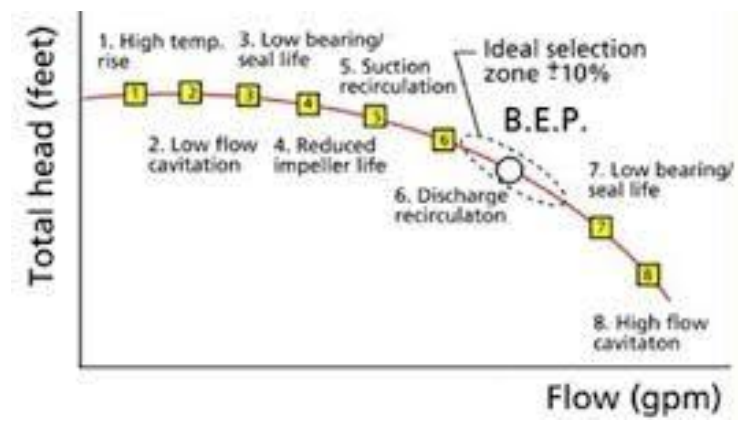


Fan & Pumps

❑ Pump / Fan Suitability:

Ensuring the pump or fan is well suited to its application, i.e. operates near its **BEP**.





Fan & Pumps

- Affinity Laws

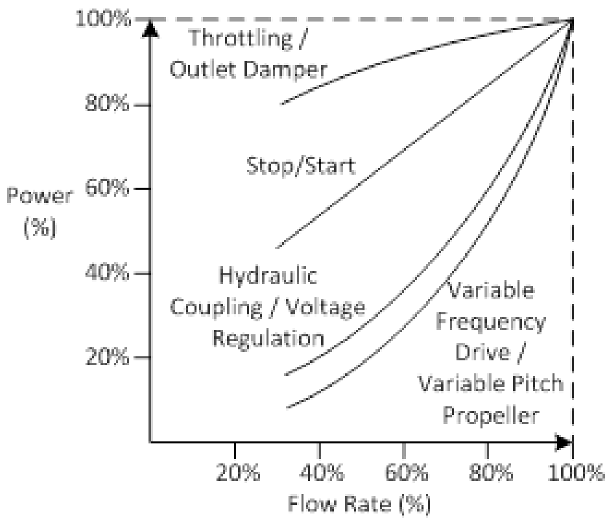
Applies to most pump and fan designs and is the reason for **potentially large energy savings** through improved control

Fan & Pumps

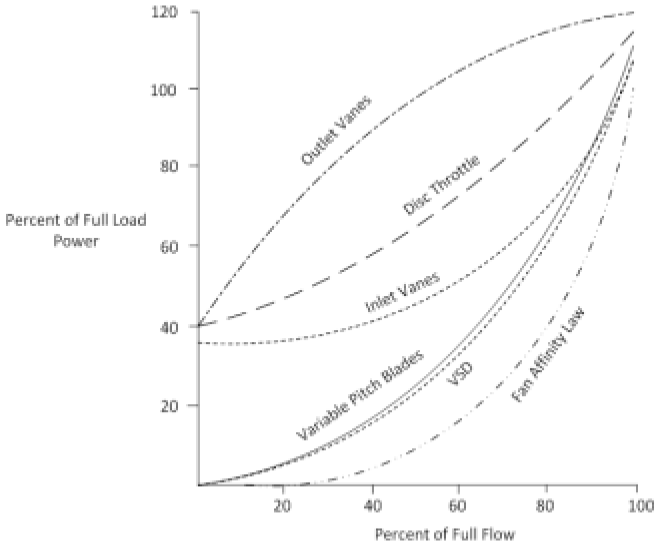
❑ Pump / Fan Control:

Ensuring the pumps or fans in a system are controlled as efficiently as possible to meet demand requirements.

