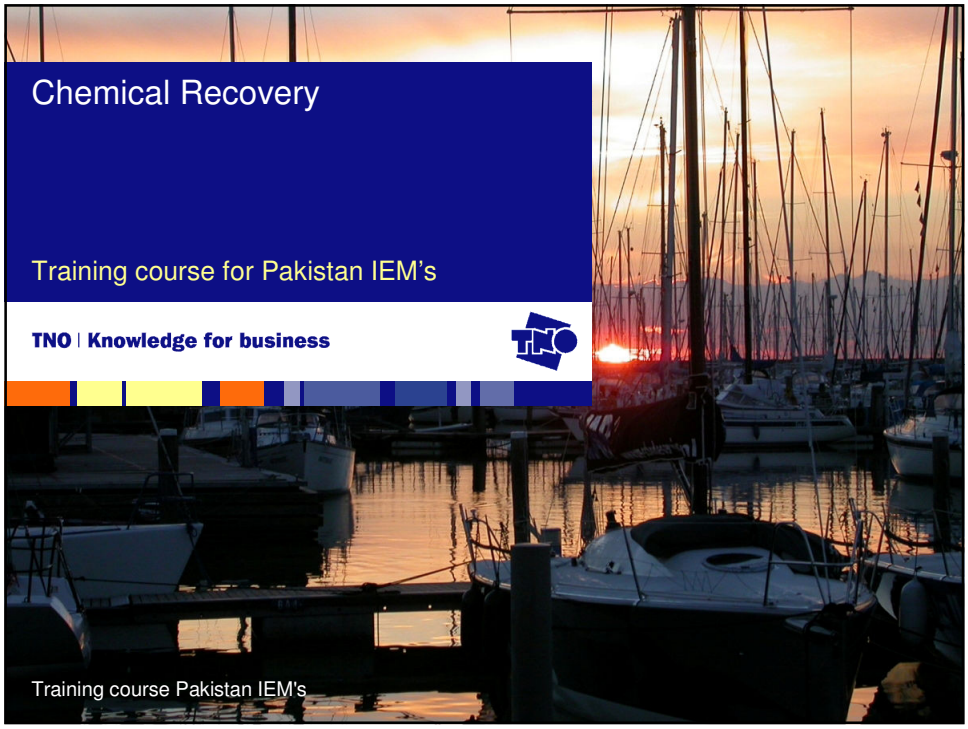


Chemical use during textile manufacturing

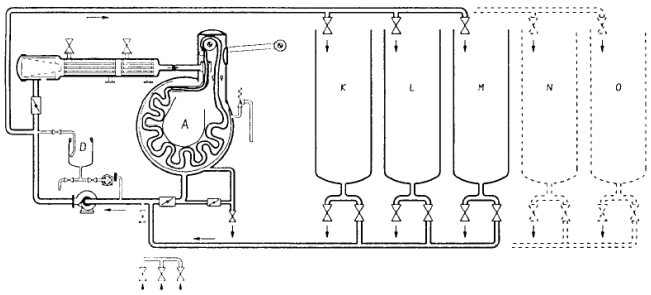
- Weaving
  - Size (starch, polyacrylates) — 10% of textile weight
- Pretreatment
  - Sodium Hydroxide — 35% of textile weight
  - Hydrogen Peroxide — 2% of fabric weight
  - Additives (wetting agents, dispersion agents, stabilizers) — 2% of fabric weight
- Dyeing
  - Salt (sodium sulphate) — 40% of textile weight
  - Dye — 0 - 5% of textile weight
    - Wasted — 0 - 1% of textile weight
  - Auxiliaries — 2% of textile weight

Chemical Recovery

- Salt 40%
- Sodium Hydroxide 35%
- Size 10%
- Wasted dye until 1%
- Water 5000 – 15000%

