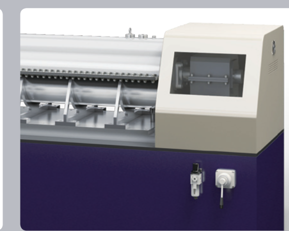
Laminar

#512, 27, Dunchon-daero 457beon-gil, Jungwon-gu, Seongnam-si, Gyeonggi-do, 462-806, Republic of Korea
Tel. +82-31-737-2375   Fax. +82-31-737-2757   E-mail. laminar@laminarm.co.kr
www.laminarm.com

The world's first
Taylor Reactor



LCTR®-series

Laminar

Laminar Co., Ltd.

Global New Technology

CE certificate

CE certificate

ISO 9001

ISO 14001

Pioneered in the new field of chemical reactor

Since the establishment in 2010, Laminar Co.,Ltd based on Technology has developed a new concept of chemical reactor named as Taylor Reactor(LCTR, Laminar Continuous Taylor Reactor) and pioneered in the new fields of chemical reactors. Furthermore, going on to enlarge the general reactor market fields.

To satisfy the needs of all customers, we are continuously studying research and doing the development of reactors.
Resultantly, Laminar possesses the best manufacturing know-hows and a number of Technologies.

The custom made Taylor reactors are also possible as per the special requirements from the chemical manufacturing processes, based on several technologies and know-hows.

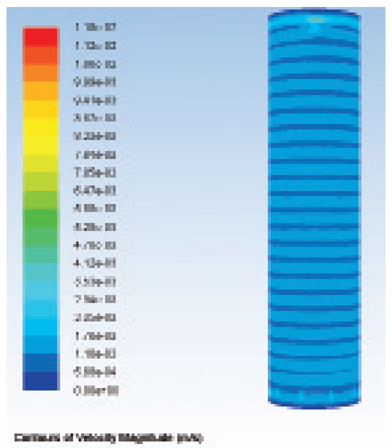
As already proved reactor in functionality and reliability in the market, Taylor reactor is exporting abroad from 2013, and now Laminar Co., Ltd is enlarging widely the business fields for Taylor reactors.

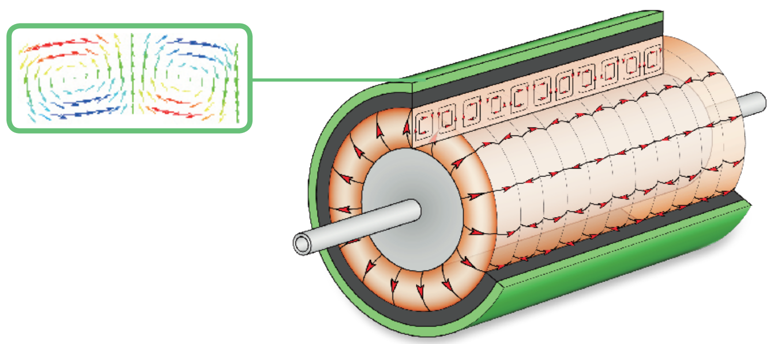
Due to innovative R&D activity, we are developing the new functional chemical reactor fields.

Laminar

Taylor fluid flow

The reactor session is made up with two cylinders, inside and outside, and the solution to be reacted is fed into the space between the inside and the outside cylinder through the feeding ports.
As soon as the inside cylinder is rotated by the motor, the solution is also starting to move and then forming a strong stream in the direction of rotation.
Simultaneously, two forces of Centrifugal and Coriolis are generated so strongly that the solution in the reactor moves fast for the outside cylinder.
The faster the inside cylinder is rotated, The more unstable the flow comes to be.
By this phenomena, the eddy current flow is created regularly in the shape of the double rings each of which is self-rotated in the opposite direction, along the rotated inside cylinder. It is shaped like a band in the reactor.
This means a Taylor flow in which is called.





