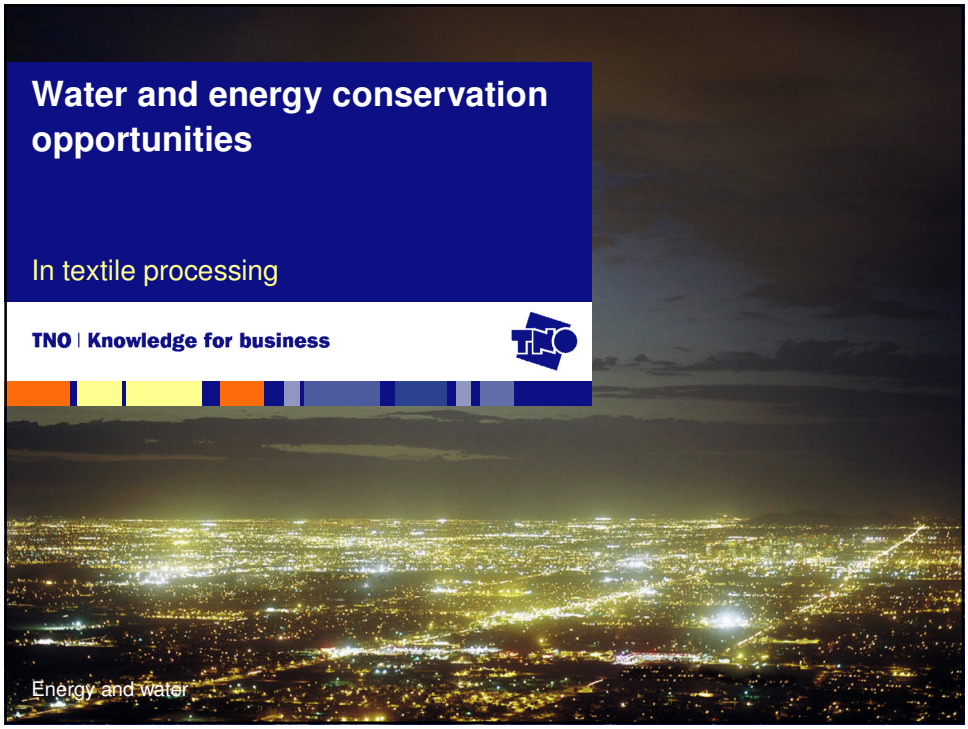


- Management commitment (motivation)
- Good housekeeping
- Monitoring and targeting (on process level)
- Process optimisation

- Getting started
- Analysing the process steps
- Generating opportunities
- Selecting solutions
- Implementing solutions
- Sustaining Cleaner Production

Elements of an effective housekeeping program

- Dust and Dirt Removal
- Employee Facilities
- Surfaces
- Maintain Light Fixtures
- Aisles and Stairways
- Spill Control
- Tools and Equipment
- Maintenance
- Waste Disposal
- Storage

Source: Canadian Centre for Occupational Health & Safety

- Management commitment (motivation)
- Good housekeeping
- Monitoring and targeting (on process level)
- Process optimisation

Examples

wrong

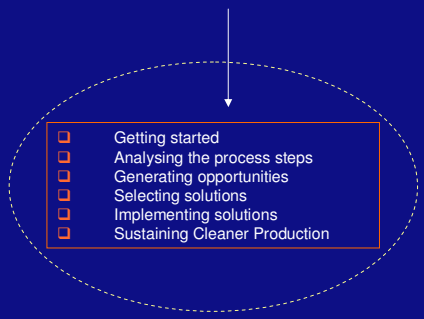
right

Good housekeeping measures

- substantial cost savings without significant investments
- duration of implementation is often very short
- better control of a certain process leads to better control of the quality of the product

- Management commitment (motivation)
- Good housekeeping
- Monitoring and targeting (on process level)
- Process optimisation