Salt recovery

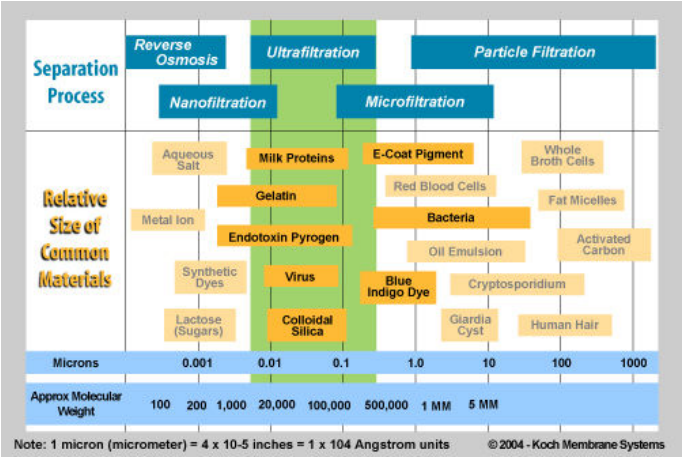
- Contaminated with dye and additives
- 1. Direct reuse
  - Inspect used dye bath for residual dye
  - Add missing dyes for next dyeing session



Salt recovery

- 2. Reuse after cleanup of waste-water
  - remove the dyes and organic auxiliaries
    - Nanofiltration with membranes
    - Anaerobic and aerobic waste water treatment
    - Oxydation/reduction/UV
    - Activated carbon filtration
  - Optionally concentrate the salt solution
    - Reversed osmosis
    - Evaporation (direct, multi-stage, mechanical vapor recompression)
  - reuse the filtrate (= salty water)

Membrane separation



Economics

- 1 million kg textile dyeing per year
- 400.000 kg sodium sulphate use
- 50.000 m^3 water use

- Benefits of salt (10 Rps/kg) 3,5 million Pak. Rps/year
- Benefits of water (50 Rps/m3) 2 million Pak. Rps/year
- Additional energy saving from reused hot water

- Investment possible economically (PBT < 5 years) = 20 million Pak. Rupees (in case there are no operational costs)

- Usually this option is uneconomical due to high operational costs and high investment.
- Option is to only treat the waste water from the dye bath

Sodium Hydroxide Reuse

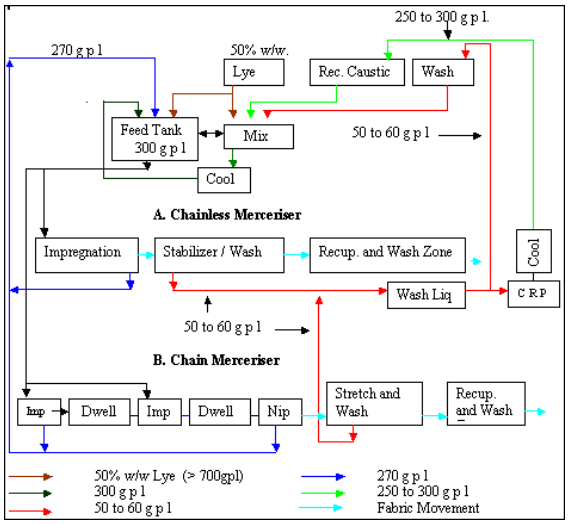
- Singeing
- Desizing
- (Scouring)
- (Bleaching)
- Mercerisation

Impregnation (250 g/l NaOH)

Rinse water

Weak lye (40-50 g NaOH/l)

Total recovery system (schematic)



Recovery process

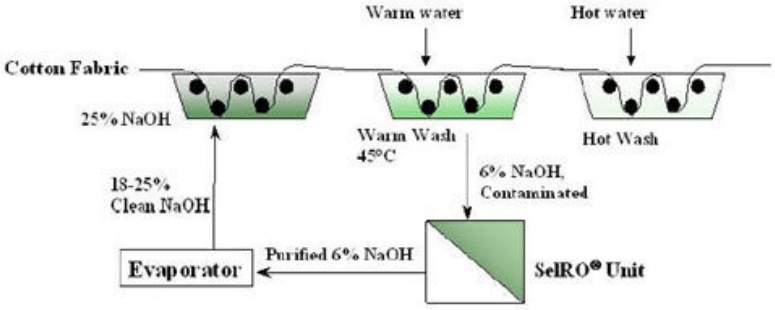
- Rinse water with 40-50 gram NaOH per liter water
- Removal of lint, fluff and particles
  - Self-cleaning rotary filters
  - Pressure microfiltration
- 3- or 4 –stage evaporation process
- After cleaning
  - Sedimentation
  - Oxydation/flotation with H_2O_2 injection

