For our Environment

Workshop Textile Industry 18-21/04/2015

BAT in textile manufacturing

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Section III 2.1 General Aspects of Pollution Control, Chemical Industry and Combustion Plants
The determination of Best Available Techniques

• Each relevant industrial installation in the EU needs an environmental permit
• Environmental permits are based on Best Available Techniques (BAT)
• BAT are identified by an information exchange process for each sector
• UBA is representing Germany in the European information exchange on BAT

Data on installations (technical descriptions, Emission data…)
EU Member States
EU Commission
Industry
Environmental NGOs

BAT Reference Documents for the sector (BREF) BAT conclusions
The definition and the determination of BAT

### Definition of BAT

<table>
<thead>
<tr>
<th><strong>Best</strong></th>
<th>most effective with respect to the prevention and – where that is not practicable – the reduction of emissions and the impact on the environment as a whole</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Available</strong></td>
<td>developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not it is used in the respective Member State</td>
</tr>
<tr>
<td><strong>Technique</strong></td>
<td>includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned</td>
</tr>
</tbody>
</table>

→ A technique in itself is not environmentally friendly if it is not well maintained
Relevance of BAT in textile manufacturing:
Environmental issues of textile finishing

- Ca. 7000 textile auxiliaries with approx. 400 – 600 single substances
- Up to 300 m³ Water per ton finished textile
- High chemical load of the waste water with non biodegradable auxiliaries
- Energy consumption
- Air emissions
- Solid wastes
- Odours

Leaking Chemicals in textile mills likely to enter the groundwater
Relevance of BAT in textile manufacturing:
Environmental issues of textile finishing

Main environmental loads from textile industry in Europe

<table>
<thead>
<tr>
<th>Substances</th>
<th>Environmental load (t/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salts</td>
<td>200 000 – 250 000</td>
</tr>
<tr>
<td>Natural fibres impurities (including biocides) and associated material (e.g. lignin, wax, etc.)</td>
<td>50 000 – 100 000</td>
</tr>
<tr>
<td>Sizing agents (mainly starch, starch derivatives, but also polyacrylates, polyvinylalcohol, carboxymethylcellulose and galactomannans)</td>
<td>80 000 – 100 000</td>
</tr>
<tr>
<td>Preparation agents (mainly mineral oils, but also ester oils)</td>
<td>25 000 – 30 000</td>
</tr>
<tr>
<td>Surfactants (dispersing agents, emulsifiers, detergents and wetting agents)</td>
<td>20 000 – 25 000</td>
</tr>
<tr>
<td>Carboxylic acids (mainly acetic acid)</td>
<td>15 000 – 20 000</td>
</tr>
<tr>
<td>Thickeners</td>
<td>5 000 – 10 000</td>
</tr>
<tr>
<td>Urea</td>
<td>5 000 – 10 000</td>
</tr>
<tr>
<td>Complexing agents</td>
<td>&lt;5 000</td>
</tr>
<tr>
<td>Organic solvents</td>
<td>n.d.</td>
</tr>
<tr>
<td>Special auxiliaries with more or less ecotoxicological properties</td>
<td>&lt;5 000</td>
</tr>
</tbody>
</table>

Source: Euratex
Relevance of BAT in textile manufacturing: Environmental issues of textile finishing

Waste water in textile finishing mills:

- Up to **1 kg chemicals per kg textiles** are used in textile finishing mills
- **More than 90 % of the organic chemicals and auxiliaries** in pretreatment and dyeing operations does not stay on the fibre, but mainly **ends up in the waste water**
- The wastewater load includes:
  - fibre by-products (e.g. fibre monomers like caprolactam, fibre solvents and catalysts)
  - preparation agents applied in down-stream processes
  - sizing agents applied in down-stream weaving mills
  - non-fixed basic chemicals, textile auxiliaries, and dyestuffs (including their by-products and impurities)

<table>
<thead>
<tr>
<th>Process</th>
<th>COD content in mg O₂/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>desizing</td>
<td>3.000 to 80.000</td>
</tr>
<tr>
<td>bleaching</td>
<td>3.000 to 10.000</td>
</tr>
<tr>
<td>Scouring</td>
<td>2.000 bis 6.000</td>
</tr>
<tr>
<td>Exhausted dye liquors reaktive dyeing</td>
<td>400 to 2.000</td>
</tr>
<tr>
<td>Exhausted dye liquors dispersing dyes or vat dyes</td>
<td>5.000 to 10.000</td>
</tr>
<tr>
<td>Residual dyeing liquors</td>
<td>10.000 to 100.000</td>
</tr>
<tr>
<td>Residual finishing padding baths</td>
<td>5.000 to 200.000</td>
</tr>
<tr>
<td>Residual printing pastes</td>
<td>50.000 to 300.000</td>
</tr>
</tbody>
</table>
Scope of the BAT Reference document (BREF) for Textile Industry

