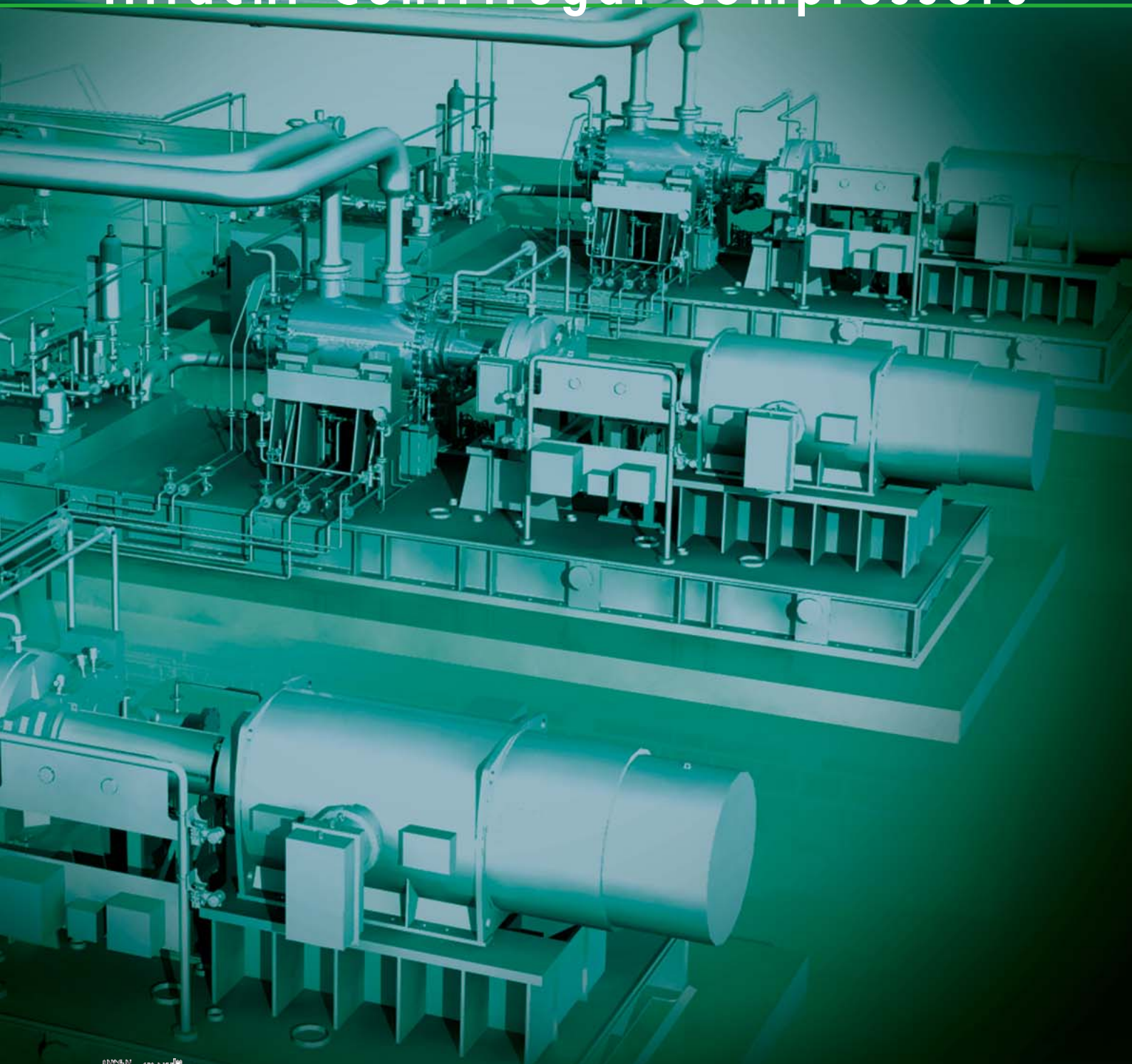
HITACHI
Inspire the Next

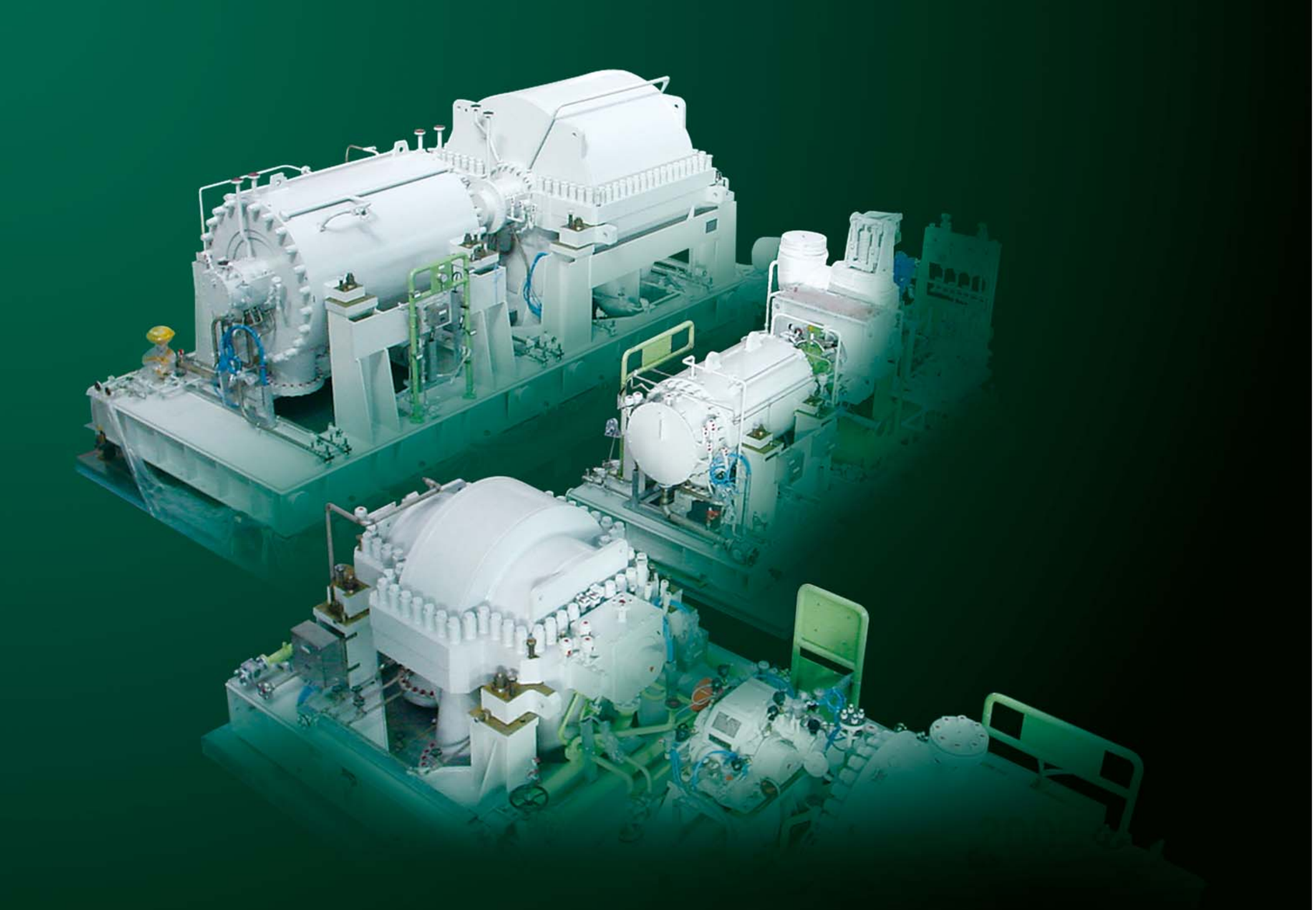
Centrifugal Compressor

Hitachi Centrifugal Compressors



جهان کمپرسور

Jahan Compressor
Since 1983



Hitachi a world leader in the manufacturing of heavy industrial equipment, electronics, and consumer product, maintains our strictly controlled quality standards to offer every customer a superior product.

Hitachi has been designing and manufacturing centrifugal compressors since 1910, and has delivered more than 1000 casings to satisfied customers all over the world.

Hitachi, through aggressive R&D, has developed many improvements and many of it' s own innovations in compressor design by use of technology including performance, rotor dynamics, and shaft seal system. We always improve our compressor technology and quality by using a fully computerized design automation system.

Hitachi's advanced centrifugal compressors have excellent reputation for high performance and high reliability and are now working as key components in various plants around world.

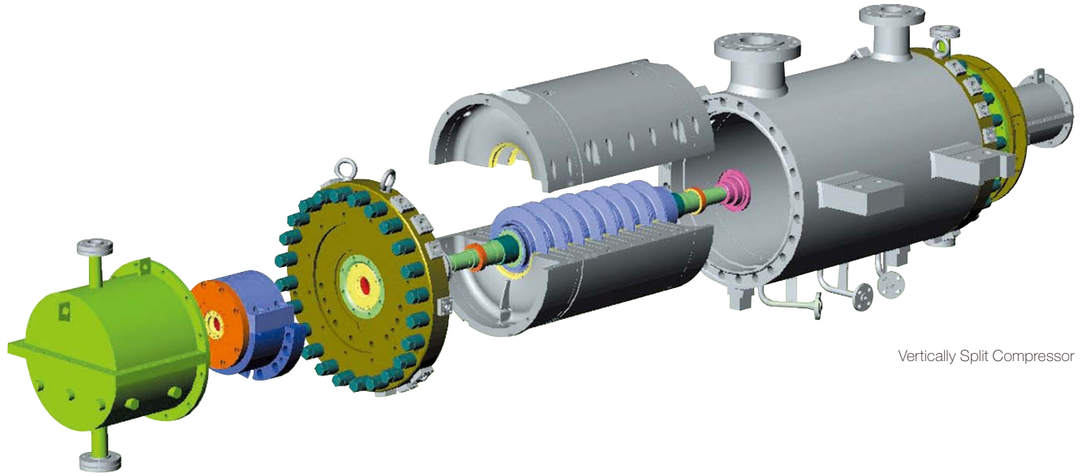
Hitachi, having carefully developed its own full design capabilities and having a long supply record can meet customer's requirements for any worldwide project.

