Benninger ready for the new carbon footprint regulations

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Textile products which are finished on Benninger systems have an excellent impact on the environment. Carbon and water footprints have been evaluated for a wide range of very different products, and a universal calculation model has been developed. What particularly stands out is the low water consumption of the Benninger finishing machines for knitwear and woven fabrics. This in turn results in the low energy consumption and the equivalent CO_2 emissions. Benninger has also achieved excellent results in terms of the consumption of chemicals. The accurate and controlled consumption of chemicals has a beneficial effect for the environment.

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 CO_2 emission in grams of CO_2 per kilogram of fabric. The 'water footprint' is the water equivalent to the carbon footprint and is usually quoted in litres of water per kilogram of fabric. A wide range of very different greenhouse gas emitters are involved throughout the lifecycle of a textile product. In the case of cotton, the irrigation of the cotton plant accounts for the bulk of the water consumption within the lifecycle. By contrast, the production of synthetic fibres results in higher CO_2 emissions. During the daily use of the textiles, CO_2 emissions are caused and water is used by the home laundry wash and dry process and even the disposal of used textiles are associated with emissions. Emissions play a hugely important role within the lifecycle assessment and can be seen in Fig. 1, which shows a case study for a dyed T-shirt. However, within the framework of an internal study, Benninger has restricted itself to looking at the portion of the emissions it can influence, i.e. the wet finishing process.

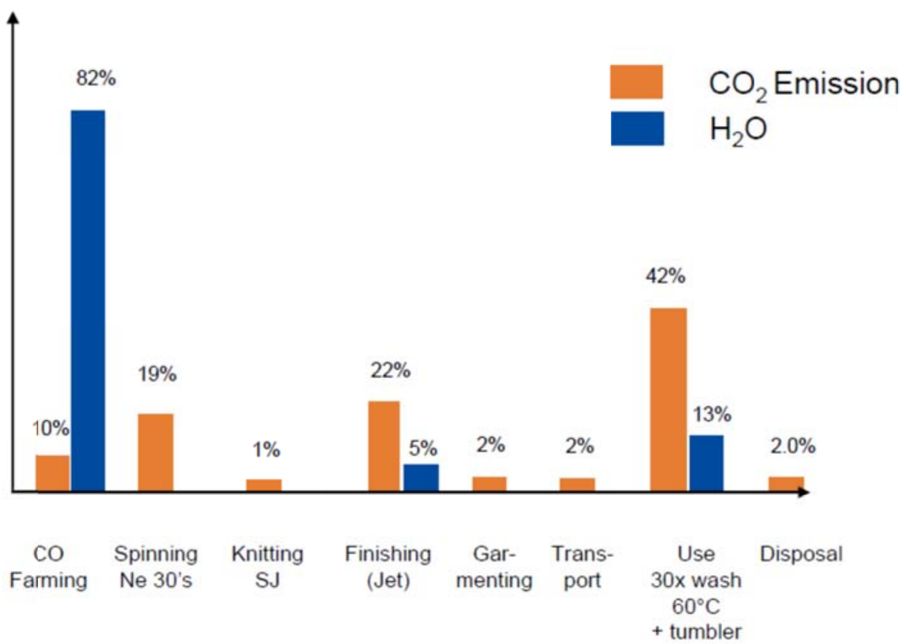

Fig. 1: Lifecycle assessment for a T-Shirt (100% cotton)

CO_2 consumers within the textile finishing process

The CO_2 emissions are caused directly by the energy consumers and indirectly by the operating fluids and auxiliaries (chemicals, lubricants etc.) which are used.

Process / consumer	Primary source of energy used	CO_2 emissions
Singeing	Gas	Low
Washing / Heating energy	Steam	High
Steaming / Reaction clima	Steam	Moderate
Drying / Evaporation energy	Gas / coal / steam	High
Fabric transport	Electricity	Low
Air conditioning technology / Exhaust air	Electricity	Low
Chemicals	-----	Low

Table 1: Energy consumers in the finishing of cotton and cotton blends

Fig. 2 shows the breakdown of CO_2 emissions for a classic textile finishing process for a cotton trouser. Within the individual process steps, the individual CO_2 emissions are homogeneously distributed throughout. If we consider the factors giving rise to the emissions, we can see that around 50% are accounted for the drying processes and 30% for washing and steaming. The remaining 20% are required by the chemicals used, the gas required for the singeing process and the electricity. This distribution reflects a fully continuous finishing process. In the conventional finishing of knitwear by the exhaust dyeing process, the CO_2 emissions are dominated by the heating of the water (up to 90 l/kg) which accounts for 60%.