Cathode material of Lithium ion battery, precursor

Class	Batch Reactor	LCTR® Reactor
Fluid mixing method	Macro-mixing	Micro-mixing
Mass transfer velocity (m/s)	1	3.3
Mixing intensity (W/kg)	0.8	5.8
Reaction time (h)	16	2
Span($[D_{90}-D_{10}]/D_{50}$)	0.5	0.2
Tap Density(g/mL)	2.1	2.2

A Taylor fluid flow can generate a turbulent flow easily by changing the rotational speed of an inner cylinder, so it is much used to study the stability of a fluid. Rayleigh performed a stability analysis for a non-viscous fluid for the first time

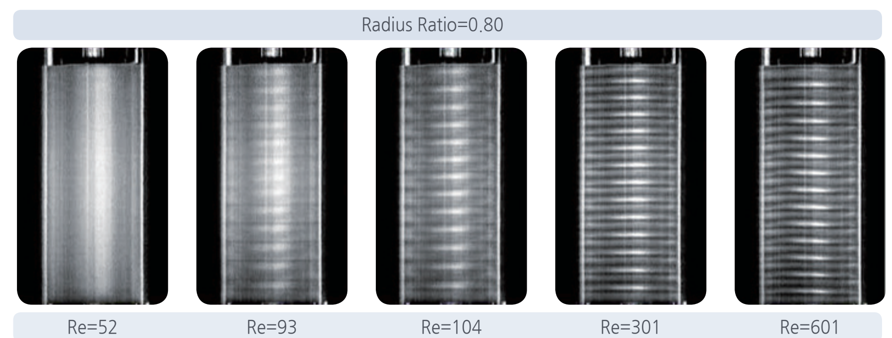
For a viscous fluid, Taylor reported that a Taylor vortex occurs in a domain larger than the critical Taylor number based on linear theory. The instability condition of a flow can be represented as a Taylor number(Ta), which is defined by a rotational direction Reynolds number and a reactor shape factor(d/r_i) as follows:

$$Ta = \frac{\omega_i r_i d}{v}\left(\frac{d}{r_i}\right)^{1/2}$$

where d is the distance between two cylinders, r_i is the radius of the inner cylinder, ω_i is the rotational angular speed of the inner cylinder, and v is the dynamic viscosity of the fluid.

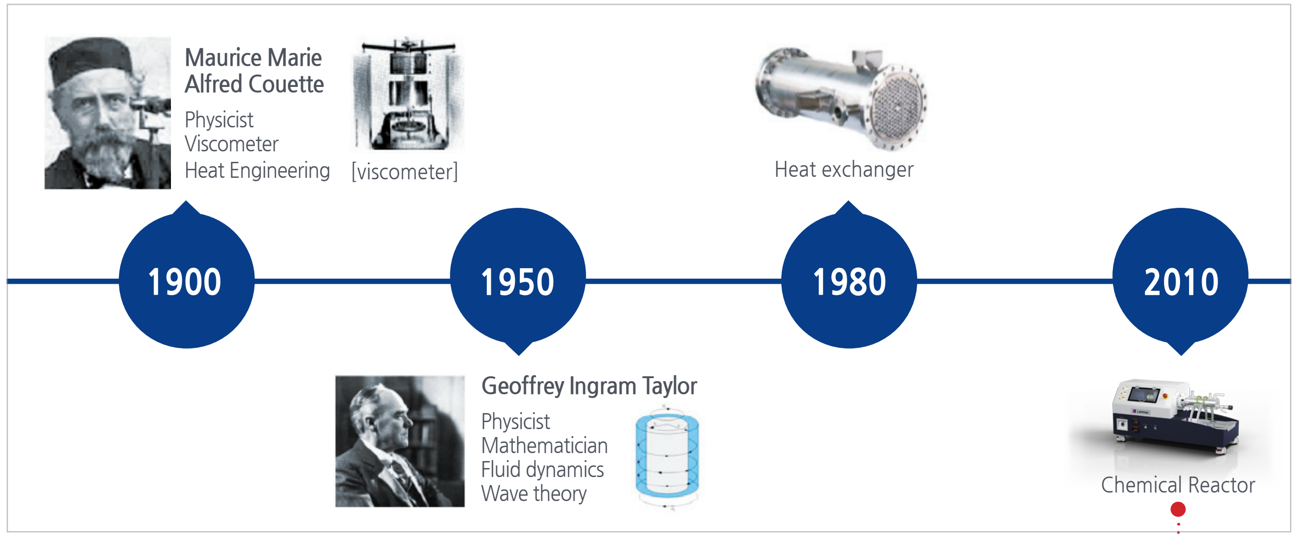
Taylor presented that the critical Taylor number(Ta_c) as d/r_i approaches 0 is 41.3, and Kataoka et al. classified the flow characteristics based on a Taylor number when d/r_i is 0.62 without axial flow as follows:

$Ta<Ta_c$	: laminar flow
$Ta_c<Ta<800$	: laminar vortex(single periodic) flow
$800<Ta<2000$	: laminar vortex(double periodic) flow
$2000<Ta<10000\sim15000$	: turbulent vortex flow
$Ta>15000$	: turbulent flow

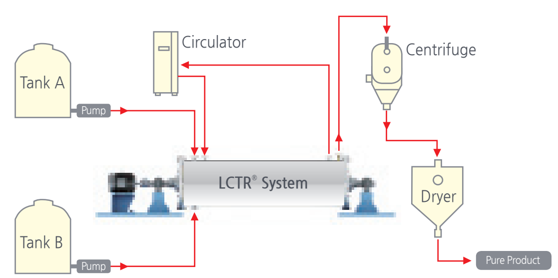


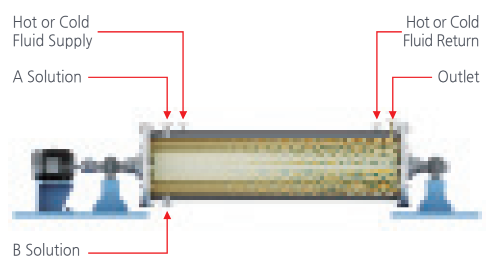
LCTR® system

HISTORY



LCTR® is possible to manufacture the new materials by feeding Gas, Liquid and Solid under the condition of the presence of solvent.

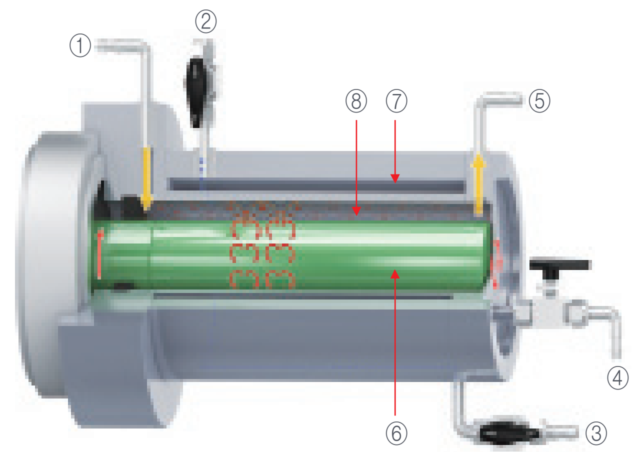




Liquid-Liquid reaction	Gas-Liquid reaction	Solid-Liquid reaction
ex) $LiCl + Na_2CO_3(l) \rightarrow Li_2CO_3$	ex) $2LiOH + 3CO_2(g) \rightarrow Li_2CO_3$	ex) $Al_2CO_3(s) + CuSO_4 \rightarrow Cu\text{-}Al_2CO_3$

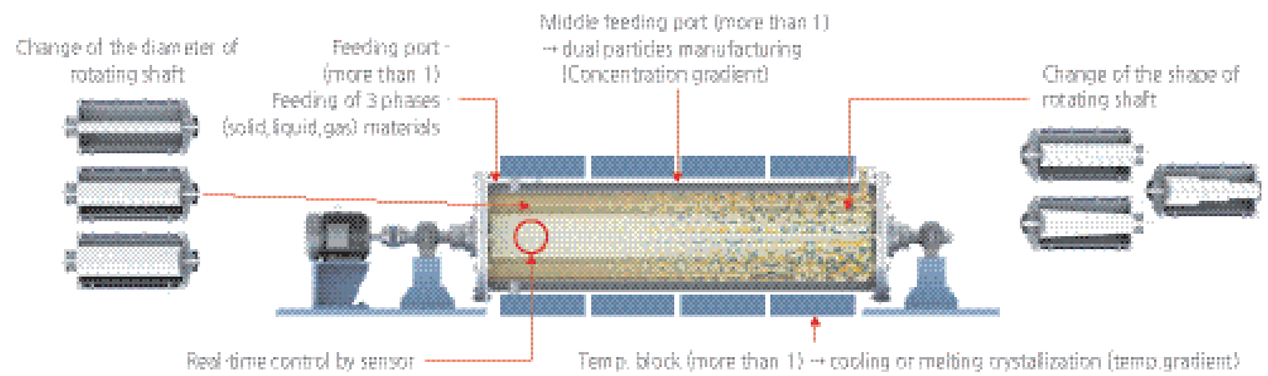
LCTR® Inner structure and manufacturing option