CONTENTS

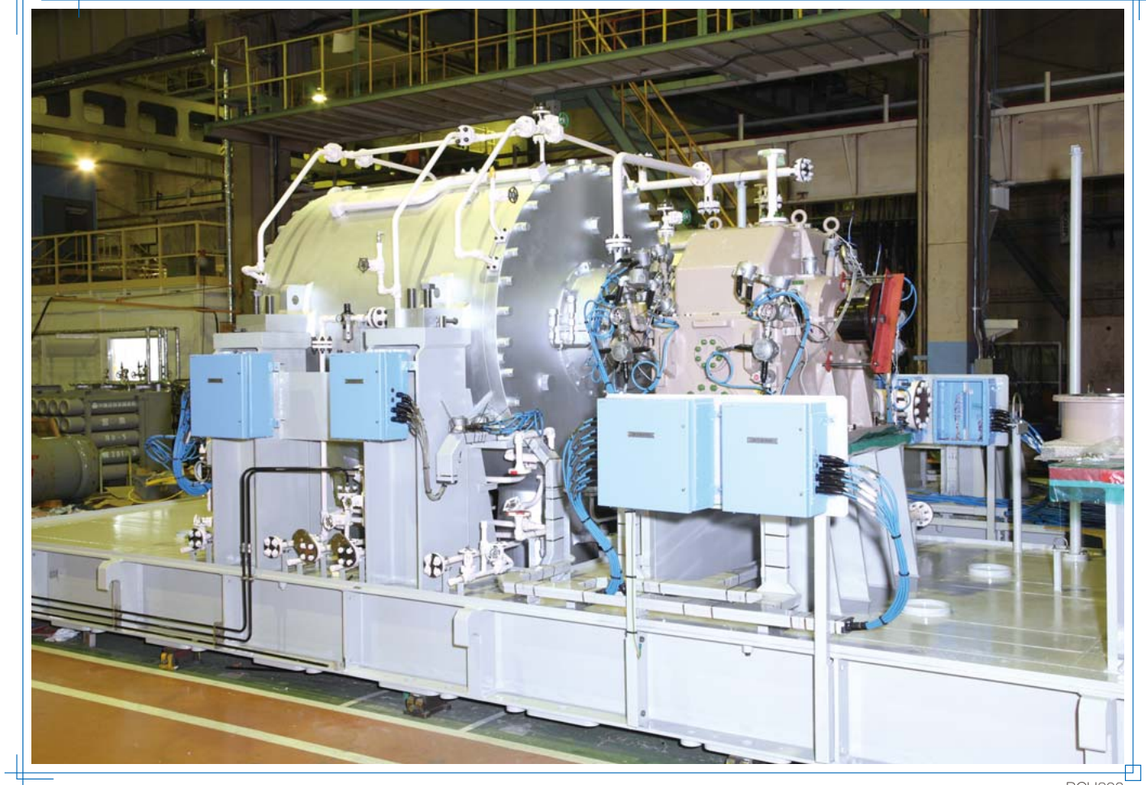
Compressor Line-up

Vertically Split Compressors (BCH)

Vertically split casings such as barrel type are applied when the partial pressure of hydrogen exceeds 1380 kPa in accordance with API 617 and/or high-pressure service.
Wall thickness is selected according to pressure. Forged or, in some case, welded construction types are available.
As the vertically split casing is constructed to withstand high pressure, the head covers are bolted or secured with a shear ring.
The bottom section of the bearing support is fixed by bolts and knock pins to provide high rigidity as well as resistance to vibrations. The bearing, however, can still be inspected without the head cover, as with horizontally split casings.
All internal parts can be removed axially without touching the casing, to which the main piping is connected, by simply removing the head cover.
This type is identified by the letter “B”, such as BCH, 2BCH, and BCH/A.



Vertically Split Compressor



BCH802
Booster Compressor

BCH804
ATM Compressor

BCH458
Recycle Compressor

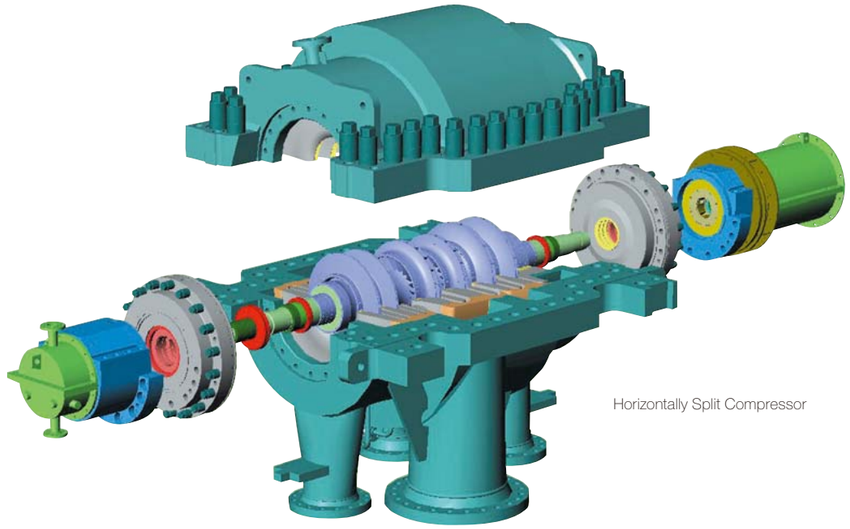
3BCH607
Propane Compressor

BCH451
Low Temperature (–165℃) Methane Compressor

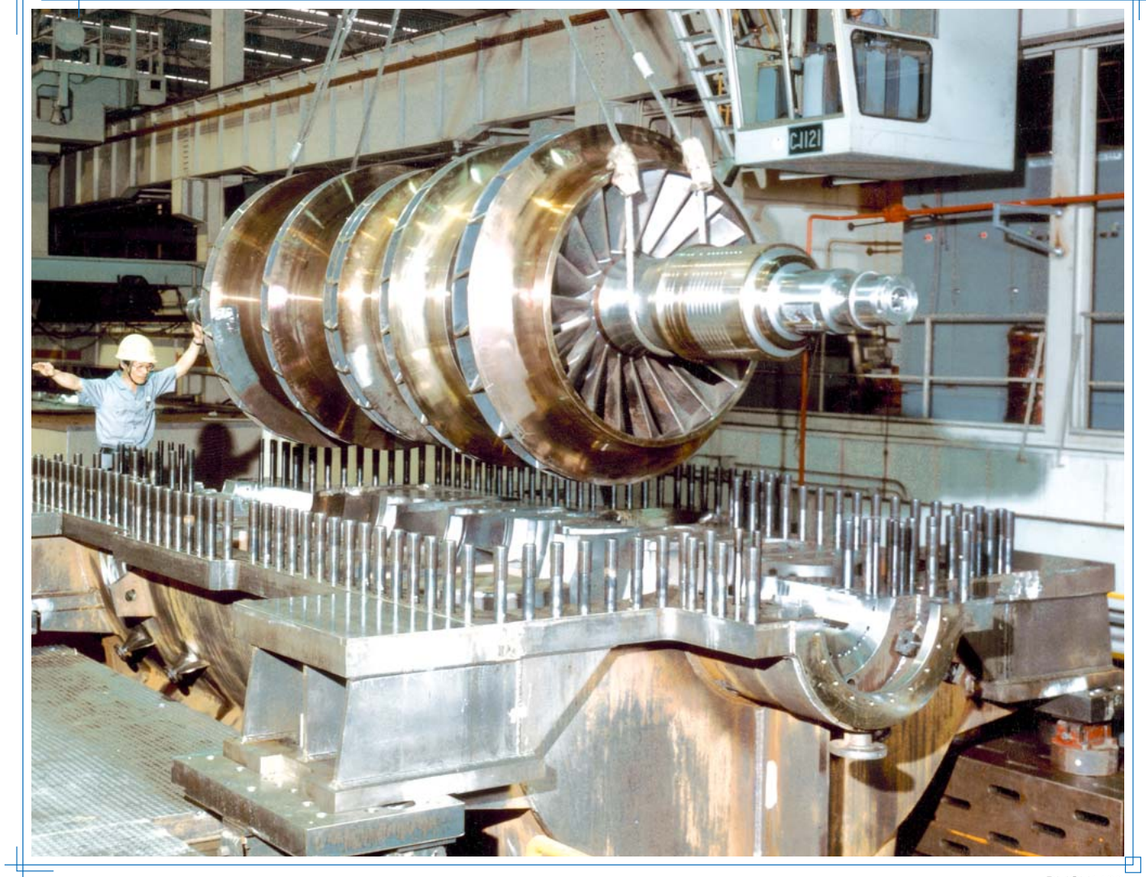
Compressor Line-up

Horizontally Split Compressors (MCH)

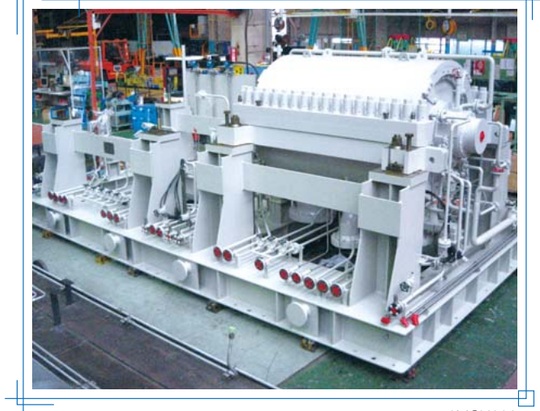
Horizontally split casings, for low and medium pressure, can be supplied in welded steel structures and/or cast steel to meet duty, service temperature and other gas requirements.
Each type feature is sophisticated configuration based on calculations by the FEM analysis.
These casings offer particularly easy maintenance. Nozzles are usually located on the bottom section of the casing, allowing easy removal of the upper section simply by removing the casing nuts. Removal of the upper section provides full access to all internal parts such as the rotor, diaphragms.
Also, bearings can be easily disassembled and inspected by removing only the bearing covers, as it is not necessary to open the casing.
Horizontally split casings are identified by the letter “M”, such as MCH, 2 MCH, and 3MCH.