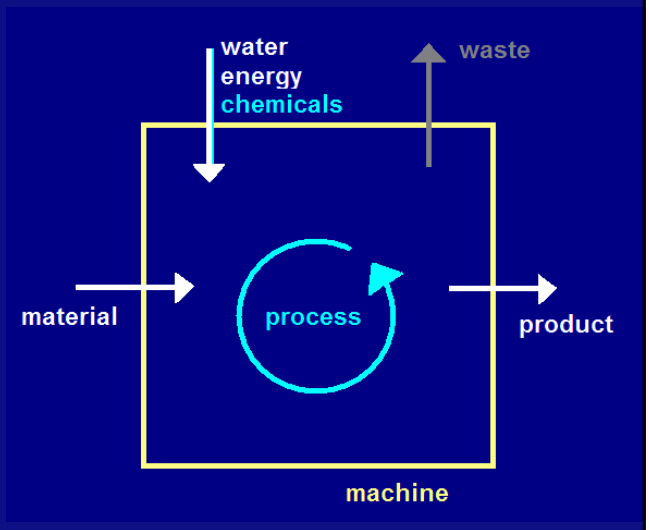
- Management commitment (motivation)
- Good housekeeping
- Monitoring and targeting (on process level)
- Process optimisation



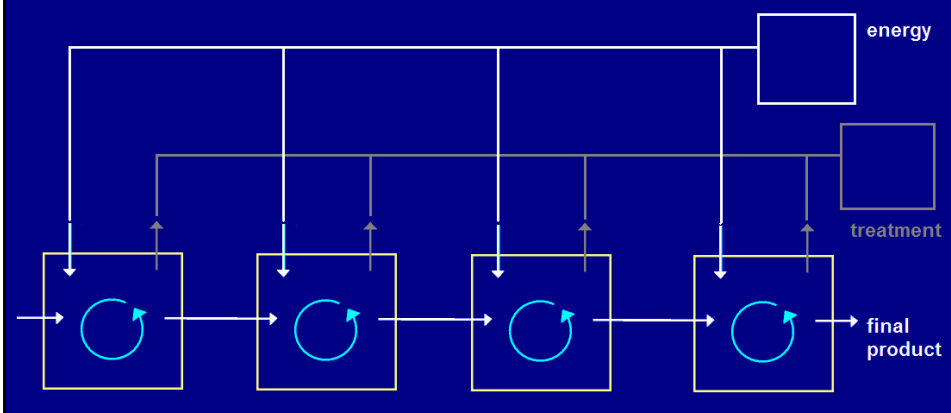
The method

Recognize opportunities to save:

- chemicals
- water and
- energy.



Factory wide view



Chemicals

- chemicals
- water
- energy

- Revise recipes regularly
- Avoid surplus applied chemicals

- Use high quality water
- Prefer auxiliaries with low environmental impact

- Control processes

- Optimise scheduling production

- Re-use baths

- Analyse
- Avoid
- Control
- Optimise
- Re-use

Reduce chemical impact at source

- chemicals
- water
- energy

- Analyse
- Avoid
- Control
- Optimise
- Re-use

For instance:
In knitting: substitute mineral oil by hydro soluble oils

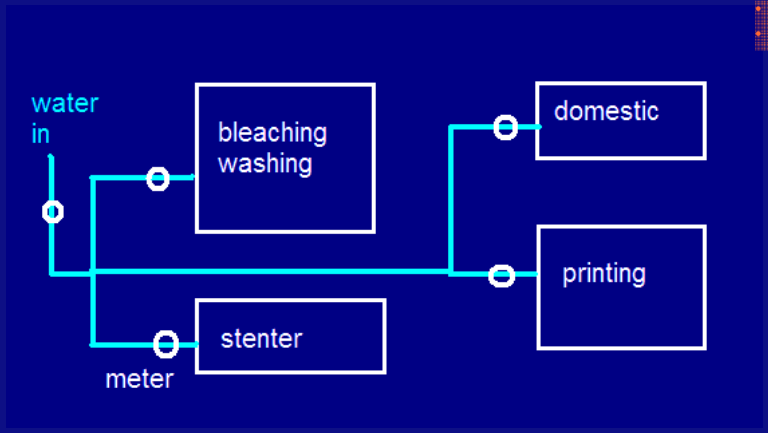
Now:
- 4-8% lubricant oil
- removal with detergents etc.
- under alkaline conditions and 80-100 °C
- resulting in water consumption of 10 l/kg