Inner structure



① Feeding port
② Out-let of the solution used for controlling temp
③ In-let of the solution used for controlling temp
④ Drain for the reacted solution
⑤ Out-let of the material reacted in slurry
⑥ Rotating shaft
⑦ Temp. control section
⑧ Reaction section

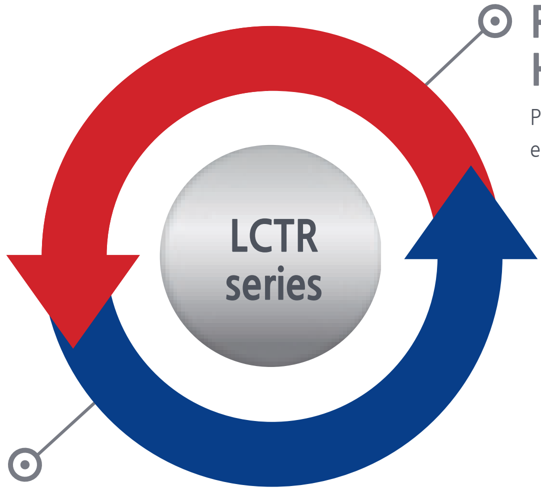
Manufacturing option



Characteristics of LCTR®-series

LCTR®: Batch + Tubular

The development of a ideal chemical reactor functioning the continuous manufacturing system for high purity materials by utilizing fully the advantages of both Batch (easy to operate, the use of mixer, easy to check in operation) and Tubular (high purity production, high reproducibility, east to produce nano-materials)



Production of High-quality materials

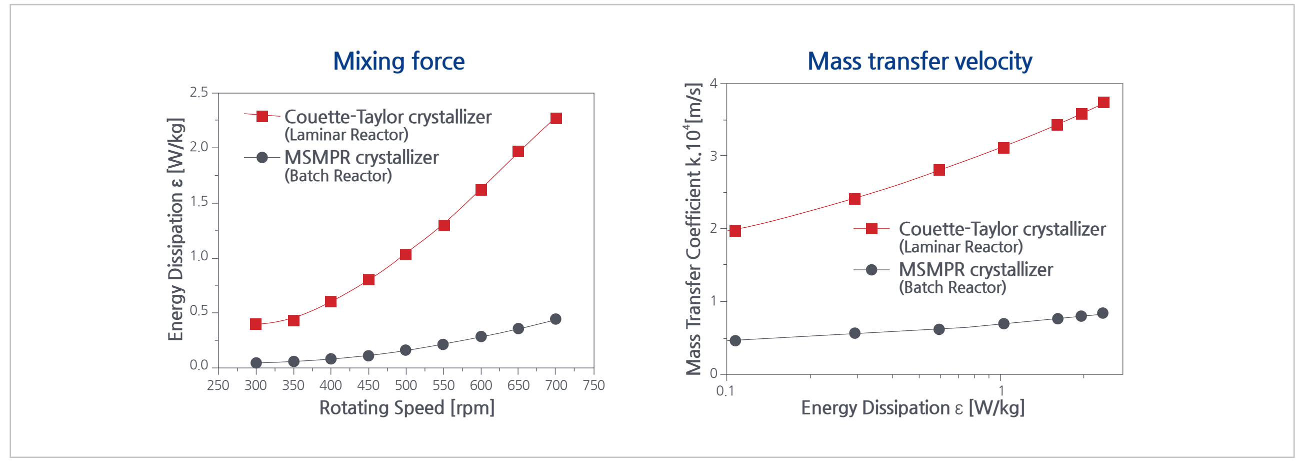
Possible to produce high-purity materials and enhance properties

