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Flow Reactor

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What's Flow Reactor

What is "Flow Reactor"

Micro-flow reaction (Flow Reactor) is a new solution performing chemical reaction by delivering raw materials into micro channels. Flow Reactor enables various types of reactions which could not have been performed in a conventional batch mode (flask, vessel).



High efficiency reaction using Microreactor

Exothermic reaction

Using precise temperature control

Reaction including unstable intermediate

Keep residence time short

Using precise temperature control

Consecutive reaction

Keep residence time short

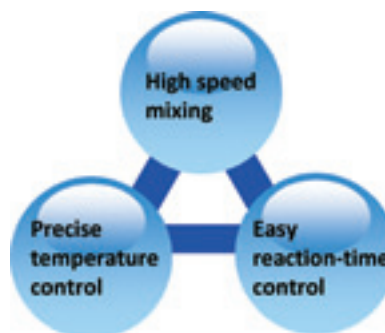
Generated fine particles and emulsions

Precise particle size and size distribution control

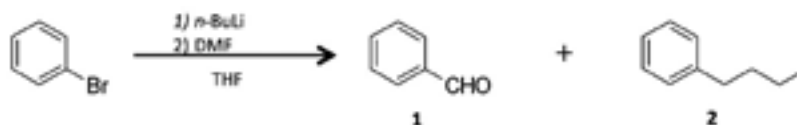
Because of generated in the micro space

Reactions depend on surface area

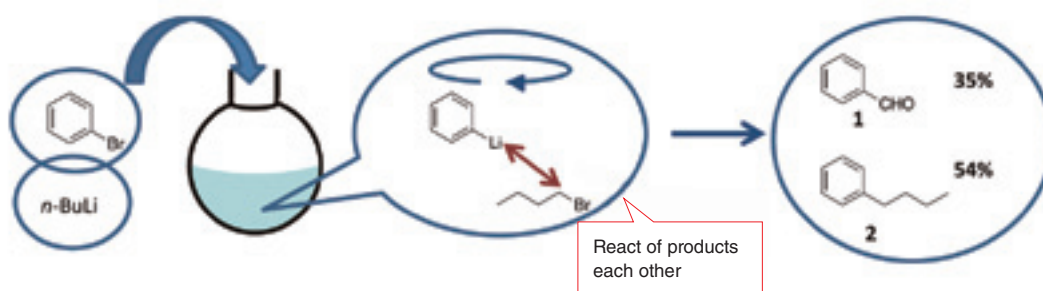
Because of a large surface area, contact efficiency increase



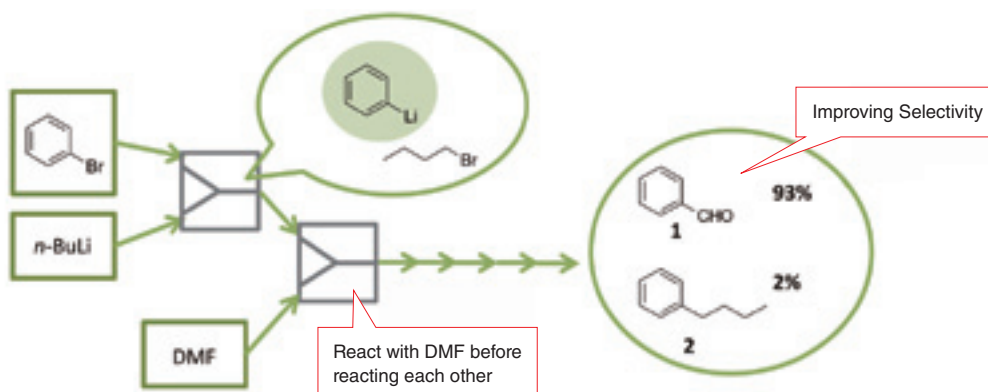
Reaction example



In a conventional batch system (flask), synthesizing of a target compound (No.1 above) alone has been extremely difficult when a product is highly reactive. This is because undesired production of a non-target compound (No. 2 above) due to further reaction of the product takes place even at low temperature.



In a flow micro reaction system, residence time of a highly reactive compound can be kept short just by adjusting the flow rate, and a rapid reaction with DMF by micromixing minimizes the undesired production of byproducts. Since there is no need to keep the temperature low, less energy cost is required.



What is “KeyChem®”

KeyChem® is an abbreviation for keyboard chemistry. “Keyboard chemistry®” has been coined by YMC by combining the words “Keyboard” (as in computer control) and “Chemistry”, to represent the new concept of a chemical reaction methodology that YMC is creating. Central to this concept is the microreactor system, which allows computer-controlled flow reaction and enables the setting of all the conditions of a chemical reaction from start to finish, via the keyboard of a computer.