- **Scope**: Textile finishing operations (where the treatment capacity exceeds 10 tonnes per day)

- **Additionally included**:
  - Upstream processes with influence on the environmental impact of finishing processes
  - backing of carpets
Content of the BREF

- BREF Textile industry includes detailed information on
  - generally applied processes and techniques,
  - emission and consumption levels and techniques,
  - techniques and associated monitoring used for pollution prevention and control
  - Conclusions on best available techniques
- Includes description of about 130 techniques in the chapter “Techniques to consider in the determination of BAT”:
  - Generic BAT for whole textile industry
  - Process-integrated BAT
  - End of pipe techniques
  - All main textile fibre types are included
  - additional information on auxiliaries, dyes and pigments, textile machinery and typical recipes
- BAT refer to industrial practice with valuable information for plants of different size and structure (small plants as well as large plants)
Examples for BAT
Examples for BAT

4 TECHNIQUES TO CONSIDER IN THE DETERMINATION OF BAT

4.1 General good management practices

4.1.1 Management and good housekeeping

4.1.2 Input/output streams evaluation/inventory

4.1.3 Automated preparation and dispensing of chemicals

4.1.4 Optimising water consumption in textile operations

4.1.5 Insulation of High Temperature (HT) machines

4.2 Quality management of incoming fibre

4.2.1 Man-made fibre preparation agents with improved environmental performance

4.2.2 Mineral oils substitution in wool spinning lubricants

4.2.3 Mineral oils substitution in knitted fabric manufacturing

4.2.4 Selection of sizing agents with improved environmental performance

4.2.5 Minimising sizing agent add-on by pre-wetting the warp yarns

4.2.6 Use of techniques that allow reduced load of sizing agents on the fibre (compact spinning)

4.2.7 Minimising residues of organochlorine ectoparasitides in the raw material by substitution

4.2.8 Minimising residues of organophosphate and synthetic pyrethroid ectoparasitides in the raw material by substitution

4.3 Selection/substitution of chemicals used

4.3.1 Selection of textile dyes and auxiliaries according to their waste water relevance

4.3.2 Emission factor concept (emissions to air)

4.3.3 Substitution for alklyphenol ethoxylates (and other hazardous surfactants)

4.3.4 Selection of biodegradable/bioeliminable complexing agents in pretreatment and dyeing processes

4.3.5 Selection of anti-foaming agents with improved environmental performance

4.4 Wool scouring

4.4.1 Use of integrated dirt removal/grease recovery loops

4.4.2 Use of integrated dirt removal/grease recovery loops combined with evaporation of the efficient and incineration of the sludge

19 May 2016

Workshop on BAT reference documents for textile industry
Generic BAT for whole textile industry
Good housekeeping

Equipment maintenance
• Maintain machinery, pumps and piping thoroughly and check for leaks
• Draw up maintenance plans that foresee regular maintenance and document all work activities
• Check and clean filters regularly

Chemicals storage and handling
• Each chemical should be stored according to the instruction given by the manufacturer in the Material Safety Data Sheet
• All areas where chemicals are stored or spillages are likely to occur should be bunded
• It should be impossible for spillage to enter surface waters or sewers
• Toxic and dangerous chemicals should be stored separately

Proper maintenance saves 5-30% of electricity consumption per motor
Generic BAT for whole textile industry
Measures for reduction of energy consumption

• heat-insulation of pipes, valves, tanks, machines
• segregation of hot and cold waste water streams prior to heat recovery and recovery of heat from the hot stream.
• optimising boiler houses (re-use of condensed water, preheating of air supply, heat recovery in combustion gases)
• installing frequency-controlled electric motors
• installing heat recovery systems on waste off-gases

→ energy savings up to 70% for heat recovery on waste gases on stenters

Increased insulation on the stenters alone from 120 mm to 150 mm saves 20 percent of energy

See annex
Generic BAT for whole textile industry
Measures to reduce water consumption

• Education/ training of employees: All staff should understand clearly the precautions needed to avoid water wastage
• Monitoring of water consumption in the various processes,
• Leak control: audits should be carefully conducted for broken and leaking pipes, drums, pumps and valves
• Use of automatic controllers for control of fill volume and liquor temperature in batch machines
• Combination of different wet treatments in one single step (e.g. combined scouring and desizing, combined scouring/desizing and bleaching)
• Use of low- and ultra-low liquor ratio machinery in batch processes

See annex
Generic BAT for whole textile industry
Selection of incoming fibres

Man-made fibre preparation agents with improved environmental performance

• Preparations are the major causes of the pollution in the downstream processes
• Conventional preparation agents are mainly based on mineral oils with:
  ➢ high add-on (3-5%),
  ➢ low temperature stability
    (smoke during high-temperature treatments),
  ➢ poor biodegradability,
  ➢ presence of polyaromatic hydrocarbons,
• Alternative preparation systems are based on:
  ➢ polyester-/polyethercarbonate
  ➢ special polyolesters
  ➢ special steric hindered fatty acid esters