Enhancement of productivity

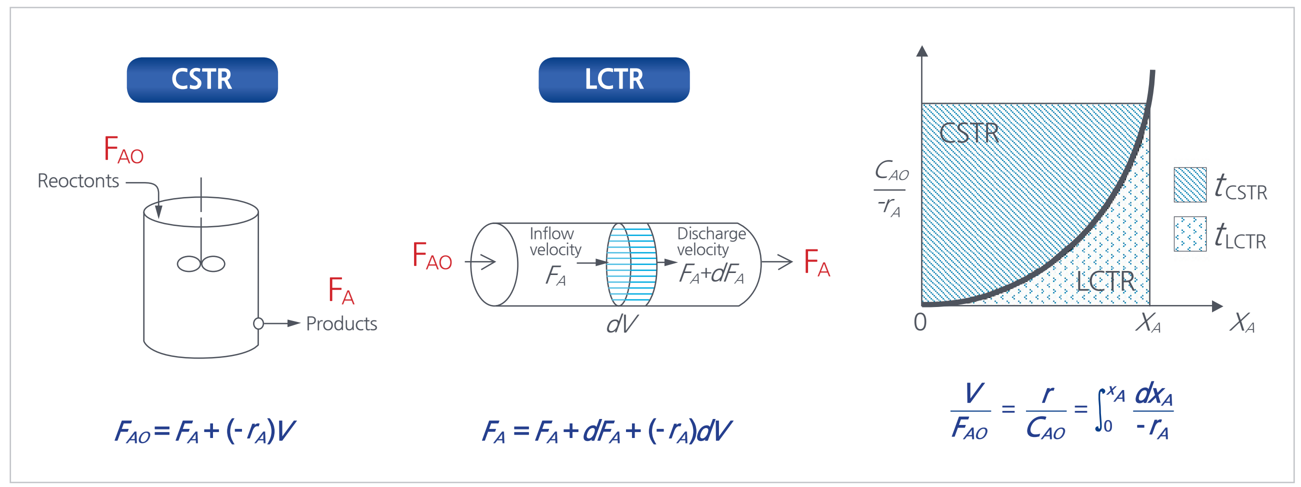
Possible to both reduce cost and increase productivity due to shortened reaction time and continuous production system.

Time reduction

Possible to shorten the reaction time by one third, due to 7 times stronger mixing force and 3 times faster mass transfer velocity



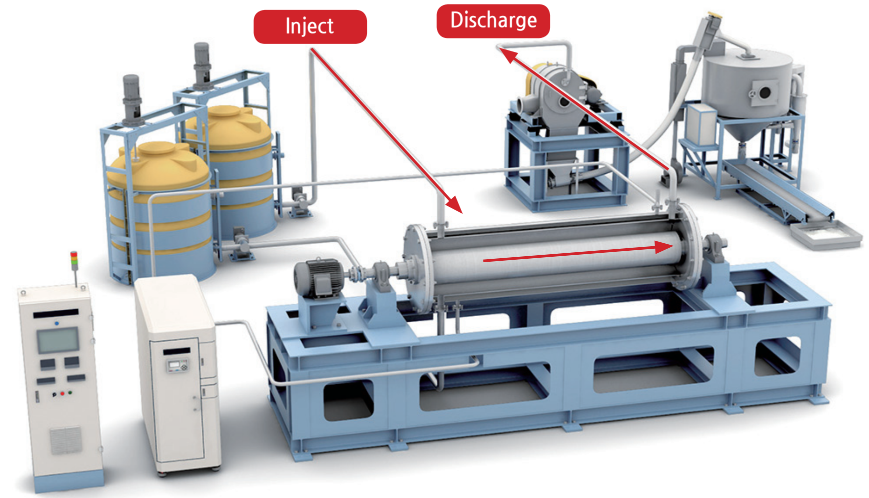
Nguyen-Anh TUAN, Jeong-ki Kang, Jong-Min Kim, Sang-Mok CHANG, Choul-Ho Lee, Woo-sik KIM, "Drowning-out Crystallization of Guanosine 5-Monophosphate(GMP) in Continuous Couette-Taylor Crystallizer" 8th International Conference on Separation Science and Technology, Karuizawa, Japan, (Oct 2-4, 2008)



