Wood Chemistry – Challenges and Opportunities during 50 years

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A personal review is given of developments in wood chemistry during the last 50 years.

Wood chemistry was established as a strong scientific field in the 1960's, thanks to work by great scientists, mainly in Sweden and in the USA. The fundamental structures of cellulose, hemicelluloses, lignin and extractives were established already then.

My research adventures started with my diploma work at ÅA 1966–67, and was followed by with work on carbohydrate-metal complexes. New analytical opportunities emerged in the 1970's with the development of new instruments such as GC-MS and NMR.

In 1971, an industrial research project was started on tall oil, containing also birch constituents. Our team made detailed component analyses, mainly by GC-MS with glass capillary columns. In 1973 we came up with a new technical concept for refining crude tall oil prior to distillation: a process for selective separation of sterols and other non-acidic components by extraction with certain solvents. The process was developed further in pilot-plant scale, until a new full-scale process unit was built in 1977. After my PhD thesis "Constituents of tall oil" in 1978, my focus was laid on toxic components in pulp mill effluents.

After the oil crisis in the 1970's much effort was put on wood chemistry. At the same time the synthetic polymer/plastic industry was developing fast. Utilisation of wood for natural chemicals and materials was a key topic. Still, most of wood chemistry was focused on understanding the chemistry of chemical pulping and bleaching. Environmental concerns also demanded studies on chlorinated lignin and related toxic compounds in mill effluents. A special challenge was the discovery of mutagenicity in chlorine bleaching effluents. This became my challenge during an 18-month-long visit at Paprican in Montreal: to isolate and identify the key mutagenic compound(s). After 11 months, our team was successful: we found a new chlorinated hydroxy furanone, shortly named MX, which contributed to the main part of the mutagenicity.

Back at ÅA in 1981, as professor of Forest Products Chemistry, my work continued on toxic chlorinated compounds. Some new challenges arose: recycled fibres, pitch deposits, the yellowing of lignin in pulps, and fibre and paper chemistry. During a year as visiting professor at North Carolina State University in Raleigh,, my challenge was to find means of retarding the yellowing of chemithermomechanical pulp (CTMP). The problem was not solved by us, and to this day, has not been solved by other researchers, either. However, a major breakthrough in 1985, was the identification of MX as the main mutagen also in drinking waters by our group.

Fibre and paper chemistry became our main research at the late 1980's. Closure of water systems lead to accumulation of dissolved and colloidal substances (DisCo´s) in process waters, causing runnability problems on paper machines. The main substances released from fibres were found to be hemicelluloses, pectins and extractives (pitch components). The role of hemicelluloses and pectins was especially interesting.

In 1998, a new discovery was made in our group: knots, i.e. branch stubs inside the tree stem, contain extremely high concentrations of various bioactive polyphenols. Of particular interest was the lignin HMR (hydroxymatairesinol) found in spruce knots. We developed a process for the separation of knots from industrial chips, and in 2006, the production of HMR began, by the Swiss company, Linnea SA. HMR is still today marketed as a nutritional supplement (www.hmrlignan.com).

In the 2000's the concept of Forest Biorefineries has emerged all over the world. There are many opportunities for less traditional pulp and paper products, e.g., biofuels, GGMs and xylans and lignin products. Extractives represent an Eldorado of bioactive compounds with a multiple of potential applications. Focus has turned to developing kraft/sulfate pulp mills to "bioproduct mills", however, with limited success, so far. Along with the decrease in production of printing papers, there has been a dramatic decrease in research on pulping, bleaching and papermaking. In our group, much work has been done on the extraction and purification of hemicelluloses from wood, especially galactoglucomannans (GGM) from spruce wood. Two of our researchers have independently created a new biorefinery technology concept: extraction of hemicelluloses with hot water, followed by extraction of lignin with dilute alkaline water, receiving pure cellulose as residue. The technology is presently under development by the company CH-Bioforce (www.ch-bioforce.com).

After retiring from ÅA in 2009, my research activities continue in our company Oy Separation Research Ab, www.sepres.com. In the EU-funded project AFORE, in 2013, we discovered that betulin(ol) extracted from birch outer bark can provide superhydrophobization of hydrophilic materials such as wood, paper, paperboard and textiles. The key to the effect is curing at higher temperatures.

Finally, the state and future of wood chemistry is shortly discussed.

References

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