Green Technology
Continuous Regeneration

**SHANGHAI
DODGEN CHEMICAL
TECHNOLOGY CO.,LTD**

Phone: 021 5068 3979
180 1605 8776
Email: inquires@chemdodgen.com
Website: https://en.chemdodgen.com
Address: 605, No.388, Fushan Road,
Pudong New Area, Shanghai

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DODGEN

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Overview of DODGEN Chemical

SHANGHAI DODGEN CHEMICAL TECHNOLOGY CO.,LTD

· 2005

Shanghai DODGEN Equipment Technology Engineering Co., Ltd. was established.

· 2012

Shanghai DODGEN Process System Technology Department was established.

· 2018

Shanghai DODGEN Chemical Technology Co., Ltd. was established.

Shanghai DODGEN Chemical Technology Co., Ltd (DODGEN)——Green technology, Continuous regeneration

DODGEN is committed to becoming a specialist in advanced materials and green process technology. We are dedicated to working rigorously with all clients in the new material, new energy, and green manufacturing industry of chemicals, creating value and success. DODGEN uses its innovative technology and cost-effective process solutions to promote industrial technology change and seize future development opportunities.

The future has already come. Fossil raw material and energy sources will gradually be replaced by other green biomass sources due to their unsustainability. DODGEN has long been committed to creating new materials, new energies, green manufacturing of chemicals for clean and low-carbon fields. By integrating technologies with new processes and new equipment throughout entire industrial chain, we can complete industrialization of scientific research and production at an unprecedented rate.

DODGEN possesses multiple patented technologies and patented equipment, which are developed, based on our own advantages. Pursuing quality, innovation and meeting client needs is our eternal theme. Driven by innovative R&D, we develop and provide customized solutions for different customers through the development of process technology package, key equipment and chemicals. These three core dimensions are well- integrated to provide our customers with highly competitive and optimal process technology solutions.








R&D Center

Based on the optimization of existing high-value-added products, and with the continuous R&D of green chemicals required for social development is the main line, we have successively promoted the development of hydrocyanic acid derivatives, degradable new materials and green chemicals industry.

Process System Center

With rich experience and professional know-how, we provide process solutions, develop new process and new equipment, as well as supply PDP design, etc.

Mainly include:

System simulation ▸ Hydraulic calculation ▸ Computational fluid dynamics simulation ▸ Finite element analysis ▸ Stress analysis

Equipment Manufacturing Center

Manufacturing of critical equipment for reaction and separation processes in chemical units.

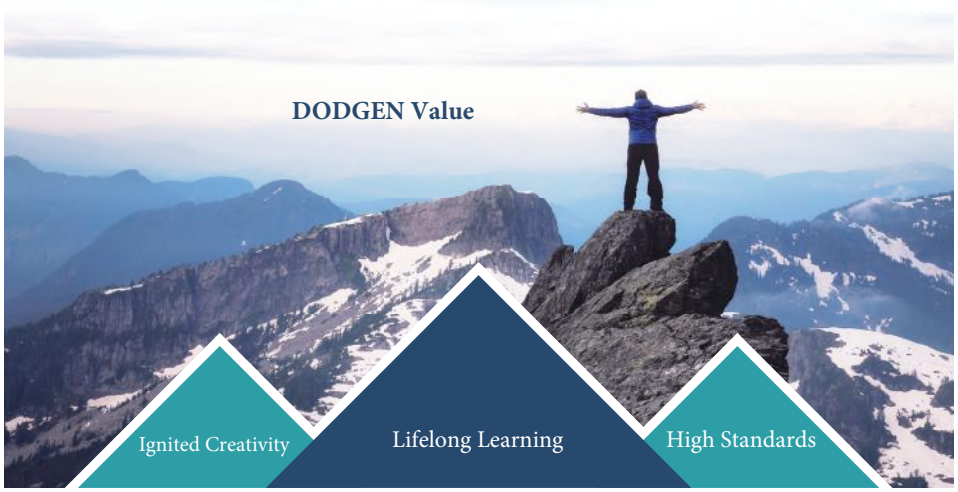
Chemical Plant Division

Based on the field of hydrocyanic acid derivatives, polylactic acid, polyglycolic acid and other degradable materials, we have established an organic combination industrial chain of hydrocyanic acid derivatives, PLA/PGA/PBS and other degradable materials, special chemicals such as catalysts and additives can be provided.