Product Comparison Table

Wide variety including Liquid-Liquid reaction system for rapid mixing of reaction liquid, and system specializing in hydrogenation or photoreaction

	Reaction type					Other	
	Liquid-Liquid	Gas-Liquid	Solid-Liquid	Gas-Solid	Photoreaction	PC Control	Customization
KeyChem®-Basic	Yes	No	No	No	No	No	Yes
KeyChem®-L/LP	Yes	No	No	No	No	Yes	Yes
KeyChem®-H	No	No	Yes	Yes	No	Yes	Yes
KeyChem®-Lumino	No	No	No	No	Yes	Yes	Yes
KeyChem®-Integral	Yes	Yes	Yes	Yes	No	Yes	Yes

* The above products can be customized to add reaction type.

Micro Flow Reactor System

KeyChem®-Basic

Perform flow reaction easily



- Micro-flow starter kit to get started quickly
 - Type-1 : Simple system
 - Type-2 : Standard system
 - Type-3 : Two-stage reaction system
 - Type-4 : System equipped with thermal control unit
- Other types are available upon request.

KeyChem®-L / KeyChem®-LP

Flow reactor system by PC control



- Superior mixing, precise thermal control, continuous-flow reactor
- Set conditions of reaction by numerical entry into PC controlled system
 - KeyChem®-L : Syringe pump type for stable pumping
 - KeyChem®-LP : Plunger pump type for continuous pumping
- Optional extra : Fraction collector

Hydrogenation Flow Reactor System

KeyChem®-H

Now available safe and highly-efficient hydrogenation reactor



- Hydrogen supply type using harmless hydrogen storing alloy
- High level contact of catalyst and raw materials by catalyst column
- Flow rate and backpressure are controllable.

Flow Photoreactor System

KeyChem®-Lumino

Expand possibility of photoreaction by superior efficiency of light irradiation



- Uniform light irradiation to sample, introducing micro channels
- Materials of light source and reactor are selectable.
- Achieve precise photoreaction

Heterogeneous Flow Reactor System

KeyChem®-Integral

Heterogeneous Reactions In Single System



- Single system plays 4 roles : Reaction of Gas-Liquid, Liquid-Liquid, Solid-Liquid and Solid-Liquid-Gas
- Porous Teflon® (AF2400) is used for the reactor of Gas-Liquid reaction
- Flow rate, temperature and pressure are controllable.
- The number of units and combinations are selectable.

Coil Reactor Unit

- Reactor for Gas-Liquid reaction made of Teflon® AF2400
- Dispersing gas gradually into liquid flowing in a SUS tube through porous of Teflon®
- Mixing gas and reaction liquid homogeneously



Mixing Block Unit

- Flow micro mixer for Liquid-Liquid reaction
- Improvement on reaction yield with rapid mixing in micro space feature



Column Reactor Unit

- Catalyst column packed with reaction liquid
- High reaction efficiency with high level contact of catalyst and reaction liquid
- No need to remove catalyst



Pump Unit

- Sending solution by plunger pump
- Highly accurate and stable in flow rate
- Available in 3 types according to flow rate range
- Available wetted material : PEEK or SUS



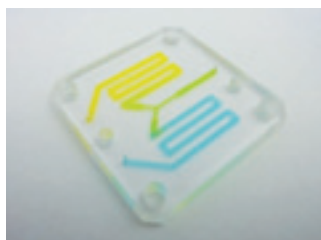
Specifications

Pump unit	Material	SUS	resin	SUS	resin	SUS	resin
	Type	Plunger					
	Range	0.001 to 1.00 mL/min		0.01 to 10.0 mL/min		0.1 to 50.0 mL/min	
	Pressure resistance	25 MPa	20 MPa	25 MPa	20 MPa	5 MPa	5 MPa
	Dimensions	(W X D X H) 140 X 186 X 123 mm					
Coil Reactor Unit		Low Temperature Type			High Temperature Type		
	Method	Peltier			Heating		
	Range	5 to 80°C			r.t.+10°C to 200°C		
	Dimensions	(W X D X H) 250 X 225 X 175 mm					
Mixing Block Unit		Low Temperature Type			High Temperature Type		
	Method	Peltier			Heating		
	Range	5 to 80°C			r.t.+10°C to 200°C		
	Dimensions	(W X D X H) 250 X 225 X 175 mm					
Column Reactor Unit							
	Method	Thermal Vibration					
	Range	r.t.+10°C to 200°C					
	Dimensions	(W X D X H) 250 X 225 X 347 mm					

Reactor (KeyChem® series mixer)

Three kinds of micro-mixers with different mixing configurations are available.

