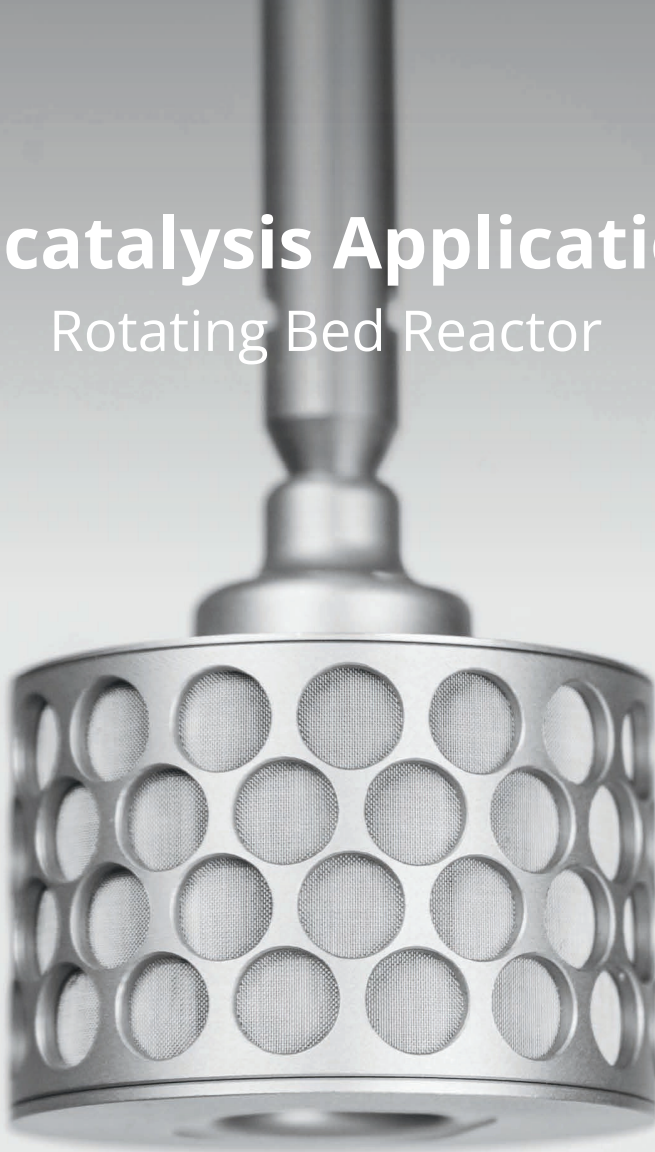
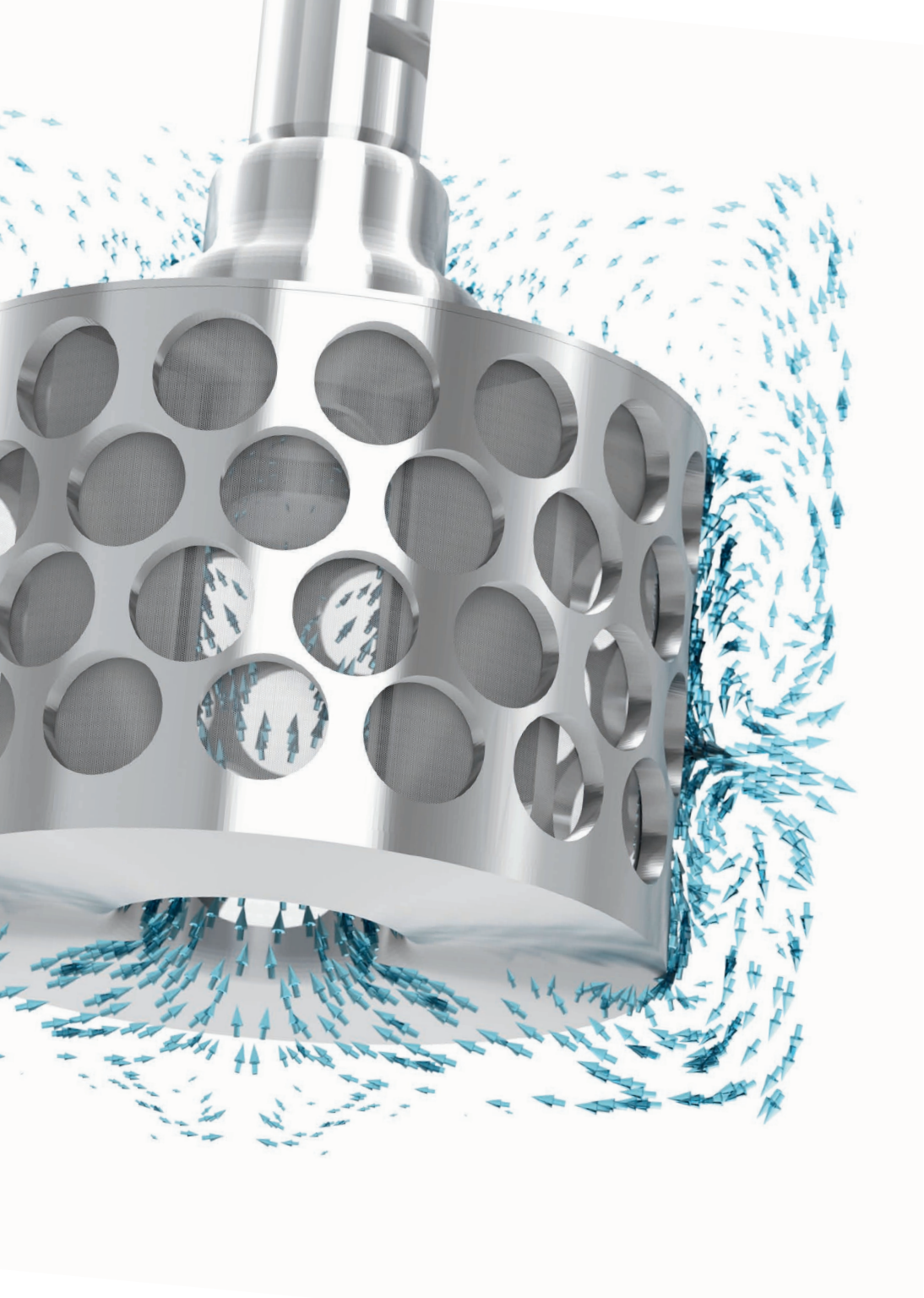