Horizontally Split Compressor

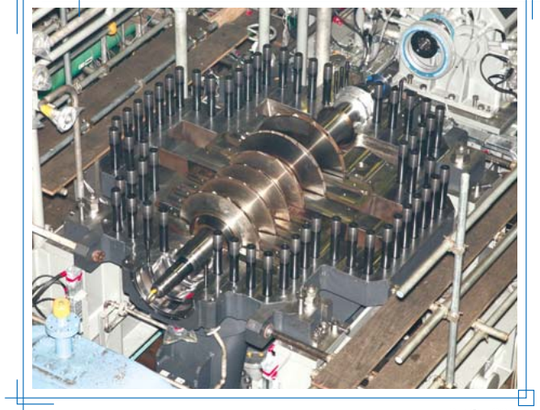


DMCH1406
Butadiene Compressor

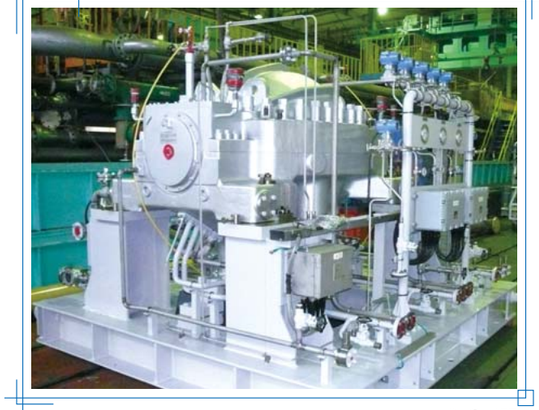


2MCH608
End Flash Gas Compressor

2MCH806+2MCH607
Air Compressor



2MCH606
CO_2 Compressor



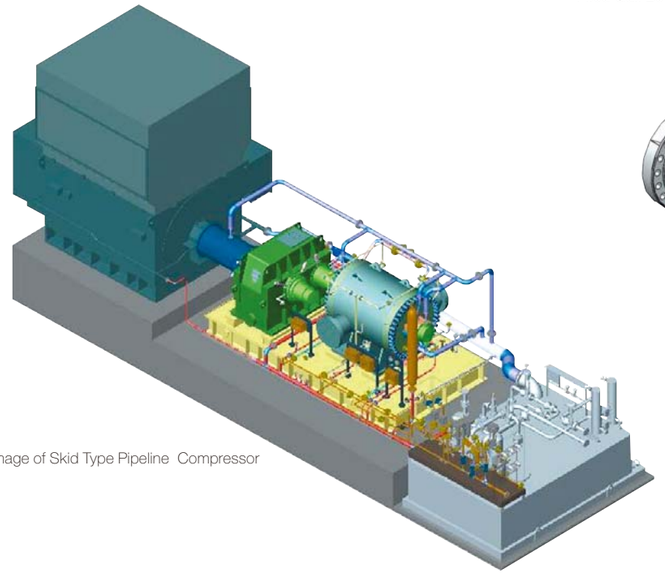
3MCH457
Ethylene Ref. Compressor

Compressor Line-up

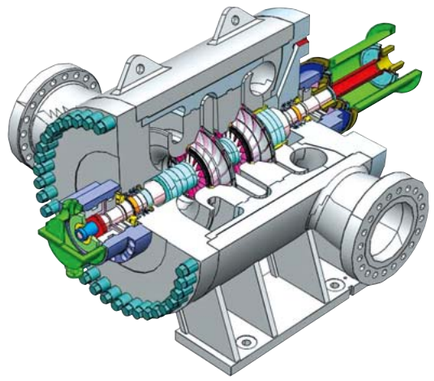
Pipeline Compressors (PCH)

This type of compressor has one or more open or closed type impellers. The open-piece cast or forged steel casing is designed for pressures up to 100barA and suction and delivery nozzles are located opposite each other to limit thrust loads on the casing. Depending on the driving method used, the casing is either supplied with its own pedestal or flanged to the gearbox. Oil seals are used for shaft end sealing.

PCH601
Feed Gas Booster Compressor



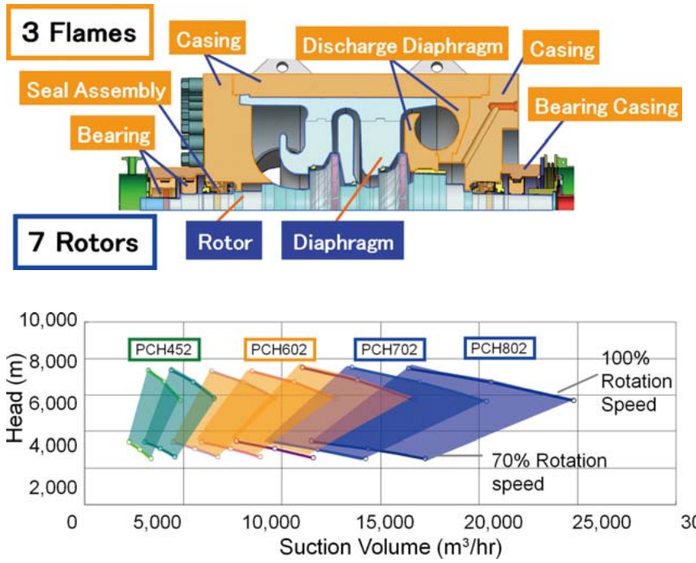
3-D Image of Skid Type Pipeline Compressor

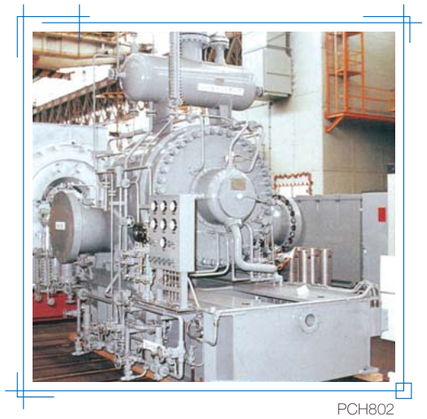


Pipeline Compressor

We have developed standardization of pipeline compressors.

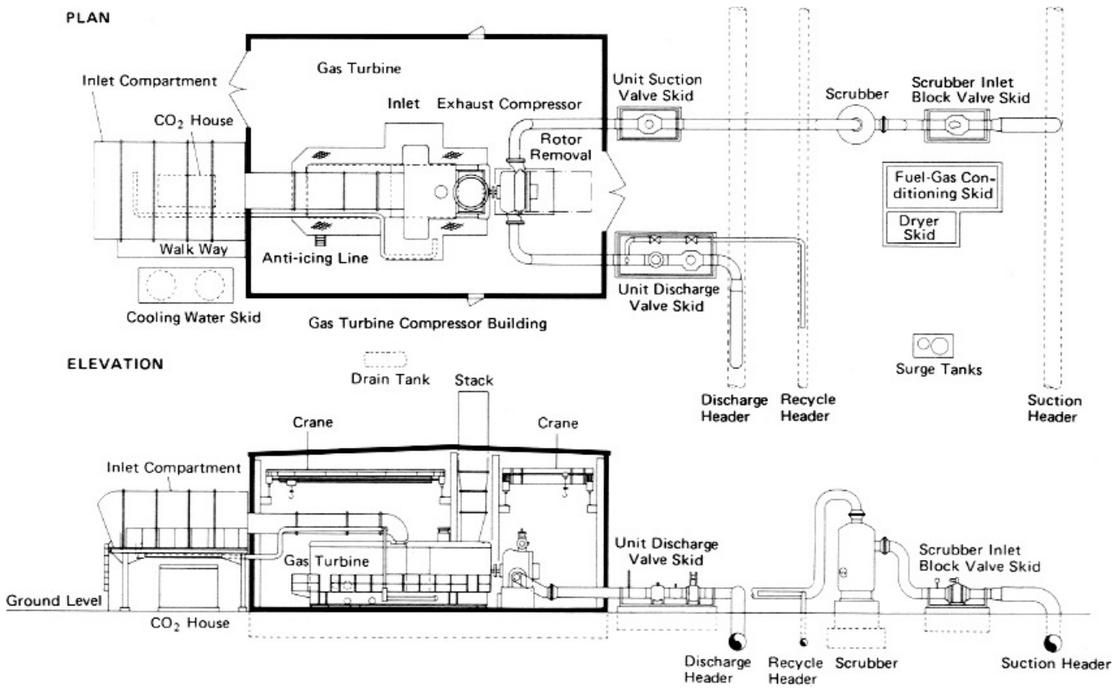
In order to optimize the compr. performance in accordance with customer's request, pipeline compressors are standardized into **3 Frames** & **7 Rotors.**
The capacity can be covered from approx. 3,000 to 24,000 m³/hr.





