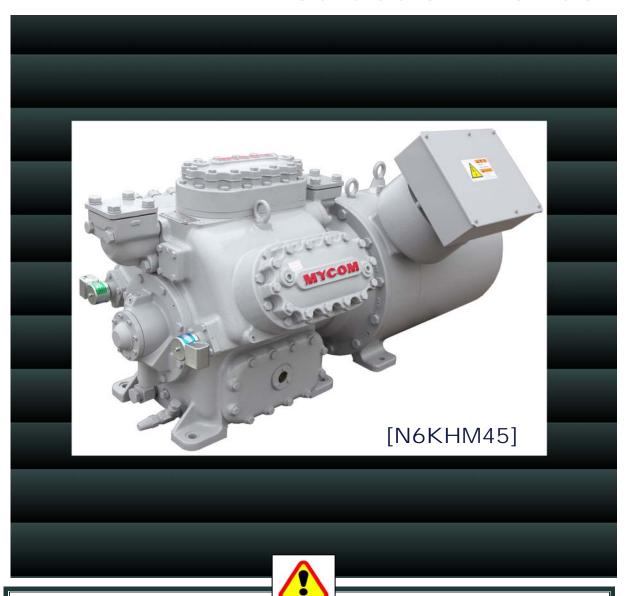
MYCOM

Ammonia Semi-Hermetic Motor with K-series Compressor Instruction Manual



This instruction manual mainly describes the assembly/disassembly way of the semi hermetic motor with the K-series compressor. Refer and follow to "Reciprocating Compressor K-series Instruction manual" for the compressor section.

Before conducting the work of operation/inspection/maintenance of this product, read this manual and sufficiently understand.

Specifications of this product and contents of this manual are subject to change without prior notice due to technical improvements.

Preface

Thank you for purchasing the **MYCOM** K-series Ammonia Semi-hermetic Compressor (hereafter referred to as "this product") of MAYEKAWA Mfg. Co., Ltd. (hereafter referred to as "MAYEKAWA").

This model has an excellent feature of the K-series ammonia compressor that we developed on the basis of the wealth of accumulated technology of industrial reciprocating compressors. Besides, by employing a water cooled ammonia semi-hermetic motor, this compressor has successfully realized further space-saving while completely eliminating the leakage of refrigerant from the shaft seal.

Every component is subjected to the manufacture and shipping inspections under perfect quality control. Thus, we are confident that this product will sufficiently perform its functions in service and meet your expectation.

This instruction manual (hereafter referred to as "this manual") describes the safety information, maintenance procedure, disassembling and assembling of the ammonia semi-hermetic motor section of this product.

For details of the compressor section of this product, refer to the "Reciprocating Compressor K-series instruction manual" as well as this manual. This manual is applicable to the following type products:

N4KHM, N6KHM, N8KHM

To maintain the initial functions of this product for a long time, please read this manual and the "Reciprocating Compressor K-series instruction manual" carefully to fully understand the handling method and exercise proper maintenance services so that this product will be kept in its best condition. Also, please keep this manual at a convenient place near this product installation to ensure that it can be guickly referred to should any unclear issues arise.

Revision History

	Title of Instruc	tion Manual	Document No.	Date of Initial Issue
Ammonia Semi-hermetic motor with K-series Compressor Instruction Manual			2200Q2JE-HO-KHM-N_2015.02.	February 10, 2015
Rev. No.	Issue Date	Re	vision Details	Prepared/Approved by
00	Feb. 10, 2015	Newly issued as electronic version due to newly-designed ammonia semi-hermetic motor with K-series reciprocating compressor.		Sekine / Muta

Warranty and Disclaimer

Warranty

If malfunctions or damages occur under proper usage and conditions following documents such as instruction manual or drawings of this product, or, if MAYEKAWA judges that malfunctions or damages are related to design or manufacture of the product, and if the malfunctions or damages are within the warranty period, we will repair or replace the product without any charges.

The warranty period is "12 months from factory shipment of this product". However, if any separate agreement has been concluded, such an agreement will have the priority in principle.

MAYEKAWA is not liable for production or man made disaster compensation due to malfunction or damage of this product.

Disclaimer of Warranty

Although MAYEKAWA warrants the clauses mentioned above, the following clauses are exempted.

- Malfunction or damage of this product caused by natural disaster, or other accidental forces (such as fire, thunderbolt, windstorm, intense rainfall, flood, tidal wave, earthquake, land subsidence, etc.).
- Malfunction or damage caused by misusage described below.
 - Malfunction, damage, or defect of this product due to abnormal or improper use (such as storing this product for middle to long term outside the building or in locations subject to high temperatures and high humidity, unexpected inspections, tests, operations, and excessive repetition start-up/stoppage of the product.)
 - Malfunction or damage caused by devices or equipments not provided by MAYEKAWA including operation control methods of those devices.
 - Malfunction or damage caused by refrigerants, gases, or refrigerant oils, and operating conditions (design conditions) not approved for this product.
 - Malfunction or damage caused by maintenance or inspection not recommended by MAYEKAWA.
 - Malfunction or damage caused by parts that are not **MYCOM** genuine.
 - Malfunction or damage caused by remodeling the product without approval of MAYEKAWA.
 - Malfunction or damage caused by unexpected misusage

Normally, while the compressor sucks in the refrigerant liquid only after vaporizing it in the evaporator, it may directly sucks it in because of the faulty adjustment or failure of the expansion valve. We call this state of compressor operation "liquid flow-back operation".

No compressor can compress a liquid. The compressor may be damaged should the liquid be sucked in.

[&]quot;Liquid flow-back operation" is ...

Important Information

Intended Use of this Product

This product is a general purpose reciprocating compressor to be used for refrigeration, cold storage, or air conditioning. Do not use this product for any purposes other than the intended use or outside the scope of the specification. Refer to Chapter 2, Section 2.3 "Compressor Specifications" in this manual for the specification of this product.

In addition, it is requested that the maintenance actions described in this manual be taken using safe and secure procedures.

Precautions for Safe Use of this Product

Although MAYEKAWA has paid a lot of attention to safety measures for this product, all hazards including potential hazards caused by human errors, or due to environmental conditions cannot be anticipated.

In using this product, there are many things that are to be strictly followed or prohibited. However, it is impractical to communicate all of such matters in this manual or using warning labels. As such, in addition to the precautions provided in this manual, the user is required to consider other safety measures that are generally required.

The following points are important work safety suggestions for everyone including the manager, supervisor, and other personnel who may work on this product.

Before using this product, please read this manual carefully to sufficiently understand the details and securely implement the safety procedures described in this manual.

- The operation, maintenance, and inspection must be performed by a qualified person who has been provided with the basic technical knowledge on this product and trained on the potential risks and how to avoid the risks.
- Anyone other than the ones who have been provided with the basic technical knowledge on this product and trained on the potential risks and how to avoid the risks is not allowed to approach this product while it is operating or during maintenance.
- Be sure to comply with the applicable laws and regulations of the government and administrative organizations.
- To prevent accidents, do not use this product for any purpose other than the ones originally intended or perform operation/maintenance work in a manner not described in this manual.
- Be sure to use only MYCOM genuine parts for replacement.
- Both the operators and the responsible supervisor are requested to participate together in the health and safety related activities in their efforts to prevent accidents.
- Whenever it is necessary to close (or open) any valve of the package unit, be sure to use the lock-out and tag-out procedures to prevent accidental closure (or opening) of the valve during the work.

"Lock-out" is to prevent people other than the worker from using the item by locking it.

The term "lock-out" refers to the action to shut down (or keep shutting down) the source of (driving) energy to be supplied to the machine or equipment by locking the relevant device.

"Lock-out" is not complete by only turning off the switch of the power source to cut the energy supply. It means that a locking device must be used to lock (fix) the switch, valve, or other device in the shut-off position to prevent further operation by others.

The term "lock-out device" refers to a lock, cover, latch, or other device used to fix the switch, valve, open/close lever, or others securely in the shut-off position.

"Tag-out" is to prevent improper work of other people by attaching a tag plate that indicates "work in progress", for example.

"Tag-out" is to place a tag that clearly indicates that it is prohibited to operate the energy cut-off device while the (driving) energy source is being shut down. Such a marking tag is intended to give a warning that the energy source cannot be operated, by clearly marking "Operation Prohibited", "Startup Prohibited", "Do not open", etc., and it is not intended to actually operate the cut off device.

Be sure to strictly observe the following instructions regarding the maintenance work on the electric control:

- The work must be performed by a qualified person who has been trained on the electric control of the particular target system as well as on the potential risks inherent to electric control and how to avoid the said risks, on top of the generally required knowledge on electrical work.
- Whenever servicing or inspecting electric machinery, be sure to cut off the motor main power and control power, implement lock-out and tag-out procedures, and prevent any accidental application of power during the work.

However, it should be noted that the system may be energized from other sources even if the motor main power and control power are cut off, if power is supplied externally, i.e., not from the refrigeration/cold storage unit that uses this product. In such a case, be sure to cut off the power supply source, implement lock-out and tag-out procedures, and prevent any accidental application of power during the work.

About this Manual

- This product is subject to continuous development and improvement without prior notice. Accordingly, the details provided in this manual may partly differ from the actual condition. If any problem is found during work, please contact one of our sales or service establishments. For each sight of MAYEKAWA, refer to following URL. http://www.mayekawa.com/about/network/
- This manual is in English. If any other language is required, it is the customers responsibility to prepare a manual for safety education and operation instructions.
- MAYEKAWA owns the copyright of this manual. Any part of relevant drawings and technical documents, including this manual, may not be copied in any possible way, including the use of electronic media, without written consent of MAYEKAWA.
- The pictures and illustrations in this manual may not accurately represent the actual condition of the product.
- In case this manual is lost or damaged, please promptly place an order for the copy to one of our sales or service offices. The use of this product without this manual can be a cause of possible accidents.
- When you sell this product, be sure to transfer this manual to the next owner.

