

A biorefinery approach to produce biobased FDCA and MEG, the building blocks for the next generation polyester PEF

Ed DE JONG

Avantium Chemicals BV, Amsterdam, the Netherlands;

Keywords: PEF, FDCA, 2nd generation glucose, Humins, Furfural, Methyl Levulinate, Polyester

Avantium Chemicals (www.avantium.com) explores novel furan (YXY) chemistry, focused on efficient and low cost conversion of C6 sugars into derivatives of the promising chemical key intermediate hydroxymethylfurfural (HMF) in the presence of a homogeneous or solid acid catalyst.

For more than a century, HMF has been seen as the “sleeping giant, a key substance between carbohydrate chemistry and mineral oil-based industrial chemistry”, guarding the large application potential for furan based products. HMF can be produced from monosaccharides such as fructose and glucose by acid catalyzed elimination of 3 molecules of water. Avantium is developing a breakthrough technology to convert 1st as well as 2nd generation feedstocks into Furans. HMF derivatives can now be obtained in high yields from carbohydrates (sucrose, starch or cellulose) and make very interesting building blocks for biopolymers. The most interesting building block for polymers derived from HMF/MMF is a molecule called FuranDiCarboxylic Acid, abbreviated FDCA. FDCA can be used as building block for a wide range of applications including polyesters such as PEF, polyamides, resins and plasticizers [1]. FDCA is not the only product produced during the YXY process, also methyl levulinate as well as humins are interesting side-streams [2,3,4]. YXY’s main building block, FDCA can be seen as a replacement for terephthalic acid (TA), a petroleum-based monomer that is primarily used to produce PET. PEF is a next-generation polyester that offers superior barrier and thermal properties, making it ideal material for the packaging of soft drinks, water, alcoholic beverages, fruit juices, food and non-food products. Therefore PEF is the 100% biobased alternative to PET. Currently, Avantium is working to bring 100% biobased PEF bottles to the market and intends to commercialize the YXY process in a Joint Venture together with BASF. The production of the other building block mono-ethylene glycol (MEG) via ethanol is relative costly and at current oil prices not competitive. So Avantium also developed an alternative hydrogenolysis route to produce MEG cheaper and much more carbon efficient. In the longer term brand-owners want to have the option to choose between 1st and 2nd generation feedstocks, therefore, Avantium has also developed a pretreatment technology to convert 2nd generation feedstocks in a “pure” glucose stream.

In this presentation particular attention will be given to produce “pure” 2nd generation glucose, to produce FDCA and MEG and into the technological superior properties of PEF.

- [1]. de Jong, E., Dam, M.A., Sipos, L., Gruter G-J.M. (2012) Furandicarboxylic acid (FDCA), a versatile building block for a very interesting class of polyesters. *ACS Symposium Series "Biobased Monomers, Polymers and Materials"* (eds Smith, P.B. and Gross, R.) 1-13. DOI: 10.1021/bk-2012-1105.ch001
- [2]. van Putten, R-J., van der Waal, J.C., de Jong, E., Rasrendra, C.B., Heeres, H.J., de Vries, J.G. (2013) Hydroxymethylfurfural, a versatile platform chemical made from renewable resources. *Chemical Reviews* 113:1499-1597.
- [3]. Pin, J-M., Guigo, N., Mija, A., Vincent, L., Sbirrazzuoli, N., van der Waal, J.C. de Jong, E. (2014) Valorization of bio-refinery side-stream products: from humins to biobased composites. *ACS Sustainable Chem. Eng.* 2:2182-2190.
- [4]. van der Waal, J.C., de Jong, E. (2016) Avantium Chemicals: The High Potential for the levulinic product tree. In: *Industrial Biorenewables, A Practical Viewpoint*. Edited by P. Domínguez de María. pp.97-120. DOI: 10.1002/9781118843796.ch4