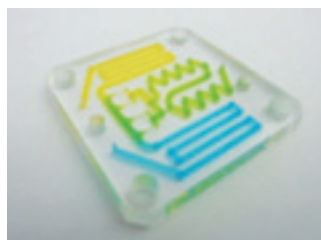
Hadar (Y type)



- Mixing on collision in simple Y-shaped channel
- Ideal for synthesis from drop

Material	Model number
SUS316	KC-M-Y-SUS
Glass	KC-M-Y-GL
PTFE	KC-M-Y-P

Deneb (Helix type)



- Powerful agitation, structure suitable for organic synthesis
- Mixing after 3D motion

Material	Model number
SUS316	KC-M-H-SUS
Glass	KC-M-H-G
PTFE	KC-M-H-P

Spica (Static type)



- mixing after repeated bifurcation and merging

Material	Model number
SUS316	KC-M-S-SUS
Glass	KC-M-S-G
PTFE	KC-M-S-P

Pump

YSP series Syringe pump

High-performance and cost-effective syringe pumps

Usable for micro-flow reaction, dripping reagents, pharmacological experiment, animal testing, etc.

YSP-101 (Standard type)

Infuse only and no capability to withdraw



- Deliver constant volumes and microliter volumes
- Change flow rate during operation
- A variety of types available to suit your needs
- Compatible with various syringe sizes and types from major manufacturers

YSP-201

(High-performance type)

Similar to YSP-101 but with withdrawal function.



YSP-301

(High performance & high pressure type)

Includes features of YSP-201 and high pressure pumping function.



YSP-202

(Double syringe type)

Similar to YSP-201 but holds 2 syringes.

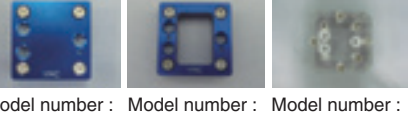



Model number	YSP-101	YSP-201	YSP-301	YSP-202
Syringe type	Standard type	High-performance type	High performance & high pressure type	Double syringe type
Infusion	Yes	Yes	Yes	Yes
Withdrawal	No	Yes	Yes	Yes
Programmable pump	No	Yes	Yes	Yes
PC Control	No	Yes	Yes	Yes
Minimum flow rate* ¹	0.012 µL/min		0.023 µL/min	
Maximum flow rate* ²	31.5 mL/min	42.57 mL/min	153.3 mL/min	76.32 mL/min* ³

The pumps may not be used at max. or min. flow rate under certain conditions.

*¹ Obtained using a 1mL disposable syringe. *² Obtained using a 50mL disposable syringe. *³ Obtained using a 25mL gastight syringe.