With alternative:
- washing at 40 °C in combination with other processes

Water balance

- chemicals
- water
- energy

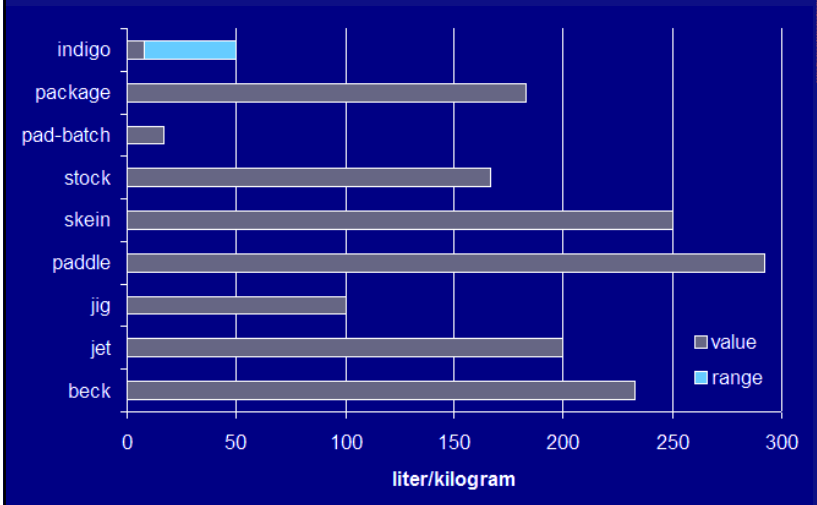
- Analyse
- Avoid
- Control
- Optimise
- Re-use



Water consumption dyeing processes

- chemicals
- water
- energy

- Analyse
- Avoid
- Control
- Optimise
- Re-use



Improving working practices
(Good housekeeping)

- chemicals
- water
- energy

- Analyse
- Avoid
- Control
- Optimise
- Re-use

- Stop leaks
- Water shut off valves on water hoses
- During filling and rinsing, avoid displacement spillage

Water reduction: avoid consumption

- chemicals
- water
- energy

- Analyse
- Avoid
- Control
- Optimise
- Re-use

Examples:
- Reduce cleaning by optimisation scheduling production
- Pre-treatment according to quality needs downstream
- Combine processes where possible
- Wet-in-wet processing

Water reduction: optimise control

- chemicals
- water
- energy

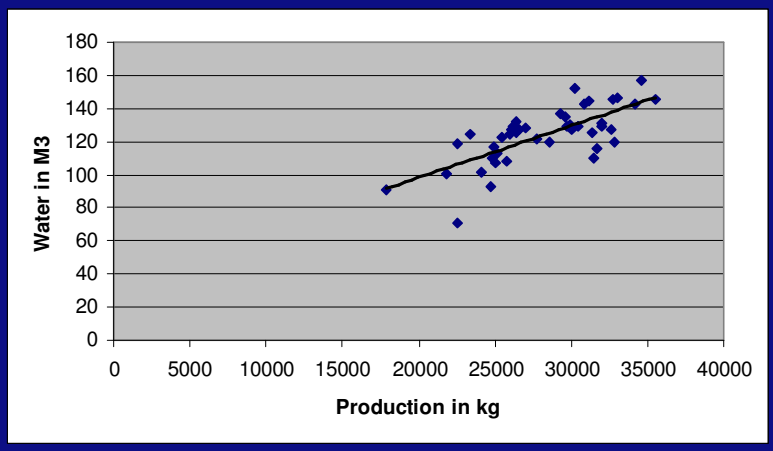
- Analyse
- Avoid
- Control
- Optimise
- Re-use