Achieved benefits:
• Up to 50 % reduction of application amount
• 90% reduction of air pollution
• Reduction of chemical load in waste water
• Reduction of odour nuisance
• Savings in water and detergent consumption
• Improved colour fastness

BREF Textile Industry Section 4.2.1
Sizing/Desizing
Minimising sizing agent add-on by pre-wetting the warp yarns

- Sizing agents account for 50 to 70 % of the total COD in the waste water of finishing mills
- Minimising the amount of size applied on the warp yarn is one of the most effective pollution prevention techniques for reducing the organic load
- Prewetting technology (running the warp yarn through hot water before the sizing process):
  - allows a more homogeneous sizing effect, increased adhesion of the size and reduced hairiness of the yarn
  → Reduction of the size add-on of about 20 - 50 %
  → Improved weaving efficiency in some cases
- Not applicable to small batches (<5000 m) as the add-on cannot be controlled adequately

Data of a weaving mill:
- 27 % cost savings
- 22 % increase in sizing machine speed
Sizing/Desizing
Recovery of sizing agents by ultrafiltration

• Sizing agents are the main source of COD in waste water
• Water-soluble synthetic sizing agents such as polyvinyl alcohol, carboxymethyl cellulose and polyacrylates can be recovered by ultrafiltration
• After ultrafiltration the concentrate can be re-used for sizing
• The permeate can be recycled and re-used as water in the washing machine
• Recycling of sizing agents is only technically and economically reasonable for integrated finishers with weaving and finishing near by

Recovery rates for sizing agents 80-85 %
COD load is reduced by 40 – 70 %
Process improvements for dyeing
Automated preparation and dispensing of chemicals

- Microprocessor-controlled dosing systems meter chemicals automatically according to a variety of profiles, such as constant rate or variable rate.
- Usually the frequently used colourants (highest consumption) are selected for automation.
- Commonly applied in many companies in the textile industry (Examples of plants with production capacity ranging from 70 t/day to 5 t/day)

**Benefits:**
- Improved right-first-time performance → minimising corrective measures (e.g. reworks, redyes)
- Significant reduction of waste water pollution and wasted chemicals thanks to the minimisation/avoidance of liquor residues

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Data of a textile dyehouse (production capacity 5500 t/year):

- 17% reduction of reworks
- 11% reduction of costs for chemicals
- 10% reduction of costs for labour
- 5% increased dye machine efficiency
Process improvements for dyeing
Use of high-fixation polyfunctional reactive dyestuffs

- Bifunctional (polyfunctional) reactive dyes offer very high levels of fixation in exhaust dyeing of cellulosic fibres
- Combination of two reactive systems in the same dye delivers the advantages of the two individual groups (e.g. high degree of fixation with high fastness levels and wash-off)
- Post-rinsing to obtain the required level of wet-fastness can be performed quickly and with reduced amounts of energy and water
- Dye manufacturers introduced small dye ranges each comprising highly compatible dyes with identical behaviour in the dye bath
- Dyeing compatibility matrixes are provided → high reproducibility,
  → low dependency on dyeing conditions (e.g. liquor ratio, dyeing temperature, salt concentration)
  and therefore right-first-time dyeing
- Fixation rate is increased from 60 % to 80 %
- Reduction of waste water pollution (e.g. TDS)

<table>
<thead>
<tr>
<th>Data for new dyes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>90°C fixation temperature</td>
</tr>
<tr>
<td>40 % reduction of water consumption</td>
</tr>
<tr>
<td>40 % reduction of energy consumption</td>
</tr>
<tr>
<td>30 % reduction of salt consumption</td>
</tr>
</tbody>
</table>

BREF Textile Industry Chapter 4.6.10
Process improvements for dyeing
Exhaust dyeing with low-salt reactive dyes

• exhaust dyeing of cellulosic fibres with reactive dyestuffs requires usually 50 - 60 g salt/l (up to 100 g salt/l for dark shades)

• Low-salt reactive dyes need only about two-thirds of this quantity

• low-salt dyes can be kept in solution at a higher concentration → use of low liquor ratio (L.R.) dyeing machines → further reduction of salt consumption

• low-salt reactive dyes are not combinable with other dyes, processing parameters have to be complied in an exact way

Quantities of salt required for dyeing 1000 kg of fabric to a medium depth of shade

<table>
<thead>
<tr>
<th></th>
<th>Winch (L.R. 1:20)</th>
<th>Jet (L.R. 1:10)</th>
<th>Low L.R. Jet (L.R. 1:5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional dyes (salt 60 g/l)</td>
<td>1200 kg</td>
<td>600 kg</td>
<td>300 kg</td>
</tr>
<tr>
<td>Low salt dyes (salt 40 g/l)</td>
<td>800 kg</td>
<td>400 kg</td>
<td>200 kg</td>
</tr>
</tbody>
</table>