PCH802
Pipeline Booster Compressor

Arrangement of Gas Turbine and Compressor Module



Compressor Line-up

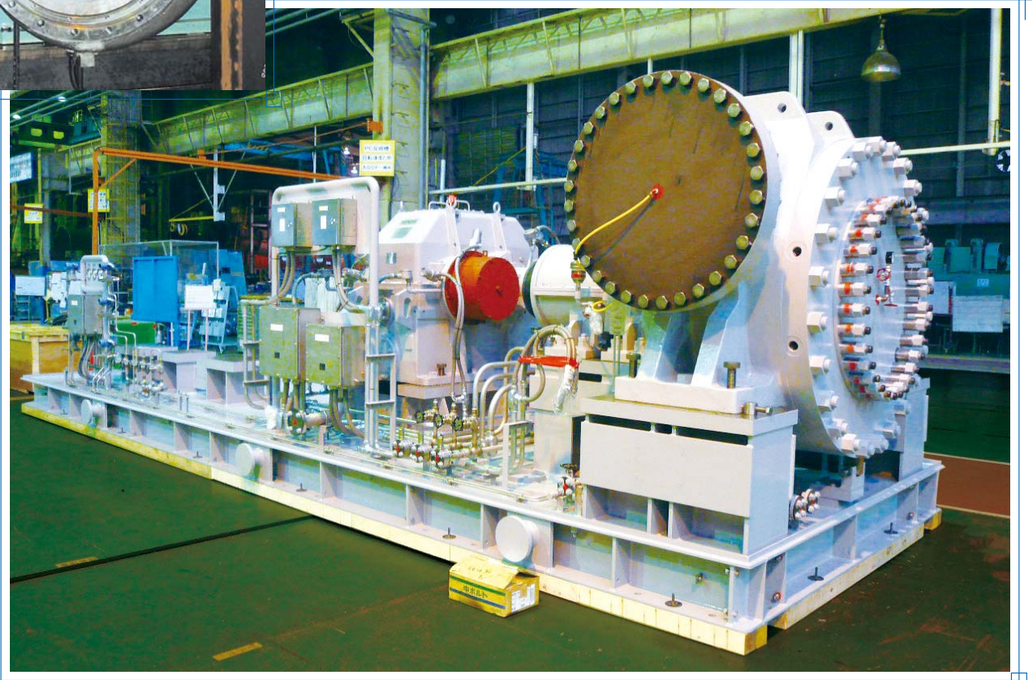
Overhang Compressors

Overhang compressors have single stage with axial flow suction nozzle, which give higher efficiency and wide operating range. The compressor flow is controlled by inlet-guide vane, suction/discharge throttle valve or by-passing. Maintenance of bearing can be done only by opening bearing casing without removing the impeller. The impeller can be easily removed by using special tool supplied by Hitachi.

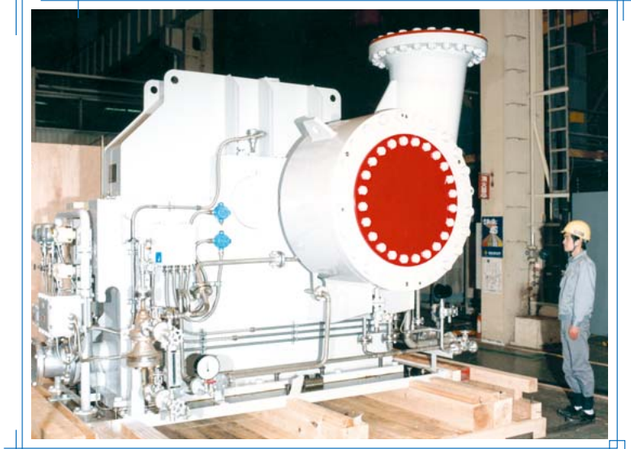
There are mainly two types of model for the overhang compressors. One is 'POB-GH' type, which is integrally geared type compressor. Another one is 'POB-CH' type, for which speed increasing gear is independently installed. Both types of compressor meet API617 requirements.

Overhang compressors are mainly used for petrochemical industries such as EO/EG plant, propylen plant and etc.

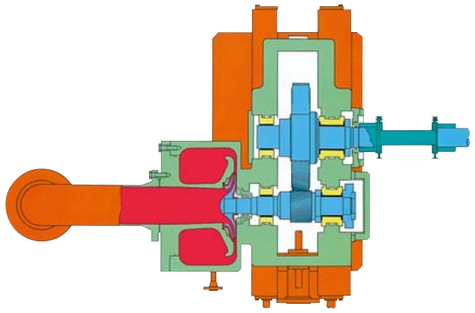
Compressor Casing



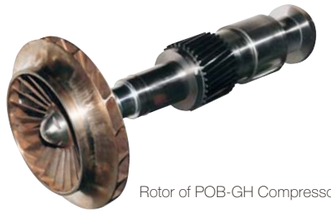
POB-CH
Recycle Compressor



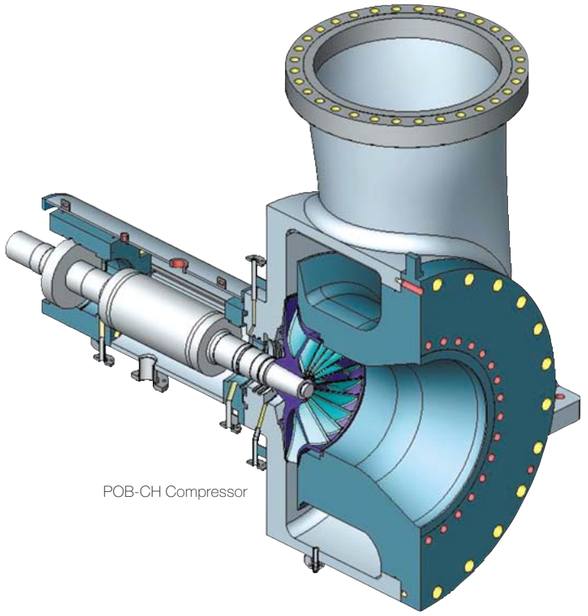
POB-GH
LLDPE Recycle Compressor



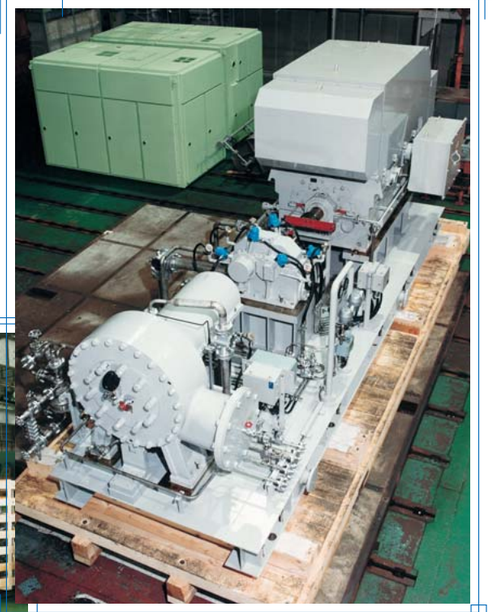
POB-GH Compressor



Rotor of POB-GH Compressor



POB-CH Compressor



POB-CH
EO/EG Recycle Compressor

Components

Casings

Casing is main pressure containing part of compressor. There are two kinds of casing constructions. One is horizontally split type and the other is vertically split type. Based on the pressure and the gas handled, the construction is determined. In terms of material used, there are three types such as cast steel casing, fabricated casing and forged steel casing.

Casing

Diaphragms

Diaphragms are located in the casing to efficiently convert the dynamic energy of the gas at the impeller outlet to static pressure. Also, return vanes are provided which direct the gas flow to the impeller eye.

Diaphragms are of welded or casting construction, and the return vanes consist of NACA profile wings. In the case of welded construction diaphragm, the return vane wings are precision N/C-machined.

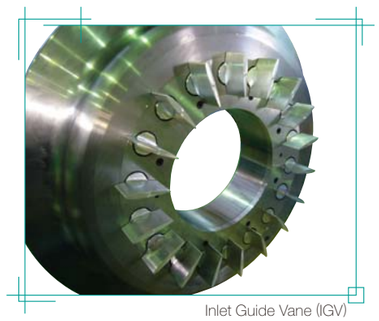
Pressure across the diaphragm differs slightly, but a particularly large differential pressure may occur across the intermediate diaphragms in back-to-back arrangement. In the computer design system, diaphragm deformation calculations are made by FEM with the emphasis places on preventing contract between the diaphragm and the rotor, and the labyrinth and the rotor.

Diaphragm

Inlet Guide Vane (IGV)

By using IGV, lower starting torque is achieved particularly for refrigeration compressor without raising motor frame size.

IGV also brings benefit of wider turn down range for constant pressure service.



Inlet Guide Vane (IGV)

Rotors

The rotor consists of shaft, impellers, balancing drum and thrust collar. The shaft is properly heat-treated and the impellers and balancing drum are shrunk-fit to the shaft. Generally, sleeves are placed between the impellers to prevent direct exposure of the shaft to gas.

Two or three dimensional impellers are manufactured by applying a welding or diffusion bonding (welding) (DB) process, machining, or precision forging. The shape of the gas passage, hydrodynamic design points and detailed dimensions of the impellers are accurately determined by computer, based on Hitachi's proven optimum design methods. In the case of welded construction or DB construction, the blades are usually N/C-machined from hubs, welded parts are limited to the shroud and blade. Welded parts are subject to magnetic particle, ultrasonic, radiographic and dye-penetrant inspections, and heat treatment is applied before and after welding and DB.

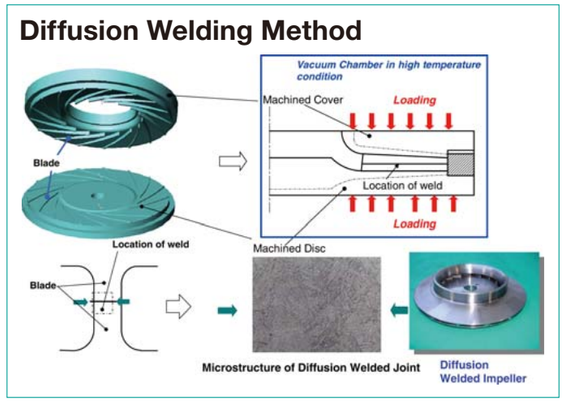
DB is a Hitachi patented technology (PATENT No. : US5964398) by which easy manufacturing particularly for narrow tip width impeller becomes possible and due to which precise dimensional construction (no deformation such by welding) becomes also possible.

