Textiles achieve ecological footprint
NEW OPPORTUNITIES FOR CHINA

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CHINA is the major global producer of textiles. Textile production consumes a great amount of energy and water, and in these times of global warming, CO₂ emissions are always carefully scrutinised. However, you can't make an omelette without breaking eggs, and the Chinese state is pushing to not only give its textile production a "green image", but also to improve its eco-balance. BENNINGER has carried out a market analysis to study the CO₂ footprint of textiles from China in more detail. There is still a lot to be done. BENNINGER has globally unique technologies for finishing textiles and processing as well as recycling of the employed sources.

The concept of the 'carbon footprint' is used to describe the complete greenhouse gas emissions which are associated with a product, and it is quoted as a CO₂ emission in grams of CO₂ per kilogram of fabric. When analysing the lifecycle of textiles, it appears that about 50 % of CO₂ emissions occur along the value-creation chain (fibre production, manufacture, trade, transport), and 50 % are caused by daily usage. Figure 1 shows the main CO₂ sources during textile production from the fibre to garment.

**CO₂ Sources during textile value chain**

![Pie chart showing CO₂ sources during textile value chain.](image)

*Fig. 1: CO₂ Sources within the textile value-added chain for a pair of trousers made of 100 % cotton manufactured in China in 2012*
In our studies we recognized significant regional differences in production, which are primarily the result of the availability and selection of energy sources.

**CO₂ DRIVERS**

**Type of energy carrier**

![CO₂ emissions for different energy sources](image)

*Fig. 2: CO₂ emissions for different energy sources*

Whereas in Europe gas and light oil are the primary energy source, in China the preferred energy source is usually coal. For example, CO₂ emissions from natural gas are only around 50% of those produced when coal is used as the energy source (Fig. 2). With the secondary energy source, mainly electrical power, the CO₂ balance results directly from the choice of the primary energy source. In China around 80% of electrical power is generated by coal-fired thermal power plants. As a result textiles made in China already have a CO₂ footprint which is around 40% higher than that of textiles produced in Europe, Turkey or South America, simply on the basis of the selected energy source. In improvement in this ecological deficit cannot be expected in the near future. However, we still see a tremendous amount of potential in for Chinese enterprises for lowering the consumption of resources by modernising plants and employing the latest technologies. Some examples are shown below.

**Sources of CO₂ emissions in the textile finishing process**

CO₂ emissions are caused directly by the energy consumers and indirectly by the consumables (such as chemicals, lubricants etc. The distribution of CO₂ emissions in a fully continuous textile finishing process for cotton textiles shows that about 50% comes from drying, 40% from washing and steaming and 10% from the use of chemicals. In knitwear finishing using the exhaust process, the largest part of emissions, i.e. 60%, is caused by heating the water.
Table 1: Energy consumers in the cotton or cotton blends finishing process

<table>
<thead>
<tr>
<th>Process / consumer</th>
<th>Primary source of energy used</th>
<th>CO₂ emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singeing</td>
<td>Gas</td>
<td>Low</td>
</tr>
<tr>
<td>Washing / heating energy</td>
<td>Steam</td>
<td>Very high</td>
</tr>
<tr>
<td>Steaming / reaction processes</td>
<td>Steam</td>
<td>Moderate</td>
</tr>
<tr>
<td>Drying</td>
<td>Gas / coal / steam</td>
<td>Very high</td>
</tr>
<tr>
<td>Fabric transport</td>
<td>Electricity</td>
<td>Low</td>
</tr>
<tr>
<td>Air conditioning technology / exhaust air</td>
<td>Electricity</td>
<td>Low</td>
</tr>
<tr>
<td>Chemicals</td>
<td>No data</td>
<td>Low</td>
</tr>
</tbody>
</table>

Twelfth five-year plan requests CO₂ reduction

The twelfth five-year plan stipulates that the CO₂ emissions must be reduced by 17% by 2015, based on the gross domestic product and the year 2010 as a reference. The shortage of drinking water is also not passing China by. On the contrary, some regions in China are suffering from an urgent water scarcity. The waste water disposal regulations for industrial plants have been tightened tremendously in recent years. The allocation of fresh water is subject to strict quotas in a wide range of provinces. Plans for expansion of textile finishing projects with a high level of water consumption are being slowed and new companies are only set up if it is proven that the employed technologies conserve water and resources.

A recent Benninger market analysis confirms that China has the greatest potential for saving water and energy. On average the European textile industry consume three times less water. Water and energy consumption are directly linked. Modern plant equipment and processes are necessary for sustainable resource conservation. A number of different approaches are possible, both for knitwear and for woven fabrics.