BREF Textile Industry Chapter 4.6.11
Airflow jet dyeing machines

• the use of air, either in addition to or instead of water in jet dyeing machines
• dyestuffs, chemicals and auxiliaries are injected into the gas stream
• for woven PES fabric: Liquor ratios of 1:2 may be reached
• for woven cotton fabric lowest liquor ratio is 1:4
• separated circuit for liquor circulation without contacting the textile
• extremely low liquor ratio and the continuous rinsing system results in a virtually non-stop process with

**Benefits:**

→ up to 50 % water savings are achieved compared to conventional machines
→ about 40 % reduced consumption of chemicals ((e.g. salt)
→ less energy needed thanks to quicker heating/cooling and optimum heat recovery
Process improvements for printing
Recovery of printing paste

• Recovery of the printing paste remaining in the supply system in rotary screen printing machines at the end of each run.

• A ball is inserted in the squeegee and transported by the incoming paste to its end. After a print run, the ball is pressed back by air pressure, pumping the printing paste back into the drum for re-use.

• Modern printing machines with minimum-volume feed systems should be used.

• Another option is to empty all drums with residual printing paste and sort it according to its chemical characteristics.

→Re-use rates of 50 – 75%
Pollution control technologies
General principles for waste water management and treatment

• Do not send any waste water into the biological treatment facility that could cause malfunctions there.

• Employ alternative cleaning techniques for waste water with relevant volumes of non-biodegradable substances:
  - chemical oxidation for highly-polluted, selected, non-biodegradable waste water partial flows (e.g. desizing baths)
  - Precipitation and flocculation for partial flows containing heavy metals
  - membrane process for heavily coloured waste water partial flows and waste water with a high volume of dissolved substances

• If waste water with non-biodegradable compounds is not treated separately, then additional physical-chemical treatment of the waste water as a whole is required.

• Specific process residue (e.g. printing paste residue, padding liquor residue) should not enter the waste water but be disposed of in a more appropriate manner.
General principles for waste water management and treatment

• Characterizing the different waste water streams arising from the process
• Segregate the effluents at source according to their contaminant type and load
  • To ensure that a treatment facility receives only those pollutants it can cope with
  • To enable the application of recycling or re-use options for the effluent

3-way valve for segregation of effluents
Segregated effluents destined for different treatments
Pretreatment

Case example: De-colouring using membrane technology

- Company finishes knitted fabric
- Pretreatment of waste water from pad batch dyeing and from continuous washers
  1. step: nanofiltration
     Efficiency of de-colouration: 80 - > 99%
  2. step: electrochemical de-colouration
- Efficiency of de-colouration: 35 – 78%
- After-treatment in municipal waste water treatment plant
Treatment of mixed effluent

Case example:
Combined treatment of textile waste water with municipal waste water

- effluent from about 30 textile finishing units is treated together with municipal waste water
- textile waste water accounts for about 30 % of the hydraulic load and for about 40 % of the COD
- the textile finishing industries discharge their waste water to the public sewer after neutralisation on site
- various companies have pretreatment plants, especially pigment printing units, which treat the waste water from cleaning the printing equipment by flocculation/precipitation
- layout of the plant is typical with bar screen, aerated grit and grease chamber, primary clarifier, denitrification and nitrification stage
- Specific characteristic: presence of an additional treatment with activated carbon powder in order to minimise COD and colour in the final effluent
Combined treatment of textile waste water with municipal waste water

<table>
<thead>
<tr>
<th></th>
<th>Influent</th>
<th>Effluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td></td>
<td>6.8 – 7.5</td>
</tr>
<tr>
<td>COD [mg O₂/l]</td>
<td>278</td>
<td>11</td>
</tr>
<tr>
<td>BOD₅ [mg O₂/l]</td>
<td>138</td>
<td>3</td>
</tr>
<tr>
<td>NH₄-N [mg N/l]</td>
<td>12.5</td>
<td>0.4</td>
</tr>
<tr>
<td>P_total [mg P/l]</td>
<td>3.7</td>
<td>0.15</td>
</tr>
</tbody>
</table>
Air emission abatement techniques

• Different textile processes demand different off-gas abatement
• Case to case studies for the choice of the abatement technique is necessary
• The following techniques are used separately or in combination:
  ➢ oxidation techniques (thermal incineration, catalytic incineration)
  ➢ condensation techniques (e.g. heat exchangers)
  ➢ absorption techniques (e.g. wet scrubbers)
  ➢ particulates separation techniques (e.g. electrostatic precipitators, cyclones, fabric filters)
  ➢ adsorption techniques (e.g. activated carbon adsorption)
• Depending on the type of air stream and pollutants to be treated, they can either be used as single treatments or be applied in combination.
• Oxidation in steam production vessels/boiler house is not appropriate: The boiler of a steam vessel has cool zones in lateral sections → uncomplete combustion (dioxine formation, high slip rates for siloxanes and other substances)
### Air emission abatement techniques