Biocatalysis Applications

Rotating Bed Reactor





Rotating Bed Reactor Technology

✓ Short reaction time

Due to fast mass transfer

✓ Simple to scale

Due to its smart design

✓ Long catalyst lifetime

Due to protected solid phase

✓ No filtration required

Due to contained solid phase

✓ Perfect for screening

Due to quick catalyst exchange

The SpinChem® Rotating Bed Reactor (RBR) contains the solid phase between a pair of filters. It rapidly aspirates the reaction solution from the vessel, percolates it through the solid phase, and quickly returns it to the vessel. By the design of the RBR and vessel, the mixing and convective transport are maximized. The resulting efficient mass transfer minimizes reaction time and boosts product yields even with liquids that are immiscible or of high viscosity, or for reactions demanding distribution of dissolved gases.

With an RBR, you can eliminate slow reaction kinetics caused by poor mass transfer between your solution and the solid phase.

The SpinChem® RBR design is flexible and can be used for heterogeneous reactions with numerous types of solid phases, including immobilized enzymes, encapsulated cells, ion-exchanger resins, or activated carbon. This typically results in faster processes, higher yields, or reduced consumption of reagents, depending on the process.

In addition, the RBR extends the lifetime of the solid phase by minimizing mechanical damage (attrition), while also making it easier to separate and recycle them.

The RBR concept is fully scalable from laboratory to production, thus providing more efficient reaction development as well as improved production economy.

Find out more at [spinchem.com](https://www.spinchem.com)

Biocatalysis Applications

Immobilized enzymes

Application 1014

Before



After

Biocatalysis by immobilized enzymes in a Rotating Bed Reactor

An example of straightforward biocatalysis by immobilized enzymes in a rotating bed reactor. Ester **hydrolysis** by an immobilized lipase formed a yellow coloured product from 4-nitrophenyl octanoate, a substrate commonly used to screen and characterize lipases. A video of the reaction progress is available online.