Characteristics of LCTR®-series

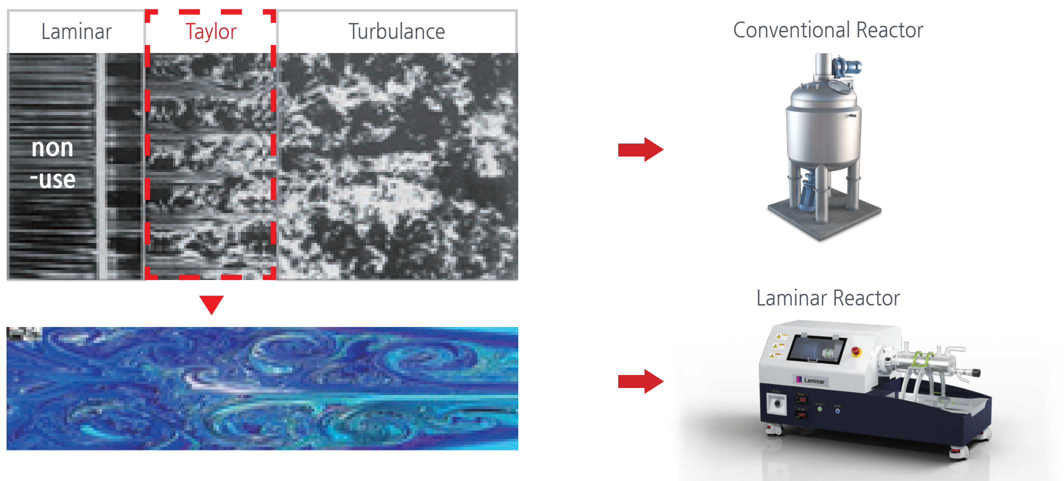
Continuous production

Possible to produce the volume same as you inject under the continuous production system



Improvement of properties

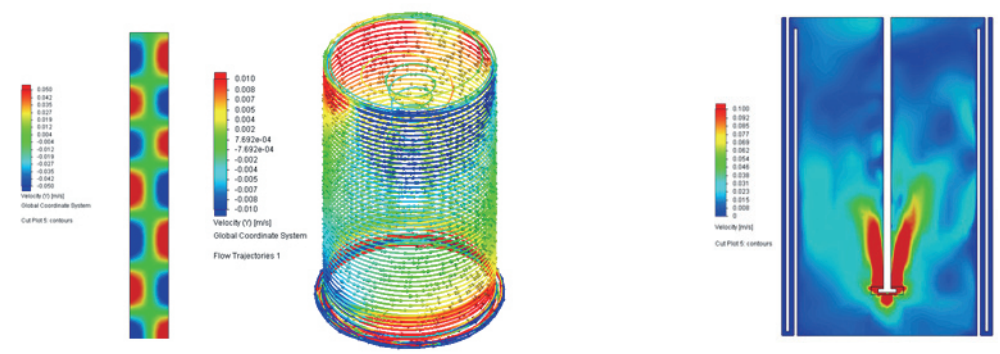
Possible to be uniformly mixed due to the vortexes regularly created



High-purity materials

Possible to reduce the formation of impurity due to that there is no any dead-zones in the reactor as an ideal fluid flow

