Comparison of Alternative Techniques to Quantify Cellulose Decomposition in Landfills

Douglas E. Jerger Ph.D., Shaw Environmental & Infrastructure, Inc.
douglas.jerger@shawgrp.com
Morton A. Barlaz Ph.D., North Carolina State University, barlaz@eos.ncsu.edu
Gary R. Hater, Waste Management, Inc., ghater@wm.com

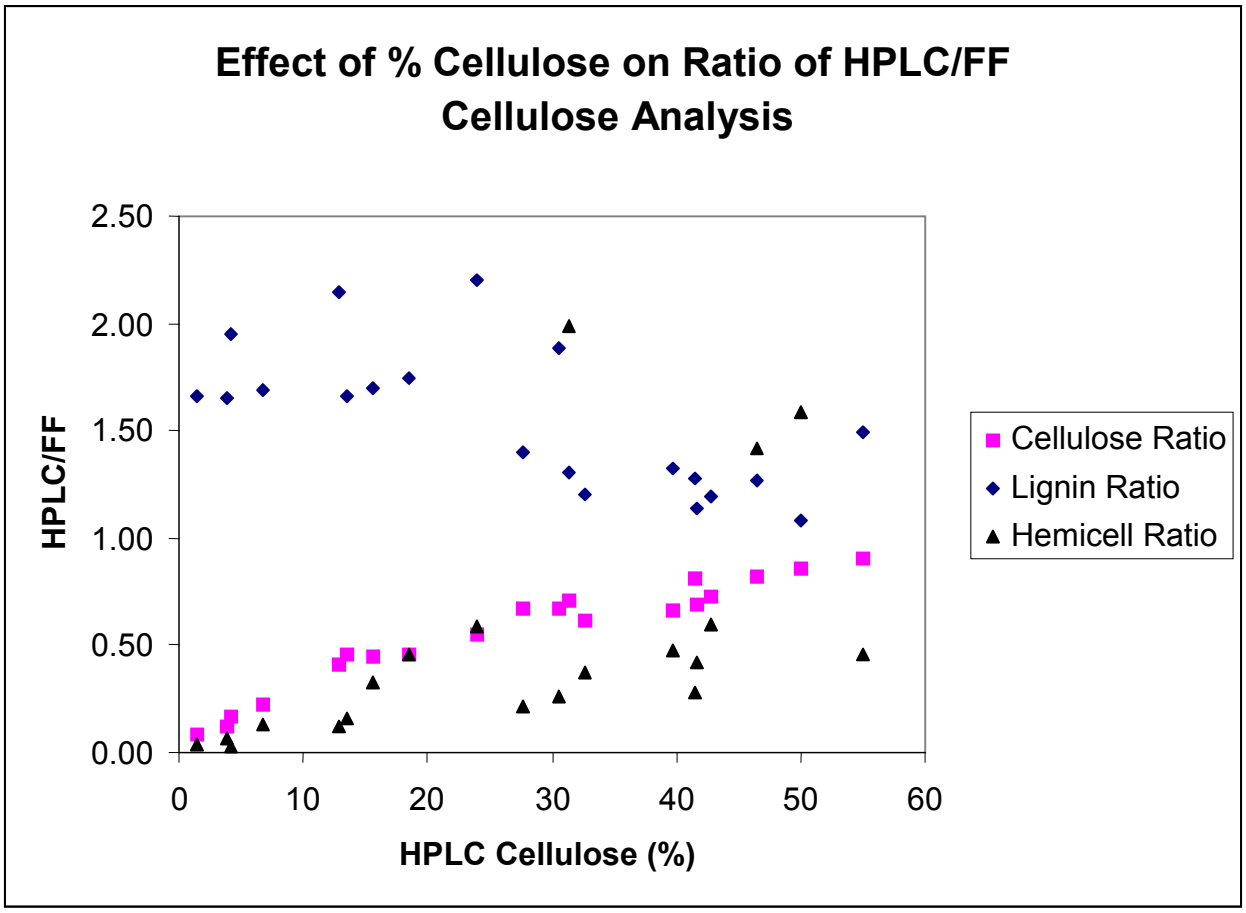
Paper, food waste and yard waste are the major biodegradable organic constituents in municipal waste. On a chemical basis, the dominant organic chemicals are cellulose, hemicellulose and lignin. The biodegradation of cellulose and hemicellulose in landfills is well documented while lignin is recalcitrant under the anaerobic conditions that dominate landfills. In addition, the presence of lignin inhibits some cellulose and hemicellulose biodegradation.

One strategy for evaluation of the degree to which refuse is decomposed is to measure the extent of solids decomposition. This can be done by measurement of the concentrations of cellulose, hemicellulose and lignin and by the cellulose plus hemicellulose to lignin this ratio. This ratio eliminates the concern that samples have been diluted by cover soil.

There are a number of techniques for cellulose and hemicellulose analysis. Detergent forage fiber (FF) analyses were developed to determine the digestibility of animal forage and to estimate their cellulose and hemicellulose content. Using FF analysis, cellulose is calculated as the difference between acid detergent fiber (ADF) and lignin. Implicit in this technique is the assumption that the ADF digestion procedure dissolves away all non-cellulose and non-lignin material. More recently, HPLC methods were developed for measurement of cellulose and hemicellulose. In the HPLC method, a solid sample is digested in strong acid and the polymeric cellulose and hemicellulose are converted to soluble sugars that are then quantified directly. The objective of this study was to compare the detergent fiber and HPLC methods.

Organic composition analyses by HPLC and detergent fiber methods were performed on selected landfill and forage fiber samples. As illustrated below, the detergent fiber method resulted in consistently high cellulose content in comparison to the HPLC method for the landfill samples. The detergent fiber method assumes the digestion procedure dissolves all the non-cellulosic material. However, MSW contains material such as rubber, leather and plastics that are not dissolved in the digestion. The fraction of these materials increases as the material stabilizes, thus underestimating solids decomposition. As illustrated below, the discrepancy between the HPLC and FF methods increased as the cellulose content decreased.

Given the variety of materials in MSW, it is critical to understand the basis for analytical procedures to be applied. Analytical techniques developed for forage fiber compositional analysis may be inaccurate when applied to a heterogeneous material such as MSW**.** The overall cost of collecting samples from landfills is an important consideration when evaluating less expensive analytical techniques.



Additional Reading

Barlaz, M. A., Ham, R. K. and D. M. Schaefer, 1989, "Mass Balance Analysis of Decomposed Refuse in Laboratory Scale Lysimeters," Journal of Environmental Engineering, ASCE, 115, 6, p. 1088 - 1102.

Wang, Y.-S., Byrd, C. S. and M. A. Barlaz, 1994, "Anaerobic Biodegradability of Cellulose and Hemicellulose in Excavated Refuse Samples," Journal of Industrial Microbiology, 13, p. 147 - 53.

Eleazer, W. E, Odle, W. S., Wang, Y.-S. and M. A. Barlaz, 1997, "Biodegradability of Municipal Solid Waste Components in Laboratory-Scale Landfills," Env. Sci. Technol., 31, 3, p. 911 - 17.

Mehta, R., Barlaz, M. A., Yazdani, R., Augenstein, D., Bryars, M. and Sinderson, L., 2002, "Refuse Decomposition in the Presence and Absence of Leachate Recirculation," J. Env. Eng., 128, 3, 228-236.