CLEAN by Design

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The full paper is available in English and Chinese at **www.nrdc.org/cleanbydesign**

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NRDC's Ten Best Practices for Textile Mills to Save Money and Reduce Pollution

Textile manufacturing has a huge environmental footprint, polluting as much as 200 tons of water per ton of fabric with a suite of harmful chemicals, and consuming tremendous amounts of energy for steam and hot water. With the industry now centered in countries with still developing environmental regulatory systems, such as China, India, Bangladesh, and Vietnam, textile manufacturing has a huge environmental footprint. To address the rapidly increasing global impact of this industry, NRDC's Clean by Design is promoting a responsible sourcing initiative that employs process efficiency improvements to curb pollution in textile dyeing while saving the industry money.

Starting in China, the world's largest center of manufacturing, NRDC's team visited more than a dozen textile mills and selected five 'typical' dyeing and finishing mills for in-depth pollution prevention assessments. The assessments revealed ten simple, practical, low-cost opportunities—that repay their cost rapidly—to reduce water, energy, and chemical use.

Taken together, NRDC's best practices can save approximately 25 percent of water and 30 percent of fuel—with initiatives that pay for themselves in less than eight months. Even absent concern about environmental impacts or government oversight, these best practices should be adopted because they enhance the productivity of mills and are good for business. Multinational apparel retailers and brands can reduce the footprint of their global supply chain by encouraging mills to adopt these best practices and rewarding those that do so with more business.

NRDC
THE EARTH'S BEST DEFENSE

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BEST OF THE BEST: INSTALL METERS AND/OR MEASUREMENT SOFTWARE TO FIND PROBLEMS AND MEASURE RESULTS

One practice underpins all others and should be adopted immediately by all textile mills: installing meters or measurement software to track water, steam, and electricity consumption at the process and equipment level, as well as for the entire mill. Meters at key locations allow mills to routinely identify and respond to leaks or detect other unusual spikes in resource use. When reported to local authorities, metering data can allow assessment of cumulative water use in water-scarce areas. And metering/measurement software provides "bottom line" efficiency data in mills, enabling retailers and brands to benchmark the performance of their suppliers and identify best-in-practice locations.

Ten Best Practices for Responsible Sourcing from Textile Mills

	Percentage Resources Saved	Cost	Payback Period
Leak detection, preventive maintenance, improved cleaning	Water: 2-5%; Energy: 1.5-5%	Insignificant	< 1 month
Reuse cooling water from singeing from air compressor system from preshrink	Energy: 1.6-1.8% Water: 2-5% Water: 2% Water: 1%	$1,500	< 1 month
Reuse condensate	Water: 2-3%; Energy: 0.8-3.2%	variable	1 month - 1 year
Reuse process water: from bleaching from mercerizing	 Water: 4% Water: 3%	$3,000 - $30,000	< 1 month
Recover heat from hot rinse water	Energy: 2-12%	$44,000 - $95,000	2 - 4 months
Prescreen coal	Energy: 3%	$35,000	5 months
Maintain steam traps	Energy: 1-5%	Insignificant	< 1 month
Insulate pipes, valves, and flanges	Energy: 0.01-0.5%	$4,500	< 1 month
Recover heat from smokestacks	Energy: 1%	$22,000	8 months
Optimize compressed air system	Electricity: 0.3-3%	Insignificant	< 1 month

CLEAN by Design

BEST PRACTICES TO SAVE WATER

NRDC's responsible sourcing initiative recommends four best practices that could save mills between 23 and 37 tons of water per ton of production—between 13 and 24 percent of total water use.

Leak detection and preventive maintenance, improved cleaning

Did you know that a 2 millimeter steam leak can result in the loss of energy equal to more than 10 tons of coal in just one year? Add up all the small leaks in a mill and quickly you arrive at considerable losses of both resources and money. Experts estimate that textile facilities can reduce resource use by as much as 10 percent with an effective leak detection and preventive maintenance program.[1] Similar or even larger savings can be expected from improved oversight of water used in cleaning operations, such as turning off hoses when they are not being actively used. NRDC's responsible sourcing initiative conservatively estimated that leaks of water and steam were responsible for between 1 and 5 percent losses of water and coal at the mills we assessed, although in fact these values could be higher based on the literature.[2] Routine investigation and repair of leaks in water, steam, and compressed air require almost no investment costs and yield instant payback.

How to adopt this best practice: Systematically and routinely check for leaks, replace and repair worn hoses, fittings, etc., and more closely monitor efficiency of water use during normal cleaning operations.