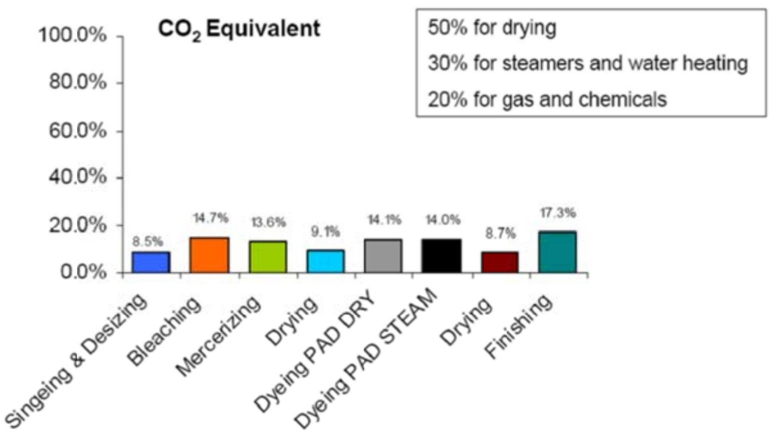

Fig. 2: Breakdown of CO_2 emissions in finishing processes cotton bottom weight trouser

Regional differences

Investigations in the textile finishing industry have highlighted some clear regional differences. The CO_2 emissions depend to a very large extent on the type of energy source which is used. This applies both to the heating of drying equipment and also to the generation of steam. Whereas mostly gas and light oil are used as the source of energy in Europe, coal is the preferred energy carrier in Asia. For example, the CO_2 emissions associated with the delivery of a particular energy value with natural gas are only around 50% of those produced when coal is used as the energy source. While modern boiler systems are used in the majority of cases in Europe, Asian producers generally fall back on simpler systems which are approximately 25% less energy efficient. There are large regional variations in the CO_2 emissions associated with the generation of electricity - a factor which is more significant in spinning mills than in textile finishing (share of energy consumption < 5%). The production of electric energy from hydroelectric power stations reflects better on the CO_2 balance than thermal power stations. Countries in the western EU and South America, particularly Brazil, do better in this regard than countries in Southern Asia and Eastern Asia, the Middle East, the USA and - in some cases - in Eastern Europe.

Optimisation of CO2 emissions

1. Optimising the environmental impact of existing textile processes

Benninger has a specialist team at its disposal which is on hand at any time to analyse and optimise textile production processes and the machinery and equipment which are used, as well as to calculate the corresponding carbon and water footprints. Based on the fishbone concept of Japanese quality expert Kauro Ishikawa, Benninger has developed a 5M concept for assessing the environmental compatibility of a textile production facility. Here, the methods and processes, machines, chemicals and auxiliary materials, the mass balance and the environmental behaviour of the personnel (man) are independently assessed and optimised in terms of their environmental relevance.

2. Elimination of intermediate drying processes

One good option is to perform the mercerizing process according to the so-called wet/wet process without previous intermediate drying. To do this, a high efficient squeezing unit and a waste water heated wetting-out box is placed before the mercerizing range. The lye concentration is monitored and kept constant with the aid of modern sensor systems and a lye management programme. This type of plant upgrade takes less than a year to pay for itself.

In the CPB dyeing process the reactive dye is set by allowing it to dwell and react at room temperature. Thanks to modern CPB dyeing centres with controlled dyeing conditions and the developments in terms of the dyes themselves, this method for cellulose fibres for woven fabrics and knitwear can be used without restriction anywhere in the world. Savings are made not only because the dye is set at room temperature, but also because the intermediate drying process after the dye application on a hot flue is eliminated. The heart of a CPB dyeing station is the padder. 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.

