



Integrated Control and Sensing for Sustainable Operation of Flexible Intensified Processes

Tackling the future of plant operation

How to integrate online data-analytics, process control, and PAT for optimal plant operation

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Project ID Card

Start date	1 st January 2015
Duration	3 years, until 31 st December 2017
EU funding	6 million €
Website	www.consens-spire.eu
Coordinator	Bayer AG Manuel Pereira Remelhe

The Partners in the Consortium

Process industry



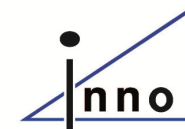
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Mission

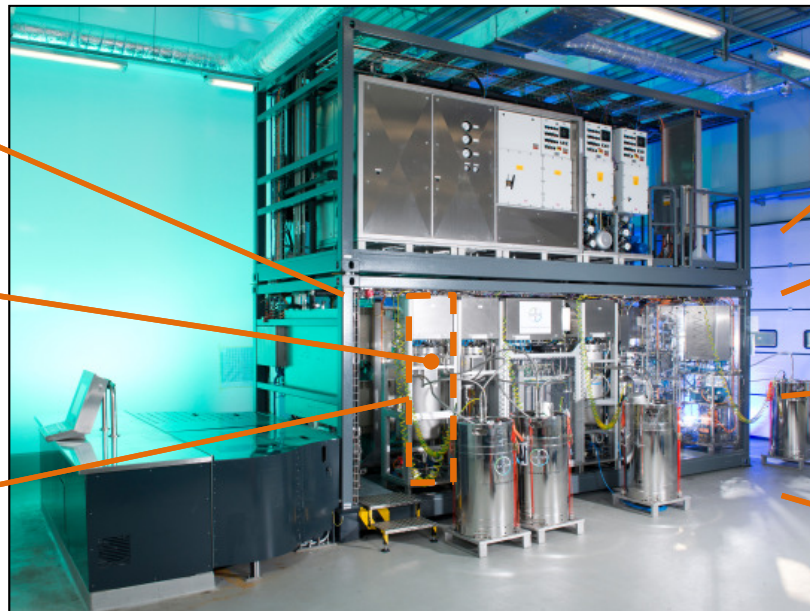
Advance the production of high-value products that meet high quality demands **in flexible intensified continuous plants** by introducing novel online sensors & closed-loop control methods.

Characteristics

Miniaturized equipment

Intensified heat & mass transfer

Possibly modular setup



Benefits

Product uniformity

Sustainability

Fast adaption to market demand

Innovative products

Containerized modular plant from F³ Factory project

Challenges of Flexible Intensified Continuous Plants

- » Small dimensions
 - fast and compact sensors
 - fouling and clogging of plant equipment
- » Higher quality levels
 - more accurate sensors
- » Complex phenomena
 - model-based control
- » Variety of products, innovative products, & short product life cycles
 - flexible control concepts
 - fast process design and optimization

Case Studies & Novel Technologies

	Intensified synthesis of organic compounds	Intensified production of high-viscous polymers	Continuous formulation of complex liquids
			
Goals	High product purity Reduce solvent use Reduce fouling	Tight control of product viscosity → less waste, solvent-free process	Tight control of product rheology → less waste, water-free product
	Fast transients for start-up, grade changes and shut down → less waste		
Novel sensors	online NMR sensor inline fouling sensor	inline rheology sensor for polymer melts	inline rheology sensor for complex fluids
Novel control	Self-adapting & self-optimizing control Plant-wide control		Data-driven control
Tools	Sensor failure detection, performance monitoring, design evaluation		

Technical Cross-cutting Aspects

- » Novel sensors are applicable to all kind of fluid processes where the specific capabilities are needed.
- » Control and monitoring methods, as well as design evaluation are applicable to all kind of continuous processes.
- » Benefits for a wide range of applications beyond flexible intensified continuous processes:
 - Chemical sector: pharma, polymers, specialties, basic chemicals, crop protection, consumer goods, etc.
 - Other sectors: engineering, gas & oil, refinery, food & beverages, ...
 - Possibly also: cement, ceramics, non-ferrous metals, steel, minerals,...

Expected Impact

» Technological:

- Enabling the migration of batch to flexible intensified continuous processes
- Making processes resilient to variances in feed-stocks and external disturbances
- Enhancing fast process development for new products.
- Less holdup of hazardous chemicals in plants → safety, urban friendly

» Economic:

- > 130 M€/year in pharma & specialty industry
- > 100 M€/year in consumer chemicals
- > 35 M€/year for specific polymers

» Environmental:

- Reduction of CO2 emissions
 - 230,000 t/year for specific polymers
 - 170,000 t/year in pharmaceutical & specialty industry
- 176,000 t/year less use of solvents in pharmaceutical & specialty industry

Measures to Maximize Impact

- » Dissemination
- » Planning Exploitation
- » Engaging Stakeholders
- » Cross-sectorial Advisory Board (CAB)
 - CAB facilitates technology transfer to other sectors.
 - Feedback from CAB was very positive (visit website for detailed feedback).
 - Number of members is to be increased.

Conclusions

- » CONSENS closes technology gaps of flexible intensified continuous plants which are a promising alternative to batch plants.
- » The technologies may also be useful for conventional chemical plants and for other sectors.
- » Cross-sectorial dissemination and exploitation will widen the impact of CONSENS on the process industries.



Thank you!

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