

REPORT

Results of the pilot deployment of the Spectrally™ X1 inline analyzer in a phenol-formaldehyde resin production plant

17.03.2025 - 17.05.2025

Spectrally X1 inline pilot – context and objective



Objective: Confirmation of the operation of the Spectrally analyzer on 5 controlled production batches.

Comparison with laboratory samples (phenol and formaldehyde reference values).

Pilot achievements:

- Central unit installed next to the reactor
- Control panel started up in the control room
- Dedicated control application developed for the device
- Dedicated algorithms developed

Schedule:

16.03.2025 – 17.03.2025 – installation of the Spectrally analyzer

17.03.2025 – 17.05.2025 – pilot duration



Scope of work in the laboratory

- 5 syntheses were carried out to develop dedicated algorithms.

The aim was to develop a safe and reliable device and algorithms.

Scope of work in the production area

Spectrally analyzer mounted on the reactor.



- 1. Probe on the reactor circulation loop
- 2. Central unit next to the reactor



Scope of work in the system part

A dedicated application was created on the control panel in the control room

(for the purposes of conducting the pilot).

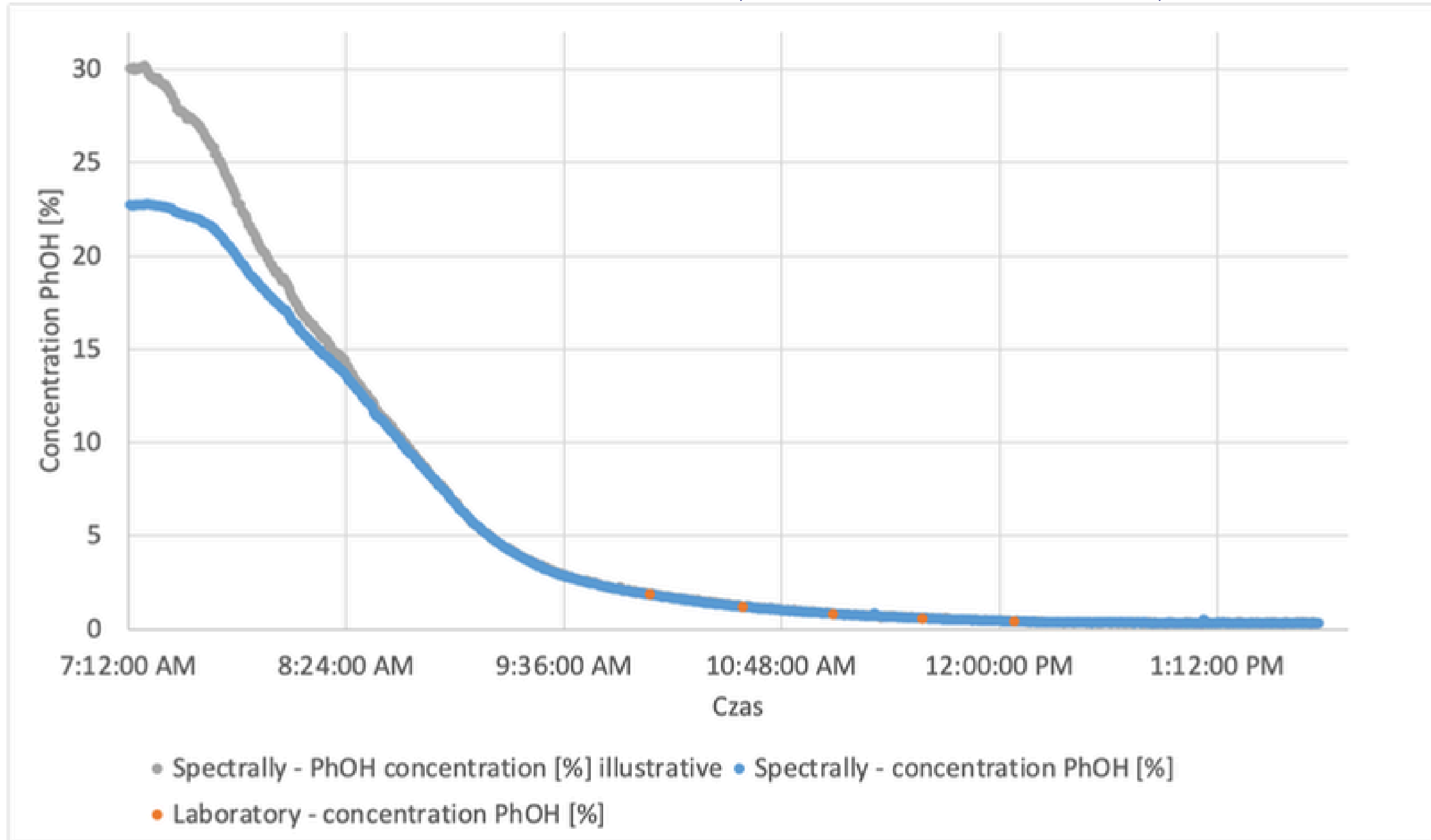




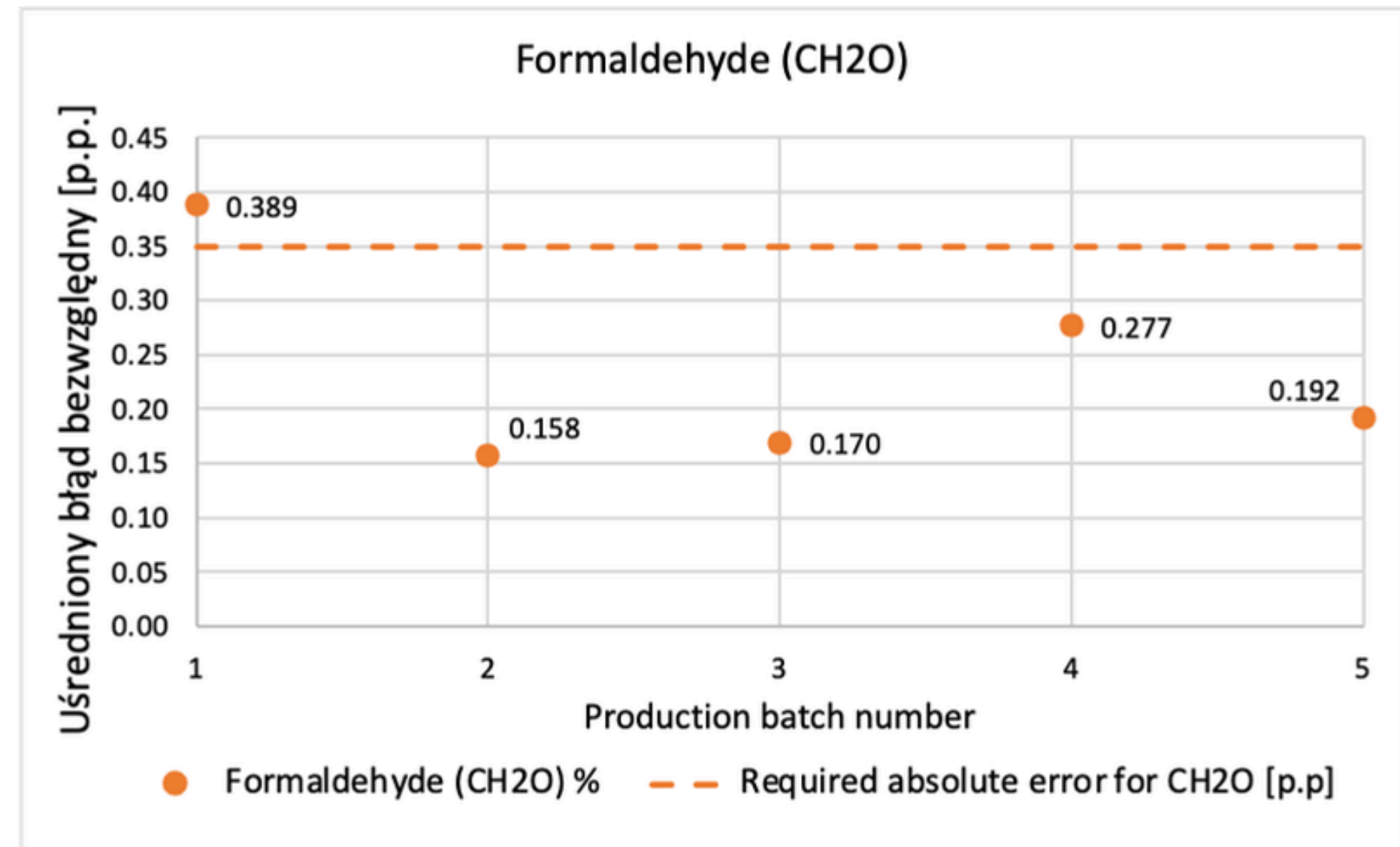
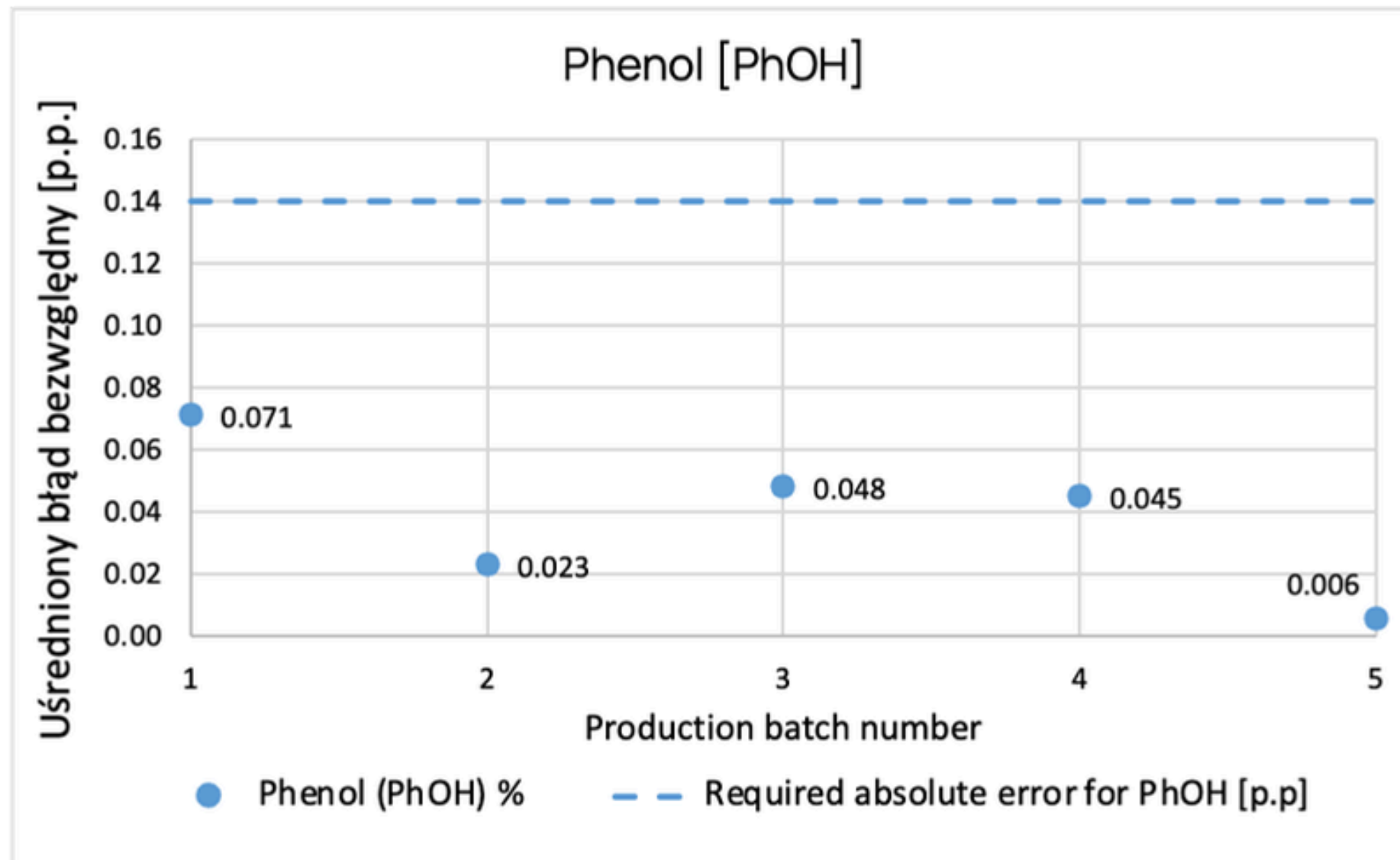
Pilot results...