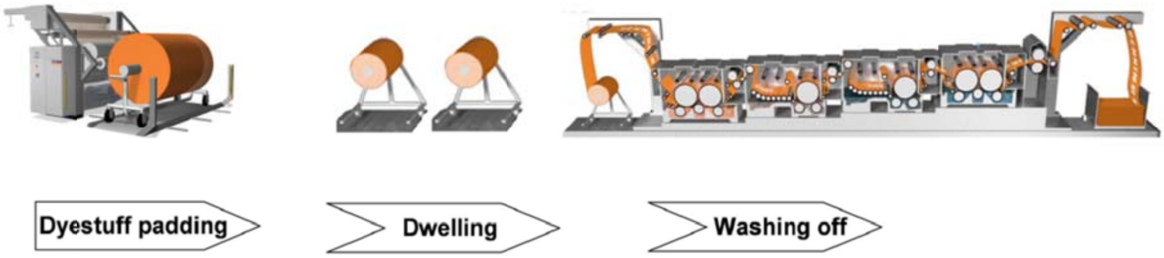

Fig. 3: CPB bleaching process

3. High washing performance means less fresh water is consumed

Washing studies which have long been published show that a combination of counterflow washing and good liquor separation can hugely reduce water consumption. Counterflow washing is today seen as the state-of-the-art and therefore requires no further explanation. However, despite the significant improvement in washing performance, the intensive liquor separation from one washing chamber to the next is hardly available from any machine builders. The additional cost and complexity of such washing compartments in terms of machine design are often overstated. A holistic cost assessment shows that this extra effort is more than justified. With strict liquor separation, less dirt is carried into the next washing chamber. This means that using the same washing zones with liquor separation and 4 l/kg washing water, the same washing result can be achieved as with 10 l/kg and no liquor separation (Fig. 4). For years Benninger has based its washing systems on the EXTRACTA washing principle. Liquor separation is achieved between the individual washing chambers by means of rollers which are pressed on pneumatically (Fig. 5). In addition to huge water savings, a low water consumption has a very positive effect on the energy balance. The amount of energy required to heat up washing water accounts for around 30% on woven fabrics and around 40% on knitwear. Reason enough to use highly efficient washing systems and - at the same time - reduce CO_2 emissions.

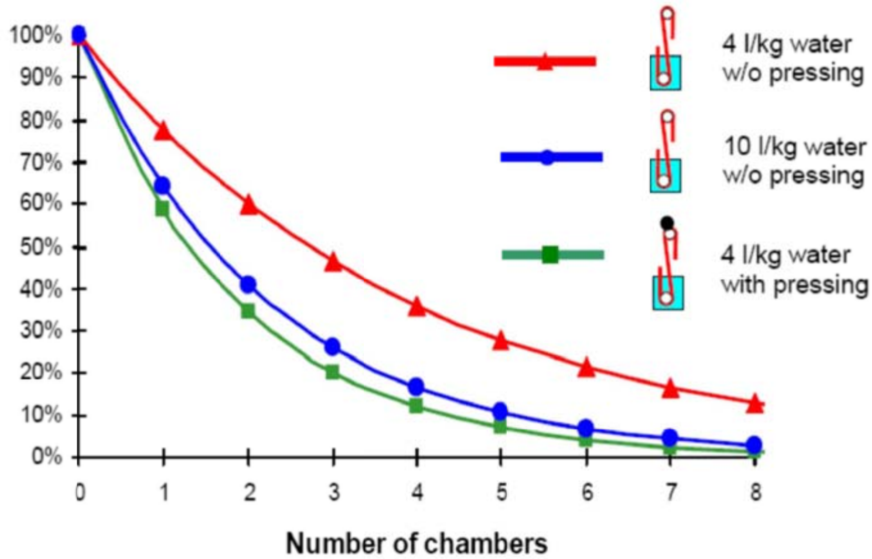

Fig. 4: Washing curves with different quantities of water and different washing principles

The new Benninger washing box is now even more efficient in terms of the resources which are used. Special attention has been paid to keeping the running costs and maintenance costs to a minimum.