Reuse of non-contact cooling water

Because non-contact cooling water is high in quality and temperature, it can be beneficially reused for processes such as desizing, scouring, washing, or rinsing. In addition, non-contact cooling water's high discharge temperature (45°C) and volume strain wastewater treatment systems more than necessary. NRDC's responsible sourcing initiative found some mills were either not reusing this hot water at all, or were using it in cold water processes that did not benefit from the heat. We identified three sources of cooling water that can be most beneficially recaptured and reused: the singeing machines, the preshrink machines, and the air compressor system.

How to adopt this best practice: Install a water reuse system: pipes, valves, pumps, holding tanks, and a control system.

Reuse of steam condensate

Textile mills rely on a large amount of saturated steam in the dyeing process. Over the course of its use, some of that steam converts into condensed water (condensate) that is very high in temperature and purity. The most efficient use of condensate is to return it to the boiler and convert it back into new steam. However, for companies that buy their steam from an outside supplier or whose boiler is located too far from the process, the condensate can serve as water supply for washing or desizing, thereby recovering both water and heat. In three mills investigated by the responsible sourcing initiative, condensate was discharted directly to wastewater treatment without reuse. In one such mill, the drying cylinders were producing condensed water at a speed of 15 kg/h, which translated into 18,975 tons of condensed water per year—2.5 percent of the total water consumption in the factory.[3] Energy savings accruing from this option are also quite substantial.

How to adopt this best practice: Install pipes and lines to capture and return condensate.

Reuse water from pretreatment processes

The water discharged from bleaching and mercerizing machines can be collected and reused for other processes, instead of discharging it directly to wastewater treatment. The water usually meets the quality requirements for scouring after simple treatment (cleanup of fibers). Many mills in the responsible sourcing initiative investigation did not reuse water from pretreatment processes.

How to adopt this best practice: Install pipes, water tanks, and electrical pumps to store and return water to the process.

BEST PRACTICES TO SAVE FUEL

NRDC's responsible sourcing initiative recommends five best practices targeting fuel that could save mills between between 11and 31 percent of total fuel use.

Recover heat from hot rinse water

During manufacturing, large quantities of very hot water are used for rinsing. The heat from this rinse water can be beneficially captured and used to preheat the incoming water for the next rinse. This opportunity carries a relatively high initial cost, ranging between US$44,000 and US$95,000 depending on mill size and layout. But in all instances the investment pays back quickly—between two and four months.

How to adopt this best practice: Purchase a plate heat exchanger that can transfer the heat energy in wastewater to the incoming cold freshwater.

Prescreen coal

In one mill that the responsible sourcing initiative investigated, raw coal was fed into the boiler and burned on stoke chains, which allowed small sized coal to pass through the chain and be wasted. To address this loss, companies should adopt spiral coal screen technology to screen the raw coal. This device greatly increases the rate of separation of good and bad quality coal, and increases the calorific value of the fired coal.[4] The operation of such equipment is easy and the noise is low.

How to adopt this best practice: Install a spiral coal screener.

Maintain steam traps

Steam traps play an important role in maintaining efficient transportation of steam through a mill; the traps remove moisture from the steam lines and prevent further condensation, thereby preventing heat loss and reducing fuel consumption. Failed steam traps allow live steam to escape into the condensate system or even to ditches. In steam systems that have not been adequately maintained, between 15 percent and 30 percent of the traps may have failed.[5] It should be common practice to replace a steam trap as soon as it is out of order. A good rule of thumb is that leaking traps should account for less than 5 percent of the trap population.[6] In addition, steam traps should be installed at appropriate intervals (typically one about every 25 meters) in the main steam headers.[7] Half of the mills that the responsible sourcing initiative investigated had a very large number of steam traps that were not functioning.

How to adopt this best practice: Regularly inspect steam traps (monthly testing is recommended) and repair or replace broken steam traps as soon as they are out of order.

Insulate pipes, valves, and flanges

Heat loss from pipes, valves, and flanges can waste resources and reduce efficiency. Insulating the steam transport equipment is relatively inexpensive and can save fuel by reducing steam losses. According to industry data, one meter of uninsulated steam pipe could lose the energy equivalent of nearly three tons of coal annually.[9] If all the steam pipelines in a typical factory were well insulated, heat loss from steam pipes could be reduced by up to 90 percent.[10] All the mills assessed in the responsible sourcing initiative had great potential for energy saving through steam pipeline insulation; many had poorly insulated pipes, and valves and flanges were almost always completely ignored.

