



The sustainable revolution in jeans manufacture

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Innovative dyeing process spares the environment, offers greater color variety and higher quality

Whether elegant or artificially aged, worn with a jacket or a T-shirt: jeans go well with almost anything. They are simultaneously a lifestyle statement, worldwide cult classic and long-selling fashion garment – with no end to the success story in sight. The statistics tell us that a US American has eight pairs of jeans, while a European comes a close second with five to six pairs. The immense number of almost two billion pairs of jeans are produced each year, claiming about 10 percent of the worldwide cotton harvest. The conventional indigo dyeing process, however, is environmentally polluting, and so Clariant has now developed, under its innovative Advanced Denim concept, a groundbreaking new dyeing process adapted to current needs that operates completely without indigo. It also needs much less water and energy, greatly reduces cotton waste and produces no effluents. Furthermore it offers a greater variety of colors, better color quality and new fashion effects. Experts are convinced: Advanced Denim will revolutionize jeans production.

Denim is the name given to the typical, tough jeans material which is produced from cotton yarn and in the conventional process is dyed blue with indigo. In its natural agglomerated form, this dye isn't soluble in water. The dye molecules first have to be separated before dyeing – this is done by reduction using the strong reducing agent sodium hydrosulfite. Because reduced indigo also adheres poorly to the cotton, dyeing has to be repeated six to fifteen times. In each of these steps, the cotton yarn is passed through a dyeing vat and then oxidized in the air to fix the dye. This process requires not only vast amounts of energy but also large quantities of water.

CLARIANT INTERNATIONAL LTD
BUSINESS UNIT TEXTILE CHEMICALS
Rothausstrasse 61
4132 Muttenz
Switzerland

WWW.CLARIANT.COM
WWW.INNOVATION.CLARIANT.COM
WWW.TEXTILES.CLARIANT.COM

National Geographic magazine estimates that 11,000 liters of water are consumed between production of the raw material and the finished jeans – a rather negative water footprint for this popular garment. Indigo dyeing also produces large amounts of cotton waste in slasher ranges because the production lines through which the cotton threads pass can be more than half a mile long. Every time the color is changed, the fibers remaining in the machines have to be disposed of. Also not very climate-friendly are the chemicals like hypochlorite and permanganate used to achieve fashionable washed-out effects in the final finishing stage.

Advanced Denim Dyeing – easier, shorter and more eco-friendly

With the revolutionary Advanced Denim technology, Clariant has now developed a more ecologically positive dyeing method. Instead of indigo, the Pad/Sizing-Ox process uses a new eco-friendlier generation of concentrated sulfur dyes such as Diresul® RDT. In the first working step – as with indigo – the dye molecule is reduced using a sugar-based reducing agent. Since sulfur dyes have a different chemical structure than indigo, they bond much better with the cotton. In the Advanced Denim's Pad/Sizing-Ox process, a single dyeing box is therefore sufficient to intensively and permanently dye the yarn. A second rinsing step is no longer necessary. The dye is then oxidized with efficient fixing agents to make it adhere. In the same immersion bath, using Arkofil® DEN-FIX the yarn is coated with layer of starch to protect it during the following stressful weaving operation. The groundbreaking technology of Advanced Denim's Pad/Sizing-Ox therefore greatly simplifies and shortens the production process.

Naturally, this considerably improves the eco-friendliness. Compared to indigo dyeing, Advanced Denim's Pad/Sizing-Ox saves up to 92 percent water, 30 percent energy and 87 percent cotton waste. Numerous practical trials have confirmed these figures. A further advantage is that there are no effluents. The innovative sulfur dye Diresul RDT has already been awarded several ecolabels for its major environmental benefits. These include the EU Ecolabel, the Oeko-Tex® Standard 100, a worldwide uniform test and certification system for textile products of all processing stages, as well as the Global Organic Textile Standard (GOTS), the world's leading standard for organic fibers, and the bluesign® standard. This is awarded for manufacturing processes geared to maximum resource productivity under environmental protection, health and safety aspects.



New scope for individual design

Besides the ecological benefits, the new Advanced Denim concept also opens up completely new possibilities for jeans design. To begin with, there is a wider range of colors: from sky blue to navy blue, from graphite gray to olive green, any desired color nuance can be obtained much more precisely and – thanks to the outstanding color fastness of Advanced Denim's Pad/Sizing-Ox – more reproducibly than ever. Designers also gain new freedom in the use of color gradients, shading, imprinting, additional colors and the popular bleached effects. With Advanced Denim, the trendy used look or vintage style can be achieved with eco-friendlier ozone and laser treatment and completely without using aggressive chemicals. Unlike conventionally dyed jeans which fade more with every wash, thanks to Advanced Denim the original color is preserved for much longer. Besides the optical effects, there is also a choice of finishing styles that make the jeans material ultra-soft, dirt resistant, water repellent or easy to clean.