Removal of lint, fluff, particles

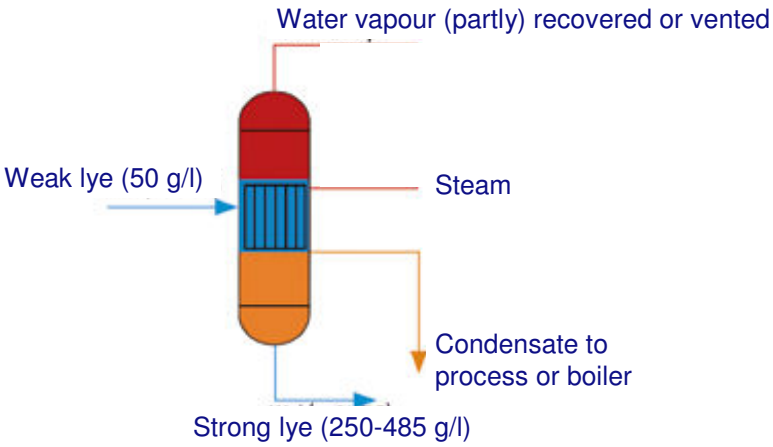
- Self-cleaning rotary filter
  - Removes lint and fluff
  - Self-cleaning, automatic back-flush
- Pressure microfiltration
  - Removes sodium carbonate crystals
  - Removes insoluble dye particles (indigo)
  - Up to 4 chambers
  - Self-cleaning, automatic back-flush\
- Membrane filtration
- Alternatives: UV or carbon-filtration

Membrane Filtration

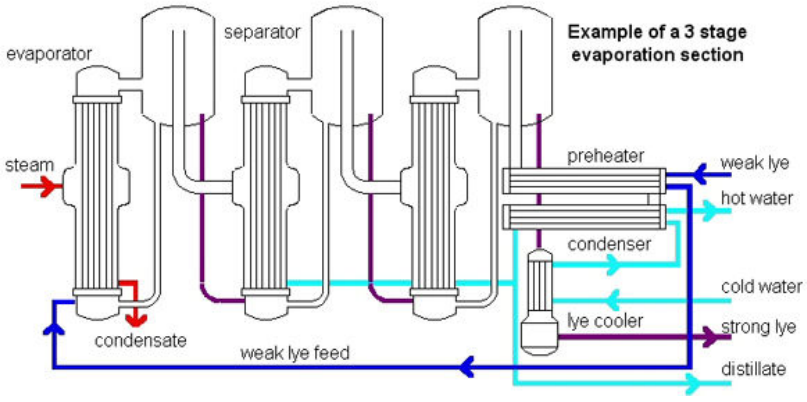
- E.g. Koch SelRO membrane unit (http://www.kochmembrane.com/selro_textilei.html)



Direct evaporation



Multi-stage evaporation process



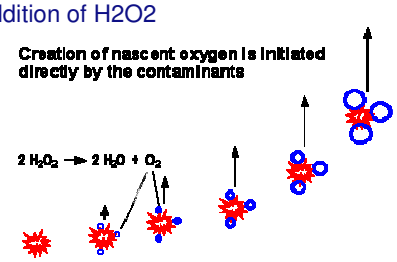
Vacuum: option for achieving highest lye concentrations (485 g/l) and necessary in case of more than 4 stages.