Structure of this Manual

Chapter/Section Title	Description
Introduction	Describes the outline and usage of this manual.
Warranty and Disclaimer	The scope of warranty by the Company is described. Provides disclaimer of warranty for the issues outside the scope of warranty.
Important Notice	Provides important information on the product as well as on this manual.
1. Safety	Safety information for the operator, safety measures used for this product, and work safety management required in using this product are described.
Product Specifications and Structure	Specifications and structure of this product are described. Sectional view and Parts configuration table of Motor section are provided.
3. Installation	The installation procedures for this product are described.
Operation of Compressor and System	Refer to the "Reciprocating Compressor K-series Instruction Manual" for the information in this Chapter.
5. Maintenance and Inspection	Inspection points, inspection interval, and disassembly/assembly procedures for the motor section of this product are described.

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Chapter 1 Safety

1.1 Strict Requirements and Prohibitions

1.1.1 Strict Requirements (Do's)

1.1.1.1 General

- Strictly observe any applicable laws and regulations.
- In an explosive atmosphere, never use this product.
- Each package unit using this product must be installed with necessary safety devices and protection systems.
- In the electric wiring work and grounding work for this product, be sure to observe the legal requirements of the country/region where this product is installed.
- No combustible object should be placed in the periphery of this product.

1.1.1.2 Do's on Operation

- Never operate this product without applying the motor terminal box cover.
- Do not use open flames or other source of ignition near this product.
- The safety devices and protection systems must be regularly checked for their normal operation.
- If any safety device or protection system does not function normally or this product operates in an abnormal manner, immediately stop the work and contact your supervisor. When the system is to be restarted, you must observe the decision and instruction of the supervisor.
- If this product has stopped operation due to an unknown cause, immediately contact your supervisor. Before restarting the system, you must seek the decision and instruction of the supervisor.
- Be sure to continue sufficient ventilation of the machine room, especially while the machine is operated.
- Regarding the characteristics of the ammonia refrigerant and lubricating oil, e.g., corrosiveness, degradability, and toxicity, be sure to obtain the latest safety data sheet (SDS) of them and follow the instructions given.
- When this product is not to be used for some period of time, close the suction (side) and discharge (side) stop valves and shut off the motor power source, heater power, and control power.

1.1.1.3 Do's on Maintenance

- Prepare work procedures according to the work plan, and be sure to conduct appropriate hazard prediction activities before actually start working on the system.
- If two or more people are to work together, be sure to mutually check the work details and procedures before the work. During the work, always keep track of the other workers' actions. In addition, do not perform your work where other work is performing on the upper side.
- Before working on any problem encountered during operation, before setting up this product, before cleaning work, and before conducting maintenance or inspection work, be sure to shut off the motor power source, control power, and power to other equipment, perform lock-out and tag-out procedures, and take effective measures to prevent any accidental power-on during the work.

- Before working on any problem encountered during operation, before setting up this product, before cleaning work, and before conducting maintenance or inspection work, be sure to check that the internal pressure of this product and the refrigeration/cold storage/air conditioning unit is at the atmospheric pressure.
- Depending on the type of refrigerant used, it may generate a bad smell or poisonous gas or could cause an oxygen deficient atmosphere. Before starting the work, measure the oxygen content in the work area, as appropriate, and provide sufficient ventilation. The ventilation must be continued steadily until the work is completed.
- Regarding the characteristics of the refrigerant and lubricating oil, e.g., corrosiveness, degradability, and toxicity, be sure to obtain the safety data sheet (SDS) of them and follow the instructions given.
- After completing the insulation resistance measurement of the motor, be sure to discharge it.
- After work, the tools used must be returned to the predefined location. Be sure not to leave them inside the package unit.

1.1.1.4 Do's on Lock-out/Tag-out Procedures after Power is Off

- A lock-out/tag-out mechanism must be installed for the main circuit breakers that supply power
 to the motor and power to the control system. The lock-out/tag-out after power down is a very
 effective means to ensure the safety when two or more workers are working on the system at
 the same time, as it can prevent possible injury of workers that may be caused by accidental
 power-on of the driving source by one of the workers.
- If there is a risk of danger, especially during cleaning, maintenance/inspection, or troubleshooting work, be sure to let the workers perform the lock-out/tag-out procedures after the motor main power and control power has been shut off.
- Because the workers may neglect to perform the lock-out/tag-out procedures or cut-off the
 power in the following situations, be sure to instruct them to strictly follow the correct
 procedure by clearly identifying the work that require lock-out/tag-out and the reasons why it is
 needed.
 - As it is a cumbersome task for the workers to cut off the motor main power and control
 power and use lock-out/tag-out devices before starting the work, they might neglect to do
 it.
 - The workers might determine by themselves that it should be OK just to cut off the motor main power and control power, and not to use any lock-out/tag-out devices.

1.1.1.5 Do's on Personal Protective Gear

- The work must be performed by preparing or using the personal protective gear that conforms to the applicable legal requirements and safety standards.
- Before use, each personal protective gear must be checked for proper functioning.
- Wear designated regular working wear or uniform and securely fasten the cuff buttons.
- Do not wear a tie or other accessories that may get caught by a moving or rotating part.
 Wear a helmet as your hair may also get caught.
- Do not put things in your pocket for not to drop them into the compressor package unit.

1.1.1.6 Do's in Handling of Hazardous and Toxic Substances

 For each of the hazardous and toxic substances, obtain the safety data sheet (SDS) from the manufacturer.

Carefully check the details of the latest safety data sheet (SDS), handle the material according to the recommended handling procedures provided by the manufacturer, and keep the SDS in storage.

1.1.1.7 Do's on the Response to Emergency Situations

 Develop an emergency action plan according to the applicable legal requirements and post it at a safe place.

1.1.1.8 Do's on the Disposal of Waste Oil, Waste Liquid, Scraps, etc.

 Disposal of the refrigerant, oil, and other materials used in this product is restricted in various ways in terms of environmental protection. Be sure to dispose them at the designated site using specified procedures by observing the rules set forth by the applicable laws, regulations, and any voluntary regulations of the customer.

1.1.1.9 Other Do's

- The entire floor around the refrigeration/cold storage/air conditioning unit must always be kept clean, and safety passages must be provided.
- During work, walk only on the above mentioned safety passages. Note that the safety passages must always be kept free from hindrances such as tools, cleaning liquid, etc.
- When water or oil is spilled onto this product or on the floor, immediately wipe it off for not to cause someone to slip and be injured.

1.1.2 Prohibitions (Don'ts)

- Never remove or reposition any safety device based on your own judgment, including any modification of electrical interfaces.
- Never disable the function of safety devices by short-circuit connections or bypassing the circuits without prior permission.
- Never leave this product in an unsafe condition by removing a safety cover, etc.
- Do not touch, clean, or lubricate any moving part of this product.
- While power is turned on, never touch any energized part such as a relay terminal or terminal block by bare hand.

1.2 Warning Notices in This Manual

The warning notices given in this manual inform the user of any dangerous situation that may be expected during the work using the four categories as listed in the following table.

Ignorance of these warnings can lead to a significant personal injury, and in some extreme cases, it could lead to loss of life.

In addition, the main unit or any accessory equipment may be severely damaged. Be sure to observe the instructions in the warning notice.

Type

Meaning

Indicates that there is a high risk of death or severe injury if it is not avoided.

Indicates that there is a potential risk of death or severe injury if it is not avoided.

ACAUTION

Indicates that there is a risk of light or medium injury if it is not avoided.

CAUTION

Indicates that there is a potential risk of material damage if it is not avoided.

Table 1-1 Warning Types and their Meanings

1.3 Residual Risks

The following information is provided assuming that this product will be operated, inspected, and maintained while it is used in a general refrigeration, cold storage, or air conditioning system. However, it is impossible for us to foresee all hazardous sources in the particular refrigeration, cold storage, or air conditioning system that the customer will actually use.

As such, the customer is requested to take proper measures regarding the possible hazardous sources.

Table 1-2 Hazardous Sources

	Hazardous Area	Predicted Hazard	Actions to Take During Operation	Actions to take During Cleaning, Inspection, or Parts Replacement
A	Head Cover of Compressor	Getting a burn by touching it when it is hot	 Installation of a guard or other protection Do not touch with bare hands directly Wearing a personal protection gear 	 Wearing a personal protection gear Perform the work only when the temperature is 40°C or less
В	Discharge Elbow of compressor	Getting a burn by touching it when it is hot	 Installation of a guard or other protection Do not touch with bare hands directly Wearing a personal protection gear 	 Wearing a personal protection gear Perform the work only when the temperature is 40°C or less
С	Unloader Solenoid Valve of compressor	Electric shock	 Installation of a guard or other protection Do not touch with bare hands directly Wearing a personal protection gear 	Lock-out/tag-out for the control power
D	Heater of compressor	Electric shock Burn	 Installation of a guard, cover, or other protection gear Do not touch with bare hands directly Wearing a personal protection gear 	 Lock-out/tag-out for the power to the heater Wearing a personal protection gear Perform the work only when the temperature is 40°C or less
E	Suction (side) Stop Valve of compressor	Contact with or inhalation of hazardous material Low temperature burn	 Wearing a personal protection gear Sufficient ventilation Installation of a guard or other protection 	 Wearing a personal protection gear Sufficient ventilation

Table 1-2 Hazardous Sources (continued)

	Hazardous Area	Predicted Hazard	Actions to Take During Operation	Actions to take During Cleaning, Inspection, or Parts Replacement
F	Discharge (side) Stop Valve Discharge Piping of compressor	Contact with or inhalation of hazardous material Burn	 Wearing a personal protection gear Sufficient ventilation Installation of a guard or other protection Do not touch with bare hands directly 	 Wearing a personal protection gear Sufficient ventilation Perform the work only when the temperature is 40°C or less
G	Gas Purge Valve of compressor	Contact with or inhalation of hazardous material	Wearing a personal protection gearSufficient ventilation	Wearing a personal protection gearSufficient ventilation
Н	Oil Drain	Burn Contact with hazardous material	Do not touch while in operation	 Wearing a personal protection gear Perform the work only when the temperature is 40°C or less
I	Motor	Getting a burn by touching it when it is hot Electric shock	 Do not touch with bare hands directly Wearing a personal protection gear 	 Lock-out/tag-out for the motor main power and control power Wearing a personal protection gear Perform the work only when the temperature is 40°C or less
J	Noise	Hearing impairment due to loud noise	Wearing a personal protection gear	_

For dangerous parts of the compressor, also refer to the illustration in the section 1.3 in "Reciprocating Compressor K-series instruction manual".