Using soft beads

Application 1025



Easy collection, washing and recycling of alginate beads and other soft particles

Traditional stirred vessels can damage soft catalysts like immobilized enzymes encapsulated in hydrogel beads, while fixed bed reactors tend to compress them and blocking the flow. The Spin-Chem® RBR solves these issues by **protecting** such beads from damage while allowing easy collection and **recycling**. This enables efficient biocatalysis **without filtration** between process steps.



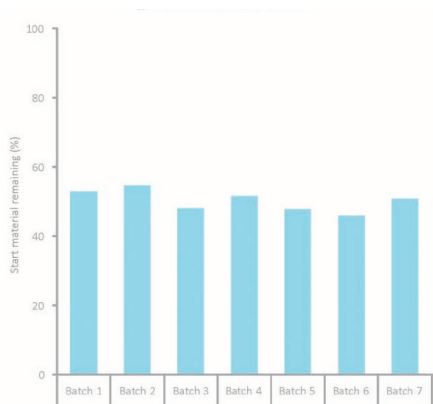
Read more about application 1014 and watch the video at spinchem.com



Read more about application 1025 and watch the video at spinchem.com

Biocatalyst recycling

Application 1019

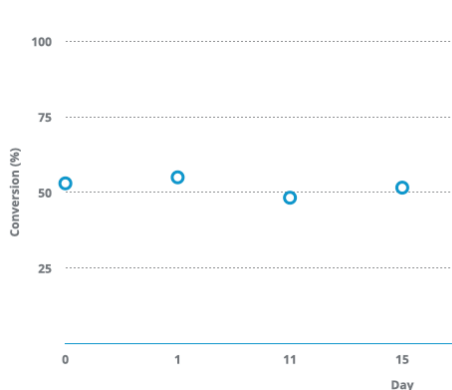


Recycling of immobilized enzymes using Rotating Bed Reactor technology

Study of catalyst recycling during esterification and transesterification reactions with immobilized lipases in rotating bed reactors. Data from several laboratories showed that **no attrition or grinding occurred** and that **no filtration** was necessary between reaction cycles. The production capacity was estimated to 50 kilograms per gram of catalyst thanks to the high catalyst stability.

Convenient screening

Application 1023



Biocatalysis in Rotating Bed Reactors - from screening to production

This poster presents several esterification reactions and the screening efforts undertaken to develop them. The rotating bed reactors (RBRs) used constitute an excellent framework for biocatalytic reactions with immobilized enzymes. The RBR offers **convenient handling of the solid phase** by keeping it confined in the rotating bed behind stainless steel filters. Not only does this **extend the catalyst lifetime**, it also simplifies the separation allowing for fast screening and catalyst recovery.



Read more about application
1019 at spinchem.com

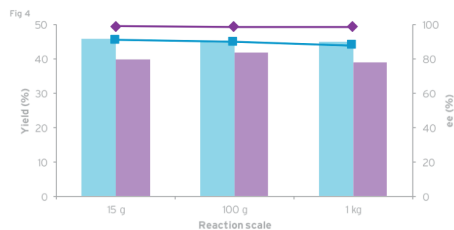


Read more about application
1023 at spinchem.com

Scale-up Applications

Enzymatic reactions

Application 1032



Immobilized enzymes and modern reactor technologies enable more efficient industrial-scale synthesis

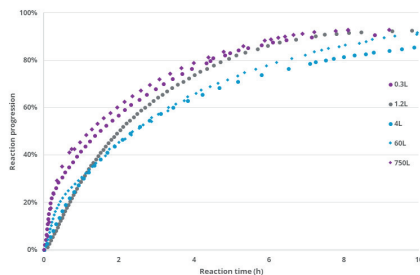
To investigate the suitability of the RBR technology for manufacturing, the volume of the enzyme catalysed synthesis was increased from laboratory development to kilogram production scale. This scaleup was very successful and the reaction reached **46% conversion within 90 minutes** (Fig 4). After an aqueous acidic workup and recrystallization, the desired product was obtained with a 39% overall yield with 99% ee.



Read more about application 1032 and download a poster at spinchem.com

Consistent results

Application 1050



The ratios of solvent to substrate and catalyst is kept constant across all scales

A collaborative study with ChiralVision demonstrated perfect enzyme activity retention over 10 cycles and successful scale-up from 300 mL to 750 L using SpinChem's Rotating Bed Reactor technology, maintaining consistent performance across a 2,500x scale difference. The RBR **outperformed the conventional batch reactor**, completing the reaction in two-thirds of the time needed to reach 90% conversion.



