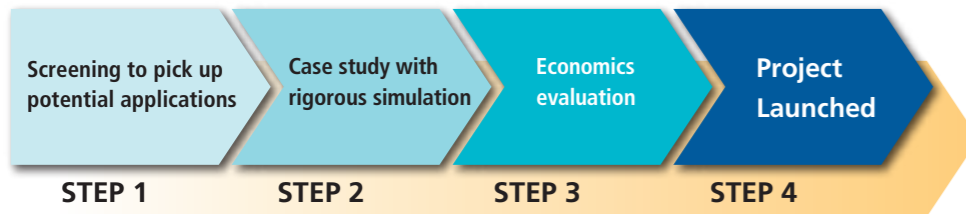


IMPLEMENTATION SCHEME

TOYO offers the best, optimized system as the result of thorough analyses of thermodynamics, distillation technology and economics.

TOYO provides a variety of services, from operating diagnostics services for existing plants to basic design and EPC, to meet customers' demands.



FAQ

Q1. How many side heat exchangers will be installed?

A1. Typically three to five exchangers. It depends on the case.

Q2. How will the number and location of each side heat exchanger be decided?

A2. Intensive thermodynamic analysis will be made to optimize the number of heat exchangers, determine that their stages have the appropriate composition, and their heat duties and the combination of stages for internal heat exchanges.

Q3. How will the distillation system be controlled?

A3. Operating pressure in high pressure column, low pressure column and reflux drum, and the heat duty of each side heat exchanger will be manipulated in the appropriate manner, which provides stable operating condition.

Q4. What is the range of turndown operation that allows for energy saving?

A4. Normally up to 70-100% of the design capacity will be possible without any deterioration in energy saving. But it depends on compressor capacity.

Q5. What type of compressor can be selected?

A5. A centrifugal, turbo or dry-screw type compressor can be selected, depending upon the benefit in accordance with the CAPEX and OPEX.

Q6. Even if the compressor shuts down, can the system continue distillation operation?

A6. The *SUPERHIDIC*[®] system can be designed with an alternate conventional distillation mode if required. The conventional distillation mode allows for operation without a compressor, but there is no energy saving benefit available.

Toyo Engineering Corporation

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SUPERHIDIC[®] is a trademark of Toyo Engineering Corporation registered in Japan (Registered Number: 5488562).

*Innovative
Energy Saving
Distillation System*

***SUPERHIDIC*[®]**

Innovative Energy Saving Distillation System

SUPERHIDIC®

SUPERHIDIC®, developed by TOYO, provides excellent energy saving of **above 50%**

compared to conventional distillation systems in various industrial applications.

SUPERHIDIC® offers attractive economics without utilizing special equipment,

but by applying well-proven technology related to distillation and heat transfer.

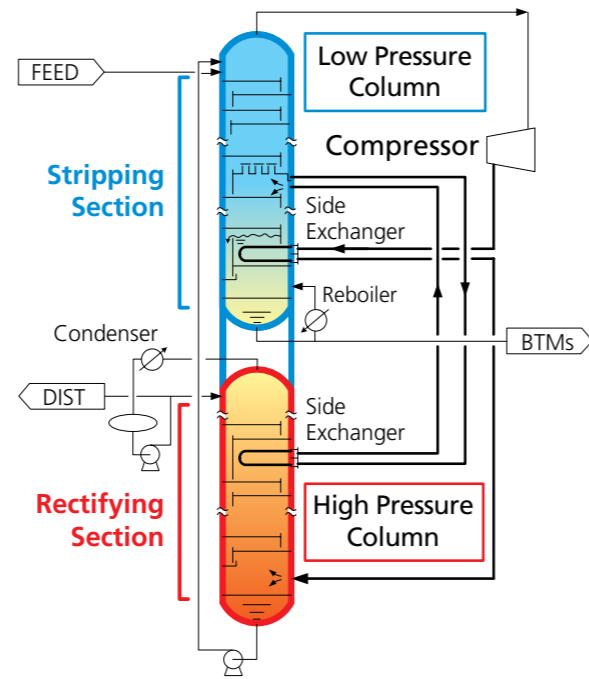
Moreover, good maintainability can be achieved with SUPERHIDIC®.

