Clean Water Wanted – and Enzymes Can Contribute to the Solution

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The textile industry is constantly facing criticism from the media, politicians and opinion leaders for being one of the most polluting industries in the world. When it comes to emitting CO_2, there is no doubt that the industry is a big contributor. But textile production also consumes a lot of water, which is subject to contamination from the chemicals used during processing.

Water is an increasingly scarce resource. Fortunately, there are ways that the textile industry can consume less – and keep it cleaner. Enzymes can combine processes to save water usage, and they can also decrease the toxicity of effluents.

Water consumption under pressure

Water is an indispensable element in the production of textiles, which uses huge amounts every day. In China, one of the largest textile-producing countries, a production output of one ton of cotton knitwear consumes on average 130–150m^3 of fresh water. This corresponds to the daily water usage of 600–700 urban Chinese people[1]. And the scale of production is large; today, industry specialists estimate that 9 million tons of knitwear is produced globally every year.

To address the large water consumption from textile production, the Chinese government's Department for Industry and Information Technology has targeted a decrease in textile plants' water use and contribution to toxicity. The goal is to consume less than 100 tons of fresh water per ton of cotton knitwear in 2011[2].

Reduce water usage with enzymes

Surfactant-based chemicals are the traditional way of wet-processing textiles. But if textile mills use enzymes for the various wet processes, water – and cost – can be saved in the rinsing after each process. Part of the explanation for this is that enzymes necessitate fewer rinses after one process than chemicals, in particular alkalis, which necessitate more water for rinsing.

Chinese textile manufacturer Esquel Group has performed several trials with a light surfactant-based process incorporating enzymes from bioinnovation company Novozymes – a concept called 'elemental textiles'. In their trials, the Esquel Group achieved a saving of 30m^3 of water per ton of knitted fabric in just one single process (bleaching) where enzymes substituted chemicals[3].

Another part of the explanation is that enzymatic processing allows a combination of more processes in one bath, leading to dramatic decreases in water consumption. This is how enzymes offer an even greater potential when they are implemented with the best available technology (BAT) in all stages of textile wet processing.

Table 1 illustrates what can happen to water consumption when switching the production of a dark-coloured T-shirt from conventional to enzymatic processing. While only 2m^3 of water is used to produce the input of enzymes, 100m^3 of water can be saved. Of this water, 80m^3 is tap water used in textile processing, and 20m^3 is water for producing chemicals.

In contrast to many surfactants, enzymes are readily degraded into harmless compounds in the water treatment plants.

Toxic substances are all around

Over the last century the global economy has kept growing. As a result of this and increasing consumption, more chemical substances are emitted into air and water. This presents a problem in that we are exposed to substances that can harm general health and the environment.

With regard to the aquatic environment, wastewater from textile mills contributes to the increased level of unwanted substances that are residuals from, for instance, surfactants, dyes, and organic matter. However, most textile mills either have their own wastewater treatment plant or are connected to one locally. This is where water is rid as much as possible of the unwanted

substances before being released into rivers, lakes, or the sea.

Unpredictable weather conditions have an impact

Heavy rain showers can easily put a water treatment plant under pressure if it does not have the necessary capacity to process all the incoming water. According to the International Panel on Climate Change, extreme weather conditions may become more frequent in future[5]. In the event of heavy showers, some of the effluents from textile production may pass through the plant without being completely rinsed and go directly into the waterways. This is not beneficial to flora and fauna, which will be exposed to the surfactants.

Here, enzymes can make a difference. An enzyme product is often a mix of the actual enzymes and a liquid solution containing mostly carbohydrates such as sugar and glucose. When the enzymes reach the wastewater treatment plant, they are deactivated and turned into tiny pieces of protein and carbohydrate. Together, they function as nutritional food for the microorganisms whose purpose is to degrade them before they are sent into waterways. In other words, enzymes are readily degraded into harmless compounds. In contrast, some chemicals such as polycarboxylates are harder for the microorganisms to degrade.

In a trial of the elemental textile concept mentioned previously in this article Esquel achieved a substantial reduction in the consumption of both water and chemicals with toxic properties. Based on the trial's life cycle assessment of the concept in use, calculations show that for one ton of blue navy knitwear changing from chemicals to enzymes may safeguard up to 2 million m^3 of water against unacceptable toxicity. In toxicological terms, the critical dilution volume of the wastewater is 460–2,000 million litres[6].

Small dosage + biodegradability = lower toxicity

The beauty of enzymatic processing is that enzymes are catalytic by nature: they will actively target one molecule, dissolve it, and move on to the next[7]. In practice, this means that a smaller dosage of enzymes is needed for textile processing. The small dosages, combined with the fact that enzymes are quickly degraded, leads to lower toxicity for enzymes. Given this and the fact that processes can be combined and the number of rinses can be reduced in wet processing, enzymes are a powerful cocktail that contributes positively to how water is used in textile production.

Enzymes are biodegradable and do not negatively impact streams or lakes.

Enzymes are the sustainable way of the future for textile processing.

Enzymes can do more for business

Given that the Chinese government has set targets for lowering toxicity and water consumption, Chinese textile producers will soon have to look for new technologies that can meet these goals, and enzymes are a good alternative. Enzymes cannot eliminate or cut textile mills' water consumption in half. But, in comparison with chemicals, they can contribute to lowering the critical dilution volume for toxicity and reduce water used in processing. What is more, they can lower the expense of water and effluent treatment. With biodegradable enzymes textile producers have the chance to stay on top of the issue with a sustainable alternative that over time can change the face of the industry.

Table 1. Changes in water use when switching to enzymatic processing. All data in m^3 of water per ton of knitwear[4].

	Dark-coloured T-shirt	Light-coloured T-shirt
Saved tap water in textile mill	$80m^3$	$60m^3$
Saved water in chemical production, etc.	$20m^3$	$10m^3$
Added water for production of enzymes, etc.	$2m^3$	$4m^3$

References

1 Calculations based on the Ministry of Water Resources of the People's Republic of China, 2008 China Water resource Communique

2 China Textile Institute

3 See the life cycle assessment of elemental textiles using Esquel's trials at www.elementaltextiles.com

4 See the life cycle assessment of elemental textiles using Esquel's trials at www.elementaltextiles.com

5 IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K ., and Reisinger, A. (eds)]. IPCC, Geneva, Switzerland, 104 pp.

6 See the life cycle assessment of elemental textiles using Esquel's trials at www.elementaltextiles.com

7 How many molecules one enzyme will target depends on the dosage