Examples:
- Installation flow control devices (continuous washers)
- Controllers for fill volume and temperature (batch dyeing)

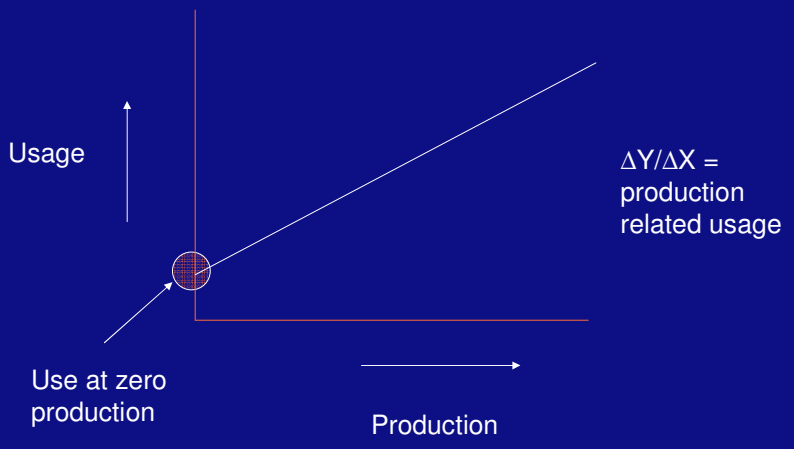
Keep track

- Daily, weekly, monthly
- Report
- Analyse
- Relate to production

Analysis water consumption



Analysis



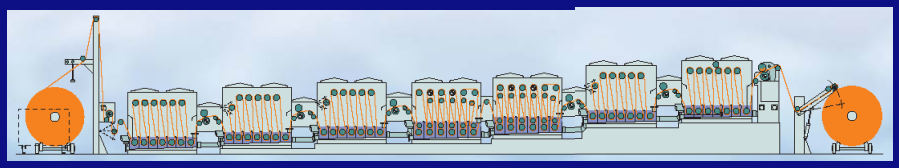
Water reduction: optimise process

- chemicals
- water
- energy

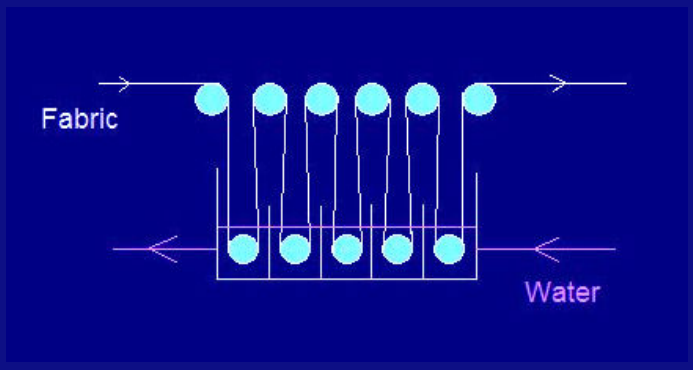
- Analyse
- Avoid
- Control
- Optimise
- Re-use

Examples:

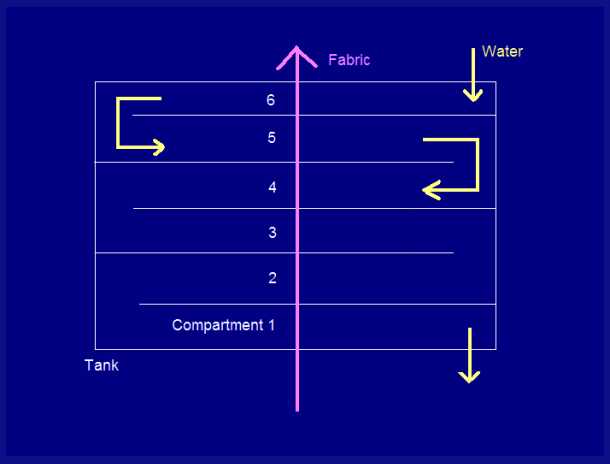
- Use counter current, separation, reduce carry-over
- Substitution of overflow-flood rinsing by smart rinsing
- Reducing liquor ratio