#### Substances with dangerous properties which may be present in waste gas

<table>
<thead>
<tr>
<th>Substance</th>
<th>Typical Emission factors and concentrationes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>1–10 g/kg Textil, 50–500 mg/m³</td>
</tr>
<tr>
<td>Caprolactam (Nylon-6)</td>
<td>1–10 g/kg Textil, 50–500 mg/m³</td>
</tr>
<tr>
<td>D4-Siloxane (e.g. in Softeners)</td>
<td>0,1–1 g/kg Textil, 5–50 mg/m³</td>
</tr>
<tr>
<td>Alkanolamine (coating, emulsifying, dispersing agent)</td>
<td>0,1–1 g/kg Textil, 5–50 mg/m³</td>
</tr>
<tr>
<td>Acrylate, Vinilacetat</td>
<td>10–50 mg/m³</td>
</tr>
<tr>
<td>Perchlorethyl en</td>
<td>20–50 mg/m³</td>
</tr>
<tr>
<td>Diisocyanate</td>
<td>1–20 mg/m³</td>
</tr>
</tbody>
</table>

#### Emissions from directly heated stenters

<table>
<thead>
<tr>
<th>Substance</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane (as C organic)</td>
<td>5 – 500 mg / Nm³</td>
</tr>
<tr>
<td>Propane / Butane (as C organic)</td>
<td>5 – 600 mg / Nm³</td>
</tr>
<tr>
<td>Fomaldehyde</td>
<td>0,1 – 60 mg / Nm³</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>5 – 400 mg / Nm³</td>
</tr>
<tr>
<td>NOx</td>
<td>2 – 10 mg / Nm³</td>
</tr>
</tbody>
</table>

Source: BAT in Textile industry, UBA Texte 14/03
Air emission abatement techniques

Typical efficiencies of combinations of scrubber and electrostatic precipitator showing raw gas and clean gas values and indicating the connected processes

<table>
<thead>
<tr>
<th>Emission values</th>
<th>Unit</th>
<th>Process</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4/-0.28</td>
<td>g C/kg T, kg C/h</td>
<td>Thermo fixing</td>
<td>80%</td>
</tr>
<tr>
<td>2.4/-0.5</td>
<td>g C/kg T, kg C/h</td>
<td></td>
<td>85%</td>
</tr>
<tr>
<td>3.2/-0.5</td>
<td>g C/kg T, kg C/h</td>
<td></td>
<td>80%</td>
</tr>
<tr>
<td>1.5/-0.23</td>
<td>g C/kg T, kg C/h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.8/-1.2</td>
<td>g C/kg T, kg C/h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2/-0.24</td>
<td>g C/kg T, kg C/h</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Beste Verfügbare Techniken (BAT) bei der Abluftreinigung in der Textilveredlung, Endbericht Vorhaben EULV 27, 2008
Information exchange on BAT
Information exchange on BAT

A complex consensus-building exchange of information with numerous stakeholders and underpinned by sound techno-economic information that has been enshrined into law by Commission Implementing Decision

The exchange of information should address:

• the performance of installations and techniques in terms of emissions and consumptions, etc.
• the techniques used, associated monitoring, economic and technical viability, etc.
• best available techniques and emerging techniques identified after considering all the issues concerned
## Information exchange on BAT

### EU Commission
- Definition of framework requirements and organisation of information exchange
- Decision of controversial issues and questions of principle
- Checking the drafts of BREFs and BAT conclusions (quality, legislative consistency)
- Publication of BAT conclusions

### EU Member States
- Appoint experts for the Technical Working Group
- Provide data on emission values and techniques
- Organisation of a national information exchange on BAT
- Vote on the BAT conclusions
- Give feedback to the EU Commission with regard to organisational and practical problems on the information exchange

### Industry
- Provide data on emission values and techniques
- Appoint experts for the Technical working group on EU and national level
- Participating in commenting documents
- Internal information exchange on technical issues
- Defining postitions
- Follow new developments concerning BAT

### Environmental NGOs
- Provide data on emission values and techniques
- Appoint experts for the Technical Working Group
- Express public interest on environmental protection and health aspects
- Collect and provide best practice examples in EU as well as worldwide
Data needed for Candidate BAT

10 heading structure

- Description
- Technical description
- Achieved environmental benefits
- **Environmental performance and operational data**
- Cross-media effects
- Technical considerations relevant to applicability
- Economics
- Driving force for implementation
- Example plants
- Reference literature
Environmental performance and operational data

- Actual plant-specific performance data from well-performing plants
- Emission levels, consumption levels of raw materials, water, energy and amounts of residues/wastes generated
- Accompanied by the relevant contextual information
- Details of relevant operating conditions
- Emission monitoring issues related to the use of technique

- Key for deriving environmental performance levels associated with BAT
- Data collection step is crucial for determining BAT
Data collection step is crucial for determining BAT