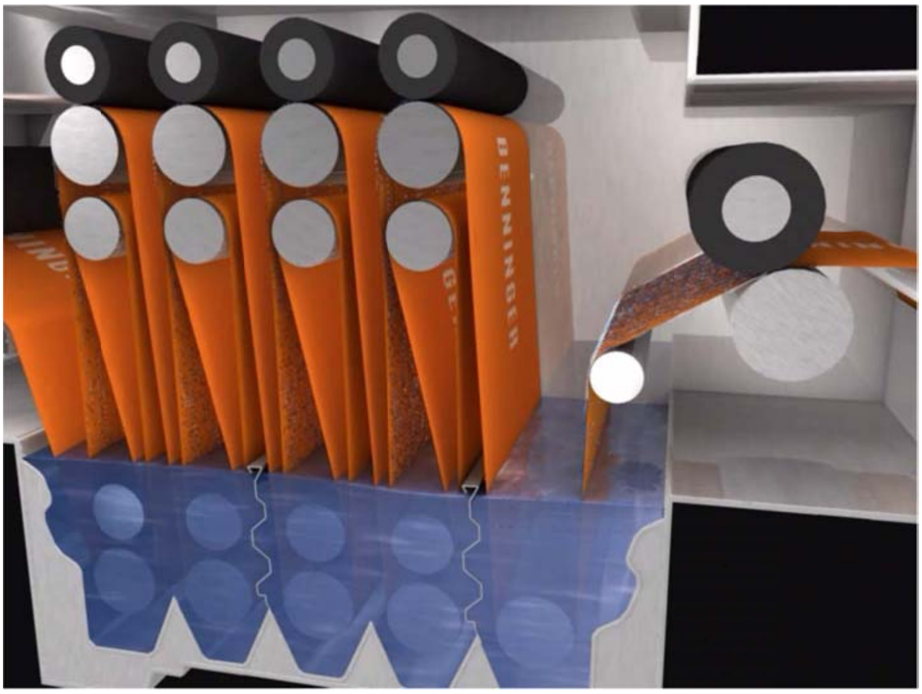

Fig. 5: EXTRACTA, liquor separation between washing chambers

4. Recycling of valuable materials

The best known application is the recovery of thermal energy from hot waste water. So-called water/water heat exchangers are used here. This method can be used particularly efficiently on the continuously operating Benninger plants. The required fresh water is heated up "just in time" by the overflowing waste water using the counterflow principle. At the same time the waste water is also cooled, which would otherwise need to be done by other means in order to comply with applicable discharge legislation. The amortisation period for integrated heat exchangers on Benninger plants is less than six months.

A new option for recycling resources can be opened up by recycling waste water using filtration techniques. Modern chemicals and temperature-resistant ceramic membranes are increasing the availability of these techniques in the textile industry. Benninger has been successfully active in this area since 2008. A recycling rate of up to 90% of the accumulated quantity of waste water does more than just help the environmental balance though. The purified waste water can be used in all areas of textile production. Although membrane filtration systems are electrically operated, the overall energy balance and therefore the carbon footprint is reduced by around 12%. Under certain circumstances it is now already possible to run waste water free textile operations (so-called 'zero discharge').