How to adopt this best practice: Routinely inspect and insulate all pipes, valves, and flanges in the mill. A popular insulation material is slag wool, which has good quality and high efficiency and is low in cost.[8]

Recover heat from smokestacks

A boiler can produce smoke fumes at a temperature of 360°C. NRDC's responsible sourcing initiative found that these fumes are sometimes directly discharged into the atmosphere without any capture of the heat energy. Instead, this heat can be used to pre-heat the boiler feed water or to create steam for the steam network.

How to adopt this best practice: Install a waste heat boiler which will use smokestack heat to make steam to add to the steam network.

BEST PRACTICES TO SAVE ELECTRICITY

Although electricity accounts for only approximately 20 percent of all mill energy consumption, one practice still achieved sufficient electricity savings to qualify as a best practice: optimizing the compressed air system. If this best practice is implemented, a mill would save between 2 and 59 kWh per ton of production—between 0.3 percent and 3 percent of its total electricity use.

Optimize compressed air system

Instrumentation consumes large amounts of compressed air at many individual locations in a textile mill, and it is susceptible to leakage. Compressed air leaks most commonly exist at threaded connection points, rubber hose connections, valves, regulators, seals, and old pneumatic equipment. In all, air leaks can account for 20 to 75 percent of air demand in a plant with no regular maintenance policy.[11] In addition, the working pressure of compressed air is often set according to the maximum pressure; it is often possible to reduce this pressure without any negative impacts on manufacturing. Optimizing the pressure settings saves energy and reduces the volume of air loss through leaks.[12]

How to adopt this best practice: Fix leaks in the system and check and optimize pressure settings on a regular basis (at least annually).

ADDITIONAL OPPORTUNITIES

Process Improvements

NRDC's responsible sourcing initiative ten best practices focus on improvements to factory infrastructure that provides steam, hot water, and electricity to the mill, as well as on green initiatives, such as recycling and reusing water and heat wherever possible.

An equally or greater area for improvement is *process optimization*: modifying the pretreatment, dyeing, and finishing processes themselves to use smaller quantities of water or heat. Processes can be modified to use smaller quantities of chemicals and require less rinsing, for example, and factory production planning can be improved to minimize idle machine time. Most promising is improving "right-first-time" dyeing rates, which improves profitability and on time delivery and substantially reduces the environmental impact associated with re-processing fabric to correct mistakes.

Process Recommendations
Undertake a failure analysis when things go wrong
Standardize optimal methods and recipes
Substitute enzymes technology in bleaching pretreatment
Investigate opportunities to reduce salt in individual reactive dyeing recipes
Increase reliance on higher fixation dyes
Improve machine utilization
Schedule colors to minimize extensive cleaning between each batch
Monitor continuously to check whether implementation of improvements is in place

Mill managers can choose to investigate changes in these areas themselves, with in-house project teams, or enlist the help of outside experts and consultants. Regardless of approach, here are eight promising starting points to begin investigations for improvement.

Good Housekeeping

Many mills could take significant and simple steps towards reducing waste and cost by implementing small changes on the factory floor, regardless of whether they are ready to implement NRDC's responsible sourcing initiative's best practices. These "good housekeeping" measures can be undertaken with little effort but still have big impact—as much as 5 to 10 percent savings in resources in some cases. NRDC's responsible sourcing initiative found nearly a dozen promising measures, from improving material handling and stock management to instituting regular cleaning regimes.

Good Housekeeping
Clearly mark stored goods
Demarcate special storage areas and raise floor
Use first-in, first-out system for chemical inventory
Routinely clean the workspace
Install shut-off valves to reduce running water
Improve bulk chemical preparation
Use dedicated dye scoops
Prepare chemical solutions in quantities needed
Calibrate equipment
Optimize boiler blow down schedule
Switch off lights when not in use, replace with energy efficient bulbs

HOW RETAILERS AND DESIGNERS CAN HELP

Designers and retailers should disqualify mills from business if they are in violation of environmental standards, unless they come into compliance. They should promote these best practices with their suppliers to protect the environment and help the bottom line. Designers in particular can make better selections of fibers and dyes to reduce environmental impact at the drawing board. Finally, designers and retailers can join with NRDC to craft solutions on the ground, reinforcing and expanding the capacity of environmental governance in developing countries for long-term results that could extend well beyond the impact of a single supply chain.

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3 Ibid.

4 BECO Institute for Sustainable Business. *Draft Report: Responsible Sourcing Initiative of the NRDC: ZJG Addchance Dyeing and Finishing Company, ZhangJiaGang*, page 26. Draft dated July 22, 2009

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8 Chen Liqiu *Textile Dyeing and Finishing Industry Energy saving and Pollution Reduction Technical Guidance*, Chemical Industry Press. October 2008. p 579. In Chinese.

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10 Ibid p.579

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