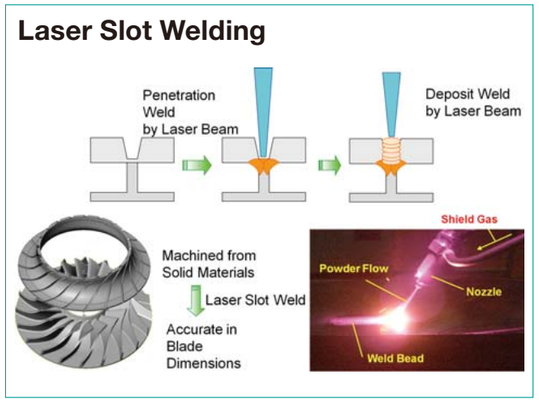
The balancing drum, which reduces the axial thrust of each impeller, is designed to minimize the residual axial thrust in all working conditions with due consideration paid to the force of the coupling. The residual thrust is borne by tilting pad type thrust bearings.

The shaft end seal is covered with a sleeve to protect the shaft from damage, especially at points of small clearance. The vibration sensor mounting section is machined simultaneously with the journal bearing part to minimize mechanical runout.

Five-Axis Machining of a Mixed Flow Impeller

Rotors with Mixed Flow Impellers





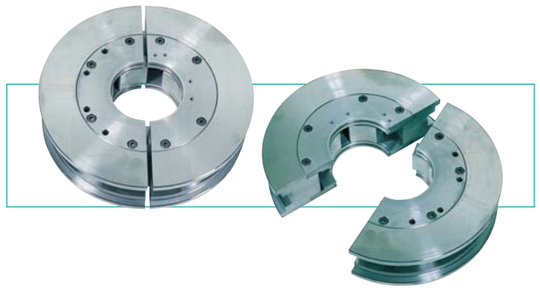
Components

Bearings

Journal bearings

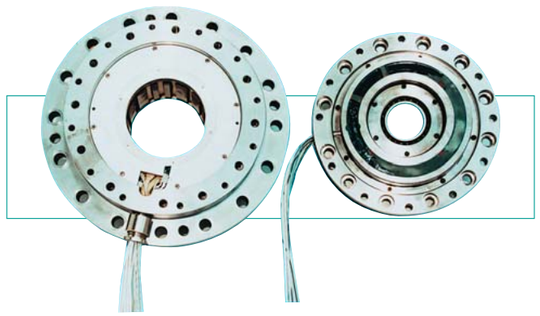
Tilting pad type bearings are generally used for journal bearings. For every bearing, rotor dynamics calculations are performed, including those for rotor critical speed, stability, and response due to unbalanced mass distribution, with due consideration paid to bearing stiffness and damping caused by oil film.

Tilting pad type bearings are particularly effective against oil whirling and have outstanding stability. Hitachi's pads are constructed to allow for adjustment of the oil clearance.



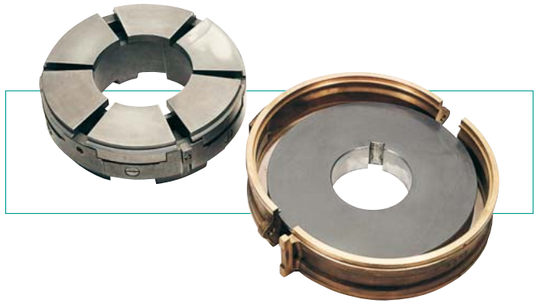
Magnetic bearings

Since the active magnetic bearings provide contact-free rotor support, parts and components do not wear. In addition, there is no need for a lubricating system, which improves compressor reliability. With oil-less operation, the bearings suffer no mechanical loss. Without a lubricating system and related components, the utility power required by the compressor is significantly reduced.



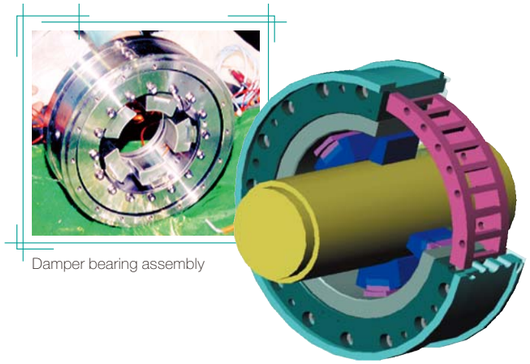
Thrust bearings

The thrust bearings are of the double Kingsbury tilting pad type for equal distribution of the thrust load and minimization of mechanical loss.



Damper bearings

Damper bearing is used to dampen the rotor and thus stable operation is secured. Due to the oil squeeze film outside of the cage-type spring, the Amplification Factor of critical speed is well suppressed.

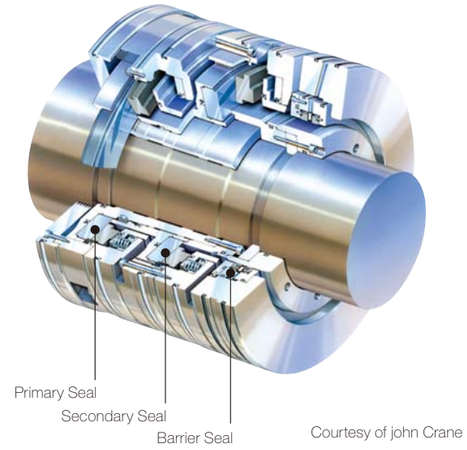


Damper bearing assembly

Seals

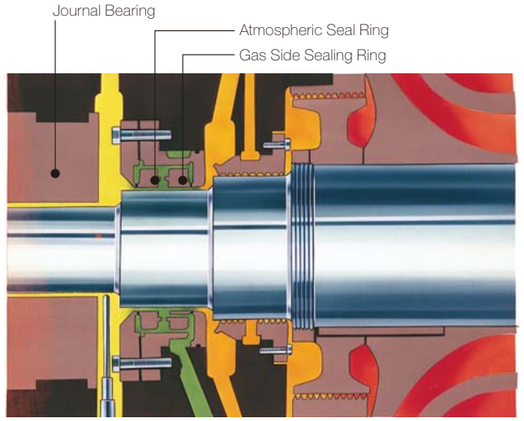
These serve to eliminate or minimize the leakage of compressed gas from and the entry of air into the compressor casing. The choice of the seal type is made on the basis of the gas characteristics and operating conditions;

Dry gas seal



Courtesy of john Crane

Oil film seal



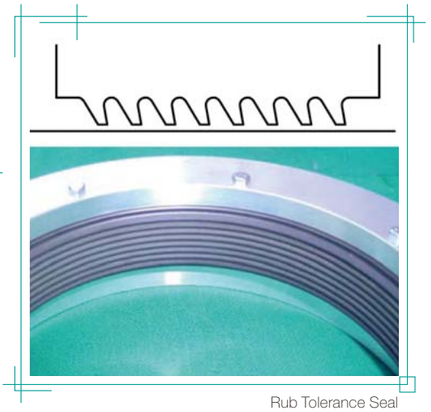
Labyrinth seal

(1) Aluminum seal

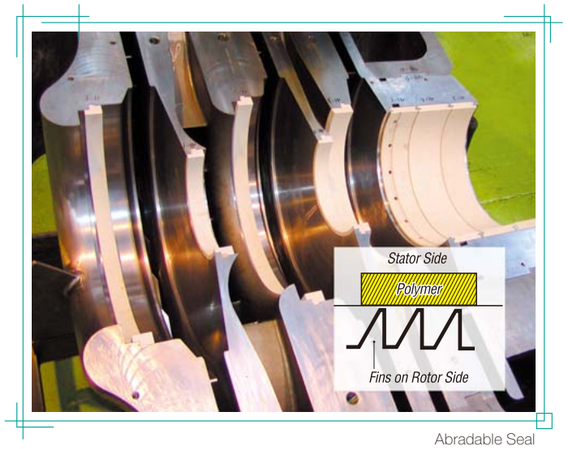
(2) Rub tolerance seal

(3) Abradable seal

Conventional Aluminum Labyrinth



Rub Tolerance Seal



Abradable Seal

Components

Oil Systems

The lube oil system provides forced lubrication to the journal and thrust bearings.

The seal oil system supplies oil at a slightly higher pressure than the compressor's internal gas pressure (reference gas pressure) in case oil film seal and mechanical seal.

Both systems are provided with main and auxiliary pumps, coolers, filters, etc. for continuous operation.

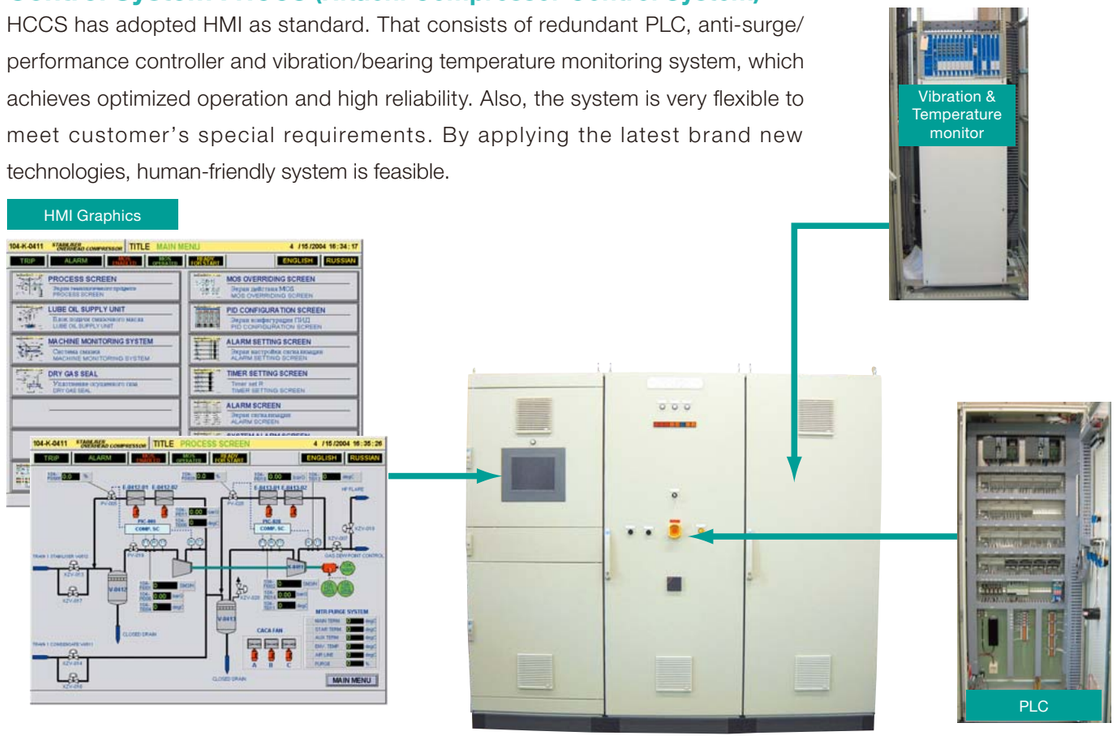
Generally, these systems are designed in accordance with API standards, and all interconnecting piping and valves are compact in size and designed to allow access and operation.