Washing tank with counter current flow in five compartments



Washing tank with six compartments (top view) with meander flow



Water reduction: re-use

- chemicals
- water
- energy

- Analyse
- Avoid
- Control
- Optimise
- Re-use

Examples:

- Re-use baths
- Re-use process water
- Provide storage facilities
- In-line water treatment and re-use
- Re-use cooling water

Examples cooling water

- chemicals
- water
- energy

- Analyse
- Avoid
- Control
- Optimise
- Re-use

- Engine and burner cooling
- Fabric cooling with cooling drums
- Cooling dye baths
- Cooling of the air in a pressure dryer

Ultra filtration

Textile wastewater

Table 1: Typology Of Textile Wastewater

	Pretreatment	Dyeing	Printing
Temperature (°C)	80-90	40/60/95	60/95
Chemical Oxygen Demand	5,000-25,000 mg O_2/l	1,000-3,000 mg O_2/l	2,000-15,000 mg O_2/l
Other	Size Caustic Soda Washing and wetting agents Salts — alkaline metals Organic impurities	Dissolved dyestuffs (reactive, direct and acids) Dye pigments (vat dyes, disperse dyes and pigment dyes)	Dissolved dyestuffs (vat dyes, disperse dyes and pigment dyes) Thickener, salts, and washing and wetting agents

Waste water treatment - Zero discharge

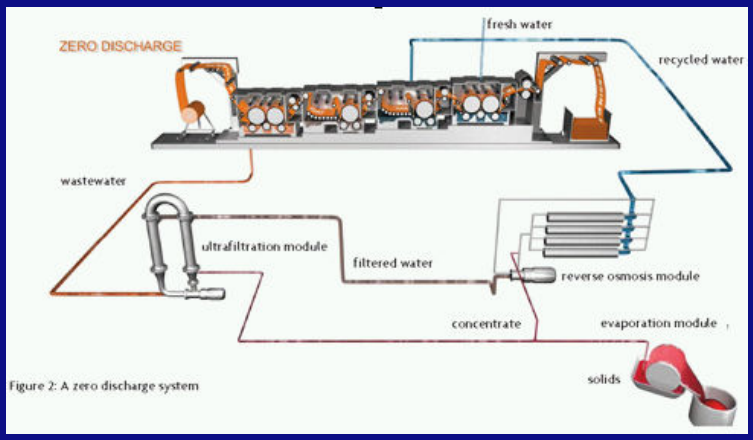
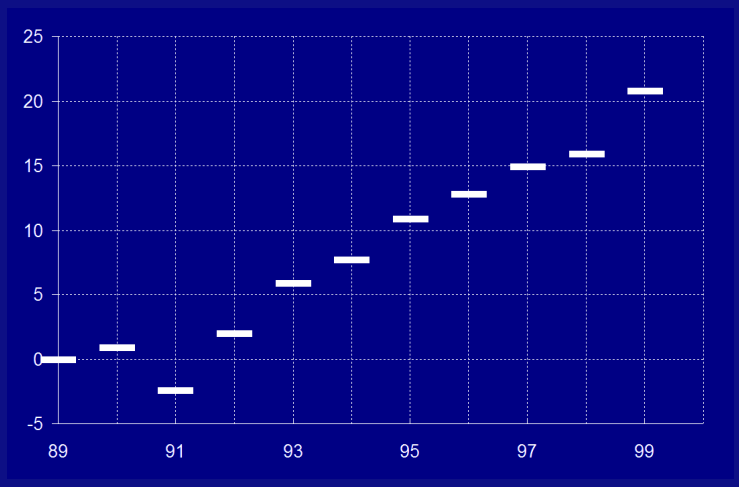