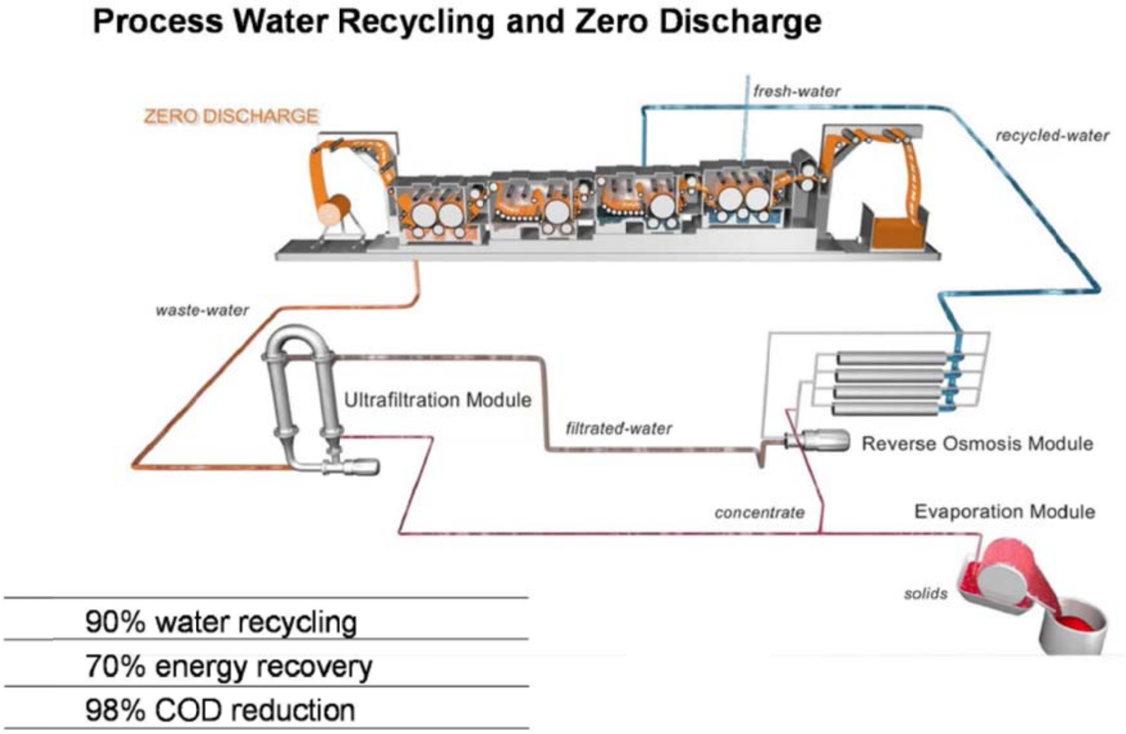

Fig. 6: Two-stage membrane filtration system for recycling water and energy

5. Case studies

Although the finishing of classic woven fabrics according to the continuous process still offers huge potential for savings in terms of water and energy consumption (some of these options have already been presented in this article), this has not been treated like a case study in the following. We have carefully chosen examples which would introduce new methods and processes to interested readers.

Replacement of the exhaustion dyeing process with continuous processes

Despite the massive efforts of machine designers to reduce the liquor ratio, the finishing of knitwear by exhaust dyeing in jet dyeing machines still requires large amounts of water and therefore also large amounts of energy. By contrast, in addition to quality benefits the continuous open width finishing process also offers savings particularly in terms of water and energy. In continuous mode, CO_2 emissions can be reduced by nearly 2/3 in comparison to exhaust dyeing processes (liquor ratio of 1:7). The TRIKOFLEX bleaching and washing plants offered by Benninger and the Benninger Küsters DyePad are perfectly suited for this type of application.