In order to serve customers better, we can also provide the service of pilot test, installation guidance, pre-commissioning inspection and start-up guidance, etc. Our goal is to be the professional and reliable partner for clients, and jointly promote the perfect implementation of the project.

Strategic Principles

Integrated → Innovative → Professional → Collaborative



BUSINESS PARTNER

Reaction and separation specialists
Low carbon technology partners

Chemtex · 中化 sinochem · 中国神华 CHINA SHENHUA · 丰原福泰来 BBCA FUTERRO · UPL · 新和成 NHU · TINCI · HISUN 海正生物材料 · HEBANG · YONTA 永太科技 · 云天化集团 · Lonsen · Abiochem.com

DODGEN SERVICE

Synthetic Biology

R&D Services

Provide the following services according to client requirements:

- Customized R&D of chemicals
- Process technology development
- Unit technology development
- New equipment development

Pilot Test Service

DODGEN can provide reaction and separation pilot test services according to client's requirements. We have modular process skid systems as follows:

- Melt crystallization skid
- Falling film reaction skid
- Polymerization and devolatilization skid
- Falling film evaporation skid
- Micro-melt crystallization skid
- DSR reactor skid
- High flux microreactor skid
- Distillation and separation skid
- Liquid-liquid extraction skid

New Material

Process Design

Provide the following services according to client requirements:

- Unit Technology solution
- PDP supply
- Debottleneck diagnosis and revamping

Key Equipment

Manufacturing and supply of key equipment, involving equipment as follows:

- Falling film crystallizer
- Static crystallizer
- Tower packing and internals
- Hgh flux microreactor
- Falling film reactor
- Falling film evaporator
- DSV gas-liquid reactor
- Polymerization reactor
- DSXL devolatilizer

Chemical

Technical Services

We provide the following services according to client's requirements:

- Installation guidance
- Pre-commissioning inspection
- Start-up guidance

DODGEN Research and Development

Professional Technical Team

DODGEN has assembled a team of experts with extensive experience in research, development, design, and operation in various fields. These professionals specialize in process engineering, environmental protection, instrumentation, electrical engineering, and more, providing comprehensive expertise for our clients.

DODGEN technical team does not suspend at the existing technology and experience, continued investment in R&D, technological innovation and progress to bring more advanced and efficient solutions to our clients. In addition, we also have a number of top experts in various fields of the industry (including 2 foreign experts), which helps to tap into the wisdom from different source sand facilitate our clients to develop.

Reliable Quality Assurance System

- Quality manual
- Management procedure, operation procedure
- Operation instruction , project procedure record

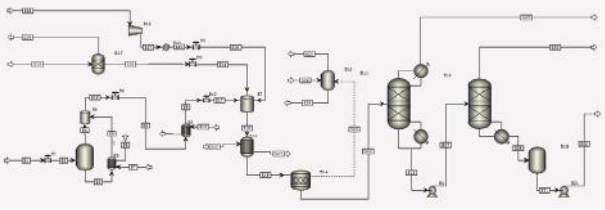
- Unit technology development
- Process technology development
- New equipment development
- Unit technology solution
- Process package preparation
- Debottleneck diagnosis and revamping