OVERVIEW

Feature 1 Operating pressure in rectifying section higher than that in stripping section
 ➔ This makes a transfer of the excess heat duty in the rectifying section to stripping section possible.

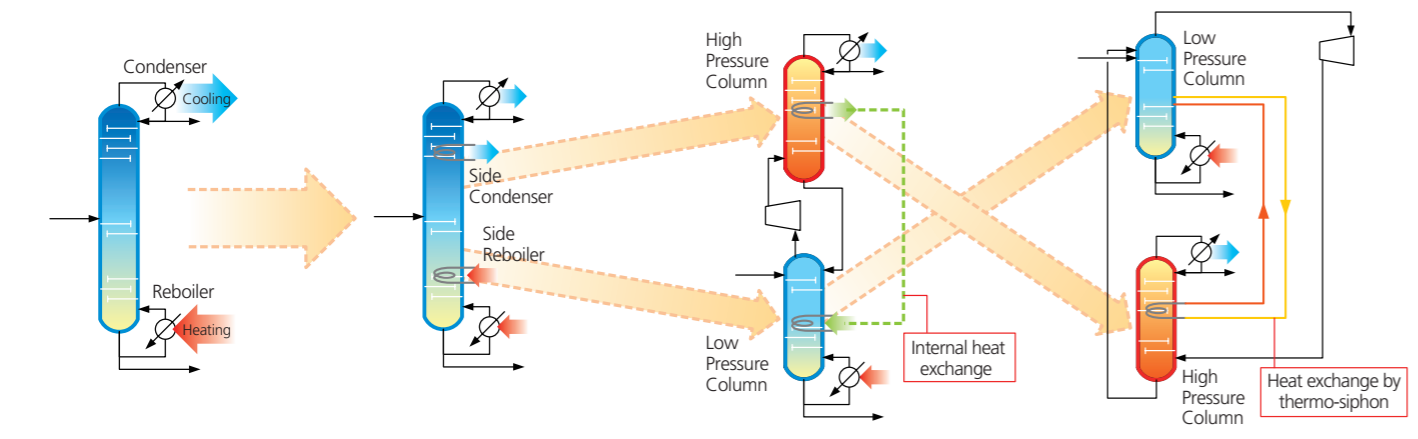
Feature 2 Stripping section (low pressure column) elevated above rectifying section (high pressure column)
 ➔ Side heat exchange is accomplished by thermo-siphon and/or gravity without pumping.

Feature 3 Existing component technology applied
 ➔ All equipment is designed with proven technology and maintenance can be performed by conventional means.



CONCEPT

SUPERHIDIC® realizes the concept of Heat Integrated Distillation Column (HIDiC), which has been recognized as the ultimate energy saving distillation system, in a simplified manner.



Conventional distillation
Heat is supplied at the bottom reboiler and removed at the top condenser.

Equipped with side condenser and side reboiler
Heat duties at the bottom reboiler and the top condenser are reduced by the side exchangers.

Pressurized rectifying section
Then, the heat duty of the side condenser is supplied to the side reboiler.

SUPERHIDIC® (concept)
By replacing the elevation of the rectifying section and the stripping section, internal heat integration is accomplished by thermo-siphon and/or gravity.

BRINGING ABOUT THE WORLD'S FIRST COMMERCIAL PLANT

SUPERHIDIC®, which is the ultimate form of energy conservation in distillation, was selected to enhance energy conservation and to contribute to the reduction of greenhouse gas emissions by Maruzen Petrochemicals Co. Ltd. (Japan) in 2014. The plant has been in commercial operation successfully since 2016.

| | |
|---|------------------------------|
| Location | Japan |
| Process unit | MEK |
| Capacity | 21 kL/h of feed rate |
| Energy consumption in conventional distillation | 6.3 MW |
| Energy conservation | 50%+ |
| Separation conditions in design | MEK in distillate: 99.92 wt% |
| | MEK in bottoms: 200 wtpm |



APPLICATIONS

Excellent energy saving and cost saving can be expected for the following conditions by introducing SUPERHIDIC® in either existing column modification or new installations.

- Temperature difference between the overhead and the bottom lower than 80°C
- Expensive utilities
- Large scale reboiler and/or condenser duty
- Process units, which have been so far confirmed for the application SUPERHIDIC® of with excellent energy conservation, are shown below.