These systems are available as separate systems or as combined system in which the lube oil system supplies some oil to the seal oil system.

Lube Oil Unit

Control System : HCCS (Hitachi Compressor Control System)

HCCS has adopted HMI as standard. That consists of redundant PLC, anti-surge/ performance controller and vibration/bearing temperature monitoring system, which achieves optimized operation and high reliability. Also, the system is very flexible to meet customer's special requirements. By applying the latest brand new technologies, human-friendly system is feasible.



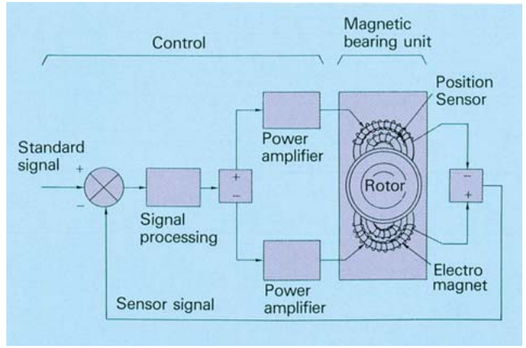
Seal Gas System

The dry gas seal requires external seal gas, which shall be filtered and shall be free of any contaminants that form residues in order to avoid damage of seal components. The seal gas system supplies the seal gas at a slightly higher pressure than the compressor's internal gas pressure. Generally the seal gas support system is designed to control the seal gas pressure, to measure leakage gas, and to detect abnormal condition of the seal.

Seal Gas Unit

Magnetic Bearing Control System

In magnetic bearing systems, the compressor shaft is levitated in the air gap by controlling magnetic forces of electromagnets. To regulate the shaft position, the position signals are always fedback to the magnetic forces through the signal processors and power amplifiers. Hitachi has originally developed the controller design and will provide the panel based on this scheme.



Design

Design Automation System

Error Elimination at Every Stage, from Design to Fabrication, Minimizes Operating Problems.

For mission-critical equipment in a plant, such as centrifugal compressors, not even the slightest error in design or manufacture is permissible. Hitachi utilizes the most advanced design and manufacturing technologies available to produce compressors of the highest quality and reliability.

Working from order specifications, the Design Automation System automatically designs and organizes the manufacture of centrifugal compressors, producing everything from drawings to tapes for N/C jobs, This system draws on years of experience as well as the latest data analysis processes and know-how.

Main features of this computer design system:

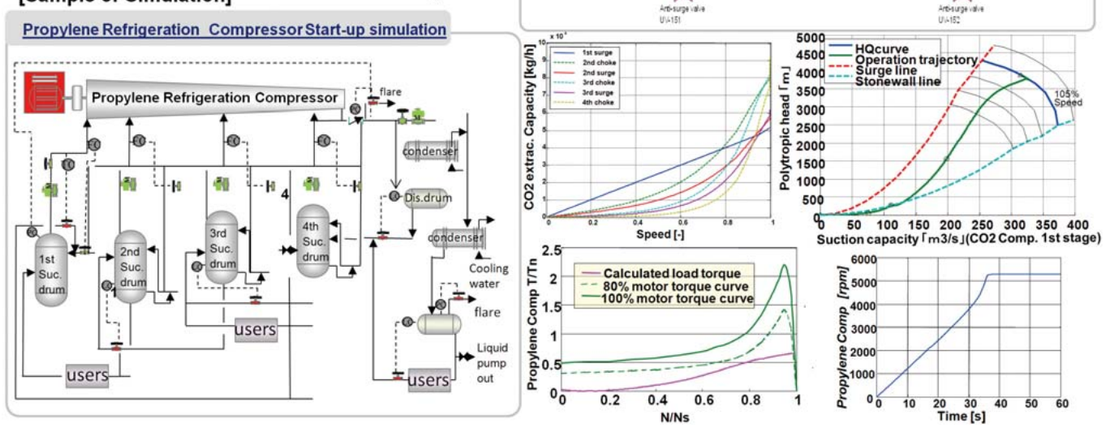
- Capable of producing complete, error-free designs based on the latest know-how and calculation processes;
- Short design times, ensuring quick delivery;
- Besides producing all drawings and N/C tapes, the system is connected to the overall manufacturing process control system to ensure rapid, high-quality production.

Process Dynamic Simulation

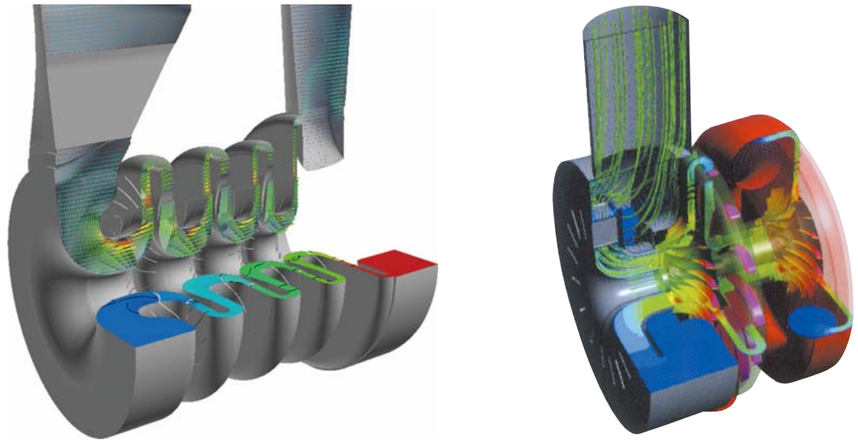
Simulation feasible

- Compressor start-up, shut-down
- Parallel Operation of compressors (load-sharing)
- Others

[Sample of Simulation] 1 4

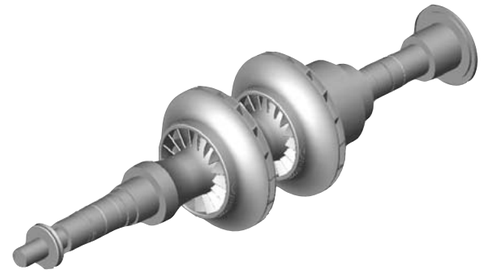


Nozzle to Nozzle Flow Analysis



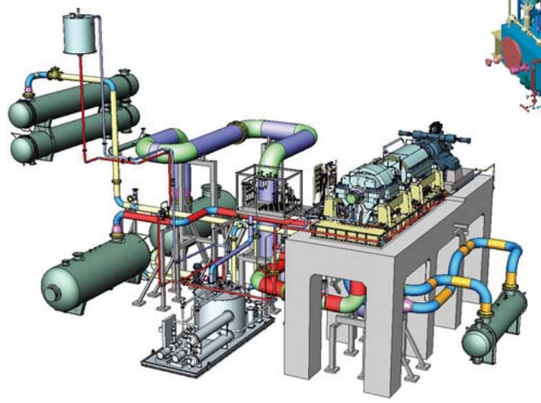
Rotor Dynamics Calculations

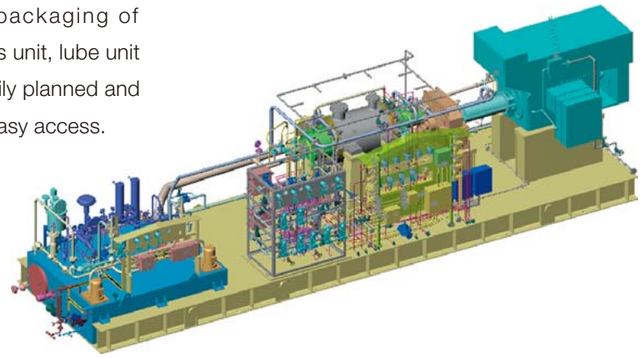
The design system outputs data only when the rotor system is completely stable through the entire operating range. Calculations are made not only for torsional analysis and lateral critical speed analysis but also for response due to unbalanced mass distribution, with bearing stiffness and damping, and occasionally aerodynamic excitations, taken into consideration.



Packaging with 3-D CAD

By adopting 3-dimensional CAD system, packaging of compressor, drivers (ex. motor and gear), seal gas unit, lube unit and relevant auxiliary piping/tubing/wiring are easily planned and designed securing good maintenanceability and easy access.