Pump Control

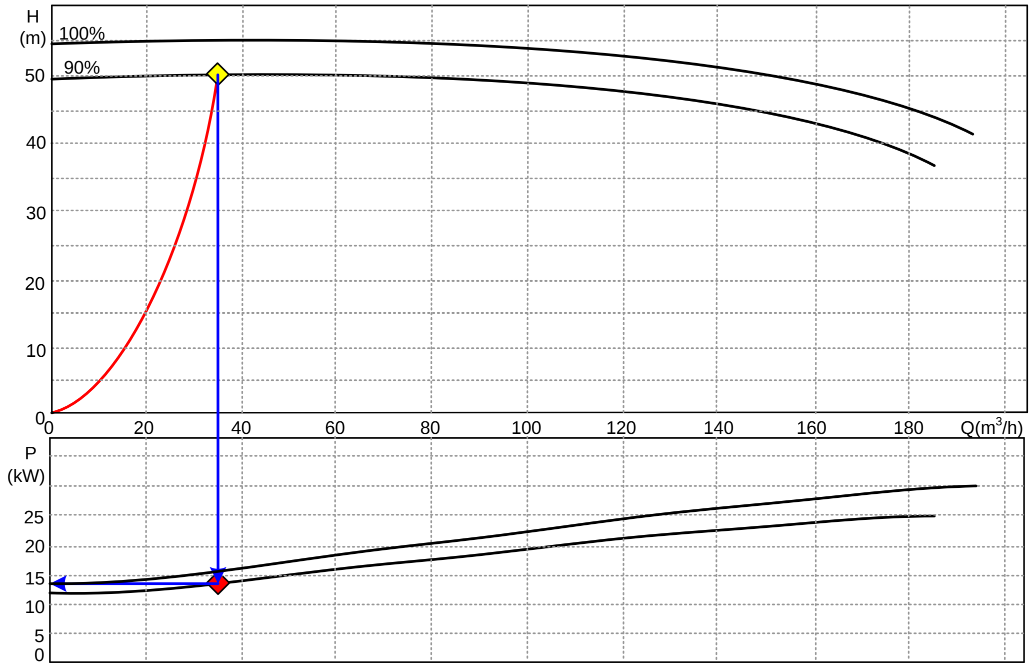


Fan Control



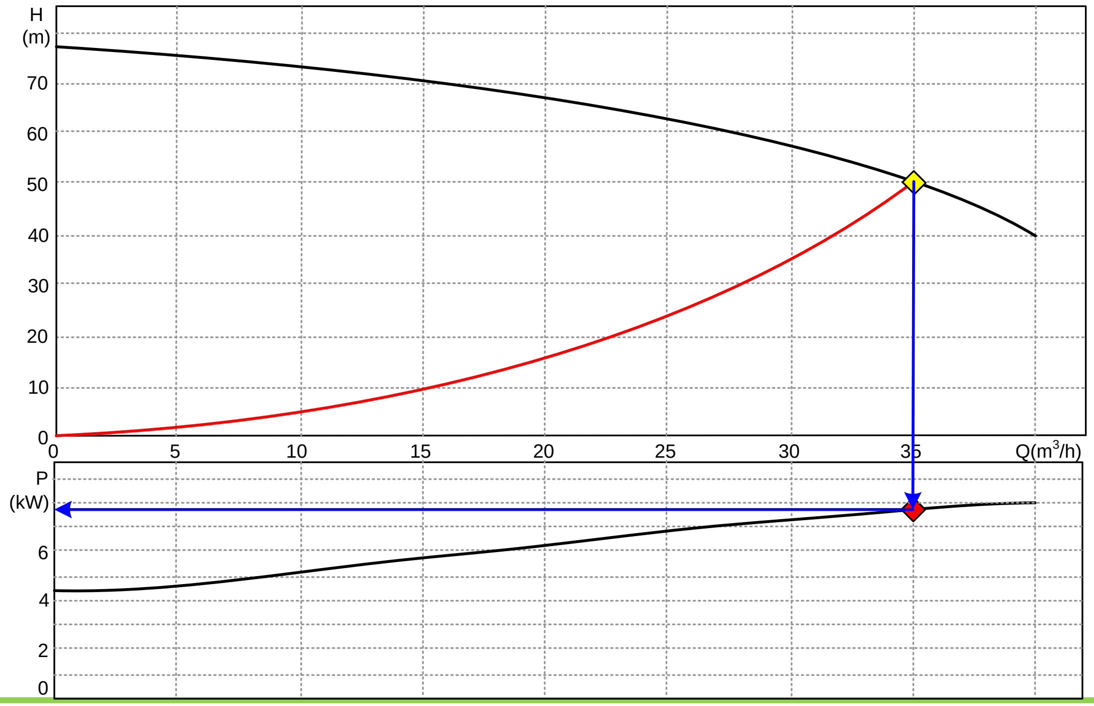
Fan & Pumps

- Single stage in-line pump **with VSD**
- 50m head; 35 m3/hr; 35.7% efficiency, **13.4kW power use**
- **Poor pump selection**, suited to higher flow rates