For the potential risk of electric shock due to the motor, a warning label is attached to this product. Refer to Figure 1-1 "Warning label pasting position" in the following page.

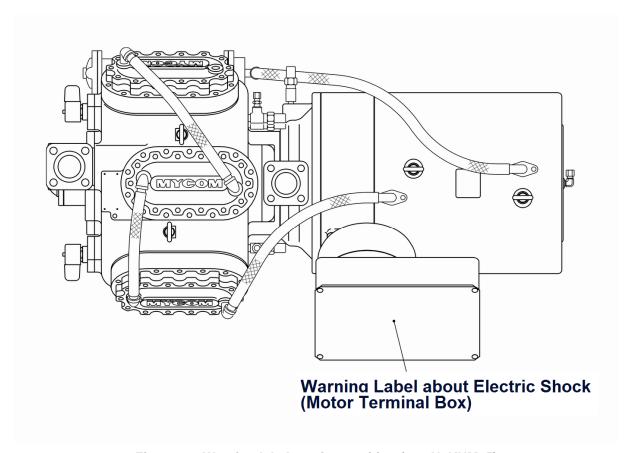


Figure 1-1 Warning label pasting position (ex.: N6KHM45)

1.4 Safety Devices

For safe use of this product and for the devices for safety, protection and control that are required to protect this product, refer to the "Reciprocating Compressor K-series instruction manual" Section 1.4.

The motor of this product is equipped with a thermostat that operates at 130°C, but not with any other protective devices. Therefore, be sure to install an overload protection device.

In addition, it is recommended to install a unit such as ground-fault circuit interrupter, reversed-phase protection device and single-phase protection device.

Make sure that the work is performed by qualified personnel or a contracting company in compliance with local laws and ordinances.

Chapter 2 Product Specifications and Structure

2.1 Overview of This Product

This **MYCOM** K-series ammonia semi-hermetic compressor that has newly joined K-series is a small size reciprocating model that is completely free from the leakage of its shaft seal part by docking semi-hermetic water cooled motor to allow this product to serving as a dedicated compressor to the use for ammonia refrigerant.

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2.2 Model Designation of the Compressor

The meaning of the type designation stamped on the nameplate of the compressor MODEL column is as follows.

[1]	[2]	[3]	[4]	[5]
N	6	K	HM	45

[1] Working fluid (refrigerant)

Symbol	Meaning
N	Ammonia (NH ₃)

[2] Number of cylinder

Symbol	Meaning
4	4 cylinders
6	6 cylinders
8	8 cylinders

[3] Series name

Symbol Meaning K K-series

[4] Series name additional entry

Symbol	Meaning
HM	with Semi-hermetic motor

[5] Motor rating

Symbol	Meaning
30	30 kW
45	45 kW
60	60 kW

2.3 Product Specifications

2.3.1 Standard Specifications

The standard specifications of the ammonia semi-hermetic compressor are shown in Table 2-1 and the standard specifications of the semi-hermetic motor are shown in Table 2-2.

Table 2-1 Standard Specifications of the K-series Ammonia semi-hermetic Compressors

Item				Model			
				N4KHM30	N6KHM45	N8KHM60	
Refrigerant		_	Ammonia				
Structure			-	Semi-hermetic reciprocating type			
Number of	of cyl	inder	-	4	6	8	
Cylinder I	oore		mm	85			
Stroke			mm	65			
Rotation	spee	d	min ⁻¹		900 ~ 1800	,	
Displacem	ont	1450 min ⁻¹	m ³ /h	128	193	257	
Displacem	CIII	1750 min ⁻¹	m ³ /h	155	232	310	
Drive me	thod		-	Se	mi-hermetic motor dr	rive	
Cooling	Hea	ad cover	-		Water cooled		
method	Oil	cooler	-	Water cool	ed / Direct expans	ion method	
metriou	Mot	or jacket	-		Water cooled		
Cooling v		•			Series		
of this pro	duct	t	_	[Oil cooler] → [Motor jacket] → [He		Head cover]	
Amount o	of coc	oling water	L/min	35 (at 30°C of cooling water temperature)			
Pressure	loss		kPa	24	36	44	
Consoitu		Method	-	Hydraulic pressure-controlled solenoid valve (Loading at energized to the solenoid valve)			
Capacity control		Power source	V	100V, 110V / 200V, 220V		20V	
		Range	%	100,50	100,66,33	100,75,50,25	
Safety valv	/e		-	External install type (not installed at the time of shipment)		hipment)	
Lubricating	, ;	Selection -		ISO - VG46 to VG68 For details, refer to "Reciprocating Compressor K-series Instruction Manual" Chapter 4 Section 4.1			
oil		Oil pressure	MPa	Suction pressure + 0.2 to 0.3		0.3	
	I	Filling amount	L	9.0	9.0	10.0	
Stop valve		Suction	-	50A	65A	80A	
bore	I	Discharge	-	40A	50A	65A	
Product mass kg			kg	650	780	950	

[■] Unless otherwise specified, the pressure unit "MPa" represents the gauge pressure in this manual.

[■] Product mass is the measured value after docking the semi-hermetic motor to the compressor. However the mass of a suction stop valve and a discharge stop valve does not contain.

Table 2-2 Standard Specifications of the K-series Semi-hermetic Motor

Mana.		Product Model Name					
Item		N4KHM30 N6KHM45		N8KHM60			
Motor model name	1	NHM30	NHM45	NHM60			
Motor type	-	Т	hree-phase induction mo	otor			
Rating output	kW	30	45	60			
Number of pole	Р		4				
Detinaryaltana	\ /		200 / 200 / 220				
Rating voltage	V	400 / 400 /440					
Rating frequency	Hz	50 / 60 / 60					
Deting augrent	А	107 / 105 / 96	158 / 155 / 140	217 / 206 / 190			
Rating current		53 / 52 / 48	78 / 78 / 71	106 / 102 / 95			
Deting and	min ⁻¹	1479 / 1772/ 1777	1482 / 1767 / 1774	1481 / 1774/ 1778			
Rating speed	min	1474 / 1766 / 1773	1483 / 1778 / 1783	1488 / 1766 / 1781			
Insulation class	-	Equal to F class insulation					
Thermostat °C		130 (working temperature)					
Starting method -		Star-delta starting or inverter driving recommended					
Cooling method	-	Water cooling outside of the motor casing (motor jacket)					

■ Do not operate this product in direct-on-line-starting.

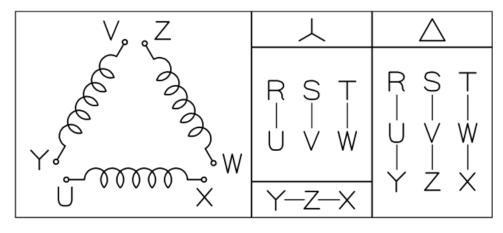


Figure 2-1 Motor Terminal Symbol

2.3.2 Service Limits

Table 2-2 Service Limits for the K-series Compressor

Item	Unit	Limit value	Remarks	
Maximum discharge pressure	MPa	2.26	Design pressure of a crankcase and covers:	
Maximum suction pressure	MPa	0.69	High pressure part: 26MPa Low pressure part: 1.5MPa	
Maximum differential pressure at high/low pressure	MPa	1.96		
Maximum oil supply pressure	MPa	Ps + 0.4	Ps = Suction pressure	
Minimum oil supply pressure	MPa	Ps + 0.1	Recommend settings: Ps + 0.2 MPa to 0.3 MPa	
Maximum discharge gas temperature	°C	140		
Maximum supply oil temperature	°C	50	Temperature at oil chamber or	
Minimum supply oil temperature	°C	30	temperature at oil cooler inlet port	
Maximum speed	min ⁻¹	1800		
Minimum speed	min ⁻¹	900		
Maximum cooling water outlet temperature	°C	50	Head jacket cover and oil cooler outlet temperature Allowable temperature of blade hose for cooling water	
Maximum cooling water pressure	MPa	0.5	Allowable pressure of blade hose for cooling water	
Degree of superheat: SH	°C	20 or less	Liquid flow-back is not allowed.	

- Unless otherwise specified, the pressure unit "MPa" represents the gauge pressure in this manual.
- In the case of ammonia refrigerant, when SH is too high, it is easy to occur to decline of the volumetric efficiency of the compressor due to overheating of the discharge gas. We recommend 10 °C to 15 °C as SH.
- Refer to the "Reciprocating Compressor K-series Instruction Manual" Section 4.3.1 "Start/Stop Limits" for the limitations (start and stop limits) to be applied when the running compressor is stopped and restarted.

