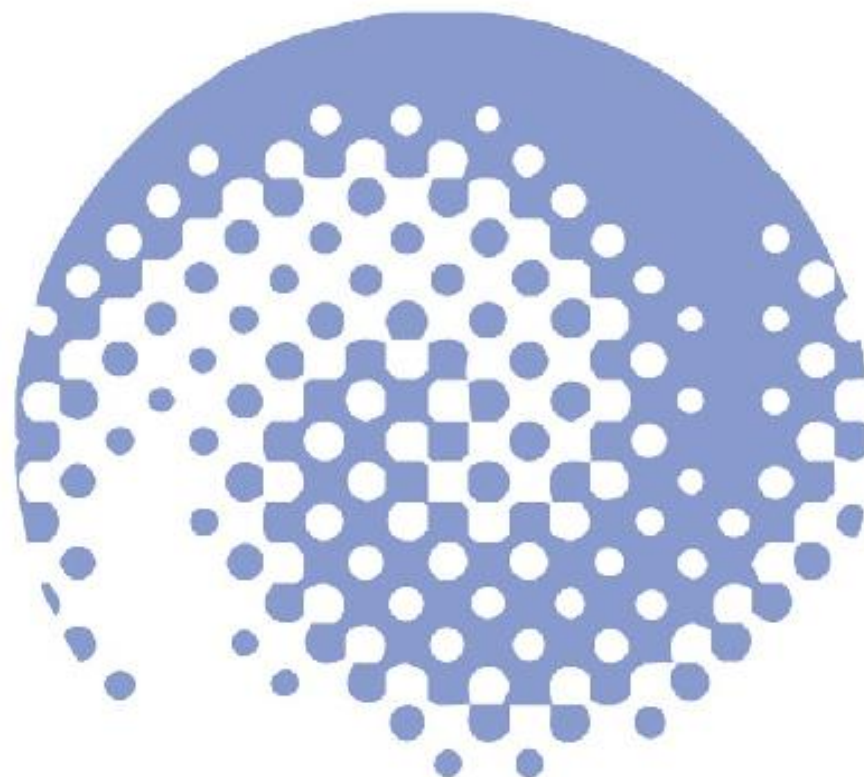




NiTech® Technology Industrial Reaction Examples

These slides summarise cases where NiTech® technology has been applied in industry for reactions.



Content

Industrial Reaction Applications

- Gas/Liquid/Solid Reaction (Genzyme)
- Liquid-Liquid Reaction with Dynamic Separation Example

Gas/Liquid/Solid Reaction – (Genzyme)

Genzyme was designing the production of a new active ingredient and was interested in potential capital and operating savings offered by NiTech's technology.

Stage Gate 1 = batch OBRs demonstrated the feasibility



Stage Gate 2 = continuous pilot unit with 25 L of working volume

NiTech Full-scale Reactor Installed (2007)



Gas/Liquid/Solid Reaction – (Genzyme)

Reaction **time 60 times lower** so **two 150 m³ STRs** could be **less than 3 m high** and with reactor volume of **less than 1 m³**

The NiTech reactor offered **uniform mixing** throughout the system and **predictable scale-up** under plug flow conditions

The plant was running, with **FDA approvals in place within two years**

It now processes **twice the rate originally assumed** (eliminating the need for debottlenecking upgrades)

Robust technology, with **maintenance levels a fraction** of those needed by pressure vessels

Continuous processing has **eliminated auxiliary** feed and collection **vessels**

Sophisticated process analytics enables **good control of quality**, not possible in conventional batch

All steps **executed continuously with no intermediate testing**, except control system data

Automation enables **operation without supervision**, in marked contrast to batch

Liquid-Liquid Reaction with Dynamic Separation

NiTech® identified an opportunity to intensify a long residence-time reaction:

- involves a reversible reaction between two reactants to produce two products
- products are separated in large gravity settling tanks

A COBR was set up which removed the by-product in-situ to enhance the forward reaction:

- 0.78 L/min through a 16 m long DN40
- The by-product was removed by gravity separation in un-baffled tube sections

The bespoke COBR removed up to 40% of the by-product during the reaction phase.

Reductions in footprint were achieved by:

- reducing the size of downstream gravity settling vessels; and
- increasing conversion, and so, reducing reactor volume for a set throughput.