Fan & Pumps

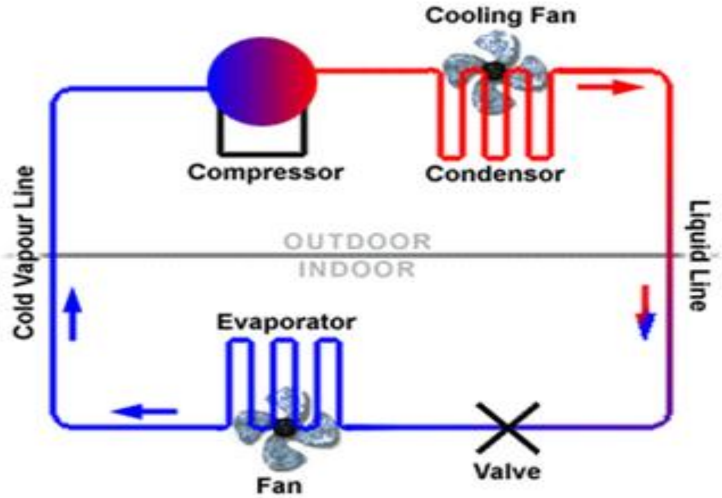
- Vertical multi-stage centrifugal pump **without VSD**
- 50m head; 35 m3/hr; 71.1% efficiency, **7.66kW power use**
- **Good pump selection**, suited to pressure and flow rate



Refrigeration

- Basic Refrigeration Cycle

1. Energy consuming devices: Compressor, condenser fans, evaporator fans, pumps (for water chillers and water cooled systems).
2. Compressor the largest consumer of electricity.



Refrigeration

- Industrial Refrigeration Systems: Meat works, Cold storage, Process Chillers.
- Typical components and sizes:

System Components	Power Rating (kW)
Compressors	20 to 500 kW
Condenser Fans	1.5 to 30 kW
Evaporator Fans	3 to 30 kW
Pumps	3 to 30 kW

Refrigeration

- System Design:

1. Systems are designed for worst case, i.e. summer time at full load
2. Systems typically designed for 95% degree days
3. Systems operate partially loaded for most of their life
4. Opportunities for when a system is partially loaded?
   - Reduce compressor speed
   - Reduce fan speed
   - Reduce pump speed

Refrigeration

- Heat Load Reduction

1. Infiltration: (Door management and protection)
   - Plastic strip curtains
   - Air curtains
   - Rapid roller door
   - Air lock doors
2. Lighting: Replace obsolete, inefficient lighting types with LEDs
3. Defrost Optimisation (Ensure defrost frequency and duration match the load)

Refrigeration

- ❑ Plant Operation / Maintenance

1. Compressor control (VSDs on trim compressors)
2. Condensing pressure (Floating condensing pressure, VSDs on condenser fans)
3. Suction pressure (keep as high as possible)
4. Split suction pressures for different users, i.e. coldstores at -18°C and freezers at -35°C
5. Seasonal adjustments for Winter and Summer conditions
6. Cleaning condensers and evaporator coils