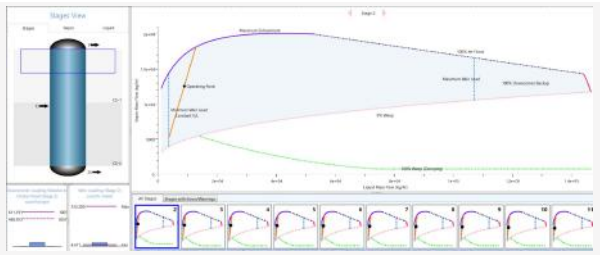
Software Capabilities

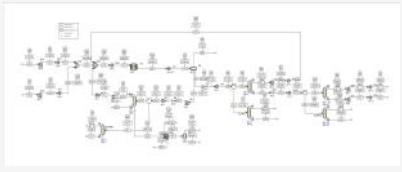
Design and Calculation Software

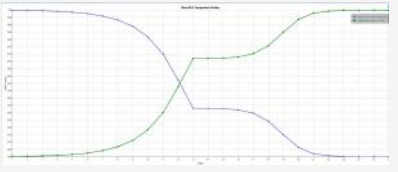
System Simulation Calculation

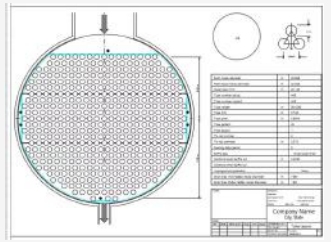
The software simulate the operation of the plant and calculate the parameters required for the operation of the device, which would result in optimized process and technical scheme; the software can predict potential safety hazards and avoid safety risks in advance; lastly the software can analyze and calculate the relationship between the unit investment and the operation cost and obtain the optimal construction plan.

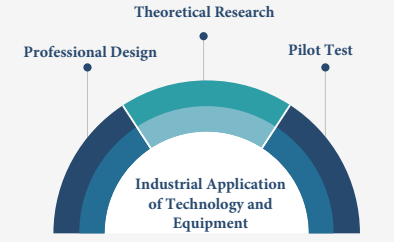












DODGEN R&D center organically combines product development, process research, chemical engineering and key equipment to achieve integrated innovation and create a R&D center with unique R&D mode. DODGEN R&D team delivers efficient, convenient and economic solutions for our customers.

Excellent Team

We have R&D and engineering team more than 100 people, 90% of them have middle or senior professional titles, with the experience in the field of R&D, pilot test, fine chemical and new polymer materials.

Green Technology

- Hydrocyanic acid derivatives
- Degradable plastics
- Other high-performance chemicals

R&D Center

Our R&D center is composed of DODGEN Biodegradable New Material Technology and Equipment R&D Center, DODGEN Chemical Center Laboratory, DODGEN & Chongqing University Collaborative Laboratory and DODGEN Pilot-test Base.

Pilot Base

Our pilot base mainly carries out the engineering and industrialization verification of process technology and equipment, improving the process conditions and verifying the stability of process and equipment. The flexible skid-mounted systems combination can rapidly develop complete sets of process technologies. Apart from supporting our internal R&D project, the pilot base undertakes industrial verification external project.

We have modular process skid systems as follows		
Melt crystallization skid	Falling film reaction skid	Polymerization and devolatilization skid
Falling film evaporation skid	Micro-melt crystallization skid	DSR reactor skid
Liquid-liquid extraction skid	Distillation and separation skid	High flux microreactor skid

Auxiliary Units			
Temperature Control Unit	Vacuum Unit	Transportation Unit	Storage Unit

Melt Crystallization

· Falling Film Crystallizer

Unique Melt Crystallization Technology and Equipment

As a green separation technology, melt crystallization technology has become an important technology for producing high-purity chemical products due to its high efficiency, low consumption and environmentally friendly characteristics. Melt crystallization is not only widely used in pharmaceutical and food separation and purification, but also in large-scale chemical production.

DODGEN is an outstanding player in the field of melt crystallization technology. We utilize our strong scientific and technological research capabilities to improve separation efficiency by enhancing the coupling of new melt crystallization separation technology with other separation technologies. Additionally, we have developed a unique melt crystallizer to adapt to the separation of specific substances.

The innovative melt crystallizer exhibits significant separation effects in the separation of stereoisomers, thermosensitive materials, high-boiling point materials, and azeotropic mixtures.

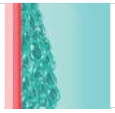
· Static Plate Melt Crystallizer

Principle of Melt Crystallization

The driving force of the melt crystallization process is the supersaturation or undercooling of a component in the molten liquid, the process is divided into three stages: crystallization, sweating and melting.