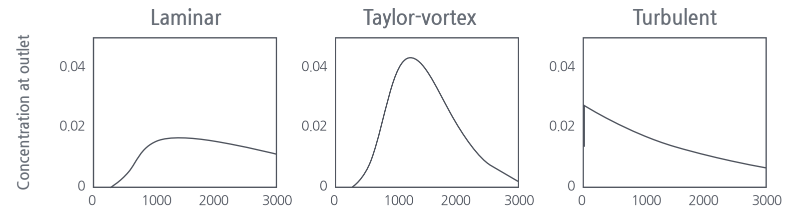
CFD



Laminar Reactor

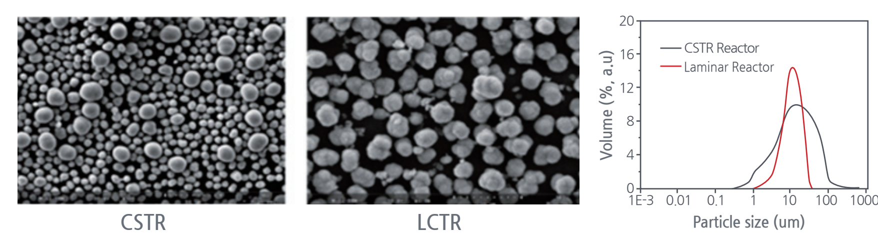
Conventional Reactor

Demonstration of mixing

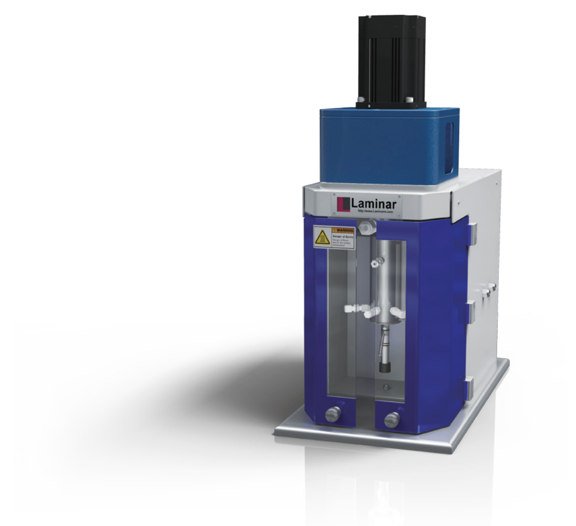


From : A. Syed and W.-G Fruh (2003). Journal of Chemical Technology and Biotechnology 78, 227-235

LIB data



LCTR®-series Laminar Continuous Taylor Reactor



LCTR® - Mini - V

	LCTR® - Mini - V
Capacity (mL)	20
Max. rotation speed (rpm)	1500
Material	SUS316L & Glass & Teflon
Dimension L/W/H (mm)	274 x 525 x 617
Weight (kg)	40

* Available on request

LCTR® - Lab II - V

LCTR® - Lab II - H

	LCTR® - Lab II - V	LCTR® - Lab II - H
Capacity (mL)	100	200
Max. rotation speed (rpm)	1500	1500
Material	SUS316L & Glass & Teflon	SUS316L & Glass & Teflon
Dimension L/W/H (mm)	500 x 500 x 1178	1102 x 450 x 574
Weight (kg)	85	120

* Available on request

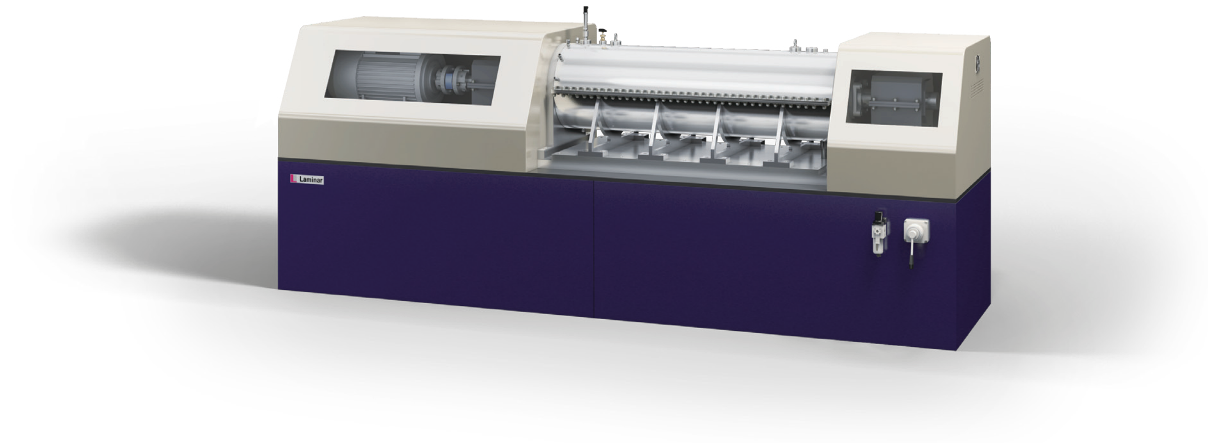
LCTR®-series Laminar Continuous Taylor Reactor

LCTR® - Tera 3100
(General Type)

LCTR® - Tera 3300
(PLC Type, CE Certified)