Refrigeration

- Heat Recovery

1. Desuperheaters
2. Screw compressor oil coolers
3. Heat Pumps

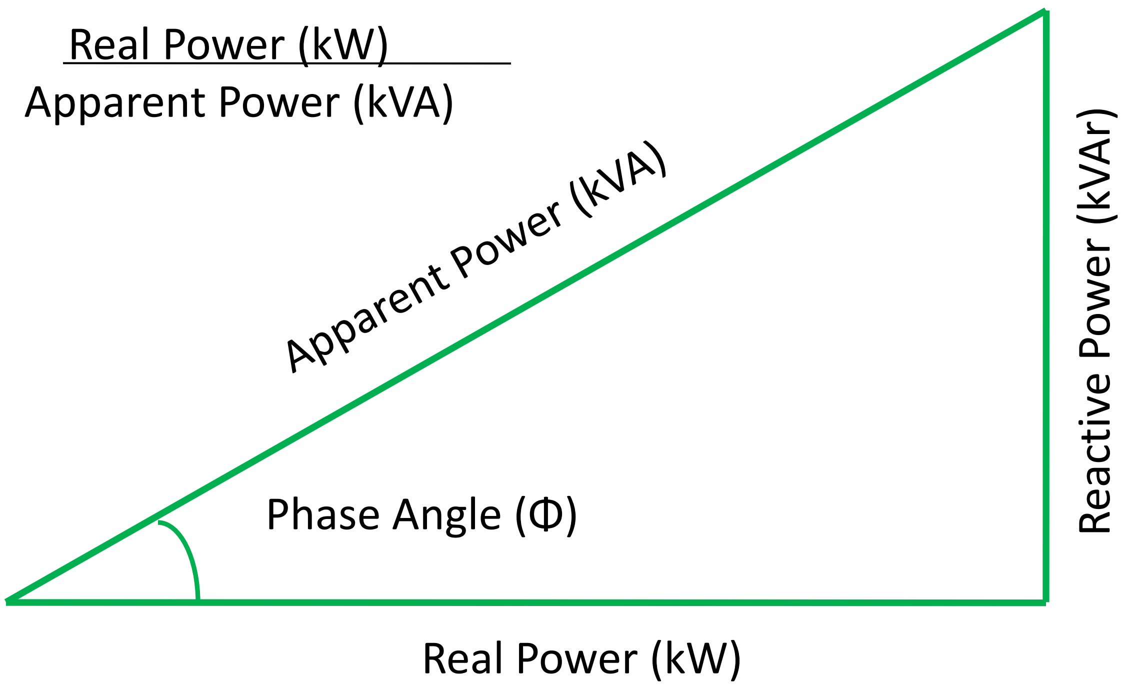
- Other

1. Retro fit Thermostatic expansion valves (TXVs) with Electronic expansion valves (EEVs)
2. Peak demand control
3. Economiser

Power Factor Correction

- The power factor of an AC electric power system is defined as the ratio of the real power to the apparent power

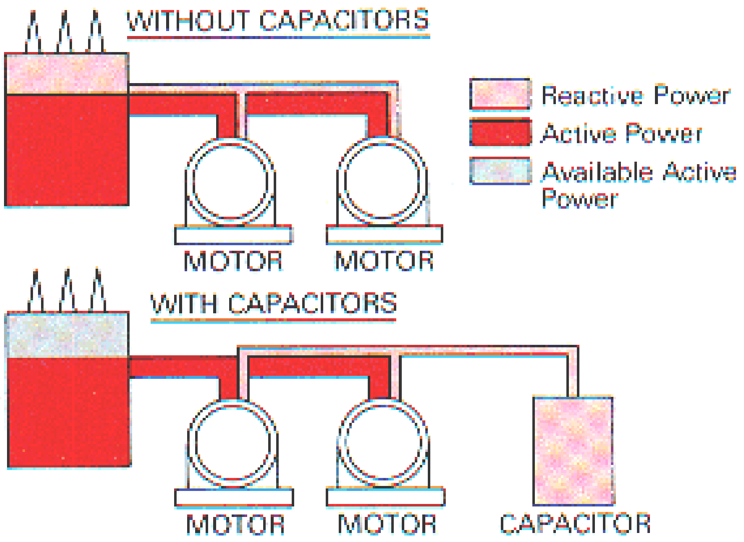
$$PF = \frac{\text{Real Power (kW)}}{\text{Apparent Power (kVA)}}$$



Power Factor Correction

- Capacitors & Power Factor Correction

1. Capacitors use almost entirely reactive power but in the opposite way to most other devices found within an industrial plant.



Industrial Lighting

❑ Lighting Factors to Consider:

1. Rated Efficiency
2. Lumen Maintenance
3. Distribution Efficiency
4. Controllability

Industrial Lighting

- Lighting Types:

Lighting Attribute	Lighting Type					
	Mercury Vapour	Metal Halide	T5 Fluorescent	CFL	Induction	LED
Rated Efficiency (lumens/watt)	48	86	88	70	81	115
Lumen Maintenance at Rated Life	50%	60%	90%	75%	65%	70%
Distribution Efficiency	80%	80%	92%	80%	80%	>90%
Overall System Efficiency (lumens/watt)	**19**	**41**	**73**	**42**	**42**	**72**
Rated Lamp Life (hours)	24,000	20,000	20,000	10,000	100,000	50,000+
Controllability	Poor	Poor	Good	Average	Good	Excellent
Annual Energy Cost, per 10,000 lumens*	$406	$189	$107	$186	$185	$108
New Lamp and Fitting Cost, per 10,000 lumens	$240	$140	$120	$340	$820	$710

*For 6,000 annual hours of operation at an effective energy price of 13.00 c/kWh

Industrial Lighting

- Typical Replacements:

Incans -> CFL


Metal Halide -> T5


Metal Halide -> LED*


50W Halogen -> LED


Fluorescent -> LED*


Mercury Vapour -> Anything!!!

*Refrigerated areas in particular

Industrial Lighting

Lighting Control:

- ❑ Occupancy Control

- ❑ Daylight Harvesting

Thank You

Questions?