Read more about application 1050 and watch the video at spinchem.com

Automated processing

Application 1007



Automated semi-continuous batch processing system with Rotating Bed Reactor

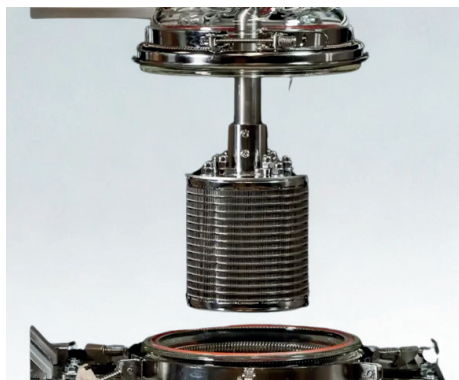
Outline of an **automated** SpinChem® Rotating Bed Reactor system capable of filling a solution, neutralizing it by ion exchange and draining it. By micro computer control, unattended semi-continuous batch processing was accomplished for many cycles until the ion exchanger was completely saturated.



Read more about application
1007 at spinchem.com

Full-scale production

Case study

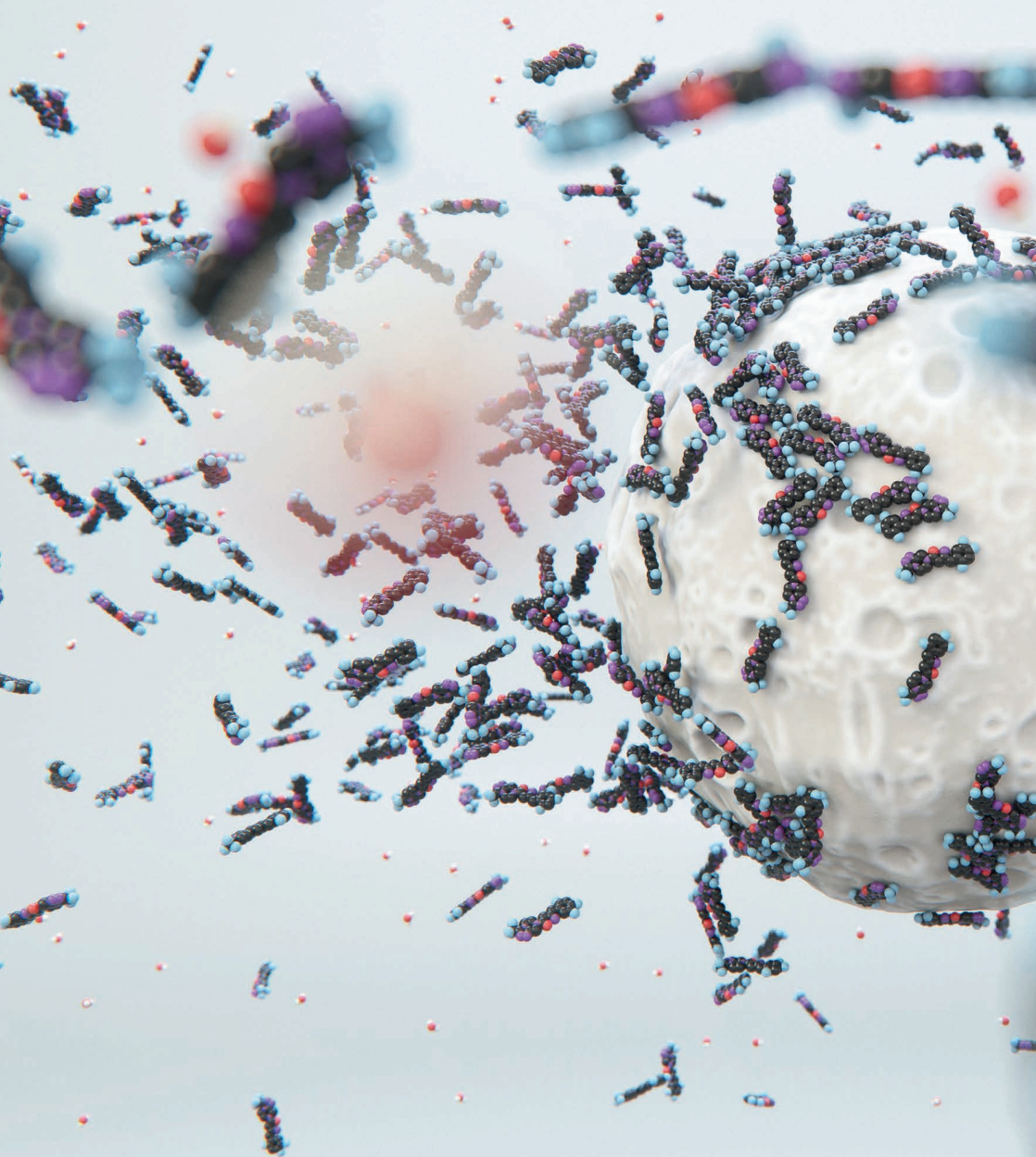



A world leading sustainable capsaicin producer uses biocatalysis to convert wood biomass

By implementing immobilized biocatalysts, a company made use of the incredible efficiency and catalytic power of enzymes using rotating bed reactors. Not only did the enzymatic approach **improve overall economics**, but it also significantly **reduced the footprint** of the process by virtue of their longevity and selectivity.



Read more about this case
study at spinchem.com





**"Results are quite amazing;
significantly improved
reaction rate, very easy
recycling and bullet-proof
stability of our enzyme."**

**Dr. Michiel van Vliet
R&D Manager
ChiralVision**

**"The results with the RBR have
been extremely convincing - so
much so that I recommended it
warmly to other colleagues
working in biocatalysis as well."**

**Dr. -Ing. André Delavault
Karlsruhe Institute of Technology**

Impact of critical parameters influencing enzymatic production of structured lipids using response surface methodology with water activity control

SpinChem® Application No. L2213

Ariana Causevic, *et al.*, *Biochem. Eng. J.*, 2022, 187, 108610.

Regioselective synthesis of structured lipids is enabled by enzymatic transesterification. This is a multi-step reaction which depends on multiple key influencing factors, including temperature, water activity and reagent ratio.

In this work, the authors employed a statistical approach to understand their individual and combined effects on yield and product quality for the reaction of ethyl stearate with high oleic sunflower oil:



Fig. 1. Transesterification reaction scheme.

The rotating bed reactor (RBR S2) including its flower-baffled glass vessel (V2) served as basis for the setup of the elaborate reactor system. Relative humidity and temperature were measured in the reactor headspace by means of a digital thermometer and a RH-sensor. This data was directly processed by an Arduino control unit which maintained the targeted water activity in the system by controlling the flow (rate) of either dry or humid nitrogen gas through a

sparger into the reactor vessel. The temperature was well controlled by means of the water jacket of the glass reactor.

precise control of

- water activity (a_w)
- temperature (T)
- substrate ratio (R_S)



Fig. 2. RBR to control influencing factors

Highlights:

- RBR used as platform technology, equipped with water activity and temperature control measures
- robust and reliable reaction control development of reproducible RSM
- models for the prediction and optimization of reaction progress



Read more about application note L2213 at [spinchem.com](https://www.spinchem.com)

Intensified, kilogram-Scaled, and environment-friendly: chemoenzymatic synthesis of bio-based acylated hydroxystyrenes

SpinChem® Application No. L2502

Philipp Petermeier et al, ACS Sustainable Chem. Eng. 2024, 12(34), 12869–12878

In this study, researchers successfully produced 1 kg of 4-acetoxy-3-methoxy-styrene using a 10 L reactor. They developed streamlined processing methods that achieved excellent yields while maintaining efficiency.

Additionally, the study includes a comprehensive environmental assessment was conducted, examining CO₂ emissions from all aspects of production, including energy consumption and the treatment of generated wastes.

The findings demonstrate that multistep chemo-enzymatic reactions can effectively produce high-volume, low-value chemicals from biorefineries, based on the holistic assessment of process optimization, scale-up capabilities, pro-duct isolation, and environmental impact.

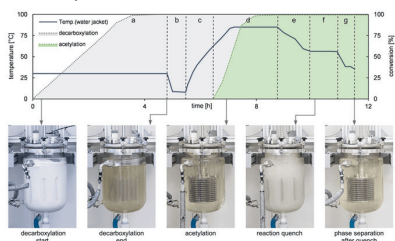


Fig. 1 A graph with temperature and conversion data over time, accompanied by a series of five reactor photographs showing different stages of the process.