Crystallization:
Crystallization is the process in which, as the temperature of the molten liquid is gradually decreased, a component in the melt becomes supersaturated and begins to nucleate and grow into crystals.

Sweating:
During the growing process of crystal, impurities of mother liquor will inevitably be trapped in the coarse crystal, so the coarse crystal needs to undergo the sweating process for purification.



Melting:
The purified crystals are melted completely by heating.

Typical Applications

Petrochemical industry
- 1,2,4,5-Tetramethylbenzene
- Maleic anhydride
- P-xylene
- M-xylene

Polymer monomer
- Bisphenol A
- Acrylic acid
- Caprolactam
- Dimethyl terephthalate
- Hexanediamine

Electronic chemicals
- Ethylene carbonate
- Dimethyl carbonate
- Vinylene carbonate
- Hydrogen peroxide
- Phosphoric acid

Biosynthetic materials
- Dimethyl succinate
- Lactide
- Pentanediamine
- Long-chain dicarboxylic acid

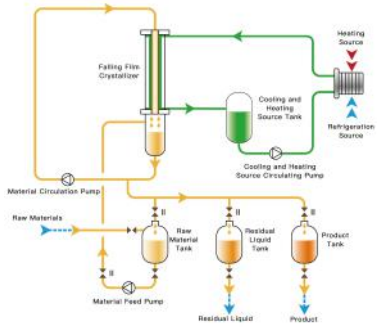
Coal chemical industry
- Refined naphthalene
- Fischer-Tropsch wax
- Cresol
- Naphthol

Fine chemicals
- Benzoic acid
- Phenylenediamine
- Dichlorobenzene
- Chloroacetic acid
- Nitro chlorobenzene

Advantages of Advanced Melt Crystallization Technology:

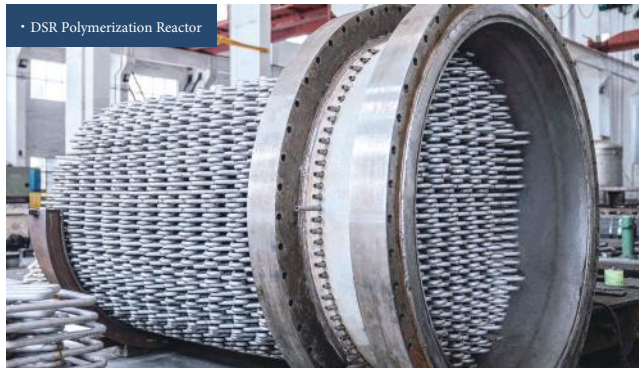
- **High product purity:** The product purity can be above 99.99% chromatographically pure according to customer requirements.
- **Low operating temperature:** Generally, it is operated at atmospheric pressure and low temperature, with simple and safe operation.
- **Wide applicability:** It is very difficult to separate isomers and chiral substances by distillation, while separation can be easily achieved by melt crystallization.
- **No solvents required:** The crystallization process does not require the addition of other solvents, which can effectively avoid the increase of impurities caused by the introduction of solvents and environmental pollution.
- **Investment saving:** There are no excessive requirements for equipment, which can reduce costs and equipment investment.
- **Energy conservation and environmentally friendly:** The energy consumption of melt crystallization is generally only 10%-30% of that of distillation.

Process Flow Diagram



Polymer Technology

Advanced Polymer Reactions and Heat-transfer Technology



· DSR Polymerization Reactor

Base on the principles of efficient static differential mixing and heat transfer, DODGEN has created a new composite DSR reactor for continuous controllable polymerization processes, such as bulk polymerization and solution polymerization. Its outstanding feature is the ability to provide very large heat transfer and reaction areas while precisely controlling heat transfer and mixing efficiency to achieve uniform temperature and concentration at the micron scale. This enhances the improvement of conversion rates and the polymer quality, thereby fulfilling various stringent and demanding requirements.