Accessories · Consumable parts

Connector 1/16 in. SUS  Model number : YMC-P-0001 Material : SUS316 Quantity : 10 Connecting 1/16 in. ext. diam. tube	Connector 1/16 in. PEEK, M6HN  Model number : YMC-P-0002 Material : PEEK Quantity : 1 Used in conjunction with ferrule (YMC-P-0012). Connecting mixer housing with 1/16 in. ext. diam. tube	Connector 1/8 in. PEEK, M6HN  Model number : YMC-P-0067 Material : PEEK Quantity : 1 Used in conjunction with ferrule (YMC-P-0068). Connecting 1/8 in. ext. diam. tube.																					
Connector for KeyChem® series  Model number : YMC-P-0005 Material : PEEK Quantity : 1 Connecting thermostat Thermo Stage of KeyChem® series. Used in conjunction with ferrule (YMC-P-0012). Connecting with 1/16 in. ext. diam. tube.	Connector for KeyChem® series (SUS)  Model number : YMC-P-LU06 Material : SUS304 Quantity : 1 Connecting reactor housing of Lumino. Used in conjunction with ferrule (YMC-P-0012). Connecting with 1/16 in. ext. diam. tube.	Connector 1/16 in. (10 pcs., plastics)  Model number : YMC-P-0006 Material : ETFE Quantity : 10 Used in conjunction with ferrule (YMC-P-0012). Connecting 1/16 in. ext. diam. tube to syringe adaptor (female type) (YMC-P-0007), lure adaptor (male type) (YMC-P-0008)																					
Housing connector (for SUS)  Model number : YMC-P-0057 Material : SUS Quantity : 1 Connecting 1/16 in. ext. diam. SUS tube to housing.	Syringe adaptor (female type)  Model number : YMC-P-0007 Material : ETFE Quantity : 1 Adaptor connecting syringe (lure lock type) to tube. Used in connection with 1/16 in. plastic connector (YMC-P-0006).	Lure adaptor (male type)  Model number : YMC-P-0008 Material : ETFE Quantity : 1 Adaptor connecting syringe needle. Used in reaction including water-reactive substance and in connection with 1/16 in. plastic connector (YMC-P-0006).																					
EASYFIT10φ  Model number : YMC-P-0009 Material : PEEK Quantity : 10 Combined fitting and ferrule connector. Connected by 1/16 in. ext. diam. tube.	Connector 1/8 in. (ETFE and FSF)  Model number : YMC-P-0070 Material : ETFE Quantity : 10 Connecting 1/8 in. tube and plunger pump.	Ferrule 1/16 in. (plastic)  Model number : YMC-P-0010 Material : PTFE Quantity : 10 Used in conjunction with 1/16 in. connector (SUS, YMC-P-0001). Mainly used in PTFE tube.																					
Ferrule 1/16 in. (SUS)  Model number : YMC-P-0011 Material : SUS316 Quantity : 10 Used in conjunction with 1/16 in. connector (SUS, YMC-P-0001). Mainly used in SUS tube.	Ferrule 1/16 in. (PTFE and GF)  Model number : YMC-P-0012 Material : PTFE, SUS316 Quantity : 10 Ferrule connecting connector 1/16 in. PTFE, M6HN (YMC-P-0002) and 1/16 in. ext. diam. tube.	Ferrule 1/8 in. (PTFE and GF)  Model number : YMC-P-0068 Material : PTFE, SUS316 Quantity : 10 Ferrule connecting connector 1/8 in. PTFE, M6HN (YMC-P-0067) and 1/8 in. ext. diam. tube.																					
Ferrule 1/16 in. (SFL)  Model number : YMC-P-0060 Material : PEEK, SUS316 Quantity : 10 Ferrule connecting connector 1/16 in. and 1/16 in. ext. diam. tube. Applicable to SUS tube as well.	Ferrule 1/8 in. (ETFE and FSF)  Model number : YMC-P-0069 Material : ETFE Quantity : 10 Used in conjunction with connector 1/8 in. (ETFE and FSF, YMC-P-0070).	Mixer housing for KeyChem®  Model number : YMC-P-0030-01 Material : aluminum Model number : YMC-P-0030-02 Material : aluminum Model number : YMC-P-0031 Material : acrylic resin																					
YMC highly pressure-resistive syringe  Model number : YMC-P-1014 Material : 25 mL Quantity : 1 YMC original highly pressure-resistive syringe. Easy to install on MR2 pump.	Disposable syringe  <table border="1"> <thead> <tr> <th>Capacity</th> <th>Quantity</th> <th>Model number</th> </tr> </thead> <tbody> <tr> <td>2 mL</td> <td>100</td> <td>YMC-P-1001</td> </tr> <tr> <td>5 mL</td> <td>100</td> <td>YMC-P-1002</td> </tr> <tr> <td>10 mL</td> <td>100</td> <td>YMC-P-1003</td> </tr> <tr> <td>20 mL</td> <td>100</td> <td>YMC-P-1004</td> </tr> <tr> <td>30 mL</td> <td>50</td> <td>YMC-P-1021</td> </tr> <tr> <td>50 mL</td> <td>30</td> <td>YMC-P-1022</td> </tr> </tbody> </table>		Capacity	Quantity	Model number	2 mL	100	YMC-P-1001	5 mL	100	YMC-P-1002	10 mL	100	YMC-P-1003	20 mL	100	YMC-P-1004	30 mL	50	YMC-P-1021	50 mL	30	YMC-P-1022
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PTFE Tube  <table border="1"> <thead> <tr> <th>In. diam.</th> <th>Model number</th> </tr> </thead> <tbody> <tr> <td>0.25 mm</td> <td>YMC-P-0024</td> </tr> <tr> <td>Ext. diam. : 1/16 in. 0.5 mm</td> <td>YMC-P-0025</td> </tr> <tr> <td>Length : 10 m 0.75 mm</td> <td>YMC-P-0026</td> </tr> <tr> <td>1.0 mm</td> <td>YMC-P-0027</td> </tr> <tr> <td>Ext. diam. : 1/8 in. 1.6 mm</td> <td>YMC-P-0075</td> </tr> <tr> <td>Length : 10 m 2.4 mm</td> <td>YMC-P-0076</td> </tr> </tbody> </table>		In. diam.	Model number	0.25 mm	YMC-P-0024	Ext. diam. : 1/16 in. 0.5 mm	YMC-P-0025	Length : 10 m 0.75 mm	YMC-P-0026	1.0 mm	YMC-P-0027	Ext. diam. : 1/8 in. 1.6 mm	YMC-P-0075	Length : 10 m 2.4 mm	YMC-P-0076	SUS Tube  <table border="1"> <thead> <tr> <th>In. diam.</th> <th>Model number</th> </tr> </thead> <tbody> <tr> <td>Ext. diam. : 1/16 in. 0.5 mm</td> <td>YMC-P-0028</td> </tr> <tr> <td>Length : 10 m 1.0 mm</td> <td>YMC-P-0029</td> </tr> </tbody> </table>		In. diam.	Model number	Ext. diam. : 1/16 in. 0.5 mm	YMC-P-0028	Length : 10 m 1.0 mm	YMC-P-0029
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