The Advanced Denim's Pad/Sizing-Ox process offers jeans manufacturers not only completely new opportunities to establish a market presence with individual creations, but also many other benefits: the costs of energy and water are drastically reduced, production times and labor costs decrease. Compared to indigo dyeing corrections and changes of color are easier and quicker, which also makes smaller production runs for specific market niches more profitable. Moreover, the sulfur dye Diresul RDT has only a low sulfide content, and no unpleasant odors develop during production. The concentrated, liquid dyes are also free of heavy metals and ensure easy and safe handling during manufacture.

Extensive tests already conducted by all major textile manufacturers have shown that the Advanced Denim concept is also successful in practice. During the course of 2012, the first jeans creations produced with the revolutionary process will be entering the market. Advanced Denim is ushering in a new era of jeans production and fashion: more eco-friendly in manufacture, with more colors and new design effects. And – the favorite jeans will still look fresher than any conventionally dyed garment even after several years.



— **THE TYPE OF WEAVE** gives the denim fabric its characteristic look. Dyed warp threads run lengthwise in the fabric and most of them are visible on the outer surface of the jeans. The weft threads left in their natural state run transversely across them and face inwards.

— **THE ADVANCED DENIM PAD/SIZING-OX PROCESS** is not only more eco-friendly but also enables new design effects and greater range of colors than traditional indigo dyeing.

Chemistry EXPLAINED



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Traditional dyeing process with indigo

Firstly, cotton yarn is spun from the raw cotton. Up to 4,500 cotton threads are passed in parallel through a gigantic production line which can reach a length of more than half a mile. The yarn is pre-wetted in several vats, degreased with chemicals and cleaned. The actual dyeing process then begins – the yarn fibers are immersed in the first dyeing box. In conventional jeans manufacture, this is done using the dye indigo.

In the natural agglomerated state, indigo is not soluble in water and cannot penetrate into the fiber. Before dyeing, it first has to be converted to the water soluble »leuco-indigo«. To do this, it is »reduced«, in other words the indigo molecules are separated and take on negative electrical charges when treated with the strong reducing agent sodium hydrosulfite. This takes place in two groups of double bonded oxygen. After reduction, the molecules have only a single oxygen bond and repel each other, which makes them water soluble. During this process the indigo loses its blue color and turns yellow. As leuco-indigo, the dye now has an affinity for the cotton fiber and can adhere to it.

After dyeing, the yarn fibers are exposed to atmospheric oxygen which removes the negative charges from the leuco-indigo molecule again. The oxygen groups are returned to their original form, in other words they are oxidized, and the yellow leuco-indigo changes back to blue indigo. The dye is now fixed on the fiber. Because the cotton only absorbs the indigo slowly, depending on the desired color intensity the yarn has to pass through 6 to 15 consecutive dyeing baths to produce an even dyeing effect. In the next step, the previously added chemicals for cleaning and reduction and the excess indigo are removed in several washing boxes. The yarn fibers are now dried and in the sizing step are coated with a starch film to protect them during the following stressful weaving process.

The conventional denim dyeing process with about altogether 15 to 20 vats and strong reducing chemicals requires large amounts of water and energy and generates considerable quantities of effluents. National Geographic magazine estimates a consumption of 11,000 liters of water from production of the raw material to completion of the final garment.

CHEMISTRY EXPLAINED

Eco-friendlier dyeing process with Advanced Denim by Clariant

The Advanced Denim's Pad/Sizing-Ox process differs from traditional indigo dyeing in two main respects: firstly, a new eco-friendlier generation of concentrated, liquid sulfur dyes is used that requires only a single, sugar-based reducing agent and a single dyeing box. Secondly, only a single combined oxidation and sizing box is required. All the other production steps are eliminated.

In the first step – as with indigo – the dye molecule is reduced with the aid of an eco-friendly, sugar-based reducing agent. The reduction makes the dye water soluble, and the cotton yarn is now dyed in a single box. During the oxidation process that follows, the dye is then fixed onto the fiber through strong ionic bonds to produce the final color.

Sulfur dyes possess not only oxygen groups but also sulfur-containing functional groups. These »thiols« can crosslink both with each other and, via the fixing agent, very strongly to the fiber. Both of these together provide particularly strong color fastness and high abrasion resistance. This is why with Advanced Denim's Pad/Sizing-Ox a single dyeing box is enough to color the fiber more permanently.

As with indigo dye, the typical »ring effect« look of jeans is achieved. This means that the dyeing can be precisely controlled and the dye does not penetrate into the fiber core. Every thread consists of a colored ring with a white interior. Only this makes possible the fashionable bleached effects such as the vintage style or used look.

The innovative technology of Advanced Denim enables a more eco-friendly and much shorter production process. Compared to indigo dyeing it saves up to 92 percent water, 30 percent energy and 87 percent cotton waste. Moreover, it produces absolutely no effluents.



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— **UP TO 4,500 COTTON THREADS** are passed in parallel through giant production lines that can reach a length of more than half a mile.

— **BEFORE THE SPINNING PROCESS BEGINS**, the cotton fibers are sorted and straightened into a strand of parallel fibers to achieve the greatest possible evenness in the later yarn.

INFORMATIVE LINKS

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