Advantages of DSR Polymerization Reactor:

- The characteristics of piston flow ensure that the time distribution and temperature distribution range are uniform, which is conducive to the distribution of molecular weight.
- No grooves, uneven distribution and dead zone will appear.
- Different grades of polymers can be produced, with precise process temperature control ca be achieved in separate reaction zones.
- Ability to handle fluids with a wide range of viscosity distributions at low operating costs.
- Preventing a large number of products deviating from specifications in production quality controlling.
- Reducing energy consumption (lower pressure drop, no mixing equipment).

Typical Applications

· Polyester · Nylon · PA · PC · POM · PLA · PMMA · Organosilicon · Copolymer · PE

Improving Product Quality and Reducing Cost with DSXL Devolatilization Technology

Based on the characteristics of polymer and the rich application experience of static mixer and high-efficiency heat exchanger, DODGEN has designed single-stage or multi-stage devolatilization process. Its core equipment including heat exchanger with mixing elements, blender and high efficiency distributor, to achieve the ultimate goal of improving product quality and reducing operation costs.

Principle of Polymer DSXL Devolatilization Technology

The underlying principle behind DODGEN DSXL devolatilization involves the rapid and even heating of the polymer to a certain temperature, and/or the addition of additives that help the volatiles escape, and then the polymer disperse evenly in the separation tank, the volatiles are released from the polymer matrix as a result.

· DSXL Devolatiler

Advantages of DODGEN DSXL Devolatilization Technology

Improving product quality:

- The Polymer degradation is reduced to avoid the destruction of polymer form due to high shear stress.
- High-efficiency heat exchanger avoids high-temperature gradients and localized high temperature effects.
- Low residue content and low operation cost.
- No moving parts, low energy consumption.
- Decreasing in maintenance costs.

Typical Applications

· PE	· PUR	· POM	Almost all degradable plastics
· PC	· PVAC	· Teflon	· PLA
· PP	· PMMA	· Terpene resin	· PGA
· PET	· Viscoserayon	· Cellulosic chemical fiber	· PPC
· PA6	· Polyester	· Silicone polymer and synthetic rubber	· PBAT / PBS

Falling Film Evaporation

Falling Film Evaporation is a process in which the liquid feed is introduced into the upper header box of the heating chamber of a falling film evaporator, and then evenly distributed to each heat transfer tube by a liquid distribution and film-forming device. Under the effects of gravity, vacuum induction, and gas flow, the liquid forms an even film that flows down from top to bottom. In the distillation unit, the vapor phase directly enters the tower for distillation, while the liquid phase is discharged from the separation chamber or circulated back into the evaporator by the pump.

• Falling Film Evaporator

Advantages of DODGEN Falling Film Evaporation Technology

- **Design conditions:**

We use the most safe and stable falling film reboiler model in present day, and the falling film introduces the multi-level distribution form including the distribution plate and the film distribution header.

- **Process Calculation:**

Based on the calculation of advanced simulation software, key parameters such as gasification rate, circulation volume, flooding factor, gas-phase rate, heat exchange area, etc. are determined.

- **Distributor/Calculation of Film Distribution Header:**

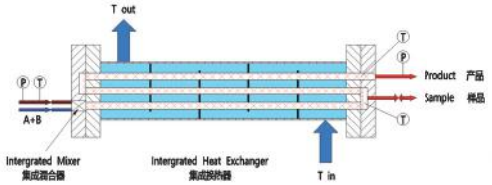
Various hydraulic models are conducted to design distribution system under specific operation conditions, further more hydraulic calculation is operated with independent software.

With rich experience and advanced technology, DODGEN falling film evaporator has been applied in various fields of heat-sensitive substances separation, the temperature of tower kettle is reduced, thus improving product quality and yield, and obtaining positive feedback from customers.

D- AMERT High Flux Micro Reaction Technology

Microchannel with Great Talent

DODGEN D-AMERT high flux microreactor technology was developed for large-scale application. The reaction system integrates transportation, metering, temperature control and reaction into one. The reaction channel of the reactor is at the millimeter scale. The materials pass through the mixing elements set inside the reaction channel of the reactor and, during the forced shear and mixing process, the size of the reaction interface is homogenized to the micron scale.