Phenol concentration profile during the production batch

For the tested resin (dated 05.04.2025)



Average absolute errors [percentage points] - all batches



Offline analysis (in the laboratory) generates higher **inaccuracy** due to the high dynamics of the process. The **process of sampling**, transport to the laboratory and preparation for analysis generates potential **timing errors**.

The laboratory result corresponds to a different stage of process progress than the current one.

Uśrednione błędy bezwzględne [p. p.] – wszystkie szarże



Area	Arrangements before the pilot	Pilot results
PHENOL Absolute error	0,14 p. p.*	0,04 p. p.
FORMALDEHYDE Absolute error	0,35 p. p.*	0,24 p. p.
Probe	Must be resistant to reactor operating conditions	Maintenance-free Automatic cleaning before and after each measurement; adapted to reactor conditions
Measurement mode	Real-time measurement	Real-time measurement – approx. 750 data points from one batch and a result provided every 30 seconds

* 0.10 p.p. + reference method error (0.04 p.p.) → 0.14 p.p.



Operational and business benefits



Operational benefits (1/2)



Feature	Benefits
Automatic real-time measurement during the production batch	Replacement of manual measurement tasks. Full history of each batch – quality documentation. Detection of shortages and quality deviations of raw materials. Possibility to adjust parameters → higher quality

Possibility of further process optimization, quality improvement and increasing the level of production automation.

Operational benefits (2/2)



Feature	Benefits
Analysis of the production process while it is running	<ul style="list-style-type: none">• Forecasting the end point of the process• Possible shortening and optimization of the process course• Potential to reduce process costs
Maintenance-free probe (automatic cleaning before and after each measurement; resistant to reactor conditions)	<ul style="list-style-type: none">• Higher level of process automation• Lower workload of personnel with repetitive tasks• Ensured process repeatability over the entire course

Benefits of full-scale implementation of the Spectrally system



1. Ability to differentiate product **quality** depending on current demand.
2. Early detection of **shortages/quality defects** of feedstock raw materials – potentially already on the delivery ship, before or during unloading.
3. Potential possibility to **expand the product base** with intermediates (waste generated in the current production).
4. Ability to quickly replicate the reactor (production cell) at any location in the world – full process reproducibility.

Profitability analysis – business context



Indicator	Value / description
Product compliance with specification	94%
Production process time	Reduction by 8% (and decrease in energy costs)
Process end time	Possibility to determine with an accuracy of 1 minute
Dosing of raw materials into the reactor	Accuracy up to 0.05%
Quality documentation for each batch	Full history – 100% quality documentation
Number of complaints	90% fewer

Profitability analysis – business context



Item	Value
Annual production value	over PLN 700 million (80% of revenues according to polish KRS)
Cost of substrates	PLN 383 million*
Energy cost	PLN 46 million*
Costs of complaints and losses	PLN 15 million*
Production margin	PLN 138 million*

* Percentage shares adopted as reference values based on a McKinsey report:
50% cost of substrates, 6% energy cost, 2% complaints and losses, 18% margin.

Profitability analysis – 3-year return on investment



	Item	Value
Savings	Total	approx. PLN 30.7 million
	Reduction of costs of complaints and reworks	approx. PLN 15.3 million
	Reduction of substrate consumption	approx. PLN 3.29 million
	Reduction of energy costs	approx. PLN 2.5 million
	Reduction of laboratory costs	approx. PLN 1.6 million
	Increase in margin by 1%	approx. PLN 8.1 million
Return on investment	PP (payback period)	approx. 8 months

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