ALTERNATIVE FUELS

(651) - (*) - ENERGETIC VALORISATION OF TANNERY SLUDGES BY GASIFICATION IN FLUIDISED BED

Massimo Urciuolo (Italy)[1]; Renata Migliaccio (Italy)[1]; Giovanna Ruoppolo (Italy)[1]; Marco Balsamo (Italy)[2]; Edoardo Imperiale (Italy)[3]; Daniela Caracciolo (Italy)[3]; Fabio Montagnaro (Italy)[2]; Francesca Di Lauro (Italy)[2]

1 - Istituto di Scienze e Tecnologie per l'Energia e la Mobilità Sostenibili, Consiglio Nazionale delle Ricerche, Piazzale V. Tecchio 80, 80125 Napoli, Italy; 2 - Dipartimento di Scienze Chimiche, Università degli Studi di Napoli Federico II, Complesso Universitario di Monte Sant'Angelo, 80126 Napoli, Italy; 3 - Stazione Sperimentale per l'Industria delle Pelli e delle Materie Concianti, Comprensorio Adriano Olivetti - Via Campi Flegrei 34, 80078 Pozzuoli, Italy

Draft Paper

The Italian leather industry counts about 1,200 companies. Italy, in 2019, produced 128 millions of m^2 of finished leathers for a production value of 4.9 billion euro, of which 3.6 billion euro accounts for export. The huge volume of sludges generated by the leather industry, with a yearly global production of solid wastes deriving from the tanning process estimated to be on the order of 10^7 ton, poses economic and environmental issues associated with their landfilling, mainly due to the relevant amount of chemicals adopted in the tanning process. In the circular economy perspective, the valorisation of the organic content of tannery sludges to produce energy vectors is a promising strategy to overcome the above mentioned issues.

In this scenario, gasification is a viable option to obtain a flexible gaseous stream (syngas) of energetic value, under operating conditions that do not favour the oxidation of Cr(III) (typically found in tannery sludges) to the harmful Cr(VI) state. To this end, and by also considering the very limited information in literature for this specific process, an industrial tannery sludge was characterised through proximate/ultimate analyses, and determination of heating value, witnessing its capability to act as solid fuel in a gasification process, and metal analyses, showing its Cr(VI) content below the detection limit (2 ppm). The material has been submitted to gasification tests in a lab-scale fluidised bed (FB) reactor. The reactor, 41 mm ID and 1 m height, was electrically kept at the operating temperature of 850°C. The fluidisation velocity was 0.30 m/s at 850°C, i.e. 7.5 times the minimum value. The gasifying stream was composed by O_2 (3% vol.) diluted in N_2. The equivalence ratio (ER) ranged from 0.15 to 0.24, so to ensure sub-stoichiometric (i.e., reducing) conditions in the FB atmosphere.

Under the most reducing operating conditions, it was possible to produce a syngas with lower heating value of 12.0 MJ/Nm^3 (dry and N_2 free basis), in line with values commonly reported for syngas for energetic purposes. It contained, under these conditions, about 42% H_2, 36% CO and 4% CH_4, plus 16% CO_2 and other components. The tar produced from the process, fully characterised by GC-MS, showed a favourably low concentration of about 25 g/Nm^3.

In the view of a full characterisation of the process, and for foreseeing application routes for the produced solid streams, bottom and fly ashes were in particular analysed for their carbon and metal contents. In bottom ash, the total Cr concentration resulted in the range 8–12 g/kg (this value, in the parent sludge, was about 21 g/kg), with Cr(VI) concentration between 8 and 10 ppm. In the elutriated stream, the total Cr concentration was about 55 g/kg, with Cr(VI) concentration between 4 and 7 ppm. The Cr(VI) concentration was higher when higher values of ER were used, but it resulted 3–4 orders of magnitude lower than the total Cr concentration, witnessing the appropriateness of the process for the production of a syngas with very limited oxidation of chromium in the solid residues.

Palavras-chave : Tannery sludges, Gasification, Fluidised bed, Syngas, Chromium