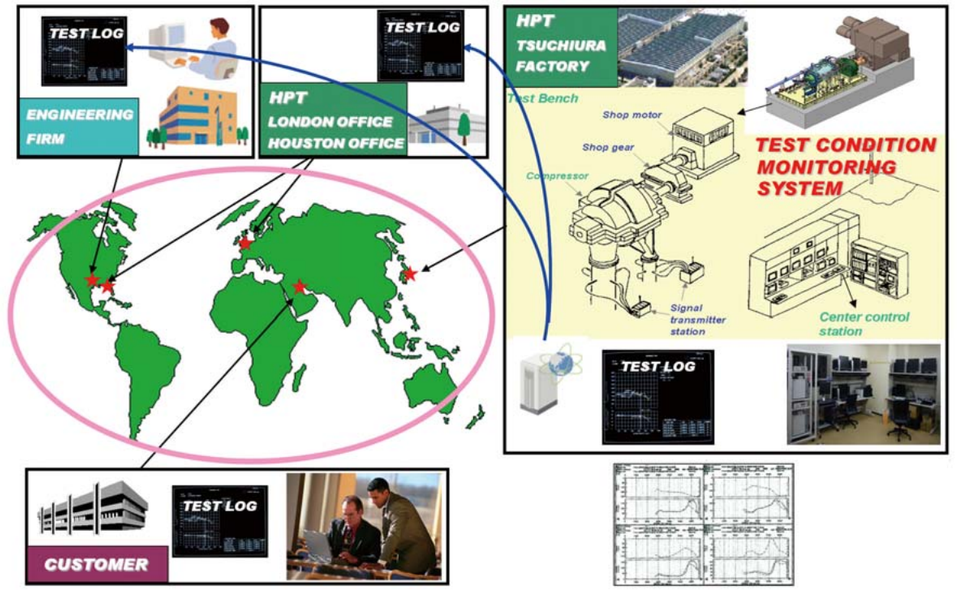
Test Facilities

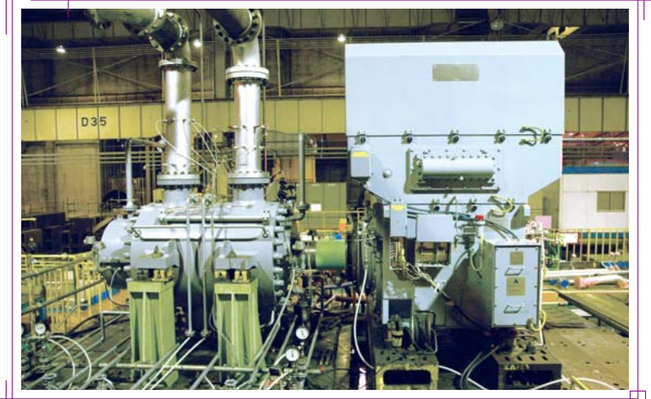
Under ISO9001 certified quality management system, all through the compressor manufacturing process from material receiving and to operational tests and final inspection, there are many inspection and test activities conducted. After assembly work of compressor completed, operational tests such performance test, mechanical running test and/or complete unit test are conducted on the shop test bench. By using a well advanced and sophisticated test facilities, long term reliability is secured. All tests can be carried out in accordance with API and ASME standards.

Complete Unit Test

On-line Test Control Room

Real Time Access to Hitachi Shop Test





High Speed Motor

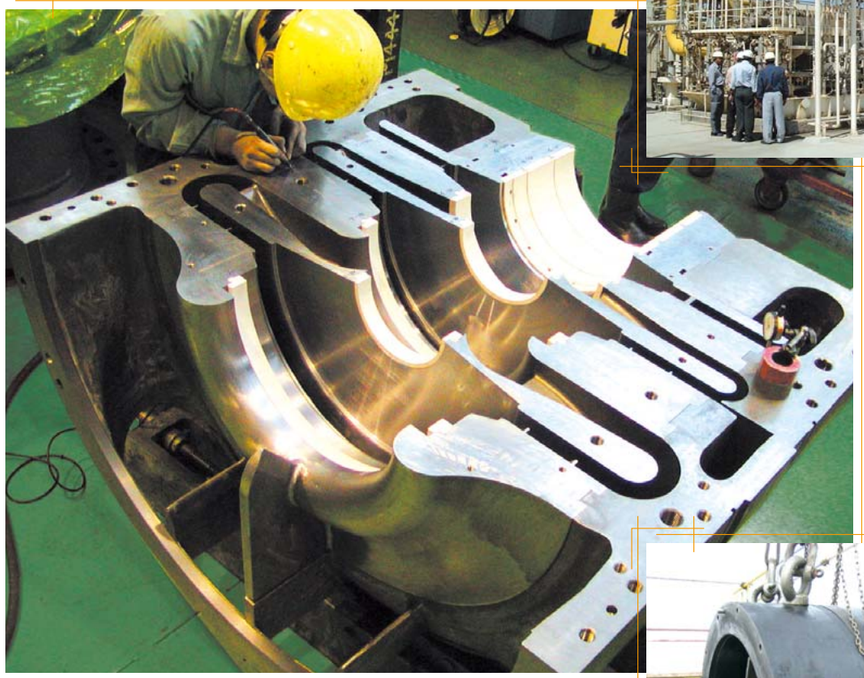
BCH804
Complete Unit Test with 35MW Motor

Satelite Test Bench

After-Sales Services

With branches in many countries, Hitachi is able to offer after-sales services worldwide.
Our service engineers provide the full set of services needed to support compressor operation.
In addition to conventional maintenance services, Hitachi prides itself on keeping in close contact with customers to ensure the prompt supply of OEM spare parts, repair parts, and retrofit services.

Gas Complessor for
Gas Gathering Plant



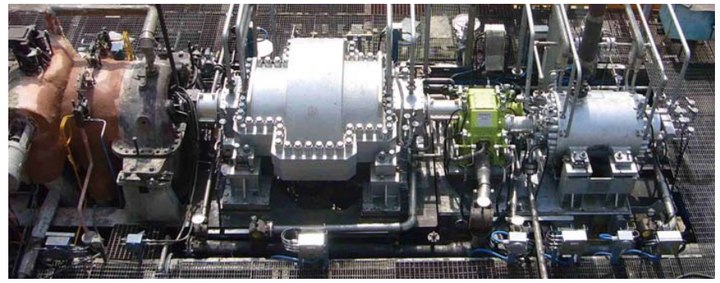
Assembly of an Abradable Seal-Mounted Compressor

Retrofit Services and Upgrade Compressor

Hitachi has many experiences of retrofit service and upgrade compressor to centrifugal compressor.
Application of latest technologies, high performance impellers, dry gas seal retrofit, coating system and repairing technologies, can realize reduction of maintenance cost and operating cost. Especially, replacement of compressor internals can be designed to increase the flow rate and for more large demand of process. Hitachi can offer both new high performance compressors and compressor modernizations.

【Before】

【After】



40% Capacity-up with
Existing S/T & New Compressors

Training

Personnel training is offered as a service for our customers.
Conducted in the shop with the actual equipment and skilled instructors on hand, this training allows your staff to acquire/improve their basis knowledge and the skills necessary for compressor operation and maintenance.