After-cleaning

- Sedimentation
  - Removal of crystals formed in recovery process
- Cleaning/breakdown of organics by H_2O_2-cleaning
  - Especially for mercerisation of dyed yarns and mercerisation after desizing or scouring or partial bleaching
  - Complete removal of size, fats, fibre remain and hemi-cellulose
  - Reoxydation of vat dyes, which are then removed
  - Oxydative breakdown of oxydisable dyes
  - Small residues of dye and pectin give colour to lye, but this is no problem for re-use

Cleaning by breakdown

- Addition of H2O2



- Circulation over a loop reactor
- Relaxation chamber
- Flotation cell
  - Removal of flotation foam and sediment

Necessary after-cleaning equipment

- feeding tank for recovered caustic soda, with level control
- feeding tank for peroxide, with metering pump and level control
- tank for purified caustic, with level control
- mixing and reacting unit with all necessary fittings
- relaxation chamber with automatic scum removal device
- 3 pumps, all valves, fittings and monitoring probes
- control panel
- support structure

Benchmark figures

- 85% of caustic soda collected from process
- 90% of caustic soda recovered in recovery plant

- 77% total recovery of caustic soda applied

- Typical reasons for non-optimal operation:
  - Poor rinsing of fabric after mercerisation
    - Poor dewatering before rinsing
    - Poor efficiency of rinsing
  - Leakage/overflow of process- and storage tanks
  - Poor filtration of caustic soda before recovery
  - Scaling of heat-exchangers
  - Non-condensing gases in recovery system

Economics

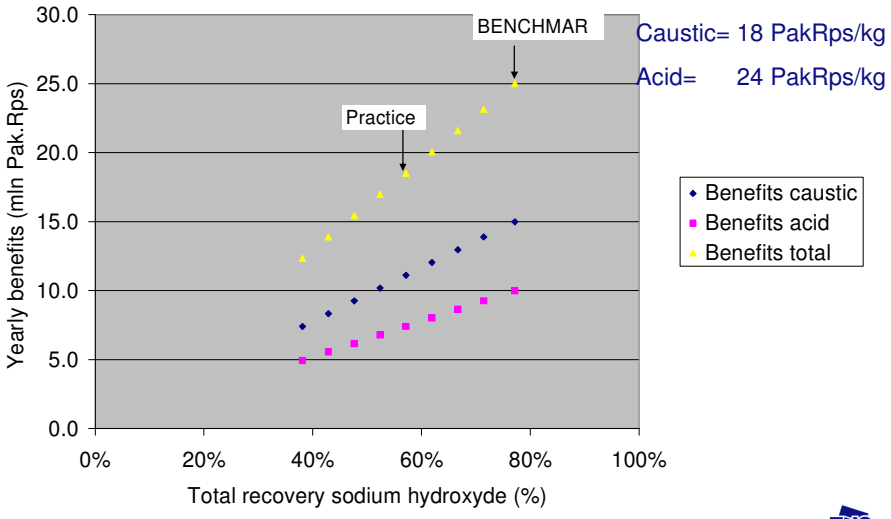
- Mercerisation production 3,00 million kg per year
- Caustic soda use 1,05 million kg per year
- Caustic soda collected from water 0,89 million kg per year
- Direct reuse in bleaching water 0,14 million kg per year
- Caustic soda to recovery plant 0,75 million kg per year
- Caustic soda recovered 0,67 million kg per year

- Caustic soda fresh input 0,24 million kg per year

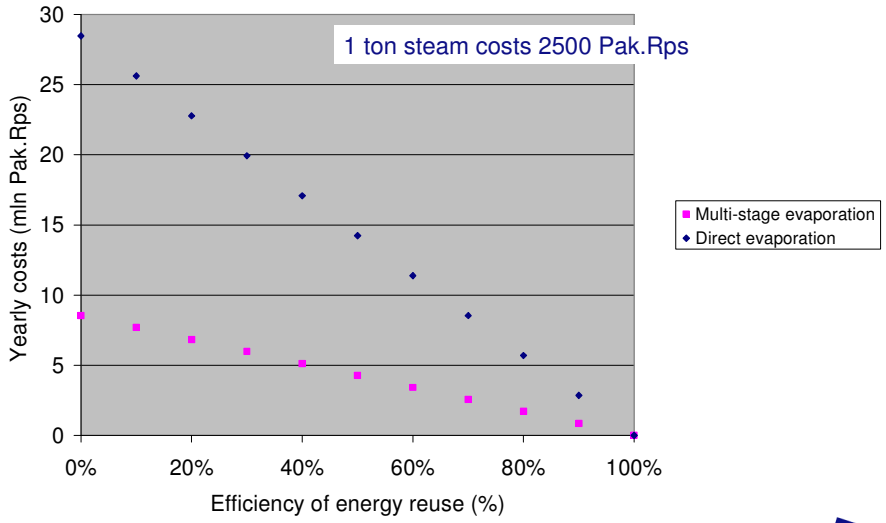
- Caustic soda savings 0,81 million kg per year
- Savings on caustic soda purchase 15 million Pak. Rps/year
- Savings on acid neutralisation 10 million Pak. Rps/year

