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[1] http://lcacopenhagen.setac.eu/embed/Copenhagen/programme_abstracts_book_31102012_v2.pdf

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Using life cycle assessment to document sustainability benefits of enzymes applied in the leather industry

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The leather industry is highly developed but also an industry generating substantial amounts of solid waste and waste water with high levels of BOD, COD, nitrogen, and sulfides. As for many other industrial operations, the energy and auxiliaries used in leather tanneries contribute to global warming, acidification, photochemical oxidation, and other environmental impact categories.

The unhairing process in which hair is removed from raw animal hides is known to be one of the most polluting processes in leather manufacturing, mainly due to the use of lime (generating sludge for disposal) and sulphides (resulting in toxic waste water).

Enzymes (biological catalysts) can be used to reduce the use of lime and sulfides (among other things) in the unhairing process but the right mix of enzymes balanced with the right mechanical processing is key to achieving satisfactory results.

The present LCA considers the environmental implications of shifting from conventional unhairing to an alternative enzymatic concept known as Beamhouse Biosolutions Bovine. In the conventional process, hair is chemically dissolved (hair-burn) and, in the enzymatic process, hair is primarily loosened and removed by filtration (hair-save). The functional unit of the LCA is the unhairing of 1 ton of bovine hides.

The study was conducted when the enzymatic concept moved into full scale production optimization in a modern European tannery during 2011. At that point, the enzymatic concept provided leather quality results satisfactory for upholstery and furniture. The LCA was conducted at this stage to allow for environmental considerations during the final process optimization and to develop solid documentation of the environmental implications of shifting to the enzymatic concept. Following the completion of the LCA, the enzymatic concept has been further developed to become a more broadly applicable process for most leather types, incl. leather for shoes and for the fashion industry. Process changes mainly concern the mechanical part of unhairing where rotation of the drums in which hides are being unhaired has been reduced. This only has a minor influence on the LCA.

The enzymatic concept reduces lime sludge generation in the tannery by more than 50%. The sulfide concentration in the waste water discharged directly from the unhairing processes (tested prior to waste water treatment) decreases by 70% and ecotoxicity of the untreated waste water is reduced by a factor of more than 10. The enzymatic process decreases BOD, COD, and N in the sludge phase of the waste water but not significantly in the water phase.

In a life cycle perspective, the enzymatic process reduces contributions to global warming, acidification, eutrophication, and photochemical ozone formation (smog). Fossil energy and water use is also reduced. At the present developmental stage of the enzymatic process, there is a trade-off in agricultural land use but realistic optimization of enzyme production would reverse this trade-off.

Using the hair by-product from the enzymatic process for energy production could provide further environmental benefits.

The LCA has been reviewed in accordance with the ISO standard by a panel of three experts and now serves as documentation for how pollution from the leather industry can potentially be substantially reduced. The case study thereby illustrates how LCA can be used to create awareness about new and cleaner technology.