Deoiling and prewashing of knits

It is important to take the entire value-creation chain into account. This already starts with the selection of the fibre material. Due to the global shortage of arable land and fluctuating cotton prices, there are currently considerable increases in the use of synthetic fibres. Regenerated cellulose fibres (e.g. Viscose, Modal, Tencel etc.) can be produced today in a fully-integrated fibre manufacturing plants in a CO₂ neutral manner. For the fully synthetic polymers such as PES and PA, the environmental advantage is the very low water consumption. As far as the ecological footprint of dyeing factories and finishing works is concerned, knitwear from synthetic fibres has significant advantages from the environmental viewpoint. Needless to say, that a modern machinery park is required. These articles do not require the classic pre-treatment that is needed for cotton, as they do not need to be bleached.

All that is needed is a low tension prewash for the removal of spinning oil. The continuous pre-treatment concept used by Benninger involves an impregnation, emulsification and wash process on TRIKOFLEX drum wash compartments. During the emulsifying phase the
chemical-saturated knitwear is placed in loops on to a dwelling system. The micro-movement of the individual loops ensures that the knits are continually loosened and promotes free relaxation, and at the same time prevents the formation of creases. In this way the bidirectional shrinkage of the material is excellent. It is well known that so-called hydro shrinkage is significantly higher and longer lasting than thermal shrinkage, e.g. using hot air. Whether with or without a subsequent thermal fixing process, the stretchability and elastic recovery of the material is retained, even following several household wash cycles and wear. The fit of the garments is retained. Another advantage of the prewash process is that the emission of silicone and mineral knitting oils during the fixing process of unwashed knitwear is prevented. The black smoke in the exhaust air from the stenter frame is a thing of the past.

The BENNINGER plant concept is of modular design and is available for a daily production of up to 25 tons/day. The consumption of water and energy can be kept low. Reducing water consumption has a direct effect on the energy household. Enough reason to invest in highly efficient washing systems. The Benninger washing machine owes its high washing efficiency to the unique washing principle of the TRIKOFLEX drum. Thanks to its multi-layer construction it is possible to wash the fabric web on both sides with a good mechanical washing effect. This results in a reduction in water and energy consumption of up to 50%.

**Fig. 3: Trikoflex prewash and relaxing of knitwear**

The future trend is "continuous" dyeing of knitwear, and replacement of softflow dyeing machines has started already.

Despite the great efforts of machine designers to reduce the liquor behaviour, the finishing of knitwear after the exhaustion process in softflow dyeing machines still requires large amounts of water and therefore also large amounts of energy. In the CPB dyeing process the reactive dye is set by allowing it to dwell and react at room temperature. The liquor ratio used is smaller than 1:1. Modern CPB dyeing centres use controlled dyeing conditions which
means that this process is almost universally applicable for all types of cellulosic fibers. Savings are achieved because the dye is fixed at room temperature and also because dyes are used to maximum efficiency. The heart of a CPB dyeing station is the padder. When using the continuous process, it is possible to reduce CO\textsubscript{2} emissions by almost 70\% compared to the exhaustion process.

The Benninger Küsters DyePad is the only colour padder in the world which features the original S-roller technology. This makes it possible to run product-specific correction profiles for the dye application. As a result, this technique therefore not only sets the benchmark from an environmental and commercial point of view, but also in terms of quality. A special advantage is the fact that only 2 litres of liquor content are used for dyeing in roller nip. The dye solution is produced just-in-time, thus avoiding residue liquor.
Recycling of resources

The most widespread application is the recovery of heat from hot waste water. So-called water/water heat exchangers are used to this purpose. This process can be used very effectively with all continuous running Benninger machines. The required fresh water is heated by the counter flowing waste water just in time. The waste water is cooled at the same time, which otherwise has to be ensured by other means for compliance with waste water disposal regulations. The investment in heat exchangers in Benninger systems is paid off in less than six months.

A new option for resource recovery is recycling waste water by means of filtration systems. Modern chemicals and temperature-resistant ceramic membranes are permitting their more frequent use in the textile industry. Benninger has been successful in this sector since 2008. A recycling rate of up to 90% of the produced waste water not only has a positive ecological effect. The purified waste water can be used in all areas of textile production. Although membrane filtration systems are run electrically, the overall energy consumption and therefore the carbon footprint is reduced by around 12%. In certain circumstances waste water free textile production is already possible today (so-called zero discharge).

**Process Water Recycling and Zero Discharge**

90% water recycling  
70% energy recovery  
98% COD reduction

Fig. 6: Two-stage membrane filtration system for recovering water and energy

**BEN-iDATA – up-to-date information on the CO₂ footprint**

The Kyoto Protocol sets out binding targets and time frames for emissions of greenhouse gases. The textile industry can also do its bit. With the help of the BEN-iDATA tool by BENNINGER, textile finishers have access to up-to-date ecological data on the process in the form of a CARBON FOOTPRINT. This makes it possible to take immediate action in order to optimise the process.
Fig. 4: BEN-iDATA provides CARBON FOOTPRINT information

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