- Investment (excl. clean-up) 20 million Pak.Rps
- Energy (5,1 kg steam/kg NaOH) partially recovered as hot process water (0,3 kg steam per kg water evaporated)

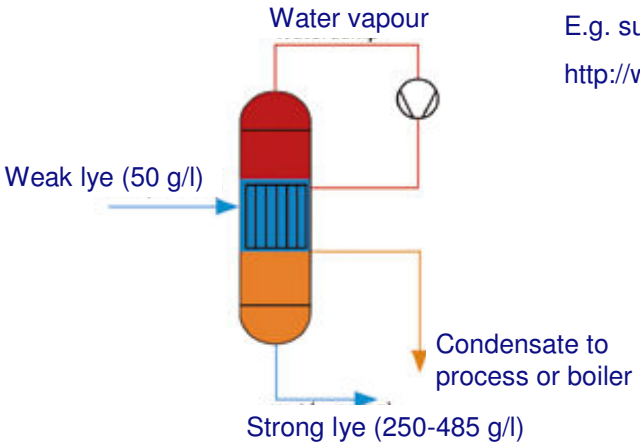
Economics and efficiency caustic recovery



Economics and efficiency energy recovery



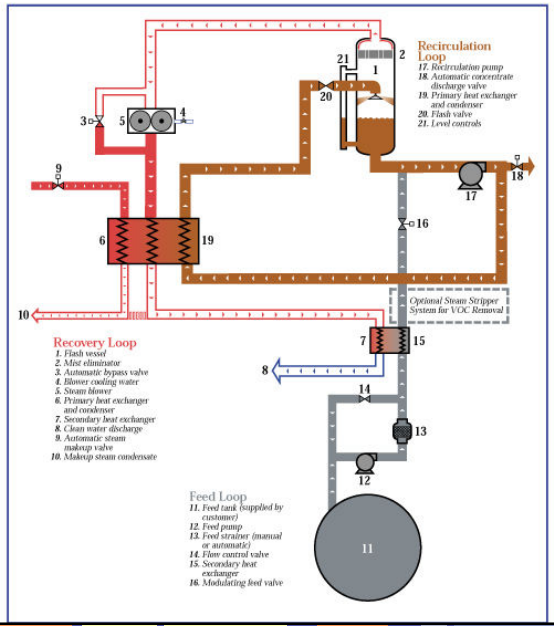
Mechanical vapour recompression



E.g. supplied by Vacom

http://www.vacomllc.com

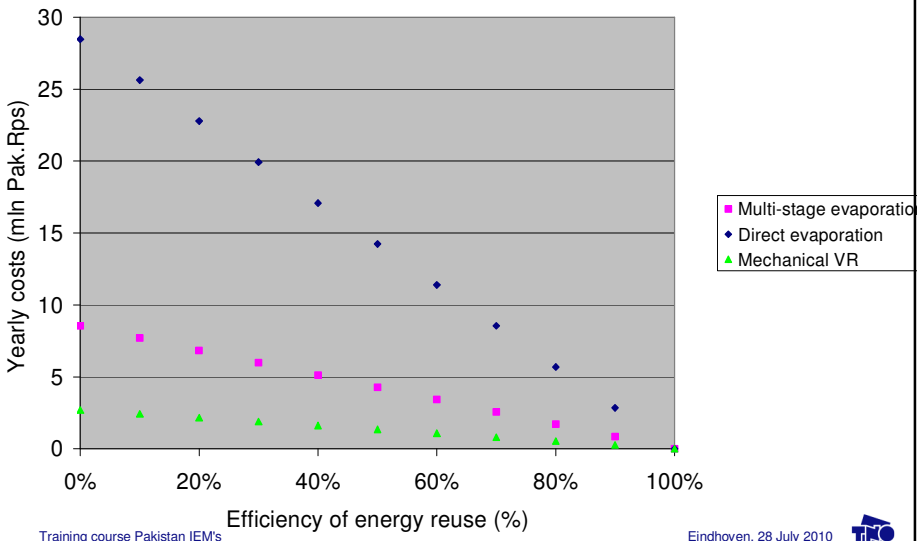
The VCD 2000 system: So sophisticated it's simple.
Exactly what you need to treat *your* wastestream.