Applications

Oil & Gas

Separation

Gas

Gathering

Treatment
NGL Recovery

Pipeline
Booster Station

Ammonia Plant

Urea Plant

Mathanol Plant

City Gas Station

LNG Plant

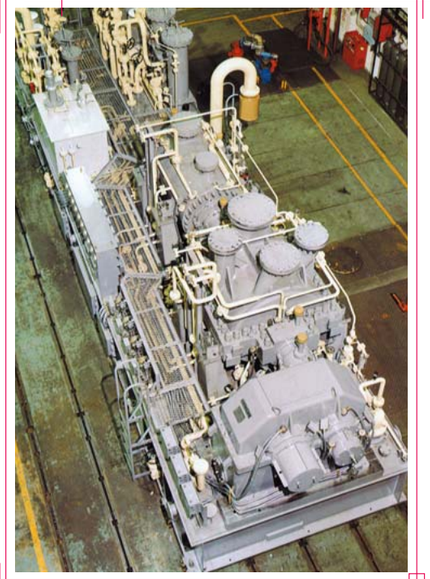
Power Station

BCH506/B
Injection Gas Compressor

BCH355/A
Reinjection Compressor

BCH605/A
Gas Compressor

MCH807+MCH608
Gas Gathering Compressors



2MCH456+BCH406
Gas Compressors

Exhaust Gas CO_2

CO_2 Underground
Storage

Reinjection

Oil Refinery

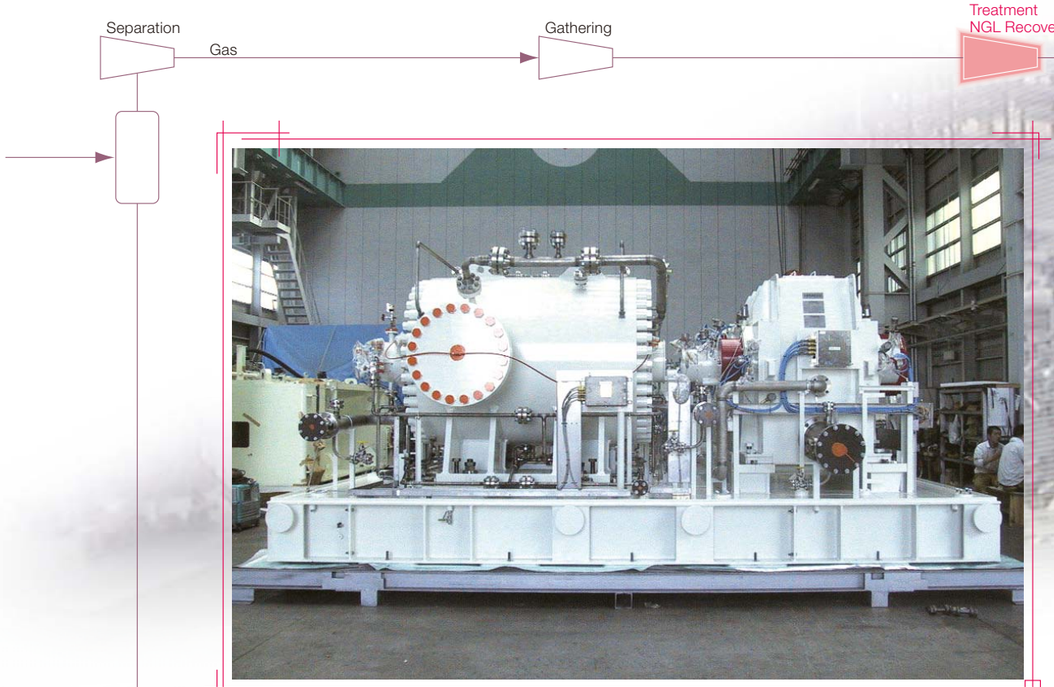
Gasoline
Lube Oil

Ethylene Center

Butadiene

Applications

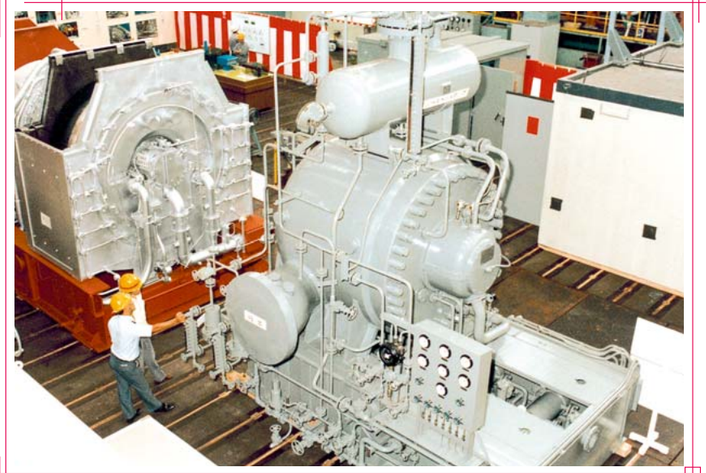
Oil & Gas



PCH802
Pipeline Booster Compressor

BCH605
Natural Gas Treatment Compressor

2BCH357
Stabilizer Overhand Compressor



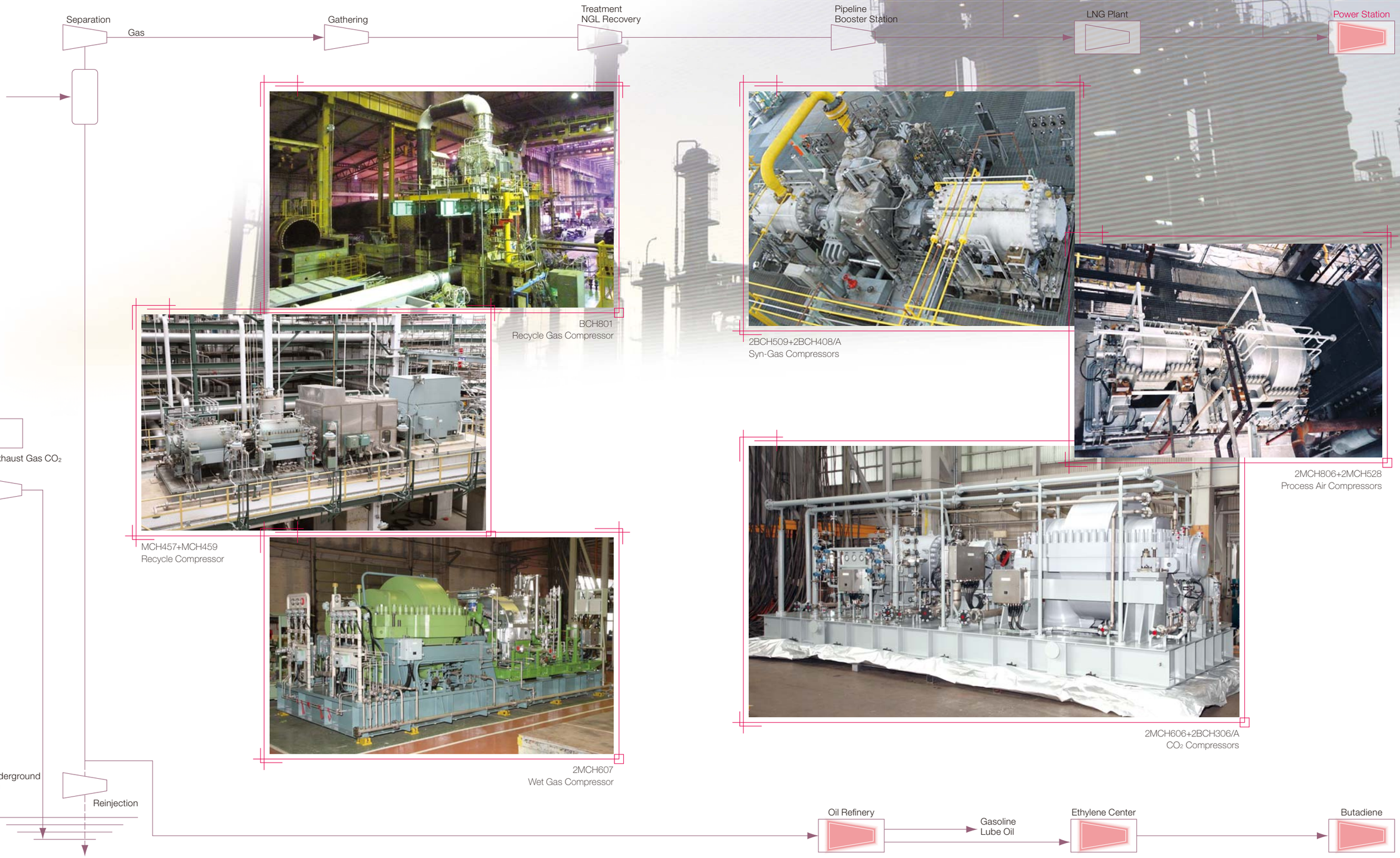
PCH802
Pipeline Booster Compressor

BCH804
Feed Gas Compressor

PCH601
Feed Gas Booster Compressor

Applications

Oil & Gas



BCH801
Recycle Gas Compressor

2BCH509+2BCH408/A
Syn-Gas Compressors

2MCH806+2MCH528
Process Air Compressors

MCH457+MCH459
Recycle Compressor

2MCH607
Wet Gas Compressor

2MCH606+2BCH306/A
CO_2 Compressors

Applications

Others

Seal Water Unit for
Steam Compressor

BCH301
Steam Compressor

BCH302
Air Compressor

BCH303
Gas Turbine Fuel Booster Compressor

Model Numbers

Hitachi's centrifugal compressors are identified with a 5-block model number, thus:

(1) (2) (3) (4) (5) (6)
2 BCH 30 6 /A

(1) This prefix number indicates the compression group type. No number indicates a single group arrangement with a single outlet and inlet; the number 2 indicates 2-group compression with back-to-back rotor arrangement; and the number 3 indicates a side stream arrangement.

(2) The letters indicate the type of casing: MCH represents a horizontally split casing, while BCH indicates a vertivally split barrel type casing.

(3) The letter 'H' indicates High-quality, High-performance and High-reliability compressors offered by Hitachi.

(4) The next set of numbers indicates the nominal diameter of the impeller, in centimeters.

(5) The final number indicates the number of stages. Normally, one to nine stages can be incorporated in a single casing.

(6) For BCH type compressors, high-pressure models are identified withe a suffix: /A, /B, /C, etc.
(See examples below).

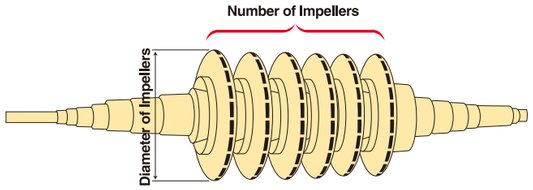
In addition to the above, there are PCH type compressors, intended mainly for pipeline applications. MCH, BCH, and PCH compressors are described on the following pages.

Sample

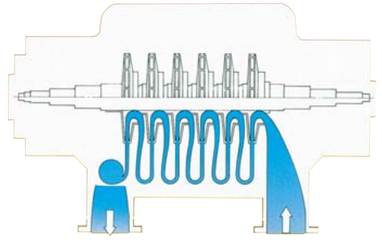
(1)	(2)	(3)		
3	MCH	100	6	
	BCH	45	8	
2	BCH	40	6	/A

(6) For BCH Type only

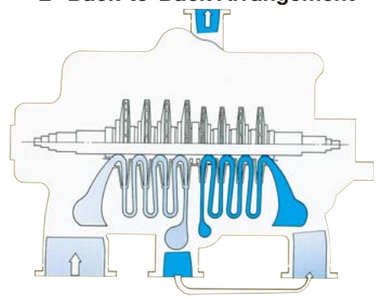
/A≧10MPa
/B≧20MPa
/C≧35MPa
/D≧50MPa



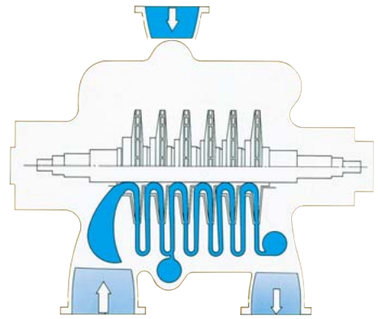
Unnumbered Straight-through Arrangement

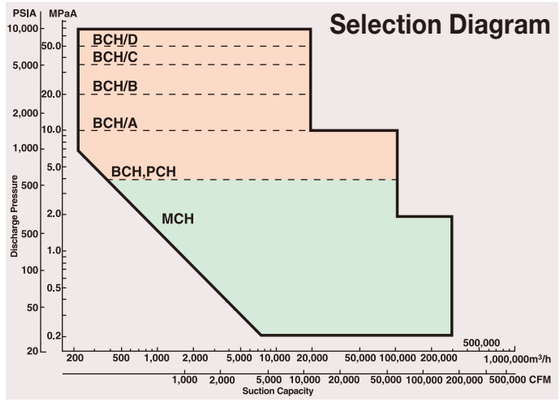


"2" Back-to-Back Arrangement



"3" With Side Stream





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