2.3.3 Outer Dimensions

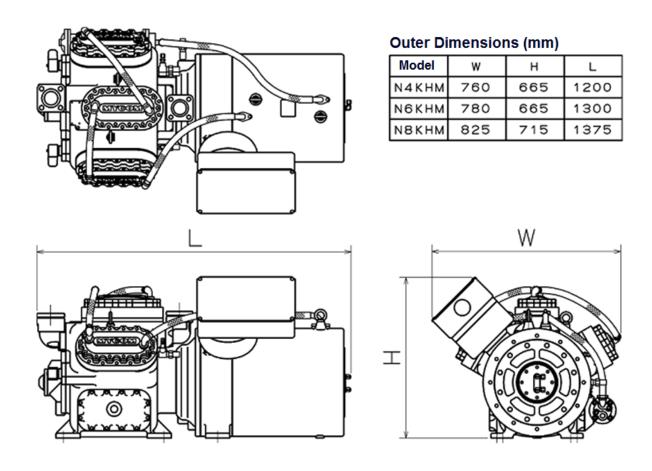


Figure 2-2 Outer Dimensions of the K-series Ammonia Semi-hermetic Compressor

2.4 Structure of Semi-hermetic Motor

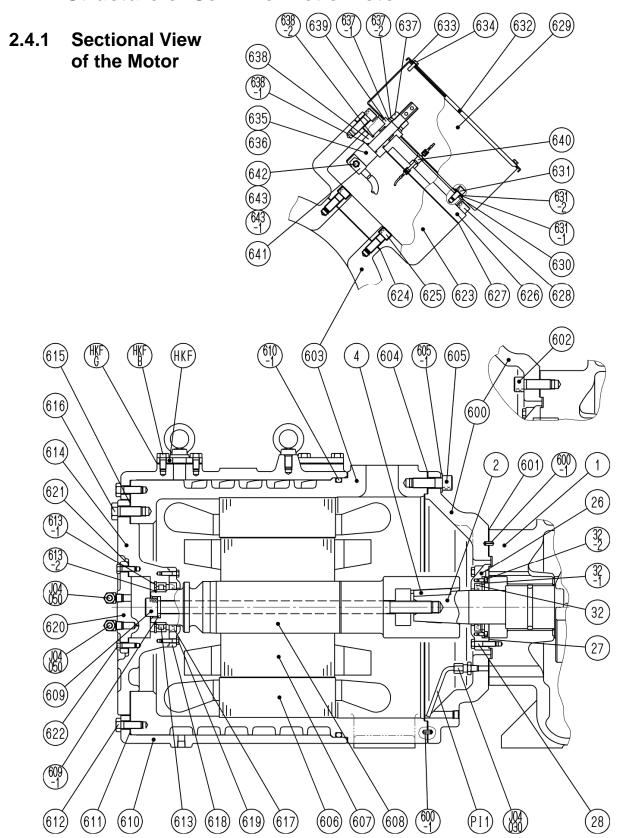


Figure 2-3 Sectional View of the K-series Semi-hermetic Motor

2.4.2 Parts Configuration Table

Table 2-4 Parts Configuration Table of the K-series Semi-hermetic Motor

No.	Part Name			Remarks
1	Compressor Crankcase			N4KHM,N6KHM,N8KHM,N62KHM
2	Compressor Crankshaft			4K,6K,8K,62K
4	Compressor Shaft Key			M15×9.7×60
26	Compressor Oil Seal Retainer			
27	Gasket, Compressor Oil Seal Retainer		1	
28	Fastening Bolt, Compressor Oil Seal Re	etainer	6	M8×35
32	Compressor Oil Seal		1	NOK-TCV type (AP3055GO)
32-1	Compressor Oil Seal Gland		1	
32-2	Fastening Bolt, Compressor Oil Seal Gl	and	4	Hexagon Head Cap Screw M5×10
600	Motor Spacer		1	for NHM30 and 45, for NHM60
600-1	Positioning Pin for Motor Spacer		2	Spring pin 6×12
601	Gasket, Motor Spacer		1	
602	Fastening Bolt, Motor Spacer		12	Hexagon Head Cap Screw M16×45
603	Motor Casing		1	for NHM30, for NHM45, for NHM60
604	Gasket, Motor Casing		1	for NHM30 and 45, for NHM60
605	Fastening Bolt, Motor Casing			Hexagon Head Cap Screw M16×50
605-1	Fastening Bolt Washer, Motor Casing			Conical spring washer CW-1L-16
606	Motor Stator			for NHM30, for NHM45, for NHM60
607	Motor Rotor			for NHM30, for NHM45, for NHM60
608	Bushing, Motor Rotor			for NHM30, for NHM45, for NHM60
	_	NHM30	1	Hexagon Head Cap Screw M20×450
609	Mounting Bolt, Motor Rotor	NHM45	1	Hexagon Head Cap Screw M20×550
		NHM60	1	Hexagon Head Cap Screw M20×580
609-1	Mounting Bolt Washer, Motor Rotor		1	Special washer (exclusive)
610	Motor Jacket Cover		1	for NHM30, for NHM45, for NHM60
		NHM30	1	JIS B 2401 P410
610-1	O-ring, Motor Jacket Cover (NBR)	NHM45	1	JIS B 2401 P410:
		NHM60	1	JIS B 2401 P475
611	Gasket, Motor Jacket Cover			for NHM30 and 45, for NHM60
612	Fastening Bolt, Motor Jacket Cover		12	M12×35
613	Motor Bearing			NU1010W
613-1	Snap Ring A, Motor Bearing			H80
613-2	Snap Ring B, Motor Bearing			WR50
614	Motor Bearing Retainer			
615	Gasket, Motor Bearing Retainer			
616	Fastening Bolt, Motor Bearing Retainer			M16×40
617	Motor Oil Seal			NOK-TCV type (AP3154EO)
618	Motor Oil Seal Retainer			
619	Fastening Bolt, Motor Oil Seal Retainer			Hexagon Head Bolt M6×25
620	Motor End Cover		1	

No.	Part Name	Qty	Remarks
621	Gasket, Motor End Cover	1	
622	Fastening Bolt, Motor End Cover	8	M8×25
623	Motor Sealing Terminal Box	1	
624	Gasket, Motor Sealing Terminal Box	1	
625	Fastening Bolt, Motor Sealing Terminal Box	6	Hexagon Head Cap Screw M12×35
626	Motor Terminal Block	1	
627	Gasket, Motor Terminal Block	1	
628	Fastening Bolt, Motor Terminal Block	8	Hexagon Head Cap Screw M12×35
629	Motor Terminal Box	1	
630	Gasket, Motor Terminal Box	1	
631	Fastening Bolt, Motor Terminal Box	6	Hexagon Head Cap Screw M8×15
631-1	Fastening Bolt Washer, Motor Terminal Box	6	Nominal 8
631-2	Fastening Bolt Spring Washer, Motor Terminal Box	6	Nominal 8
632	Motor Terminal Box Cover	1	
633	Gasket, Motor Terminal Box Cover	1	
634	Fastening Screw, Motor Terminal Box Cover	6	Cross recessed hexagon head screw with captive washer M5×15
635	Aluminum Terminal V-shaped type	4	Ф16 v-08
636	Aluminum Terminal H-shaped type	2	Ф16 h-08
637	Mounting Nut, Aluminum Terminal	6	M16
637-1	Mounting Washer, Aluminum Terminal	6	Nominal 16
637-2	Mounting Spring Washer, Aluminum Terminal	6	Nominal 16
638	Teflon Parts 1 for Aluminum Terminal	6	1v7_4
638-1	O-ring (NBR)	6	JIS B 2401 P16
638-2	O-ring (NBR)	6	JIS B 2401 P22
639	Teflon Parts 2 for Aluminum Terminal	6	2v7_4
640	Thermometer Terminal	2	NPT1/8
641	Aluminum Crimp Terminal	6	
642	Aluminum Bolt	6	M8×35 Special Bolt
643	Aluminum Nut	12	M8 Special Nut
643-1	Aluminum Washer	6	Special washer (exclusive)
699	Eye Bolt for Motor	2	M12
HKF	Water Flange	2	15A
HKFG	Gasket, Water Flange	2	
HKFB	Fastening Bolt, Water Flange	4	M10×L20 (SUS)
JO4030	Half Union Joint I-type	1	R1/4×Ф8
JO4050	Half Union Join L-type	2	R1/4×Ф8
PI1	Piping	1	Ф8×115mm
JO4050	Half Union Join L-type (attach to Motor Spacer)	2	R1/4×Ф8
PI2	Oil supply/Return Piping for Motor Bearing	2	Ф8×1000mm

Chapter 3 Installation

3.1 Safety Precautions during Installation

[NOTE]

- The description in this Chapter 3 "Installation" assumes that this product is to be installed in a generic and commonly used refrigeration, cold storage, or air conditioning system. If the installation procedures described in this chapter are not directly applicable to the customer's specific refrigeration, cold storage, or air conditioning system, the customer is requested to prepare a separate work procedure document by paying sufficient attention to the safety issues and by referring to the relevant descriptions in this chapter, before actually performing the installation work. For any unclear issues, please contact our local sales offices or service centers.
 - It may be required that this product installation work be done by a qualified technician.
 The work must be performed by technicians who have been qualified for the work according to the applicable laws, regulations, and other regulatory requirements in the country this product has been delivered to.
 - Carefully read and sufficiently understand the content of this chapter and other related materials before actually performing the installation work.
 - Wiring work and/or other electrical work must be performed by a qualified electrical technician.
 - Never get into or put any part of your body into an area immediately below this product being lifted up.

3.2 Installation Work

3.2.1 Unpacking

Check that this product is free from any damage or abnormality.