Calculation for practical case

- Ref. Caddet report 'industrial heatpumps' report no. AR23
- 13400 m3 weak lye per year
- 1,7 m3 weak lye per hour during 8000 hours per year
- Energy use mechanical vapour compressor 48 kW
- Yearly energy use 384.000 kWh
- Yearly energy costs (7 Rps/kWh) 2,7 mln Pak.Rps
- Operating temperature 60°C
  - Can be chosen higher here → cheaper equipment
- Recovered 12000 m^3 water at 60°C (or higher) which partly recovers the electrical energy input

Economics



Size recovery

Waste water with sizing agents

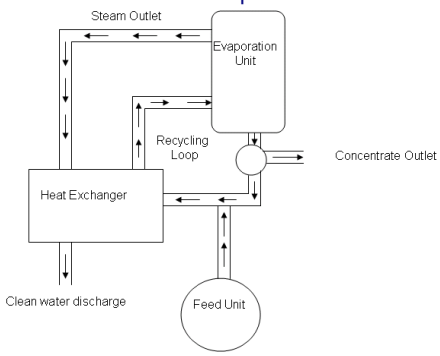
Fresh rinse water

Size recovery

- Only applicable for (cold) water removable sizes
  - Selected starches (e.g. Quicksolan from Avebe)
  - Several polyvinyl alcohol types
- Not applicable for sizes that need to be broken down (enzymatically or oxydative)
  - Many cheaper sizes made from agricultural products
- Co-operation between dyer/finishing company and weaving preparation company

Separation technologies

- Ultra (or nano-) filtration membranes
  - E.g. Koch KMS HFM-116 Spiral membranes
- Evaporation
  - E.g. mechanical vapor recompression/ vacuum flash evaporation process



Economics

- Textile production 3,00 million kg per year
- Size use 300.000 kg per year
- Size collected from water 270.000 kg per year
- Size recovered 250.000 kg per year

- Size savings 250.000 kg per year
- Savings on size (30 Pak.Rps/kg) 7,5 million Pak. Rps/year
- Savings on waste water treatment p.m.
- Savings on (hot) water reuse p.m.

- Energy for liquid pumps (membranes) or compressor (MVR) around 0,25 million Pak.Rps/year

Water recovery

- 50-150 litre per kg textile treated

- 1. Internal optimizations
  - Cancel overflow rinsing
  - Optimise rinse water flows (pretreatment 4 l/kg textile, dyeing 20 l/kg textile)
  - Optimise cooling and cleaning water flows
  - Direct re-use of cooling water as process water

Water recovery

- 2. Separate-off pollutants and re-use
  - Flocculation and sedimentation/flotation
  - Reversed osmosis
    energy costs < 5 Pak.Rps per m^3 water
    chemical and investment costs
    water spill
    membranes sensitive to clogging!
  - Active carbon
  - Evaporation
    MVR energy costs 250 Pak.Rps per m^3 water

Water recovery

- 3. Break down pollutants and re-use
  - Anaerobic waste water treatment
    - E.g. Pacques (http://www.pacques.nl)
    - Optionally followed by aerobic waste water treatment
  - Degradation with ozone/UV/Fenton reagent

Anaerobic water treatment

- COD 15000 – 60000 mg/l
- Special versions for water with much sizes or oils and fats
- No sludge formation
- COD removal up to 90%
- Dye removal (broken down)