Summary Chemistry Sessions

Biobased aromatics & Process Intensification

Monday 17 – Tuesday 18 October 2016

Within the "CHEMISTRY" theme at i-SUP2016, the participants discussed 1) the role the chemical industry has in delivering technological solutions to the challenges facing society today and in addressing the new market needs, and 2) how the chemical industry can support sustainable development.

In a first session held on Monday October 17th, the 14 lectures that were presented demonstrated that **biobased aromatics** can play an important role in improving sustainability and that their use often leads to stronger and better performing materials with less health and safety issues. The "biobased aromatics" journey at i-SUP2016 started from a chemical perspective over the clustering and supporting actions to a climax in the afternoon focusing on applications and ending with two implementations in the Port of Antwerp, which is in the middle of the Antwerp-Rotterdam-Rhein-Ruhr area. This areas forms one of the biggest chemical megaclusters in the world and this area has a need for smart specialization and innovation. One of these smart innovation strategies is based on innovative, better performing, safer, environmental-friendly, biobased aromatic molecules for the chemical and manufacturing industry.

The "bioaromatics" session could be summarized as follows:

- FISCH (Flanders Innovation Hub for Sustainable Chemistry) presented the way in which they support the bioaromatics initiative and its importance for the chemical industry.
- The European Commission stated that the Strategic Smart Specialisation Platforms should lead to European Strategic Cluster Partnerships via the implementation of Networked Demonstrations with support of the EIB Investment Platforms.
- The Public Private Partnership BBI (BioBased Industries) gave a strong support to the bioaromatics initiative and stated that it expects further development into materials and end products.
- To demonstrate the importance of functionalized molecules, Thomas Farmer (University of York) presented lignin in the middle of the hydrogen/oxygen curve, thereby indicating the advantage of making functionalized molecules with less materials and energy.
- Bert Sels (KU Leuven) showed the advantage of treating wood directly leading to well-defined mixtures with a limited number of specific alkylfenols.
- Ludo Diels (VITO) showed the developments in separating aromatic fractions originating from several processes.

- Brazil, developing its R&D strategy via a unique data management system, has a strong emphasis on 2nd generation (2G) ethanol with special attention to energy cane and the need to develop valorization of lignin. Canada indicated biobased chemicals as being absolutely the key to make business from lignin. This was fully supported by Stora Enso in explaining their strategy to transform pulp & paper into biomaterials.
- Biochemtex showed that they could upgrade lignin to aromatics especially from 2G ethanol and from the pulp and paper industry. TFC showed the transformation of molasses to furfural and further to polyfurfurylalcohol for the foundry industry as well as for new applications such as resins for wood upgrading. Kebony uses the same furfurylalcohol to transform softwood into tropical hardwood. Scion showed the development of ligate, a formaldehyde-free resin made from lignin as such, that is used to make low formaldehyde-emitting plywood.

All participants, as well as those that indicated their interest to participate but could not make it to Antwerp, were (and are still) invited to send their ideas and suggestions to set up complete "bioaromatics" value chains leading to commercial materials and/or products. Some concrete projects under preparation were mentioned, such as the Marie-Curie ITN-EID project, the BMBF-project and the pilot project of Vanguard. Finally, the whole group of participants was invited to become member of the "Biorizon" community on www.biorizon.eu/community and to participate at the Biorizon annual event on December 1st, 2016 in Bergen-op-Zoom, The Netherlands.

In a second session held on Tuesday October 18th, the 11 lectures that were presented focused on the (future) challenges of a sustainable chemical process industry and on how to redesign processes making use of alternative feedstocks, new conversion processes and more integrated systems using the proper **process intensification technology**. The following main "take home" messages could be formulated:

- Cefic demonstrated that SPIRE is a unique cross-sectorial PPP and is running at full speed.
- According to Deloitte, the next industrial revolution is underway: "Industry 4.0" opportunities are transforming the way we operate and grow the business. To succeed, companies have to build new skillsets, capabilities, and a partnership ecosystem across functional domains and solution layers.
- Tom Van Gerven (KU Leuven) showed that process intensification is a revolution, not an evolution (intensification versus optimisation). Process intensification technologies (also) have to go through a technology maturity ("learning") curve ➔ "faster learning", however. Alternative energy forms have a great potential, particularly in flow technologies.
- Bioprocesses might have challenging economics, but it was overcome by Green Biologics by utilising the unique characteristics of solventogenic Clostridium (combined with solvent removal).

- Flowid explained that “Spinning is winning”!: micro mixing enhances mass and heat transfer ➔ this enhances conversion, selectivity, efficiency, safety, … The spinning disc reactor/extractor can be a continuous processing alternative for every unit operation.
- Agfa showed that flow chemistry processes (e.g. for bromination, azides) add to safety and process intensification, because they increase energy efficiency, avoid the production of derivatives, provide less hazardous synthesis, and maximise atom efficiency.
- Competitive biotechnologies can be developed that allow the expansion of the renewable chemicals portfolio (e.g. green polyethylene, green polypropylene). For this purpose, enzymes and metabolic routes are changed by Braskem using synthetic biology (metabolic engineering).
- Bioprocess platforms can benefit from process intensification … but high effort is needed to commercialise a product of industrial biotechnology. Thyssenkrup’s experiences to enhance success:
  - Develop your market early;
  - Collaboration along the value chain is essential;
  - Successful bioprocesses should be smart;
  - Rather scale down than scale up.
- VITO explained that membrane reactor integrated systems offer opportunities for highly diluted systems (e.g. macrocyclisation):
  - Same/higher yield and purity compared to highly diluted batch processes can be reached;
  - Reduced solvent usage can be obtained (reduced process mass intensity);
  - Shorter time to market in product development stage (no need for pilot scale).
- Avantium elaborated on how electrochemistry in a biorefinery offers opportunities (e.g. furanics), particularly for regimes that are not accessible to conventional catalysis or chemistries:
  - Target specific molecules;
  - Where number of process steps can be reduced;
  - Where the amount of waste can be diminished.

Overall, it could be concluded from both “CHEMISTRY” sessions at i-SUP2016 that investment in innovation and new technologies/products will enable chemical companies to develop sustainable solutions for society as a whole, which can deliver the sustainable innovation that Europe needs for boosting competitiveness and for achieving more jobs and growth. Sustainable chemistry research and innovation actions not only provide Europe with raw materials for products as well as consumer products, it also leads to the development of advanced materials and advanced process technologies that enable more flexible production with more efficient use of energy, feedstock and water. Furthermore, it contributes to improving recyclability and increases the use of renewable feedstock.