• The information on key environmental issues is obtained through plant-specific questionnaires covering:
  • emissions to air and water
  • generation of solid by-products, residues and wastes
  • efficient use of resources (e.g. energy, water)
  • techniques that are potential BAT candidates
• Importance of contextual information:
  • details on the techniques used (characteristics, historical data)
  • other than normal operating conditions
  • link between the fuel characteristics and generated pollutants
  • consumptions (e.g. raw water, energy, chemicals)
• Plant-specific questionnaires are developed with the contribution of the whole TWG
• Pre-selection of well-performing plants/installations willing to participate
• Member State representatives sending/collecting questionnaires from operators (providing preliminary quality check)
BAT is about real plant performance

Example: Waste water treatment in the chemical sector

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio</td>
<td>Biological treatment</td>
</tr>
<tr>
<td>Filtr</td>
<td>Filtration (includes MBR and sand filtration)</td>
</tr>
<tr>
<td>Flotation</td>
<td>Flotation</td>
</tr>
<tr>
<td>NI</td>
<td>No information provided</td>
</tr>
<tr>
<td>Physico-chemical treatment only</td>
<td></td>
</tr>
<tr>
<td>Sed</td>
<td>Sedimentation</td>
</tr>
<tr>
<td>Sand filtration</td>
<td></td>
</tr>
<tr>
<td>Ultrafiltration</td>
<td></td>
</tr>
</tbody>
</table>
1.5. **Treatment of emissions to water**

10. **In order to reduce emissions to receiving waters, BAT is** to apply waste water treatment comprising an appropriate on-site and/or off-site combination of the following techniques:
   (i) mechanical treatment;
   (ii) physico-chemical treatment;
   (iii) biological treatment;
   (iv) biological nitrogen elimination.

**Description**

The application of an appropriate combination of the techniques described below. …

**BAT-associated emission levels**

BAT-AELs apply for:

(i) direct waste water discharges from tanneries on-site waste water treatment plants;

(ii) direct waste water discharges from independently operated waste water treatment plants covered under Section 6.11 in Annex I to Directive 2010/75/EU treating waste water mostly from tanneries.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BAT-AELs mg/l (monthly average values based on the average of the 24-hour representative composite samples taken over a month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD</td>
<td>200-500 (1)</td>
</tr>
<tr>
<td>BOD 5</td>
<td>15 - 25</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>&lt; 35</td>
</tr>
<tr>
<td>Ammoniacal nitrogen NH 4 - N (as N)</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Total chromium (as Cr)</td>
<td>&lt; 0.3-1</td>
</tr>
<tr>
<td>Sulphide (as S)</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>

(1) The upper level is associated with COD inlet concentrations of ≥ 8 000 mg/l.

**Applicability**

19 May 2016 Workshop on BAT reference
Questions for discussion

- How are the COINDs developed in India?
- Is there an extensive information exchange between all stakeholders (Industry regional competent authorities, institutes, public)?
- How are COINDs embedded in legal system?
- What instruments for enforcement are in place?
- How are environmental standards are derived? (are the technically based considering environmental Quality targets as well?)
- How are standards for SMEs are differentiated from standards for larger installations?
- …
Thank you for your attention!

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General technical measures to increase energy efficiency
Control of energy consumption

• Monitoring and control of energy consumption is an essential precondition for energy efficiency increase in companies
• establishment of a register of energy consuming processes and of all single aggregates including air condition and lightning
• For monitoring consumption, indicators are defined for the entire company and for single processes e.g.
  ➢ energy consumption (gas, oil, etc.) per ton of steam produced
  ➢ electricity consumption of big aggregates per ton of product produced
  ➢ consumption of steam and electricity per processed goods or group of goods
  ➢ gas consumption for the stenter frame per group of goods

German textile plant:
Cost savings of 175 000 €/a due to measures taken after monitoring/control of energy
General technical measures to increase energy efficiency

- heat-insulation of pipes, valves, tanks, machines,
- do not forget to insulate also condensate or waste water lines
- Replace damaged insulation

Increased insulation on the stenters alone from 120 mm to 150 mm saves 20 percent of energy

BREF Textile Industry Chapter 4.1.1

Proper heat-insulation of pipes

Source: Systain consulting
Energy recovery

- Reuse of warm water by counterflow (e.g. washing of raw cotton, peroxide bleaching and alcalic boiling off, Dyeing, continuous washing and rinsing).
- Use of warmed-up cooling water (e.g. from soda lye recovery, batch dyeing, water-cooled compressors) directly for warm processes like dyeing or rinsing.
- Use of water/water heat exchanger for heating fresh water, e.g.:
  - Heat exchanger for waste water from reactive dyeing
  - Heat exchanger for waste water from washing and rinsing
- Use of air/water or air/air heat exchange, e.g.:
  - Heat exchanger for waste gas from stenters for pre-heating of air introduced into the stenter
  - Heat exchanger for cooling air of compressors for pre-heating of process water or heating water