[NOTE]

- If there is any abnormality or missing part with this product, please contact our local sales offices or service centers.
- All packing materials that are no more needed after unpacking must be disposed of in a carefully controlled manner in accordance with the applicable laws, regulations, and any voluntary regulations of the customer

3.2.2 Storage

If this product is to be stored before the installation:

- Place this product in such an indoor area, where ventilation is adequate, no direct sunlight is projected and free from any excessive variation of air temperature occurs.
- To avoid damaging the bearing due to fretting, store this product where no vibration occurs.
- Absolutely avoid placing this product for storage directly on the ground
- Fill this product with Nitrogen gas and seal it (at the gauge pressure of approximately 0.15 MPa).

[NOTE]

• Upon packing, this product is filled with Nitrogen gas to prevent rust.

3.2.3 Transportation

A DANGER

Should this product being lifted drop, there is a high risk of death or severe injury.
 Provide sufficient protection such that no one can enter an area below this product being lifted up.

For the mass of this product, refer to Table 2-1 in this manual Chapter 2 Section 2.3.1 "Standard Specifications".

For the outer dimensions, refer to Section 2.3.3 "Outer Dimensions" in this manual Chapter 2.

- 1. When lifting this product, be sure to prepare and use lifting devices and other proper tools capable of lifting this product mass within the specified safety load limit.
- 2. A sufficient space must be provided to ensure that the lifting work can be safely conducted.
- 3. Make sure to check the wire ropes and belt slings before use. Carefully check the wire ropes for any kink, knot, or broken strand, and the belt slings for any scar, abrasion, hooking scratch, or belt peeling. Never perform the lifting work before it has been confirmed that the wire ropes and/or belt slings have no problems.
 - If any doubt remains, ask a qualified specialist to check the condition.
- **4.** If only this product body is to be lifted, use the eye bolts on this product to hook the wire ropes (refer to next page picture).
- 5. If the unit base structure with this product to be lifted, use the eye bolts on the unit base structure to hook the wire ropes. Never use the eye bolts on this product.
- **6.** Check that the transportation path is free from any obstacles that can hinder smooth transport, according to the size of this product.
- **7.** Before lifting this product, check that the hook is positioned above the center of gravity of this product.
- 8. Before starting to lift up this product, instruct all the workers to be sufficiently away from the lifting area
- 9. Just before starting to lift up, provide the coworkers with a sign (such as a call, hand signal, etc.) of starting the lifting action. Do not start to lift up unless the sign (such as a call, hand signal, etc.) has been fully acknowledged.
- 10. Wind up the wire ropes slowly until shortly before this product leaves from the ground.
- 11. Wind up the wire ropes again until this product leaves the ground, and check that this product is not tilted. If it is tilted, return this product to the ground and correct the tilt. After that, restart the lifting operation.
- **12.** Slowly lift up this product. A sudden lifting may cause damage to the wire ropes and/or other hoisting tools or some part of this product.
- **13.** After the hoisting has started, check the condition to see that the wire ropes and other hoisting tools are in normal condition. Check that this product is not tilted.
- 14. When moving this product in the lifted condition, be sure to use guiding ropes.
- 15. Evacuate people from the forward path and check the safety in the direction of the movement.
- **16.** Unless it is inevitable, do not bring this product above any safety passage.
- 17. Do not place this product (unit) on a safety passage. The safety passages shall always be kept unblocked.
- **18.** Before lifting down this product, clear the area from any obstacles. Make sure this product will not be tilted or become unstable.
- 19. When lowering this product, also notify the coworkers around the working area.
- 20. Be sure to carefully and gradually lower this product so that it is not damaged by impact on the ground.
- **21.** If this product body is to be placed on two or more blocks, properly adjust the height of each block for this product to be stably leveled on the blocks.

Example for Lifting Up this product:

For slinging up this product, the use of belt slings or wire ropes (hooking wire) facilitates the lifting in an equalized load at each of the four eye bolts.

If no hook is attached to each of the belt slings or wire ropes, hang the load by using each of the eye bolts and the eye (ring) of the lifting tools via a shackle.



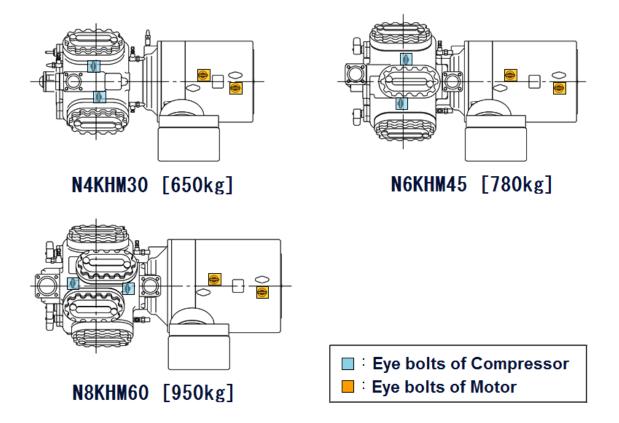


Figure 3-1 Positions of Eye Bolts

3.2.4 Preparation for Installation

■ Installation space

Prepare an installation space of this product where the operation, cleaning, maintenance, and inspection work can be easily performed.

For performing overhaul of the compressor:

Because the crankshaft must be taken out from the main body during an overhaul work, a sufficient space must be provided on the oil pump side, for a length corresponding to the full width of the crankshaft, as measured from the crankcase end.

In addition, along the direction of taking out the cylinders, a clearance of at least 300 mm shall be provided to avoid interference with other components such as pipes.

For the overhaul of the semi-hermitic motor, secure as enough space as at least 1.2 times of the total motor length in the axial direction.

Lighting

Provide sufficient lighting to allow easy operation, cleaning, maintenance, and inspection work.

Ventilation

If natural ventilation is not sufficient, install proper ventilation fans according to the laws and regulations.

Cooling water

In this product, water cooling method has applied to cooling the compressor head cover and ammonia semi-hermetic motor.

Closed type cooling tower facility should be employed to cool down the water used in this product.

Ensure that a sufficient amount of cooling water is provided as required by the customer's system.

3.2.5 Installation

For more information about the installation of this product, refer to the "Reciprocating Compressor K-series Instruction Manual" Section 3.2.5.

3.2.5.1 Placement

Make sure that this product mounting surface of the package unit is sufficiently flat and level. If it is not sufficiently leveled, tightly fastening this product mounting bolts can cause deformation of this product and could hinder normal operation.

3.2.5.2 **Piping**

For the details of piping connection to the compressor, refer to the "Reciprocating Compressor K-series Instruction Manual" Section 2.3.3.

For the precautions of refrigerant piping to the compressor, refer to the "Reciprocating Compressor K-series Instruction Manual" Section 3.2.5.5.

Connected Port	N4KHM30	N6KHM45	N8KHM60
Compressor gas inlet port	50A	65A	80A
Compressor gas outlet port	40A	50A	65A
Cooling water inlet/outlet port of compressor head cover, oil cooler and motor jacket cover	15A		
Compressor suction pressure	Ф6 Byte Type Tube Fitting		
Compressor discharge pressure	Ф6 Byte Type Tube Fitting		
Compressor oil supply pressure	Φ6 Byte Type Tube Fitting		

Table 3-1 Connected Piping Dimensions

Chapter 4 Operation of Compressor and System

For the following items description is required in this chapter, please refer to the "Reciprocating Compressor K-series Instruction Manual" Chapter 4.

- Requirements for the lubricating oil (refrigerating oil) of this product
- Precautions for selecting the lubricating oil
- Changing the brand of the lubricating oil
- Management criteria of the lubricating oil
- Lubricating oil replacement timing.
- Replenishment of lubricating oil
- Precautions for initial operation
- Initial operation method
- Operating precautions
- Management contents and points of daily operation
- Action to take when the compressor is stopped for a long time

Chapter 5 Maintenance and Inspection

5.1 Precautions for Maintenance and Inspection

When reading this Section, also refer to Section 1.1 in this manual Chapter 1.

DANGER

- When entering the machine room for maintenance services, ensure that sufficient ventilation has been started and measure the oxygen concentration so that there is no risk of oxygen deficiency. The ventilation must be continued steadily until the work is completed.
- For performing the inspection work, be sure to prepare safety shoes, protective glasses, gas mask and other proper protective equipment and do not fail to use them whenever they are required.
- After stopping the machine and before working on a regular inspection or overhaul, be sure to shut off the main motor power, control power, and other power to each equipment and valve. After they are shut off, be sure to make the switches inoperable by others. Also, be sure to attach notification tags to prohibit operation (lock-out/tag-out).
- When any manual stop valve has been closed, be sure to make the valve inoperable by others and put a notification tag to prohibit the operation (tag-out).
- When the compressor is to be overhauled, check that the internal pressure of this
 product is at the atmospheric pressure before starting the work.
- When using lifting devices, e.g. a crane, etc. and/or lifting tools, ensure that they can sufficiently withstand the load.
- When lifting a heavy load object, do not allow anyone's body to put under it.
- The work to turn each power supply ON/OFF or operate a lifting unit must be exclusively performed by qualified personnel.

MARNING

- Be sure to use only MYCOM genuine parts for replacement. Using parts that are not genuine can cause damage to this product or other devices during operation.
- Do not convert or modify this product or its components without prior permission from MAYEKAWA. Otherwise, it can lead to an unexpected accident.
- Exercise sufficient care for handling a heavy load, and use such a lifting device as a crane or work with an adequate number of personnel commensurate with the magnitude of the weight. Also, be sure to use stud bolts (safety retention bolts) and other support tools for the work. Neglecting the above warning can lead to low back pain of the worker or injury due to dropping of the parts.
- Not only the work to turn each power supply ON/OFF or operate a lifting device, but also any type of work requiring qualification must be exclusively performed by qualified personnel.