Figure 2: A zero discharge system

Energy efficiency improvement
Dutch Textile Industry 1989 - 2000

- chemicals
- water
- energy

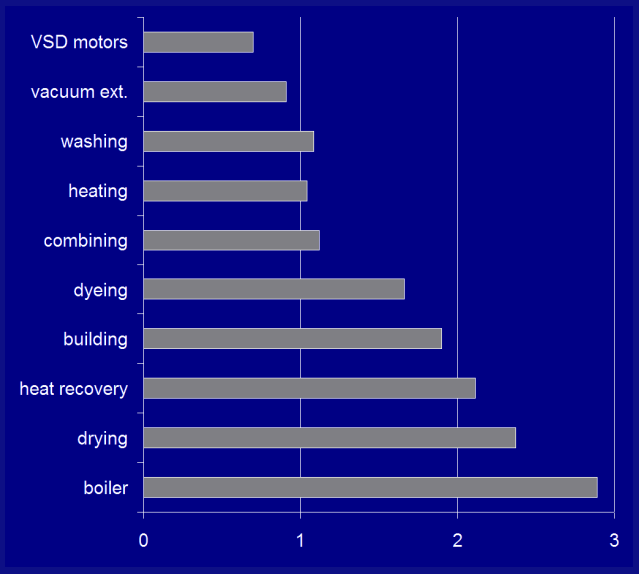


27 Energy and water

Most successful measures

- chemicals
- water
- energy

Rated as a percentage of total energy consumption



28 Energy and water

Energy

• chemicals
• water
• energy

Shapes:
- Wood
- Natural gas
- Furnace oil
- Electricity
- Steam
- Thermal oil
- Compressed air

Users:
- Boiler
- Motors (fans)
- Air conditioning
- Compressors
- Lighting

Conversion factors

• chemicals
• water
• energy

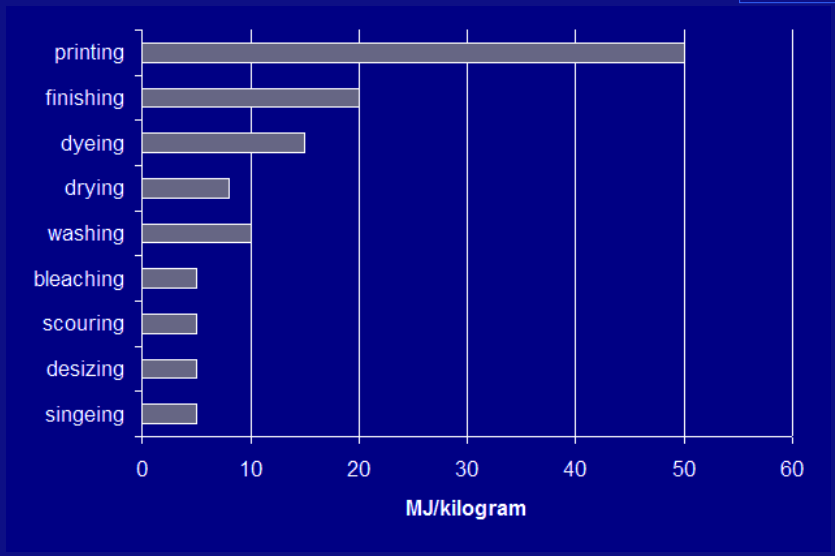
S.I. unit of energy is Joule

- 1,000,000 Joule = 10^6 J = 1 Mega Joule = 1 MJ
- 10^9 J = 1 Giga Joule = 1 GJ

- Electricity: 1 kWh = 3.6 MJ
  (40% efficiency during generation: 9 MJ)
- Gas: 31.65 MJ/m^3
- Steam: 3170 MJ/ton
- Oil: 41.45 MJ/kg
- Coal: 27.2 MJ/kg
- Wood 18 MJ/kg
- Compressed air: 1.82 MJ/m^3

Energy consumption per process

- chemicals
- water
- energy



31 Energy and water

Energy

- chemicals
- water
- energy

- Make an energy balance
  - Domestic (office)
  - Standby
  - Production related
- Prevent losses
- Measure energy streams
- Optimise processes
- Recovery (re-use)