Composition of D-AMERT High Flux Microreactor:

Transfer metering unit → Temperature control unit → Micro-reactor → Online analysis unit

D- AMERT High Flux Micro Reaction Technology

Advantages of D-AMERT High Flux Microreactor

- **Rapid temperature response:** High-efficiency heat transfer system and extremely short reaction time, instantaneous response for the reaction temperature changes.
- **Conversion/yield:** Short reaction residence time, precise control of reaction time, reduce the by-products and improve the selectivity.
- **High safety performance:** Small reaction liquid-holding, quick mass and heat transfer, and avoiding the "Flying temperature" phenomenon.
- **Continuous production:** Flexible continuous production process. **No amplification effect:** Parallel amplification, simple and reliable amplification process.
- **Device miniaturization:** "Refrigerator-on-Wheels" concept, highly automatic controlling.
- **Low investment cost:** Low investment, high income, low production management cost, flexible operation.

Technology suitable for rapid and strong exothermic and high-risk reaction

- Rapid and strong exothermic reaction
- Reactions requiring rapid and uniform mixing
- Reaction requiring precise control of process parameters
- Reactions involving unstable intermediate products or subsequent side reactions
- Reactions involving hazardous processes or chemicals
- Reactions requiring high process stability and good repeatability

Falling Film Reaction

Rapid Completion of Falling Film Reaction at Gas-liquid Interface

The falling film reaction process is accompanied by mass and heat transfer in most cases: the liquid phase enters the upper tube box from the top of the reactor, distributes evenly through the liquid distribution system into each heat exchange tube, and forms a uniform liquid film on the inner tube wall. The gas phase enters from the top or bottom of the reactor reacts with the liquid phase through the gas-liquid interface in the pipe. The liquid film is constantly renovated along the pipe wall, and the volatile substances produced by the reaction are evaporated into the gas phase, while the generated heavy boiling point substances continue to flow along the pipe wall to the lower pipe box with the liquid phase, the reaction is completed rapidly at the gas-liquid interface.

Advantages of DODGEN Falling Film Reactor

- Small temperature and concentration gradients, short residence time and controllable reaction conditions.
- According to the physical properties of the reaction system and conditions, different types of liquid distributor and film distributor are utilized to distribute the material evenly in the downcomer.

The liquid film distribution system and gas distribution system designed by DODGEN improve the reaction conversion rate, stabilize and uniformly control the reaction temperature and residence time, improve the quality and yield of the reaction products effectively.

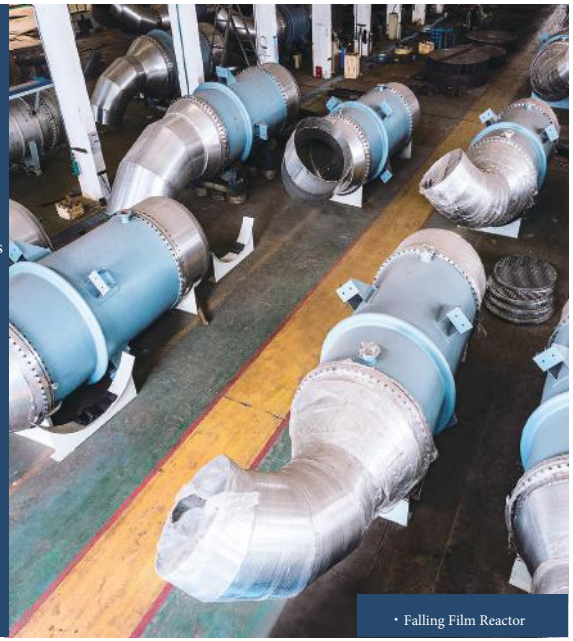
Typical Applications

Main Applicable Reaction Systems:

- Thermo-sensitive reaction system
- Gas-liquid contact reaction system
- System requiring removal of gas reaction products

Application Fields:

- Petroleum and natural gas chemical industry
- Pharmaceutical industry
- Fine chemical industry
- Food
- Light Industry
- Bioenergy
- Environmental Protection Engineering



· Falling Film Reactor

Advanced liquid-liquid extraction technology resolve separation problems that can't be solved by distillation or other separation processes and provide economic solutions.

