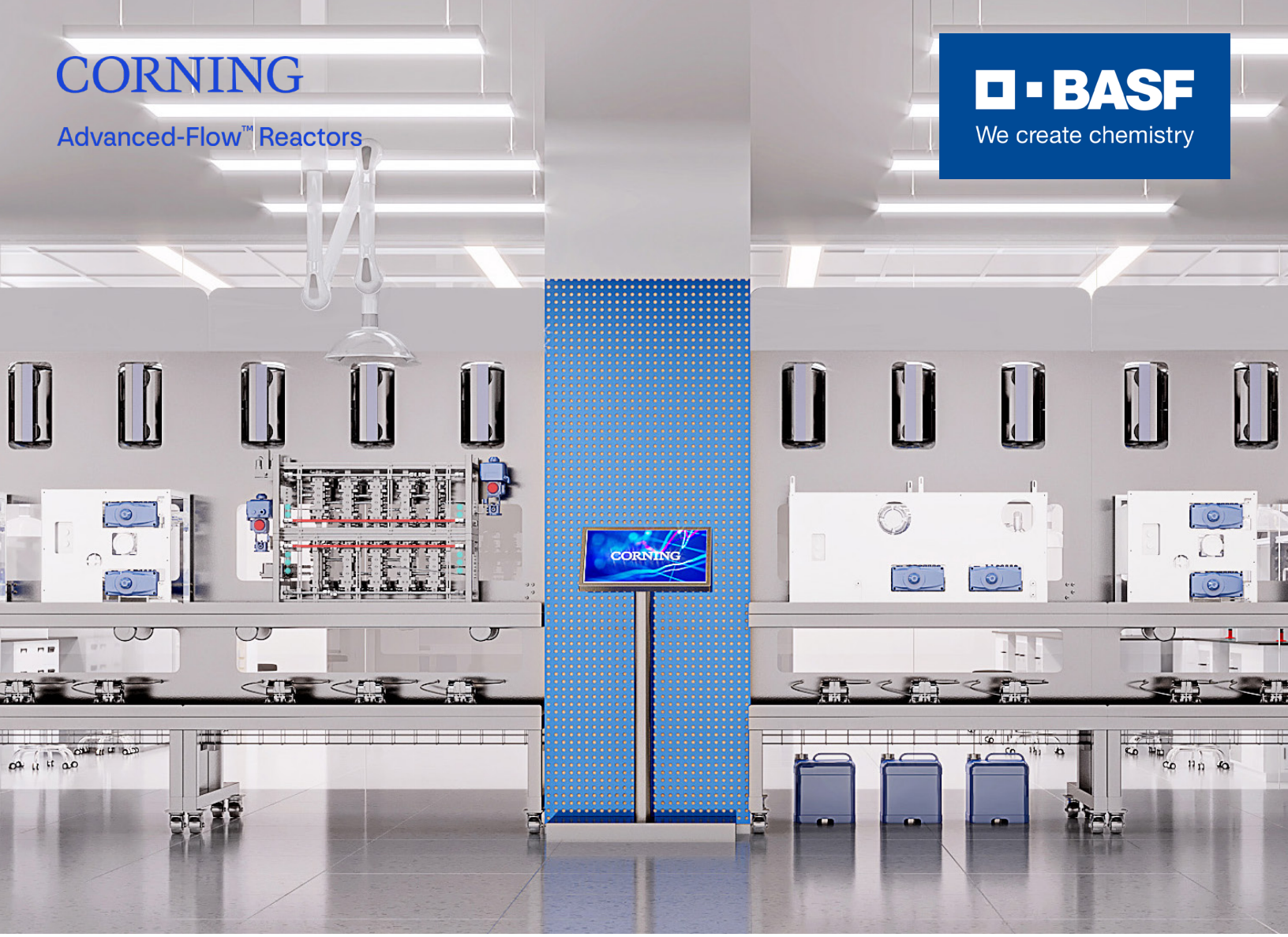
CORNING

Advanced-Flow™ Reactors

BASF
We create chemistry



ADVANCED-FLOW REACTORS

Scaling-up: Developing an optimized flow chemistry industrial scale process and manufacturing hundreds of kilograms of product in eight weeks

Learn how BASF, one of the largest chemical producers in the world, and Corning® Advanced-Flow™ Reactors collaborated to seamlessly scale-up a new chemical synthesis for the agro-chemical industry from laboratory equipment to pilot scale production and produce hundreds of kilograms of this new chemical compound in just eight weeks.

Leveraging Corning's service offerings through its newly established business, Corning AFPT. The Corning team was able to provide chemical manufacturing, statistical analysis, and continuous flow expertise to meet BASF's needs and while demonstrating AFR's capabilities.