- Analyse
- Avoid
- Control
- Optimise
- Re-use

32 Energy and water

Energy efficient Lighting

- chemicals
- water
- energy

- Use natural light
- Reduce lighting near windows
- Install skylights (shaded and sealed in summer)
- Turn off lights after work
- Turn off lights in unoccupied rooms
- Don't use (unnecessarily) low voltage spot lights
- Reduce light in corridor or reception if possible
- Consider alternatives to incandescent light globes

Lighting

	General Lighting Service Incandescent lamps	Tungsten Halogen (quartz iodine) lamps		Hot cathode Fluorescent lamps	Metal halide Discharge lamps	Colour improved High pressure sodium
		240V	6-12V			
Capital cost	Very cheap & Easy to replace	Low	Low/medium	Low/medium	High	High
Relative cost	High	High	Medium	Low	Very low	Medium
Wattage	15 - 1500	50 -2000	10 - 75	8 - 125	35 - 3500	35 - 50
Efficiency (Lumens/W)	10 - 20	22	35 - 50	Up to 70	60 - 115	40 - 44
Av. Life (hours)	1000	2000	2000 - 4500	8000 - 16000	6000 - 8000	12000 - 15000
Depreciation (Lum. maint.)	Light output falls 15%	Very little	Very little	~15-20%	45%	~15%
Colour rendition	Good	Excellent	Excellent	Good based upon lamp choice	Good for clear lamp and excellent for phosphor coated	Good

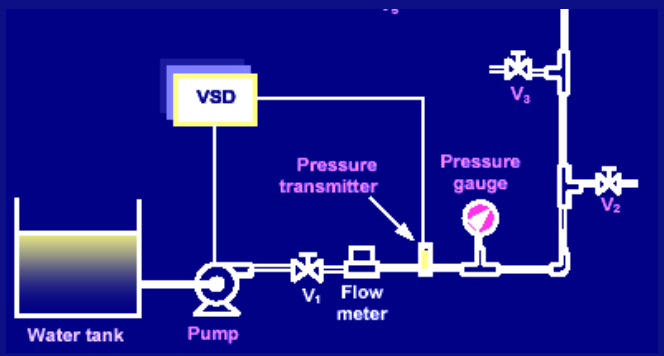
Electrical motors

- chemicals
- water
- energy

- Analyse
- Avoid
- Control
- Optimise
- Re-use

- Optimize motor sizing (size adequate for its task)
- Improve driven machinery (fans, pumps, compressors)
- Improve process (layout, logistics, control)
- Application of more efficient motors
- Application of variable speed drives (VSD)

Example of a VSD



Variable speed

Variable speed Drive

Air compressors

Facts:

- Annual energy cost is approximately 7 times the compressor's capital cost.
- a 50 kPa pressure reduction yields 4% saving
- Every 10 l/s of air leakage increases energy use by about 7 MWh/yr costing about $1,000 (at 15c/kWh)
- Regularly system leakage exceeds 20% - 50% of the total output.

Possible inappropriate use:

- Dusting, Clean-up, Drying, Process cooling
- Low pressure blowers, mixers, fans, brooms, nozzles
- Aspirating, Sparging, Atomizing
- Padding
- Vacuum generator
- Personnel cooling
- Compressed air-operated coolers
- Air-to-air heat exchanger or air conditioner
- Air motor-driven mixer
- Air-operated diaphragm pumps
- Idle equipment

Options

- Avoid
- Leaks
- Lower pressure
  - Relate to individual machines who need high pressure
- Shut off system when possible (maybe pressure needed for boiler room)
- More efficient and dimensioned compressors

Increase efficiency by:

- Establish a regular maintenance program
- Hunt for air leaks
- Check system operating pressure
- Check temperature reduction at the compressor intake
- Check all belt drives
- Check or install shut-off timers
- Control your air compressor usage
- Abuse and miss-use
- Consider adding variable speed drives
- Consider Heat Recovery
- Installing New or Upgrading Plant?