	LCTR® - Tera 3100	LCTR® - Tera 3300
Capacity (L)	1	1
Max. rotation speed (rpm)	1500	1500
Material	SUS316L & Teflon	SUS316L & Teflon
Dimension L/W/H (mm)	1470 x 700 x 1157	1400 x 700 x 1150
Weight (kg)	450	650

* Available on request



LCTR® - Peta

	LCTR® - Peta	
Capacity (L)	10	50
Max. rotation speed (rpm)	1500	1200
Material	SUS316L	SUS316L
Dimension L/W/H (mm)	2330 x 700 x 1220	3400 x 1300 x 1600
Weight (kg)	1200	3000

* Available on request

LCTR®-series Laminar Continuous Taylor Reactor

LCTR® - Exa

LCTR® - Exa			
Capacity (L)	100	500	1000
Max. rotation speed (rpm)	300	250	250
Material	SUS316L	SUS316L	SUS316L
Dimension L/W/H (mm)	5800 x 2300 x 1850	6500 x 2500 x 2000	8500 x 3000 x 2300
Weight (kg)	5000	15000	25000

* Available on request

LCTR® Application fields

Product		
$LiFePo_4$	$Ba(NO_3)_2$	$NiSO_4$
$(NiMnCo)(OH)_2$	KNO_3	$CoSO_4$
Li_2CO_3	$NaHCO_3$	TiO_2
$CaCO_3$	Durene	Methionine
K_2CO_3	Diiodobenzene	GMP
$NH_4H_2PO_4$	Triiodobenzene	IMP
NaI	Lysine	Graphene Oxide
SiO_2	Tryptophan	SMZ

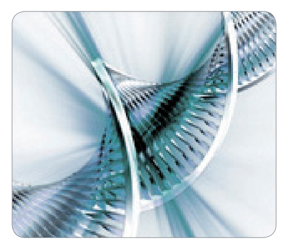
Manufacturing process		
Crystallization	Sol-gel process	Impregnation
Re-crystallization	Polymerization	Extraction
Co-precipitation	Radical reaction	Core-shell process
Precipitation	Coating	Exfoliation

Electronic material

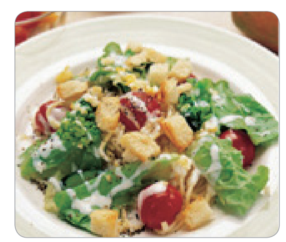
Battery

Petrochemistry

Medicine



Bio



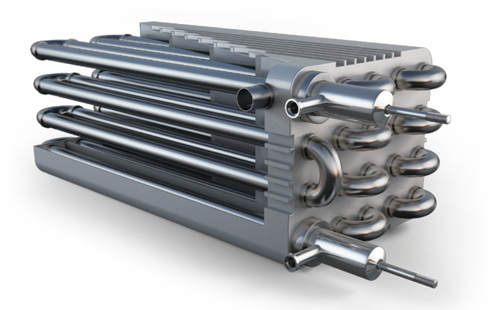
Food

Environment

Fine chemical

General types Reactors

Laminar co., Ltd is manufacturing all purpose of reactors based on our own technologies.



Tubular reactor

Catalytic reactor

Autoclave

Emulsifying device

Option

Centrifuge

Solid-liquid separation
Use at the tail of a reactor
Use or non-use depending on the powder condition

Flowmeter

Proposed in accordance with the process conditions

Circulator

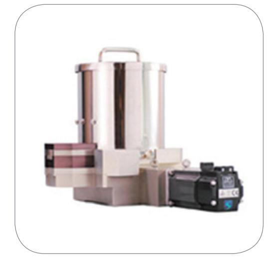
Temp. control of the reaction solution
-25 ~ 150 ℃

Solution feeding pump for Lab.

Max 20 mL/min
Max 6 bar
Materials : PP or PTFE

pH controller

Control by PID



Solid quantitative feeding device

Feeding of powder to the reactor or a storage tank
0.1 ~ 1000 g/min
Materials : SS41

Solution feeding pump for production

Max 200 L/min
Max 16 bar
Materials : PTFE

Electronic scale (weigh the feeding quantity)

Alternative to a flowmeter
0.01 ~ 10 kg
0.001 ~ 1 kg

Solution feeding pump for slurry material

Max 600 rpm
Max 8 bar

pH sensor

Acid & alkali solution
For slurry