A CAUTION

• When checking the operation data of units and executing other daily maintenance services, pay particular attention to avoid touching the area heated to a high temperature causing skin burns or inadvertently moving the handle of a valve leading to an erroneous operation.

A CAUTION

- In the disassembly/inspection workplace, secure a sufficient space for temporary storage of the removed parts and tools, replacement parts, and for the disassembling work as well as safety passages, and then put up necessary off-limit signs.
- In the workplace, secure a sufficient space and refrain from putting tools directly on the floor or from haphazardly laying wires.
- Keep the floor clean all the time. Leaving the floor smeared with oil and the like causes it to be slippery and may result in the fall and injury of personnel. Thus, do not leave it but wipe it off right away.
- Make sure that the temperature of the high temperature sections such as head covers and discharge lines has been cooled down to normal ambient temperature, before working on them.
- When disassembling and reassembling the compressor, use the specified tools properly. Before starting to use those tools, gain the full understanding of their characteristics and the method for use.
- During the maintenance service, keep the tools clean all the time. Using those tools smeared with oil increases the risk of slip and fall, leading to an injury. Also during the service, there is a risk of foreign matters intruding inside the compressor to cause its damage.
- Parts are slippery with oil. Fully watch out for the risk of any object falling down. Pay attention to any parts falling down, which could lead to personal injury.

CAUTION

- Before disassembly, inspections, and handling of the compressor and the semi-hermetic motor, sufficiently understand the disassembly and assembly procedures.
- When removing a part, be careful not to damage it.
- Place the removed parts on a clean workbench in an orderly manner.
- For cleaning parts, use kerosene and machine parts cleaning sprays available on the market.
- Washed parts shall be dried by compressed air or wiped up using clean cloth. Do not use synthetic textiles or woolen textiles to prevent fibers from attaching the parts.
- Removed bolts from each part should be classified into each used section to prevent confusion.
- For details of overhauling the compressor, refer to the "Reciprocating Compressor K-series instruction manual" Chapter 5. Note that although this manual describes the disassembling and reassembling practice of the semi-hermetic motor, it does not define the maintenance procedure to the minute details, but only covers its key points only.
- If complete disassembly and reassembly of this product are required, please contact your nearest sales office or service center of MAYEKAWA.
- The figures marked with brackets [] immediately following each part name in this manual indicate the part numbers given in the Sectional View of the Motor shown in Section 2.4 of this manual and parts configuration table.

5.2 Contents of Maintenance and Inspection

5.2.1 Daily Management and Regular Inspection

For the daily maintenance and regular inspection, refer to the "Reciprocating Compressor K-series instruction manual", Section 5.2 and exercise every corresponding item.

Particularly for this product, properly control its cooling water in its flow rate, water quality and temperature, conduct regular inspection and cleaning of the strainer and water channels to maintain the cooling system in normal condition.

5.2.2 Overhaul

The overhaul of the semi-hermetic motor is required not only for the overhaul of the motor described in Section 5.3.1.2, but also when removing the crank shaft of the compressor.

When overhauling the motor, first remove the whole wiring including power cable connected to the motor before disassembling.

Before removing the wires, give marking (matching marks) to the wires and terminals to avoid connection errors that may occur at re-wiring.

[POINT]

When performing overhaul only motor jacket block described in Section 5.3.1.1, it is unnecessary
to remove the power supply line and other wires connected to the motor.

5.2.3 Guideline for the Semi-hermetic Motor Overhaul Timing and Details

CAUTION

 The required frequency of overhaul will vary depending on the compressor model, refrigerant, rotating speed, usage condition, state of system, and type of oil.
 The cost of parts replacement will be charged to the customer even if the part failure occurs before reaching the overhaul time listed in this section.

The recommended overhaul timing and details is shown below as a guideline.

Here, it is assumed that:

- (1) The operating condition is within the specified operation range
- (2) The number of start/stop cycles is within the specified limit,
- (3) Daily maintenance and regular inspection services including recording are properly exercised.
- (4) The cooling water cooling system used for this product is of the closed type.

5.2.3.1 Overhauling the Motor Jacket

Conduct the overhaul at intervals of 1 year or 8,000 hours, whichever earlier, after the commissioning. Remove the oil feeding/draining tubes of the motor and jacket cover, and conduct the inspection and cleaning inside the motor jacket. In a daily inspection, if no fault is found in each inspection item, there is no need of overhauling the motor or other components.

The rust preventive paint that is peeled during cleaning of the inner surface of motor jacket, touch it up by painting with a brush.

Inspect the O-ring [610-1] of the motor jacket cover, and replace it if any fault is found.

Replace the motor jacket cover gasket [611] and water flange gasket [HKFG] without fail.

5.2.3.2 Overhauling the Entire Motor

Conduct the overhaul at intervals of 2 year or 16,000 hours, whichever earlier, after the commissioning. Besides the overhaul contents of the motor jacket, remove the motor end cover, motor bearing retainer, motor casing, motor rotor and compressor oil seal retainer to inspect the internal parts.

Table 5-1 Inspection Parts and Action when Overhauling the Entire Motor

No.	Inspection Part	Action
617	Motor Oil Seal	Replace if any abnormality is found
613	Motor Bearing	Replace if any abnormality is found
32	Compressor Oil Seal	Replace if any abnormality is found
-	Other Each Part	Replace if any abnormality is found

Inspect the O-ring [610-1] of the motor jacket cover, and replace it if any fault is found.

Always replace the jacket cover gasket [611], water flange gasket [HKFG], oil seal retainer gasket [27], motor casing gasket [604], and motor end cover gasket [621] of the opened blocks of the motor.

5.3 Disassembly

5.3.1 Refrigerant Gas Recovery

Since the semi-hermetic motor is integrated with the compressor, the ammonia refrigerant inside must be recovered before overhauling.

There are a few methods of recovering the refrigerant. For example, one method is to operate the refrigerator, close the supply source valve, turn the gas into liquid, and recover the liquid at the receiver. Another method is to use a refrigerant recovery machine to recover the liquid. As such, choose the means that best meets your purpose and legal requirement.

Prepare a working flow sheet of the system beforehand. Prior to the recovery work, check the valves to be controlled during the recovery work by comparing them with the ones in the flow sheet, and clearly note the valves to be operated, other connected devices, and tubes on the flow sheet.

Two flow sheets must be prepared, i.e., one at the foreman and the other for posting in the workplace. In addition, prepare a work procedure document for the refrigerant recovery work to reflect the actual conditions of the workplace, and sufficiently share the work details among all the coworkers through checking and confirmation before actually starting the work.

The gas mask and other protective gears required at each stage of refrigerant recovery work must be prepared before starting the work.

MARNING

- Before the work, be sure to check and communicate the work details and procedures among all coworkers, and carry out hazard prediction activities based on the information shared. Neglecting to do this will increase the risk of on-the-job accidents and injuries to a considerable level.
- All the valves that have been opened or closed during the work must be prevented from accidental operation through proper lock-out and tag-out procedures.

If the lubricating oil used is compatible with the ammonia refrigerant, a large amount of refrigerant should be contained in the oil. Accordingly, after the refrigerant has been recovered once, the refrigerant contained in the oil will be evaporated to increase the pressure inside the crankcase. As such, be sure to recover the refrigerant repeatedly for a few times, until the pressure becomes low and no more increased.

After completing the recovery work, shut down the related drive power and control power, and securely carry out the lock-out and tag-out procedures.

5.3.2 Draining the Lubricating oil

As soon as the refrigerant recovery work is completed, drain the lubricating oil remaining in the compressor crank case [1]. Connect a hose of pipe to the oil supply and discharge valve located at bottom left of the compressor oil pump, and drain the lubricating oil into a container. Applying a pressure of 0.1 MPa or so by using nitrogen gas or dry compressed air makes the draining easier. If the pressure is applied, be sure to vent the gas to bring the pressure back to the atmospheric pressure after draining the lubricating oil.



Oil Supply and Discharge Valve

[POINT]

 When performing overhaul only motor jacket block described in Section 5.3.1.1, draining the lubricating oil is not required.

5.3.3 Motor Jacket Cover

The overhaul of motor jacket cover involves the overhauling items described in Section 5.3.1.1 and 5.3.1.2. When performing the work described in Section 5.3.1.1 (inspection and cleaning the inside of jacket) alone, remove the two jacket hoses for motor cooling and two tubes (Φ 8 mm) for motor bearing feed/return oil, but there is no need of overhauling other components of the motor.

MARNING

- The motor jacket cover is a heavy component. The removal work must be performed using lifting devices such as a crane, chain block, etc.
- a) Prepare the set-up to lift up the jacket cover [610] by using a crane or chain block and the eye bolts (hanging bolts) provided at two spots on top of the jacket cover.

Table 5-2 Mass of the Motor Jacket Cover

Motor Model Name	NHM30	NHM30	NHM30
Mass (kg)	52	68	80

- b) Before starting the work, close the valve at the inlet and outlet of compressor water cooling system and drain the cooling water remaining in the compressor.
- c) Remove the bolts of the hose elbow flange located in the upper area of the motor jacket cover, and take off the flange from the jacket cover (following picture to the left).
- d) Remove the cooling water drain plug (hexagon socket plug) at the bottom of the jacket cover, and drain the cooling water in the jacket (following picture to the right).





- e) Remove the two pipes (Φ8 mm) between the motor spacer [600] and motor end cover [620]. The pipes can be taken off by removing the nuts for fixing the coupling of each pipe (following picture).
- f) Loosen and remove the fastening bolts [612], and take off the motor jacket cover.

