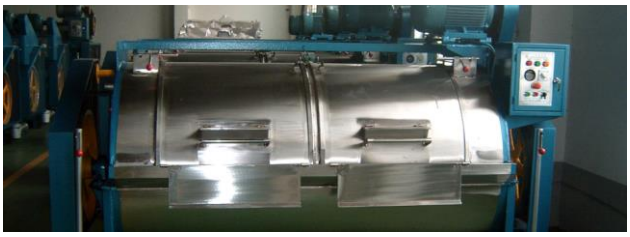
BEST TECHNOLOGY: OZONE BLEACHING OF DENIM

BACKGROUND AND EXPLANATION

Global demand for denim products is huge and it has been estimated that, the average pair of jeans requires 42 litres in the laundry washing stage.

The warp threads of denim are dyed to a very dark blue shade and the garments are washed/bleached to achieve the desired shade – which can vary from dark navy to almost white – and the amount of bleaching chemicals and washing processes varies from colour to colour.

There are two basic types of denim washing machine with the more modern front loading machines using less water than the older, simpler belly washers.



Belly washer

Front loading washer

There are several ways to achieve the overall (as opposed to localised) wash down of denim garments including detergents, pumice stones, enzymes or chemical bleaching agents (such as Sodium Hypochlorite, Potassium Permanganate and, to a lesser extent, Hydrogen Peroxide and Laccase enzymes).

Over 75% of bleached denim, where a significant reduction of the depth of shade is required, is produced using the oxidative bleach Sodium Hypochlorite as the bleaching agent. Sodium Hypochlorite is an effective bleaching agent but the garments smell unless they are subjected to an 'anti-chor' process, usually using sodium bisulphite, and rinsed repeatedly. The effluent from the process contains chlorinated species that can be difficult to remediate.

Ozone (O_3) is a very strong oxidising agent that can be used to provide all over bleaching of denim garments in a closed, batchwise operation.

Ozone is generated on-site by applying, typically electricity or UV radiation to oxygen (O_2) and this is fed into the washing machine for processing.

Because ozone is a gas the garments only have to be moistened for the process to be effective and this significantly reduces the water requirement. After the ozone bleaching process has been completed the garments require one or two standard washes to remove residues of ozone and the residues of the bleached indigo dye.

Denim fabric has a blue warp and white weft and denim garments typically have white pocket bags and are sewn with white or yellow threads. Typical washing process, even those using bleach, can cause back-staining of loose blue dye onto white yarns in the fabric, white pocket

bags and threads resulting in aesthetically displeasing results. Ozone bleaching is regarded as being very good in terms of low levels of back-staining.

Although ozone is a gas, it is denser than air and will settle in machine unless there is a means of achieving uniformity of the atmosphere within a machine. Ozone is highly reactive and can cause severe damage to machines, seals, plastics, pipes etc. Therefore installations must have appropriate materials with appropriate automated safety devices.

ADVANTAGES OVER TYPICAL BLEACHING PROCESS

- Bleach process is damp – much less water used
    - Some machinery manufacturers are promoting dry ozone treatments (these still require post-bleach wash-off)
- Fewer chemicals used in bleaching
    - Ozone ultimately degrades to oxygen and requires no liquid effluent remediation
- Ozone bleaching process is faster than sodium hypochlorite bleaching so processes can be shorter
- Fewer post-bleach wash baths required
    - Less water used
    - Less energy required to heat water
    - Lower volume of effluent / lower effluent loading
- Shorter bleach process and reduced number of wash baths means overall processes are shorter and machines are more productive
- Reduced back-staining
- Machines must have excellent controls and therefore batch to batch reproducibility is generally good
- No AOX (adsorbable organic halogens)

WHEN SHOULD OZONE BLEACHING BE PROMOTED?

Ozone bleaching can be a very low impact and equally effective bleaching process compared to sodium hypochlorite bleaching, so in principle it can and should be promoted.

However in practice, it should be ensured the risks of ozone exposure have been minimised and automated safety devices have been installed.