DODGEN unique liquid-liquid extraction or high-efficiency centrifugal liquid-liquid separation technology based on the principle of similar dissolution and density difference, appropriate extractant and extraction equipment will be required to extract the substance from the matrix liquid. It has the advantages of large treatment capacity, good separation effect, high recovery rate, low energy consumption, etc.

Based on strong application accumulation and theoretical basis, we provide customers with reliable hydraulic calculation of extraction tower and design &supply services for upgrading the existing units.

Advantages of DODGEN Extraction Technology

DODGEN high-efficiency rotor extraction tower has been designed thoughtfully, it involves accurate fluid dynamics model simulation, and a large number of tests and practical application verification:

- Providing High Theoretical Level
- Perfect hydraulics model to provide high mass transfer efficiency and effective residence time
- Minimum anti-mixing design with the best product quality The
- Optimal dispersion and remixing model has been used to realize rapid and uniform mass transfer

· Extractor

· Rotor

Typical Applications

- Phenol-containing wastewater
- Acetic acid recovery
- Solvent recovery
- Lactic acid purification
- Lithium extraction from salt lake
- Lubricant oil refining
- Food-grade phosphoric acid
- Vanadium extraction from titanium dioxide waste liquid
- Inorganic substance extraction
- Catalyst recovery
- Recovery and extraction of pharmaceutical high value-added organic substance

Distillation and Absorption Technology

The Accurate and Stable System and Optimal Process for Our Customers

DODGEN has adopted and combined advanced distillation technology. Relying on strong technical design and the R & D team, a perfect and flexible test center and high cost-effective tower internals manufacturing base have been established to provide customers with premium quality solutions.

Drawing on mature process simulation calculation software, reliable gas-liquid equilibrium interaction parameters, a large number of field device operation data and test data, customized process will be provided for customers.

Advantages of Distillation and Absorption Technology

- From the view of fundamental interests about our customers, system design ,project progress and project management have been checked at all levels so as to control the costs.
- Based on DODGEN design, we provide packing, tray, internals, various reboilers/condensers and other products as well as on-site start-up guidance services.
- Based on customer requirements, we can process customized packing, tray, tower internals, various reboilers/condensers and other products for customers.

Design and Manufacture of Packing, Tray and Internals

The design of distillation and absorption system and the design of tower internals are elemental for the whole separation. The manufacturing and quality of products are correlative to the process design index.

Combined with worldwide advanced technology and engineering experience, the tower internals designed by DODGEN are optimized according to fluid dynamics model and manufactured in strict accordance with our quality management measures to ensure the quality.

· Packing

DODGEN has a strict quality management system to ensure the quality and delivery time of our projects.

Tower Packing, Tray and Internals

Characteristics of High-performance Packing

·Vertical support ring, reduce the occupancy of tower section area.
·I-shaped support beam, free gas circulation can be achieved on both sides of the support beam.

Wire Mesh Demister

·Large specific surface area.
·Interlaced woven wire mesh and winding flow path.
·High removal efficiency of liquid droplets entrained in the vapor phase.

Vane Mist Eliminator

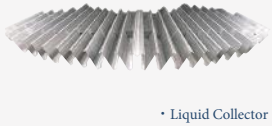
·Consisting of parallel wavy plates.
·For applications with large processing capacity, compact separators can be provided.
·Ideal for gas processing applications.

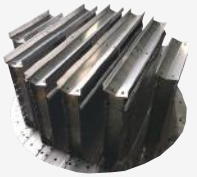
Liquid Collector

·Short liquid residence time.
·Promote the uniform distribution of gas with low gas pressure drop.
·Reasonable structure, resistance to gas impact, thermal expansion and cold contraction.

Overview of Products and Services

·Random packing
·Grid packing and Structured packing.
·Experimental packing.
·Tray.
·Tower internals.
·Hydraulic test.
·Ultrasonic degreasing, acid pickling passivation and sand blasting treatment.
·Technology development, simulation calculation, engineering design and manufacturing.
·One-stop service for skid mounted module, site installation and start-up guidance.





