Green Process Synth 1 (2012): 231–232 © 2012 by Walter de Gruyter • Berlin • Boston. DOI 10.1515/gps-2012-0010

Company profile

C-Tech Innovation: microwave chemistry – from laboratory to plant

Paul Fitzpatrick

C-Tech Innovation, Capenhurst Technology Park, Chester, Cheshire CH1 6EH, UK,
e-mail: paul.fitzpatrick@ctechinnovation.com

C-Tech Innovation provides a wide-ranging consultancy service designed to maximise your innovation and business opportunities. We have vast experience in innovation management and technology development. We help organisations to implement new processes and create new products; assist them in knowledge transfer and in commercialisation and business support.

Background

Most chemists are familiar with the benefits of working with microwave reactors in the laboratory. The technology enables them to test different chemical reactions and find the perfect compound much faster than using conventional heating methods. C-Tech Innovation undertook a Carbon Trust funded project to quantify the potential energy savings available if microwave chemistry could be scaled up to plant scale. Previously moving directly from laboratory-scale work, where small quantities of compounds are produced for compound libraries, and scaling up to pre-production quantities, has proved difficult to achieve using microwave technology.

Challenges

As scale increases, the advantages of using microwaves compared to conventional methods can be lost. This is because the power generated from microwaves can dissipate rapidly as the distance the microwaves have to travel into the reaction mixture increases. Consequently, this can result in overheating at the surfaces, just as is the case with conventional heating. Furthermore, materials that are used to build small-scale reactors are often not suitable to fabricate larger reactors, and problems of measurement and control can be more acute as the scale of operation is increased.

Approach

C-Tech Innovation decided to use a continuous flow approach as this would overcome the problem of penetration depth. A thick walled quartz glass tube was chosen as the reactor material as it is chemically resistant, microwave transparent and could withstand the high temperatures and pressures required. A customised seal was then designed to close the reactor tube and contain the microwave field. A fibre optic temperature probe was used to measure the reactor temperature.

Outcome

C-Tech Innovation developed a continuous flow microwave reactor, capable of processing up to 1 T of material per day. A range of reactions was used to test the performance of the reactor with the following results:

- significant reductions in reaction time (8 h–3 min) compared to conventional processes,
- significant increases in yields (35%–70%),
- reduction in energy consumption (up to 90% in some cases),
- reduction in CO_2 emissions.

The sizable increases in yield observed also had the further benefit of a downstream energy saving as it reduced the degree of purification required and also decreased the volume of starting materials necessary for the reaction. Using a continuous microwave flow approach is also much safer than the batch approach as there is a much lower inventory of hazardous materials. C-Tech Innovation has demonstrated that large-scale microwave chemistry is no longer the future, it is here today.

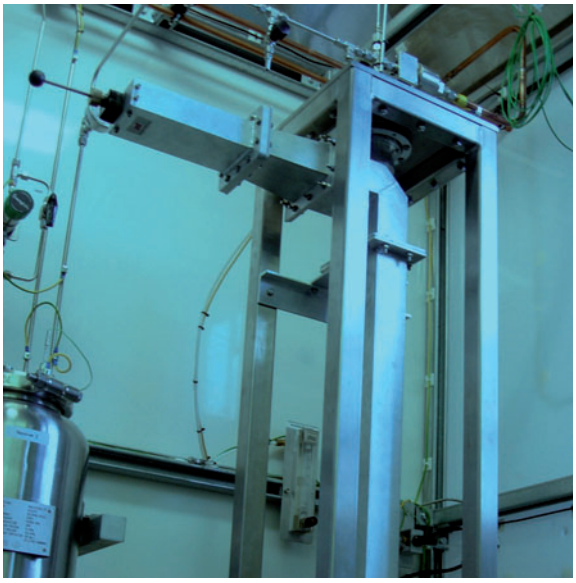
Features

- Microwave power: 1 to 6 kW as standard (higher as required)
- Temperature range: ambient to 220°C
- Pressure: atmospheric to 20 bar
- Flow rate: 5–500 ml/min
- Materials of construction: glass, stainless steel and polymers
- Automatic temperature control

Options

- Fibre optic temperature measurement
- Halide resistant coating of steel parts
- Complete plant or bare reactor

Microwave Laboratory Reactor



Scaled-up Microwave Reactor

Benefits

- Faster reactions, more throughput
- Cleaner: no hot oil, no fouling of hot surfaces
- Greener: higher yields, less by-products, less catalyst, less waste
- Safer: lower inventories, easy temperature control
- High throughput and continuous operation
- Handles liquids and light slurries
- Excellent chemical resistance

For further Information, please contact:
C-Tech Innovation Limited
Capenhurst Technology Park,
Capenhurst,
Chester, CH1 6EH,
UK
Tel.: +44-151-347-2900
E-mail: paul.fitzpatrick@ctechinnovation.com
www.ctechinnovation.com

C-Tech
INNOVATION