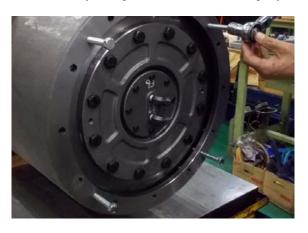


g) Attach the jacking bolts in the threaded holes at four spots on the motor jacket cover flange surface. Gradually retract the jacket cover by turning a half turn at a time of each of the four jacking bolts (following picture to the left).

[POINT]

Depending on the contamination or water quality of the cooling water, the inside wall surface of the jacket may be deposited with considerable amounts of water stain and scale. If this is the case, the water stain and scale are deposited in the gap between the jacket cover and motor casing, causing it hard to take out the jacket cover. Pull out the jacket cover by using the jacking bolts, while giving light knocks to the body of the jacket cover with a somewhat larger soft hammer.

After moving it for about 15 mm, the jacket cover is separated from the jacket cover O-ring [610-1], and the jacking bolts can be turned lightly.





- h) Hook the lifting tool at each eye bolt and pull out the jacket cover while slightly lifting it (picture at right above).
- i) Take off the O-ring [610-1] from the O-ring groove of the motor casing.

5.3.4 Motor End Cover (approx. 2.3kg)

The motor end cover shown in the picture right is fixed to the motor bearing retainer [614] with eight bolts [622].

To take it off, remove the bolts and pull the cover toward yourself.

[POINT]

 There is a bearing box containing a small amount of oil inside the motor end cover.

When opening the cover, receive the oil spilling out from the inside by using a container.



5.3.5 Motor Bearing Retainer (approx. 16.6 kg)

- a) After removing the two bolts [616] in the upper area of the motor bearing retainer [614] and screwing two stud bolts for safety (the two bolts in the upper area in the picture at left below), take off all the remaining bolts.
- b) Screw in the bolts (the two bolts in the lower area of the picture at left below) into each of the threaded holes for jacking bolts on the left and right side of the flange, and pull out the motor bearing retainer. As soon as it is pulled out to the extent where the gasket tends to be peeled off, hold the flange with both hands and pull it out toward yourself (following picture to the right).





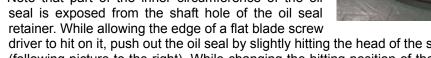
5.3.6 Motor Bearing Outer Race and Motor Oil Seal

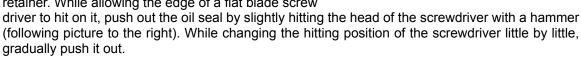
The outer race of motor bearing [613] is mounted in the motor bearing retainer [614]. As long as the bearing does not show any particular abnormality, there is no need of removing it. In case of replacing the motor bearing, remove the snap ring A [613-1] for the motor bearing (following picture to the left) and pull the bearing outer race toward yourself to take it off. The inner bearing race is shrink-fit to the shaft end of motor rotor bushing [608]. For details of removing the inner race, refer to the Section 5.3.8. f).





- The motor oil seal [617] is fixed to the inside of the motor bearing retainer while it is mounted in the motor oil seal retainer [618] and tightened with six bolts [619]. The oil seal retainer can be taken off by removing the bolts (picture to the right).
- As long as no fault is found in the lip (in contact with the shaft) of the motor oil seal (following picture to the left), the oil seal need not be taken off. When the replacement of the oil seal is required, take it off by using the following procedure:
- d) Note that part of the inner circumference of the oil









CAUTION

The oil seal, once it is removed, it is deformed and consequently cannot be used again. If the oil seal is removed, replace it with a new one.

5.3.7 Motor Casing

MARNING

- The motor casing and the motor rotor described on the next page are heavy items.
 To remove them, be sure to use a crane or other lifting device.
- a) Prepare the set-up to lift up the motor casing by using a crane or chain block and hooking the lifting tool. The motor casing [603] can be lift up by using the eye bolts (hanging bolts) on top of the outer circumference of it on the compressor side and screwing in an M12 size eye bolt (hanging bolt) into the single threaded hole on top of the motor jacket cover so as to hook the chain slings (following picture to the left) or by using a belt sling around the body of motor casing (picture in the middle below).

Table 5-3 Mass of the Motor Casing

Motor Model		NHM30	NHM30	NHM30	
Mass	(kg)	250	300	340	







- b) Loosen the two bolts fixing the leg parts of the motor casing to the base frame, and take them off.
- c) The motor casing is mounted on the motor spacer [600] by using 12 bolts [605]. Remove the bolts and take the casing off by pulling it toward yourself. First remove the two fastening bolts for the motor casing and screw in the stud bolts (picture at middle above). These bolts can be used as guides in the initial stage of pulling out.
- d) Remove the remaining bolts for tightening the motor casing, while slightly lifting up the motor casing.
- e) Mount the jacking bolts in the threaded hole on the left and right side of the motor spacer and screw in them equally on the left and right to peel off the gasket and take off the motor casing from the spigot section of the motor spacer (picture at right above).
- f) Then, slightly lift up the motor casing while preventing the interference with the motor rotor [607], and gradually pull the motor casing toward yourself. Continue the extracting work while visually checking so that the motor rotor will come to the center of the motor stator. Complete the extracting work while exercising sufficient care not to damage the winding of the motor stator with the fins of the motor rotor in the course of pulling out.



Motor Rotor Fin and Stator Winding

5.3.8 Motor Rotor

 a) Likewise the case of motor casing, prepare the set-up to lift up the motor rotor [607] by using a crane or chain block and hooking the lifting tool

Table 5-4 Mass of the Motor Rotor

Motor Model		NHM30	NHM30	NHM30	
Mass	(kg)	60	80	120	

b) Loosen the motor rotor mounting bolt [609] at the end of the motor rotor shaft (following picture to the left). Keep the bolt loosed to an extent of about three turns.





- c) Use a pulley extractor to take off the motor rotor from the compressor shaft [2]. Hook the claw of the pulley extractor at the flange of the motor rotor bushing [608], with the tip of the extractor jacking bolt in contact with the head of the motor mounting bolt (see the above picture to the right).
- d) While screwing the jacking bolt of the pulley extractor, the joint of compressor shaft and motor rotor bushing is disengaged. Since the compressor shaft is tapered, once the tapered section is disengaged, the shaft can be readily withdrawn.
- e) Take off the pulley extractor and try to lift up the motor rotor liberated from the compressor shaft. Pull off the motor rotor mounting bolt and pull the motor rotor toward yourself to pull it off (picture to the right). The shaft is attached with a key [4], which should be stored to prevent from losing it.
- f) At the end of the motor rotor bushing, the inner race of motor bearing [613] is shrink fit (following picture). As long as the bearing does not show any particular abnormality, there is no need of removing it.





When replacing the bearing, remove the snap ring B [613-2] that is fit in front for retaining the motor bearing, and heat up the outer circumference of the inner bearing race with a gas torch or the like to remove it.

CAUTION

 When pulling off the heated inner bearing race, use a pair of thick leather gloves to prevent your hand from a burn.

5.3.9 Compressor Oil Seal and Retainer

- a) The compressor oil seal retainer [26] (picture to the right) is located inside the motor spacer [600] and mounted to the crank case [1] of the compressor with six bolts [28]. It can be taken off by loosening and removing the bolts and pulling toward yourself. If it can hardly be taken off because of the sticking gasket, slightly hitting it with a soft face hammer will allow you to remove it.
- b) The compressor oil seal [32] is inserted inside the oil seal retainer. As long as no fault is found in the lip part (in contact with the shaft), the compressor oil seal need not be taken off.



When replacement of the oil seal is required, remove the four bolts [32-2] that are tightening the compressor oils seal gland [32-1] (following picture to the left), and take off the oil seal gland.





c) To remove the compressor oil seal, while allowing the edge of a flat blade screwdriver to hit on the slightly exposed part of the inner circumference of the oil seal through the shaft hole of the oil seal retainer, hit the head of the screwdriver with a hammer to push out the oil seal (picture to the right). While changing the hitting position of the screwdriver little by little, gradually push it out.



CAUTION

• The oil seal, once it is removed, it is deformed and consequently cannot be used again. If the seal is removed, replace it with a new one.

5.3.10 Motor Spacer (NHM30/NHM43: 29 kg, NHM60: 37 kg)

As long as no gas or oil leakage has been checked from the joint section of the motor spacer gasket [601] in a daily inspection or monthly regular inspection, there is no particular need to overhaul the motor spacer [600].

If any gas or oil leakage is verified, replacement of the motor spacer is required. To dismount the motor spacer, loosen and take off the 12 bolts [602] fixing the motor spacer to the crank case.

After replacing the gasket, mount the motor spacer.

- a) Remove the bolts in two spots on the top of motor spacer, and screw two stud bolts (safety bolts) into the appropriate bolt holes.
- b) After loosening the remaining bolts, remove every bolt while supporting the motor spacer by hand (following picture to the left). Pulling the motor spacer toward yourself allows it to be removed.





- c) After removing the old gasket and cleaning the flange surface, mount a new gasket that should be applied with oil (picture at right above). Allow the positioning pin hole of the motor spacer and the position of oil hole to meet the counterpart.
- d) Using each stud bolt as a guide, mount the motor spacer. Mount the motor spacer in such a way that the oil return tube [PT1] in the motor casing comes immediately below, screw in the bolts, and tighten them with the specified torque.

5.4 Reassembly

When replacing a part, check if it is a correct one or not before using it for assembling.

Start the reassembly work after completing the cleaning of assembly parts and tools. Most of the reassembly work will be performed in the reverse order of the disassembly work.

To tighten the fastening bolts of each section of the semi-hermetic motor, use the respective torque specified in Table 5-5.

Start the tightening work with 50% of the tightening torque of the specified value for each pair of bolts in the mutually facing position. Then, tighten all bolts in the clockwise order applying the specified torque. As regards the tightening of bolts involving a gasket, the bolt tightened in the first place has a tendency to be loosened. Accordingly, perform another round of the tightening with the specified torque with the additional aim of checking the last tightening operation.

