

From Industry 4.0 to Research 4.0. A modular approach for the development of cellulosic fibres

Steffen Müller-Probandt¹, José Canga Rodríguez^{2*}

^{1,2}DIENES Apparatebau GmbH (GERMANY)
(E-mail: mueller-probandt@dienes.net, j.canga@dienes.net)

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ABSTRACT (text-only, 337 words)

Biobased fibre products pose a big technological challenge as growing demands on the varying quality of recycled feedstock and the achievement of a consistent fibre performance require a continuous development and optimisation of both technology and production parameters.

Research 4.0 aims to enable researchers working on their development optimally supported by the system. As already mentioned, research work in the field of biobased fibres is characterised by a high degree of adaptation needs. Research facilities must be able to be adapted after initial experiments and the knowledge gained thereby. All necessary adjustments are made under the conditions of a highly complex manufacturing process, which is determined by many parameters. This results in the following requirements for the flexibility of modular research facilities:

- **INTEGRATION:** Easy integration of new production modules
- **SCALABILITY:** Easy replacement of production modules with modified specifications
- **FLEXIBILITY:** Easy modification of production steps' positioning within the production line
- **HIGH PERFORMANCE:** Intelligent production modules synchronized by a master process control level
- **ANALYTICS:** Continuous monitoring and evaluation of process parameters

A reliable development of new innovative biobased fibres demands an efficient, systematic and, in part, self-optimising experimental working system, which must be intelligent in gathering data from the process and flexible in enabling the rearrangement of the process. Applying the principles of Research 4.0, each module of a plant represents a production step and is equipped with a PLC to control itself and to organise in association with other modules within the line. The control hierarchy has an intelligent modular structure that configures itself according to the arrangement of each single module given by the hardware

and the interfaces within the system. Moreover, all production parameters can be permanently visualised and recorded, enabling a complete traceability of the process.

This paper will present the implementation of Research 4.0 as a tool for the development of a product from the idea to the practical implementation needs a modular conceptual approach offering the required flexibility for the complete validation process: principle > process > product.