Fig. 2. Key performance metrics of the kilogram-scale chemoenzymatic synthesis

Highlights:

- The reaction cascade was conducted on a 120 mL lab scale using the SpinChem rotating bed reactor S2 in a 200 mL baffled glass reactor.
- Once the refined workup procedure was demonstrated on the lab scale, the reaction cascade was conducted on a 10 L scale to produce 1 kg AMS in a single batch.
- Promising environmental metrics of the kilogram-scaled system, based on the E factor and the total CO₂ released.



Read more about application note L2502 at spinchem.com

Products

Start your research fast

Complete starter kit S2



Get started quickly with biocatalysis experiments using this kit for 120–300 mL volumes. The kit includes everything you need: an RBR S2, reaction vessel V2, lid, seal, hose connectors, shaft guide, holder, stand, and motor.

Complete starter kit S3



The quickest way to your rotating bed reactor experiments up and running. The all-inclusive kit allows processing of 250–1,500 mL volumes. Includes RBR S3, reaction vessel V3, lid, seal, hose connectors, shaft guide, holder, stand, and motor.



MiniRBR

>5 mL

RBR S2

100 mL



RBR S3

1 L



Order Rotating Bed Reactors
at spinchem.com

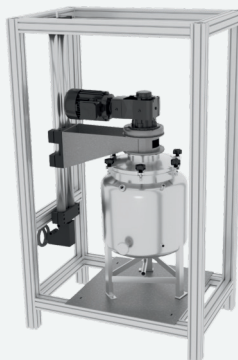
Pilot batch production

ProRBR Complete Kit



The ProRBR Complete kit is a plug and play system used for pilot and industrial scale. The system can be used with a variety of vessels thanks to its modular design, with typical liquid volumes ranging between 50-1000 L. The electrically controlled lift and motor make the system easy to use for a single operator.

Complete S5



Get started with pilot testing or production in 120 L of liquid, with the RBR S5 installed in a jacketed stainless steel vessel. The lifting aid raises the rotating bed reactor for service operations, such as solid-phase replacement or cleaning.

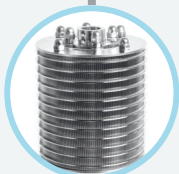
RBR S4

10 L



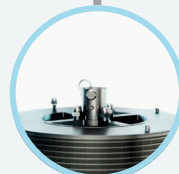
RBR S5

100 L



ProRBR

100 - >1000m³



Order starting kits
at spinchem.com

Swedish Innovation

The SpinChem® RBR is developed, designed and sold by the technology company SpinChem, based in Umeå, Sweden.

40+

countries where customers chose SpinChem technology

100+

scientific publications feature Rotating Bed Reactor (RBR) technology

10/10

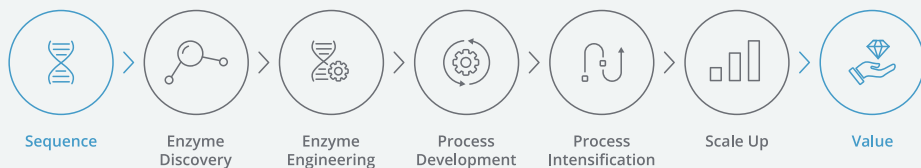
of the world's largest pharmaceutical companies are our customers



End-to-end solution

A group of seven global companies, collaborate to bring competitive solutions for protein development processes to market at scale.

From enzyme discovery to tailored immobilization and process development CDMO service. The Enzyme Technology Alliance (ETA) offers significant value to biotech companies, start-ups, and corporations by providing complete support from initial protein discovery through to final production, eliminating the need to work with multiple vendors.



Leverage expertise from 50+ scientists with extensive experience in enzyme discovery and cGMP production

SpinChem's RBR technology enhances mass transfer, simplifies enzyme recovery, and scales effectively from lab to industrial applications while reducing enzyme usage. As part of ETA, this technological expertise perfectly complements other members' capabilities in enzyme discovery and engineering, creating a comprehensive approach to industrial biocatalysis.

By doing business with ETA you get access to integrated services including:

- AI-supported enzyme engineering
- Enzyme immobilization
- Process optimization
- Scale-up capabilities



Read more about ETA at
spinchem.com



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