Table 5-5 Tightening Torques of Hexagon Head Bolt / Hexagon Head Cap Screw

No.	Name	Туре	Qty	Size	Torque (N·m)
609	Motor Rotor Mounting Bolt for NHM30	Hexagon Head Cap Screw	1	M20×450	260
	Motor Rotor Mounting Bolt for NHM45	Hexagon Head Cap Screw	1	M20×550	260
	Motor Rotor Mounting Bolt for NHM60	Hexagon Head Cap Screw	1	M20×580	260
602	Motor Spacer Fastening Bolt	Hexagon Head Cap Screw	12	M16×45	160
605	Motor Casing Fastening Bolt	Hexagon Head Cap Screw	12	M16×50	220
616	Motor Bearing Retainer Fastening Bolt	Hexagon Head Bolt	12	M16×40	160
612	Motor Jacket Cover Fastening Bolt	Hexagon Head Bolt	12	M12×35	80
625	Motor Sealing Terminal Box Fastening Bolt	Hexagon Head Cap Screw	6	M12×35	80
628	Motor Terminal Block Fastening Bolt	Hexagon Head Cap Screw	8	M12×35	80
HKFB	Water Flange Fastening Bolt	Hexagon Head Bolt, SUS	4	M10×20	10
622	Motor End Cover Fastening Bolt	Hexagon Head Bolt	8	M8×25	30
631	Motor Terminal Box Fastening Bolt	Hexagon Head Cap Screw	6	M8×15	10
619	Motor Oil Seal Retainer Fastening Bolt	Hexagon Head Bolt	6	M6×25	10

5.4.1 Compressor Oil Seal and Motor Oil Seal

When the replacement of compressor oil seal [32] and motor oil seal [617] is required, use the following procedure for the assembling. The size of oil seals for the compressor and motor is different, but the mounting method is the same. Pictures of the following procedure exemplify the case of the compressor oil seal.

a) Mount the oil seal (following picture to the left) by allowing its flat side to face downward and to match the mounting hole (position) of the oil seal retainer (following picture to the right).





b) Place a disk-like inserting jig (which is slightly larger than the oil seal) onto the oil seal. While holding the jig by hand, lightly hit it in the top, bottom, right and left with a hammer to insert the oil seal gradually (see the following picture to the right).

Such a steel disk with a diameter of $\Phi 85$ to 90 mm and thickness of about 5 mm (following picture to the left) or a 10-mm or so thick wooden disk with the similar diameter may be used as a jig.





c) As soon as the motor oil seal is inserted in the motor oil retainer [618], the mounting is complete. For the compressor oil seal, after inserting the compressor oil seal retainer [26], install the oil seal gland [32-1]. Mount the oil seal gland and tighten it with four bolts [32-2] (following picture to the right).





5.4.2 Compressor Oil Seal Retainer

- a) Apply oil on the gasket [27] and attach it to the oil seal retainer [26] while allowing the bolt holes to match the oil holes (picture to the right).
- b) Apply oil on the lip (in contact with shaft) of the oil seal and the sealing area of the compressor crank shaft.

While keeping the oil seal retainer in the right angle with the shaft, fit it in the crank case. Mount the oil seal retainer so that the oil hole of the crank case matches that of the oil seal retainer.





c) While holding the oil seal retainer, screw in the bolts [28] (above picture), and tighten them with the specified torque.



5.4.3 Motor Rotor

a) Motor rotor [607] is a heavy component. In the same way as in the disassembly, prepare the set-up to lift up the motor rotor by using a chain block and lifting tool (see Section 5.3.8).

[POINT]

- Provisionally marking the key slot position on the circumference of the motor rotor shaft will facilitate the matching with the key on the crankshaft during assembling.
- b) Mount the key [4] with the key slot on the compressor crank shaft facing upward.
- c) While keeping the key slot on the motor rotor shaft facing upward, lift up the motor rotor. While lifting the motor rotor so that the center of shaft hole matches the center of crank shaft, mount it on the shaft by pushing the motor rotor (following picture to the left).
- d) Tighten the motor rotor with the motor rotor mounting bolt [609] attached with a washer [609-1] (following picture to the right).



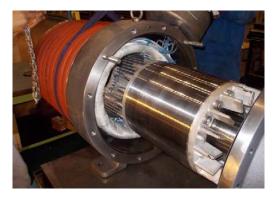


e) If the motor bearing [613] is replaced, fix the inner bearing race on the motor rotor by shrink-fitting. Heat up the inner bearing race to a temperature of 80 to 100°C by using a bearing heater or the like to fix it on the motor rotor shaft, and attach the motor bearing snap ring B [613-2].

5.4.4 Motor Casing

CAUTION

- When mounting a motor casing, pay meticulous attention to avoid damaging the coil end of the motor casing with rotor fins. Damaged coil insulation coating may cause burn-out of the motor.
- a) Motor casing [603] is a heavy component. In the same way as in the disassembly, prepare the set-up to lift up the motor rotor by using a chain block and lifting tool (see Section 5.7.3).
- b) Screw in two stud bolts into two of the upper bolt holes in the motor casing. Use them as guide bolts for jointing the motor casing and motor spacer [600].
- a) Apply oil on the gasket [601] and attach it while allowing the gasket pin holes match the positioning pin holes on the upper part of the flange of motor spacer.
- d) Lift up the motor rotor while allowing the motor casing is aligned with the motor rotor in parallel. When the rotor is lifted up so that the center of the motor casing matches that of the motor rotor, gradually move the motor casing toward the motor spacer. When moving it, while visually aiming at the motor rotor through the hole in the motor stator to adjust the rotor comes to the center of the hole, gradually push it in (photo below).





- e) When the stud bolt reaches the bolt hole of the motor spacer, adjust the motor casing to the motor spacer so that the stud bolts are inserted.
 - When the motor spacer (convex) fits into the spigot (concave) of the motor casing, screw in the bolts [605] and tighten them with the specified torque.

5.4.5 Motor Bearing and Motor Oil Seal Retainer

a) When the bearing has been removed for the replacement of motor bearing [613], mount the bearing in the motor bearing retainer [614]. After inserting the outer race that is in pair with the planetary ring of the bearing (following picture to the left), attach the snap ring A [613-1] for motor bearing in the groove in front side (following picture to the right).





- b) Install the oil seal retainer [618] on the motor bearing retainer [614] (following picture to the left).
- c) Screw in the six bolts [619], and tighten them with the specified torque (following picture to the right).

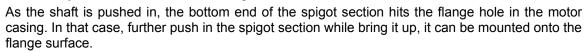




5.4.6 Motor Bearing Retainer

- a) Apply oil on the planetary ring of the motor bearing [613] and the lip part (in contact with the shaft) of the motor oil seal [617].
- b) Screw two stud bolts (safety bolts) into appropriate top bolt holes.
- c) Apply oil on the gasket [615] and attach it to the bearing retainer [614] so that the bolt holes allow the stud bolt to enter.
- d) While holding the bearing retainer with both hands, mount it in the motor casing (picture to the right).

Push the motor rotor shaft [607] into the bearing that has already been mounted in the bearing retainer.



e) After slightly tightening the motor oil seal retainer fastening bolts [619] and fit the hexagonal bar wrench to the motor rotor mounting bolt [609], ensure that the shaft can be turned by hand (following picture to the left), tighten them with the specified torque (following picture to the right).





5.4.7 Motor End Cover

- a) Apply oil on the gasket [621].

 Attach the gasket to the flange of motor end cover [620] while allowing it to the bolt holes.
- b) While fitting the motor end cover to the motor bearing retainer (following picture to the left), screw in the eight bolts [622], and then tighten them with the specified torque (following picture to the right).





5.4.8 Motor Jacket Cover

- a) Motor jacket cover [610] is a heavy component. In the same way as in the disassembly (see Section 5.3.3), prepare the set-up to lift up the jacket cover by using a chain block and the eye bolts (hanging bolts) provided at two spots on top of the jacket cover.
- b) Screw in the stud bolts (safety bolts) to the top two spots of the motor casing [603] flange, and attach the motor jacket cover gasket [611] that has been applied with oil to the motor casing flange surface (picture to the right).
- c) Apply grease on the entire surface of the motor jacket cover O-ring [610-1], and fit it in the O-ring groove in the motor casing (following picture to the left). After fitting the O-ring, fill the O-ring groove with grease using your finger (picture to the right).





- d) Apply grease on the O-ring fitting face of the motor jacket cover (chamfered and uneven edges of the inner end of the groove).
- e) Lift up the motor jacket cover by hooking the lifting tools at the eye bolts. Slowly insert the jacket cover while allowing it to fit the outer perimeter of the motor casing (following picture to the left).
- f) The jacket cover can no more be smoothly pushed in when it touches the O-ring. Screwing in the two bolts [612] at the mutually opposite positions will allow you to push it in easily.
- g) Screw in all the remaining bolts and tighten them with the specified torque (following picture to the right).





5.4.9 Oil Supply/Oil Return Piping to Motor Bearing

a) For feeding and returning oil for the motor bearing, fix the two pipes (Φ8 mm) connecting the motor end cover [620] and motor spacer [600] (following picture).



b) Screw in the nuts for the joint located at both ends of the pipe at each joint and tighten them. The pipes constitute each system of the oil feeding piping from the joint in the lower area of the motor end cover to another on top of the motor spacer as well as the oil returning piping from the joint in the upper area of the motor end cover to another in the lower area of the motor spacer. Connect the pipes cautiously not to confuse them.







Motor space side

5.4.10 Connecting Power Wiring to the Motor

After completing the motor assembling, connect the wires including the power cable in the original way.



[N4KHM30]



[N8KHM60]



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