Contact Us
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Introduction

BASF recently developed a new chemical synthesis process with a nitration step at their lab leveraging Corning's AFR Low Flow reactor. After developing this new process, BASF was looking for a solution to quickly scale-up the process and produce 300 kilograms of this new chemical compound in eight weeks for further downstream processing and evaluation.

Figure 1: BASF and Corning AFR collaborated to seamlessly scale-up a new chemical synthesis process for the agro-chemical industry.

Challenges

01

Scaling up a new chemical development process, using a challenging nitration step, in 4 weeks.

Producing a large quantity of a new chemical compound, using a traditional batch process can be unpredictable and take time to fully optimize and deliver a high-quality product that replicates initial lab scale reactions. Additionally, the inclusion of a nitration step in the production process requires precise controls. Nitration reactions are highly exothermic and require precise mixing and temperature management throughout the entire process – challenges that flow chemistry are well-suited to address.

02

Producing 300 kilograms of the new chemical compound in 4 weeks.

Flow chemistry provides a path to seamlessly produce large quantities of new chemical compounds in a reduced time frame compared to batch processing, while also using inherently safer technology.

Solution

To better understand the chemical development process, the Corning AFR team replicated BASFs initial results on an AFR Low Flow reactor. Then, the team created a Design of Experiment (DOE) plan to optimize BASFs new process for a Corning G1 Reactor. The DOE optimization plan was designed to maximize starting material conversion into final product by optimizing the residence time, molar ratio, and reaction temperature, which all have a direct impact on the capacity and production cost of the final chemical compound. Building on that knowledge, the Corning team developed a mathematical model and simulated the new production process.

Building on years of expertise from hundreds of installed industrial scale production systems, the team created an optimized set-up for this new process that required two Corning G1 SiC fluidic modules for the reaction and an additional G1 SiC fluidic module for the quench phase of production. Then, the Corning team used the parameters defined by BASF to monitor the quality of the product in real time.

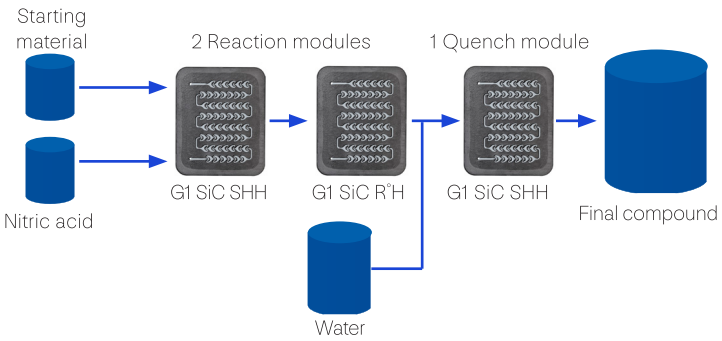

Figure 2: The final set-up required two Corning G1 fluidic modules for the reaction and an additional fluidic module for the quench phase of production.

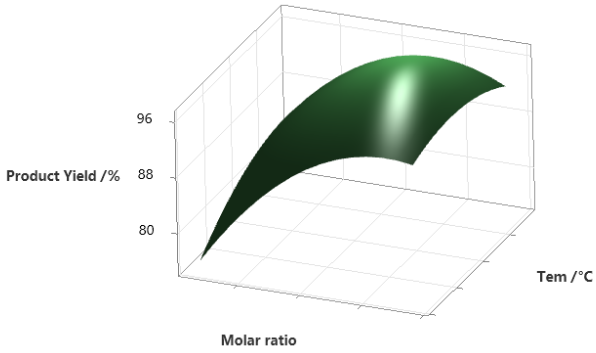

Figure 3: Validated full optimization of the new process with a surface methodology statistical analysis.

Results

Corning and BASF effectively delivered an optimized process, leveraging Corning's G1 production system, in **four weeks.** The combined team used this optimized process to produce 300 kilograms of the new chemical compound for evaluation with a **yield improvement of ~4%** compared to the lab scale trials. When compared to batch production, the purity of the final chemical compound produced using the AFR system is several percentage points higher and has better stability.

Additionally, the AFR team validated the optimization with mathematical assessments, including a surface methodology statistical analysis. The team was able to demonstrate that the theoretical and real results have less than 1% difference on the unconverted staring material and the conversion to final product – directly addressing the team's goal to maximize the conversion of starting materials into the final compound in this phase of production.

Hundreds of kilograms of BASFs new compound were produced on time with an improved yield compared to the lab development phase, leveraging inherently safer continuous flow technology.

While there is still more work to be done, Corning and BASF celebrated this success and are working together to explore further opportunities.