The use of heat content of rinsing water from continuous washing for heating of fresh water leads to energy savings of approx. 75%.
Minimisation of energy consumption of stenter frames

• Reduction of moisture content of the fabric with vacuum extraction systems, squeezing rollers etc. before it enters the stenter
  → Energy saving of up to 15%
• Regular maintenance of the burners
• Use of optimised nozzles and air guidance systems (e.g. nozzle systems that can be adjusted to the width of the fabric)
• Optimisation of air flow at the stenters (exhaust humidity between 0.1 and 0.15 kg water/kg dry air)
  → Energy saving of up to 57%
• installation of heat recovery systems
  → Energy saving of up to 70%
• insulation of thermal treatment units
  → Energy saving of up to 20%
Example for reduction of specific water consumption in yarn finishing

Company finishing Yarn implemented several measures for reduction of water and energy consumption:

• Reuse of low loaded water from washing
• Minimisation of number of process baths via optimisation of washing and rinsing processes and selection of chemicals for removal of dye hydrolysates (reactive dyes)
• Use of single-head centrifuges for dewatering of polyester cones (reduction of water content from 30-40% with old technique to 8%)
• Use of waste heat from compressors for drying of cones

29 % reduction of specific water consumption
44 % reduction of gas consumption
Example for reduction of specific water consumption in continuous washing

- Optimisation of an old washing machine for continuous washing of dyed fabrics:
- Analysing of washing process (monitoring of colour, pH value, conductivity)
- Stepwise optimisation with consideration of quality (colour fastness as main parameter), e.g.
  - Re-use of parts of washing water
  - Installation of extractors
- Use of tensides not longer needed

Subsequently installed Extractor

70 % reduction of water consumption
80 % reduction of energy consumption
Efficient washing processes

- Replacement of overflow rinsing with “drain and fill rinsing” or “smart rinsing”.
- Use of “Drain and fill” in combination with low liquor ratio machines equipped with time-saving devices (power draining and filling, combined cooling and rinsing, full volume heated tanks)

→50 – 75 % less water consumption

Water conservation in continuous washing and rinsing:
- Water flow control
- Countercurrent washing
- Use of squeeze rollers or vacuum extractors for the reduction of carry-over

Achievable specific water consumption levels for continuous washing processes

<table>
<thead>
<tr>
<th>Pretreatment process</th>
<th>Water consumption (l/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing for desizing</td>
<td>3 - 4</td>
</tr>
<tr>
<td>Washing after bleaching</td>
<td>4 - 5</td>
</tr>
<tr>
<td>Washing to remove NaOH after mercerisation</td>
<td>4 - 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Washing after dyeing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactive dyestuffs</td>
<td>10 - 15</td>
</tr>
<tr>
<td>Vat dyestuffs</td>
<td>8 - 12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Washing after printing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactive dyestuffs</td>
<td>15 - 20</td>
</tr>
<tr>
<td>Vat dyestuffs</td>
<td>12 - 16</td>
</tr>
</tbody>
</table>

BREF Textile Industry Chapter 4.9.1, 4.9.2
### Examples after optimised water consumption reduction

<table>
<thead>
<tr>
<th>Technique</th>
<th>Water consumption approx. [l/kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester knitted goods, continuous prewashing on perforated drum washing machine at 80°C to 35 m/min fabric speed with vacuum sucking technique and discontinuous dyeing (Jet and HT-beam) at 130°C with reductive aftercleaning for dark shades in the dyebath</td>
<td>80</td>
</tr>
<tr>
<td>Cotton, outerwear, oxidative desizing, cold pad batch-reaktive dyeing, mainly continuous technique with roller tub washing machines and vacuum sucking technique</td>
<td>75</td>
</tr>
<tr>
<td>Polyester/polyamide yarn dyeing, only discontinuous technique, optimised liqour ratio by using displacement devices and adapted aggregate dimensions</td>
<td>85</td>
</tr>
<tr>
<td>Cotton cord fabric, desizing and hot bleaching continuously in two steps, reaktive dyeing in discontinuous technique (Jigger)</td>
<td>120</td>
</tr>
<tr>
<td>Dyeing and printing, only continuous technique, mainly cellulosic fabrics, reactive and vat dyeing and printing</td>
<td>50</td>
</tr>
<tr>
<td>Polyester/cotton dyeing, continuous technique with polyester Thermosol dyeing with subsequent continuous reactive or vat dyeing on pad-steam-aggregate</td>
<td>40</td>
</tr>
</tbody>
</table>
Recycling of textile waste water by treatment of selected streams with membrane techniques

Company A

- treats woven fabric, mainly consisting of cotton and polyester
- Process sequence: pretreatment, dyeing (cold pad batch), pigment printing and finishing
- waste water treatment plant, with a pre-treatment, ultrafiltration, nanofiltration and reverse osmosis.
- 90% of water is recovered and can be used for most processes in the company (except for bleaching, dyeing and finishing liquors)
- Waste water from pretreatment (scouring and bleaching) and finishing (residual padding liquors) is not treated in the membrane plant

Benefits:

→ reduction in water consumption and waste water discharge of about 60 %
→ COD load in the remaining effluent discharged is reduced by about 50 %
Automated preparation and dispensing of chemicals

Description

• Automated and semi-automated colour kitchens and automated chemicals dosing and dispensing systems are commonly applied in many companies in the textile industry.

