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Approaches for chromium recovery from leather processing residues

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Leather products need to be tanned before further processing. The most commonly used method is tanning with chromium(III) salts. World consumption of chrome tanning agents is 500,000 tonnes per year (Maraz, 2021). Chromium-containing shavings are a by-product of the cutting of semi-finished leather products. In Germany, about 4,500 tonnes of shavings are produced annually, while the global production is about 60 times higher (Kamaraj, 2016). Only a fraction of the shavings is used to make leather fibre materials for wall coverings, shoe soles and flooring, the majority is disposed of. In addition to landfilling, the shavings are incinerated, resulting in a loss of chromium through incorporation into the slag. A new approach is being developed using organic leather components to produce biogas and recover the chromium from the digestate. It is intended that the recycled chromium will either be returned as a leather tanning agent or evaluated for alternative uses, such as ferrochromium in the steel industry (Figure 1).

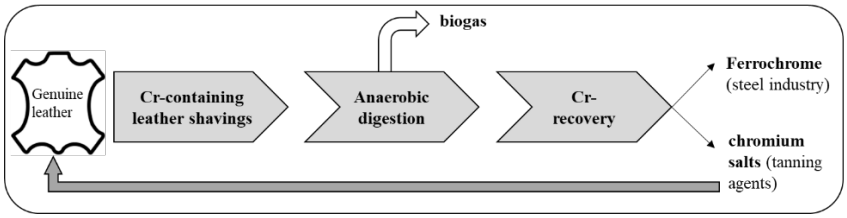

Figure 1. Material and energetic use of chrome containing leather shavings.

The chromium oxide content in the shavings was determined by ICP-OES to be 4.1% (Table 1).

Table 1. Chemical composition of Cr-containing shavings.

Constituent	***Mass %***
Water	52.4
Organics	93.5
Inorganics	6.5
Chromium oxide, Cr_2O_3	4.1

The basic concept of the new process is to maximise the use of the waste leather fraction while preventing the formation of Cr(VI). In the first stage, the shavings are digested microbiologically, producing biogas. Under ideal process conditions, the chromium remains completely bound in the solids of the digestate and is not released into the liquid phase. Subsequent thermal hydrolysis, ultrasonic disintegration and alkaline hydrolysis were investigated to mobilise chromium. For these purposes, the bonds between collagen and chromium need to be broken to recover it, e.g. as $Cr_2(SO_4)_3$. None of the above methods allowed complete release of Cr^{3+}, so a thermal utilisation of the chromium-containing digestate was tested. After incineration at 950°C, the loss on ignition was 97%, leaving 3% Cr_2O_3 as residue. Conversion of the latter with iron oxide waste and Si wafer scrap at 1600°C yields a FeCrSi alloy which is a Cr(VI)-free high quality additive in the steel industry, a use which helps to save natural resources and reintegrate Cr into the raw material cycle.

References

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