Using Solid Supported Catalysts

Column reactors may be used in flow for a variety of purposes, for example solid supported reagents, SPE, scavenger resins or solid supported catalysts.

Using Column Reactors in the R Series

The Vapourtec R Series system offers the same support to tube **and** column reactors, offering total visibility of the reaction while ensuring good heat transfer.

In the picture shown, an R4 standalone reactor module is being used with a tube reactor feeding directly into a column reactor. Each of the 4 available positions on the reactor module are independently temperature controllable.

(The black wires are the temperature sensor leads).

Note that the reaction is fully visible throughout both reactors.

Columns up to 15mm Ø x 150mm in length can be accommodated. Because the cooling / heating of the column is achieved using moving air, the heat transfer into the column is not in any way dependent on the column's external size tolerance.

Why Catalysis in Flow ?

Though solid supported catalysts can be used in batch (with the catalyst filtered from the solution at the end of the reaction), there are several advantages to using a flow based approach:

- Even highly exothermic reactions are easily contained
- High temperature and pressure capability enables microwave-like reaction speed, but without the scale-up issues associated with microwave.
- Subsequent reactions or cleanup steps can follow on immediately (or products can be quenched after a precise amount of time in the reactor)
- Reaction time and temperature profiles are precisely controlled and totally repeatable
- Proven reactions can be rapidly scaled up
- Several different reaction variations can be attempted in sequence using the same catalyst with no manual intervention

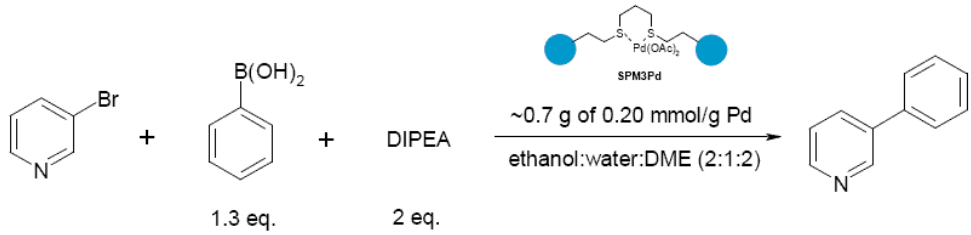
Case Study - Suzuki Reaction

In this example, a palladium catalyst immobilised on silica (from PhosphonicS™) is used. This form is commonly used as a slurry in batch reactions then filtered out at the end.

However, it is also easy to use in columns in a continuous flow scenario, requiring no pre-swelling, and having good thermal, physical, chemical and mechanical stability.

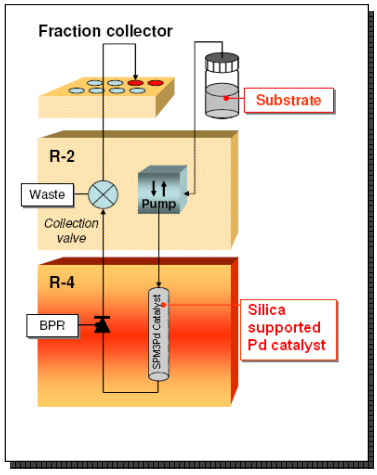
Full details of this study may be found on the Vapourtec website under "applications".

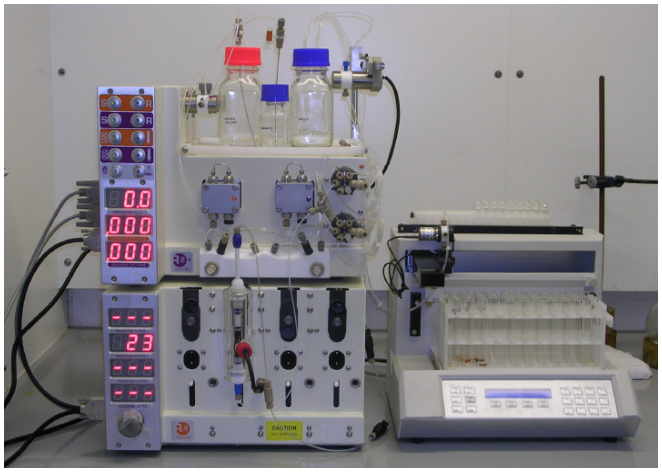
Overall Scheme



Suzuki coupling in flow mode using Phosphonics SPM3Pd catalyst to synthesise 3-phenylpyridine

Equipment Setup





For this reaction, reagents were pre mixed in a single bottle and fed through the catalyst column (which was maintained at 130 °C).

The study evaluated the effects on the overall conversion of varying both residence time and substrate concentration.

Result Summary

Reactor residence times of 2.5 minutes proved sufficient at 130 °C.

Substrate concentration of between 0.5 and 2.5M gave best conversion rates.

The 3-phenylpyridine product of the flow synthesis was generally as clean as the corresponding sample prepared similarly under batch conditions.

A small column 6.6 x 75mm (0.7g of catalyst) retained activity for nearly 3g of final isolated product before it dropped off and conversion fell below 94%.

Exactly the same reaction conditions were applied to a variety of substrates. By varying the boronic acid, an array of 3-Substituted Pyridines was produced

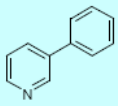
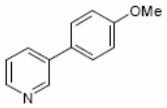
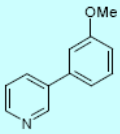
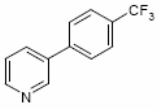
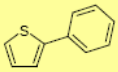
Entry	Suzuki Product	Conversion % by HPLC *($UV_{215\ nm}$)*
1		> 99
2		> 99
3		> 99
4		60
5*		96

Table 1. Suzuki reaction products from 3-bromopyridine and boronic acids under flow conditions with SPM3Pd catalyst

Full details of this study may be found on the Vapourtec website under "applications".

References/ Further Reading

Vapourtec applications page http://www.vapourtec.co.uk/applications

The Ley Group in Cambridge http://leyitc.ch.cam.ac.uk/publications/publicationsSupported.html

Phosphonics ™ http://www.phosphonics.com