• Microprocessor-controlled dosing systems meter chemicals automatically according to a variety of profiles, such as constant rate or variable rate.

• Expert systems based on self-learning software systems upgrading their knowledge by algorithm are developed for textile processing and in use.

• Online measurement of the liquor pick-up and of the quantity of processed fabric, the exact amount of liquor can be prepared and added. Liquor surpluses and waste water pollution are therefore minimised.

• ....

• ....
Automated preparation and dispensing of chemicals

Main achieved environmental benefits

• Automation leads to a number of environmental benefits:
• tighter control of the process allows for improved right-first-time performance → minimising corrective measures such as reworks, stripping and shade adjustment.
• automated systems with just-in-time preparation of liquors and separate dispensing of the different chemicals (i.e. no premixing) allow a significant reduction of waste water pollution and wasted chemicals thanks to the minimisation/ avoidance of liquor residues (particularly important in continuous and semi-continuous processing)
• safer and healthier working environment. Eliminating human contact means no workers handling and breathing toxic and hazardous substances.
Automated preparation and dispensing of chemicals

Operational data

• Highly automated and also semi-automated systems generally require qualified personnel, but usually one person can easily operate the system.
• High precision in dosing is fundamental, especially for powder dyes. Modern automated dosing systems can dose amounts of powders as small as 0.8 g.
• Automated laboratories can reduce reworking to 2 – 3 % of total production.

Data from a textile dyehouse (size 5500 t/year) show the following improvements before and after the installation of an automated dosing and dispensing system for chemicals:

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seconds</td>
<td>1.6 %</td>
<td>0.9 % (43 % reduction)</td>
</tr>
<tr>
<td>Reworks</td>
<td>4.5 %</td>
<td>3.7 % (17 % reduction)</td>
</tr>
<tr>
<td>Chemicals reduced costs</td>
<td></td>
<td>11.2 %</td>
</tr>
<tr>
<td>Labour reduced cost (in the dyehouse)</td>
<td></td>
<td>10 %</td>
</tr>
<tr>
<td>Increased dye machine efficiency</td>
<td></td>
<td>5 %</td>
</tr>
</tbody>
</table>
Automated preparation and dispensing of chemicals

Cross-media effects
• There are no cross-media effects to be mentioned.

Applicability
• Automated dosing and dispensing techniques are applicable to both new and existing installations
• Highly sophisticated techniques (e.g. colour-on-demand principle) → very expensive and more suitable for large installations.
• The size and the age of the plant is no limitation in the applicability. Examples are available of plants with production capacity ranging from 70 t/day to 5 t/day
• The use of dosing systems can also be payed-off if long distances to different sites of operation have to be covered.
• In small batches with long distant pipelines → minimum batch for pipe cleaning and the filling volume of the pumps. This quantities are often higher than the needed liquor volume of the batch. Example: 100 m textile good (patternning) requires 30 l liquor, minimum quantity of the dosing system is 60 l.
• …
Automated preparation and dispensing of chemicals

Economics

- Investment costs for the automated dosing of liquid chemicals, depending on the number of machines to be served, liquors to be prepared and chemicals to be used, range from EUR 70000 to EUR 250000. The reported figures do not include costs for pipes and conjunctions.
- Cost savings can be derived from
  - a reduction of consumption of chemicals, dyes and water
  - a reduction of residual liquors – reduced waste water impact
  - an increase of reproducibility
  - ...
- Savings of up to 30 % have been reported. COD-load in the waste water of the dosing system could be reduced by approx. 80% compared to the conventional aggregate.
- ...
Automated preparation and dispensing of chemicals

Driving force for implementation

• The main driving forces for implementation are increased reproducibility and productivity along with health and safety requirements defined by legislation.

Reference plants

• Some examples of installations using automated systems for just-in-time preparation of liquors are in Germany: (List of Companies)

• There are many examples of installations equipped with fully automated preparation and dosing in Europe and worldwide.

Reference literature

[Kohla et al., 2008]: Kohla, Marzinkowski, Schafmeister, Schwake; Effizienzsteigerung in der Textilindustrie (Efficiency Increase in Textile Industry), Erich Schmidt Verlag, Berlin, 2008.
Generic BAT for whole textile industry (III)

- Implementation of a monitoring system for process input and output
  - Precondition for identifying priority areas and options for improving environmental performance
  - Input/output stream inventories can be drawn up on different levels (site level, process)