Bio-based chemicals for leather processing

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Climatic change and global warming have been identified as major threats to sustainable development. With the European Green Deal, the EU has committed itself to net climate neutrality by 2050, that implies a significant reduction in greenhouse gas emissions of 55% by 2030, in comparison to 1990.

Why renewable carbon in chemicals?

About 85% of the carbon used for the production of organic chemicals or derived materials comes from fossil sources1. The use of renewable carbon, therefore, is a global trend in the chemical industry and an important step towards achieving carbon neutrality. By using renewable feedstock, greenhouse gas emissions associated with the production of chemicals are reduced substantially. A major part of embedded carbon in industrial or consumer goods, including leather chemicals or leather itself, eventually finds its way into the atmosphere as CO_2. When working with fossil feedstock, the carbon used was bound in the earth, and its release therefore implies a strongly negative carbon balance. Renewable raw materials based on vegetable or animal feedstock have a much better carbon footprint: plants are binding CO_2 from the atmosphere, and livestock is fed on a natural diet. Consequently, by changing to renewable raw materials, the inflow of CO_2 into the atmosphere is actively stopped.

The question of time

Due to the relative longevity of leather articles, leather chemicals have an advantage over other process chemicals. Notably, the release of carbon only takes place at the end-of-life of an article. In the case of leather, this can be many years, if not, in exceptional cases, many decades. In this context, the achievement of high leather quality with good fastness, an appealing look and durability, is directly related to sustainability – the longer the leather article is used, the longer the time before the carbon is released back into the environment. Nevertheless, using renewable carbon does improve the carbon footprint in leather.

What type of raw materials and products are used for bio-based leather chemicals

Historically, leather production was based on bio-based feedstock. Tanning with vegetable extracts has been practised for thousands of years and has been constantly refined. Enzymes of sometimes odd sources have been used for bating and unhairing, not to mention natural oils, dyes and fillers that have always been present in leather processing.

In modern leather chemicals, the trend for natural components is coming back. Natural oils are the base for emulsifiers and fatliquors, which are used to clean, degrease or soften the leathers. The know-how is that essentially, the processing is done by replacement with carbon-free or low-carbon components. Normally, oils are not used directly, but in a highly processed step. Fatty alcohols or fatty acids are the precursors for many components, which are of interest for leather processing, for fatliquors, emulsifiers or even monomers for polymeric softeners. These precursor molecules are esterified, condensed or etherified, in order to impart the type of functionality needed for leather processing. The resulting products might be considered as synthetic but can be based on fully natural components.

There are also interesting examples of molecules, which come with 100% bio-based carbon. Alkyl polyglycosides (APG) have been introduced as leather degreasing agents. These products are made from corn starch and purified vegetable fatty acids and are very good examples that excellent performance and 100% renewable carbon can go hand in hand. APGs are used in various modern degreasing

and washing agents, often in synergy with classic surfactants. Another example is phosphoric esters, which use carbon-free phosphoric anhydride as a reactant. When the fatty alcohols used as precursors are bio-based, the final molecule has 100% bio-carbon.

Bio-based components are also part of many other types of leather chemicals. Retanning agents containing amylose, cellulose or lignin components as well as products based on functionalised proteins are examples, which have been refined in recent years. Highly specific enzymes have replaced many traditional preparations and are used in many steps of the beamhouse process. Also cost-wise, bio-based chemicals can nowadays often compete with fully synthetic products.

One important subject in the development of new bio-based leather chemicals is to achieve the same quality that tanners are used to with the use of synthetic, fossil-based materials. One example is natural fatliquors, which, due to the presence of double bonds, in many cases give more yellowing and oxidation than synthetic ones. However, in last decades with the use of specific man-made antioxidants and techniques for the pre-oxidation of oils, the propensity to yellowing has been significantly reduced. The use of the concept of extended surfactants is another new possibility to make use of fully saturated carbon chains for highly resistant chemicals. It is fascinating that these new and complicated molecules, which are made by complex chemical synthesis, originate from a great proportion of materials of natural origin.

Contradictions

A common misunderstanding regarding bio-based chemicals is that they would, per se, be more sustainable. The use of renewable carbon in all sorts of industrial activity is certainly a fundamental necessity for slowing down climate change, but “Climate Action” is in fact only one of 17 UN goals for sustainable development. Excessive land use, monoculture, the production and use of fertilisers, or excessive water use for farming do have a clearly negative impact on overall sustainability. Life cycle assessment is used to quantify various impact characteristics and thus gives a more holistic approach for decision making regarding the sustainability of products. Although the quality of data is still not good enough, LCA can be a good tool for comparing specific products for the same usage area.

Outlook

More than 70% of the carbon footprint of the chemicals industry originates from indirect, Scope 3 emissions. More than half of these emissions are attributed to the raw materials used in production. Although for a precise calculation, data is still lacking, but it is already perfectly clear that the chemical industry is not going to reach climate neutrality without shifting to a substantially higher percentage of renewable feedstock. For the tannery and the leather itself, the use of products made from bio-based carbon brings the big benefit of further improving the carbon footprint of leather. In the end, it seems only logical to combine natural leather with a chemistry made with bio-based raw materials.

References:

1. *https://renewable-carbon.eu/publications/product/turning-off-the-tap-for-fossil-carbon-future-prospects-for-a-global-chemical-and-derived-material-sector-based-on-renewable-carbon/*