· Liquid Collector

· Grille

Breakthrough Tray Design and Manufacturing Technology

The tray design and manufacturing technology by DODGEN has realized the breakthrough of low pressure drop, high tray efficiency, anti-blocking, high vapor-liquid/liquid-vapor ratio and high operating flexibility. We provide our customers with reliable hydraulic design, cost-effective tray selection and rich tray types.

· Liquid Distributor

Advantages of Tower Internals and Packing

- Optimal distribution, phase separation, and extremely low operating pressure drop.
- Emergent replacement and repair services for internals.
- Comprehensive training service for tower internals installation.

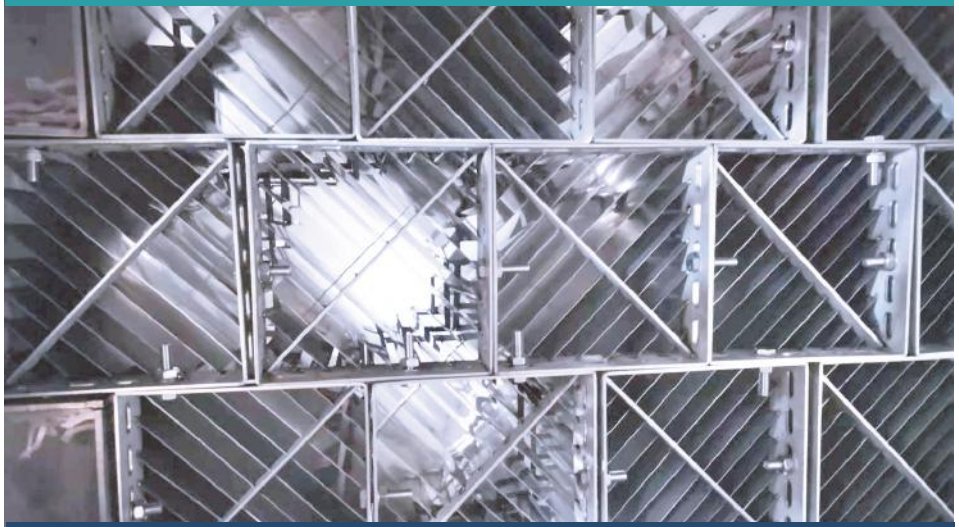
High Efficiency Gas-liquid Separator

Complete separator product chain has been considered to customize separation scheme for customers.

Gas-liquid separation technology is widely used in reaction, distillation, evaporation, water washing, absorption and MVR unit operation, in order to improve product quality, reduce product loss, decrease harmful substances in tail gas, cut down equipment load and protect the equipment.

Advantages of DODGEN Gas-liquid Separator:

- 99% removal efficiency can be achieved for droplets above 0.1-200 μm;
- Wider operating flexibility and optimized separator shell size while ensuring separation efficiency;
- Applicable in gas-liquid-solid three-phase separation also;
- No rotating parts, maintenance-free and long life;
- Have complete package of oil-water separation solutions.



Typical Applications

- Natural gas purification
- Natural gas transportation
- Synthetic system
- Compressor stage separation
- Steam drying and dehydration
- Gas phase dehydration of organic substance
- Industrial gas oil mist removal
- Recovery of organic substance in industrial gas
- Gas-liquid separation of MVR evaporation
- LNG low-temperature separation
- Water-electrolytic hydrogen generating system

Unit Process Technology Package

Unit Process Technology Package Classification

Vitamin E | Electrolyte solvent | Hydrocyanic acid derivative

Polyglycolic acid | Carbon disulfide | Polylactic acid | Sulfonation technology

	Degradable	Bio-based	Plastic Recycle	High Performance
Commercialization		PLA		Hydrocyanic acid and its derivatives /CS_2
Pilot Test	PGA	Biobased fertilizer		ADN/PA66
	PBAT	Purification of succinic acid	RPET	Electrolyte solvent
Laboratory Test	PCL	Purification of malic acid	Plastic oil	Aramid fiber monomer
	Poly α-hydroxy acid			PDO/PTT
Pre-research	Poly β-hydroxy acid	HMF purification		LCP/PEN