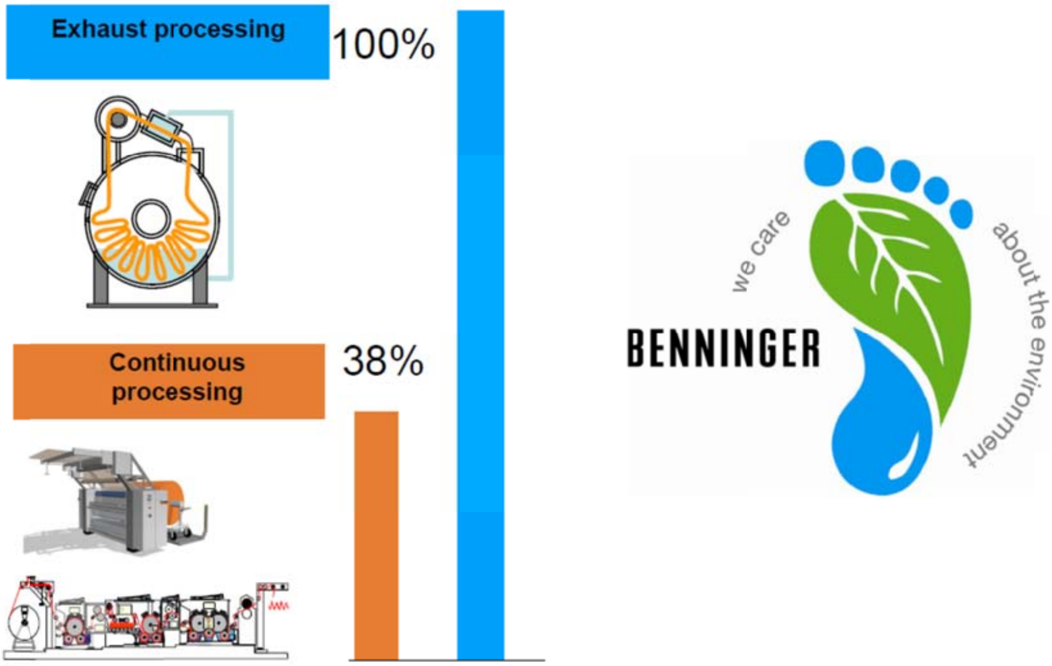

Fig. 7: Carbon Emission of conventional and continuous finishing of knitwear

The advantages of dyeing terry towelling using the continuous method follow the same patterns as knitwear. Here again, the changeover to the new technology has been initiated all around the world. Large-scale international manufacturers of terry towelling have already invested in Benninger plants and are now profiting not only from the low consumption figures, but can also report with pride that CO_2 emissions have been reduced by more than 50%.

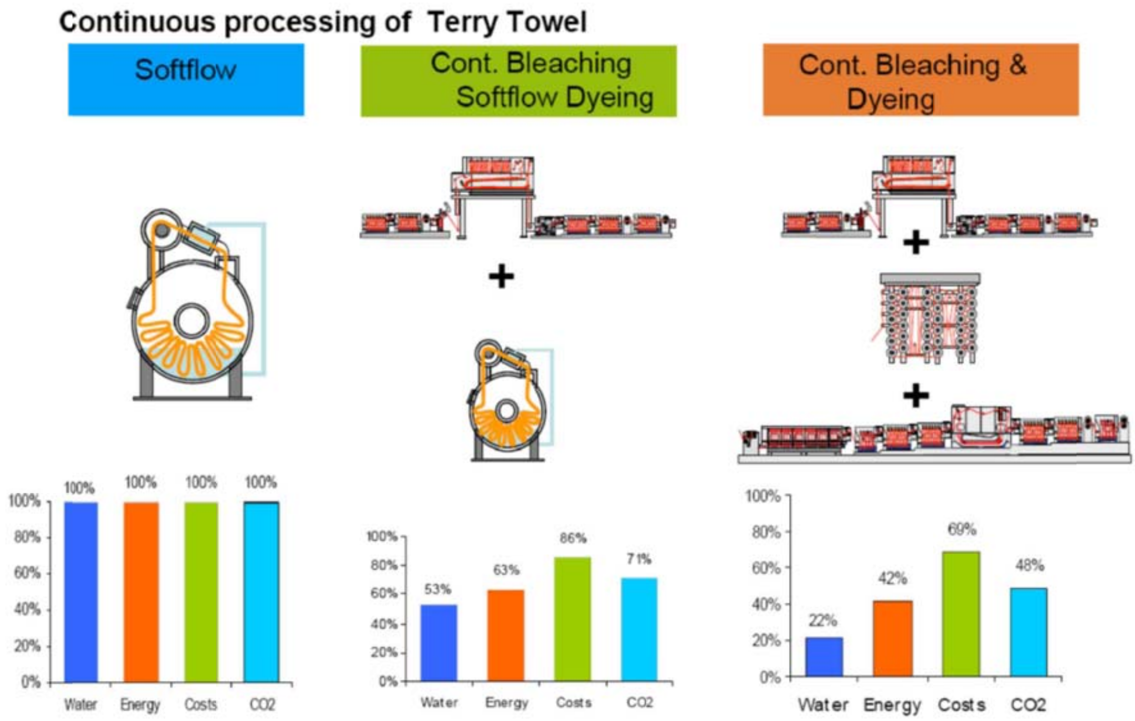

Fig. 8: Energy and water savings with continuous finishing of terry towelling

Zero-discharge textile operations

The Kyoto Protocol sets out binding targets and time frames for emissions of greenhouse gases. The textile industry can also do its bit. Detailed and accurate analysis of the consumers is followed by optimisation of water and energy consumption. The continuous dyeing and finishing processes for textiles will help here, and it will be necessary to replace exhaust dyeing processes. Not only does Benninger have the necessary expertise to calculate carbon and water footprints for different finishing techniques and processes, but it also offers machines which are particularly efficient in their use of water and energy. One particular highlight is the recycling of water and energy from Benninger plants, with the aid of which it is now possible to refine textile systems to the stage where the discharge of waste water is reduced to zero.

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