



INSTRUCTION MANUAL OF GEAR REDUCER

天益齒輪工廠股份有限公司

TIEN YI GEAR WORKS CO., LTD

ADD : NO.57, KWANG-FU RD., HSIN-CHU
INDUSTRIAL PARK, TAIWAN, R.O.C.

TEL : 886-3-5970206

FAX : 886-3-5970210

地址：新竹縣湖口鄉新竹工業區光復路 57 號

電話：(03)5970206 (代表號)

傳真：(03)5970210

Table of Contents

A	Preface	2
B	Delivery and Inspection	3
	• Delivery	
	• Items for inspection	
C	Installation and Storage of Gear Reducer	5
	• Foundation	
	• Leveling	
	• Shaft coupling	
	• Appendix	
	• Oil pump	
	• Oil cooler or Cooling coil	
	• Piping	
	• Check the direction of rotation	
D	Normal Operation of Gear Reducer	7
	• Oil filling	
	• Preliminary Inspection	
	• Startup	
	• Break-in Running	
	• Inspection during operation	
E	Maintenance and Inspection	10
F	Procedure for handling abnormal conditions	11
G	Disassembly and Assembly	12
H	Appendix	
	Drawing 1 Shaft coupling alignment	14
	Drawing 2 Oil level indicator	15
	Table 1 Suggested lubricant specification table	16
	Table 2 Suggested grease table	17
	Table 3 Maintenance Timetable	18
	Table 4 Bolt Tightening	19

Preface

To our valued customers, thank you very much for choosing (T.Y. Pai) gear reducer . The life of our gear reducer depends greatly on a lot of factors aside from its own design, material, precision and method. Even on the surrounding of our gear reducer, assembly procedure and others have a very important factor. And because of this, as part of our company's customer service, we are providing an instruction manual for your reference as to improve the working condition of the gear reducer and at the same time extend the life of its usefulness.

Within the period of our warranty, there are certain operating conditions to be followed depending on the design material. Dear customer, please pay attention for any misuse, abnormal loading or excess loading and other abnormal condition that may occur. During assembly, please refer to the instructions on this manual.

Delivery and Inspection

- Delivery Conditions
 1. Do not add oil into the gear box, internal components are already assembled, Please do not disassemble.
 2. The gear reducer machine already have a thin film in it that guards against oil, this thin film dissolves into the lubricant when adding lubricants later on, thus, there is no need for cleaning when adding lubricants. The non-painted metal portion on the exterior of the reducer is applied with anti-rust solvent. Before installation, solvent maybe used for cleaning.
 3. When the reducer is not in use, it can be kept for 6 months. (Do not place it outdoor)
- Items for inspection on testing the gear reducer
 1. When receiving the gear reducer, please check the exterior body and other parts for any damages or loosening caused by delivery. If this situation arises, please inform our head office for assistance.
 2. Please check if the Model, Input, Ratio are the same with the specification ordered as indicated on the gear reducer's engraved plank. The drawing below indicates the contents of the engraved plank as follows:



Definitions of various items mentioned above:

① Reducer Model: The company's standard model are: TKA~TKJ.

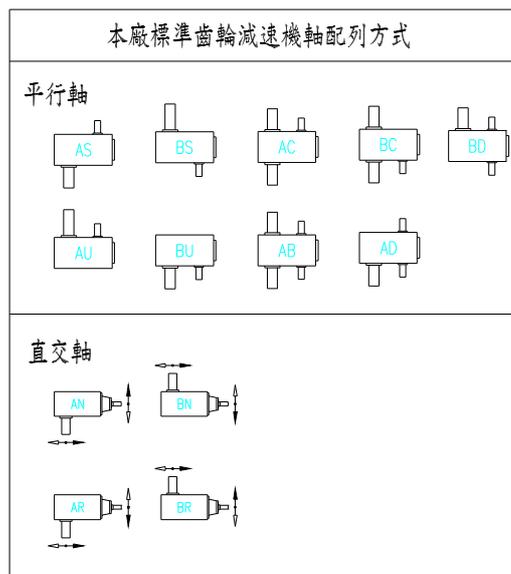
② Manufacturing Date: The first two digits is the year followed by the month.

Example below:

2005 Year 7 Month → 0507

③ Actual Ratio: Depending on the gear disposition as calculated ratio, this number will have a $\pm 3\%$ deflection error with the expected ratio

3. Make sure if the in and out power axle is the same as with what the customer has requested. Examples of axles are as follows:



Example of Axles

Installation of Gear Reducer

Installing the gear reducer

1. When hoisting, please use the hooks below the box or use the ring bolts.
(Do not hoist it on any other parts!)
2. When transferring the gear reducer, take note for any loose parts. If this happens, screw tighten it first before transferring.
3. When transferring, hoisting or moving the gear reducer, make sure that the area is clear of any person or objects as to prevent any injury in case if the gear reducer falls.

- Foundation

One should choose a rather sturdy and vibration free base, generally we would suggest using cast iron or steel structure as common foundation.

- Leveling

1. When using pads (or thin copper sheet) to adjust the level of the reducer, one should use the even portion pad on the lower part (located where the bolt is installed), and evenly screw tight on installation to prevent distortion of the body and centralize the stress.
2. Adjust the gear reducer level within 0.1mm/m deflection error. (adjust level with level, slanting pads)

- Alignment

Making good alignment work is the first step in assuring no breakdown during operation and prolongs the life of the machine. To accomplish the goal of alignment, Axial and radial deflection indicators should be well calibrated at the same time.

- Coupling

1. A person with good balance is needed and must not make added axial and radial stress on the gear reducer
2. When installing and disassembling of coupling, one should not use any sharp or heavy tools.
3. All kinds of coupling installation allow some errors as indicated on Drawing 1.

- Oil pump

1. For the oil pump of the motor, before starting the reducer, make sure if the direction of the motor is correct.
2. Flanged single – acting gear oil pump
For the Flanged single-acting gear oil pump of the gear axis, it can only have

one direction. There are some that can work in both direction, please refer to the PUMP type or PUMP as indicated on the index plate.

3. Suction Head

The suction head should not be more than 3m, the pipeline should as much as possible be short and with few bended curves.

- Oil cooler or Cooling Coil

The volume of water should be enough and cold, and the temperature of the water entering should not exceed 30°C

- Piping

Before piping it should be acid washed, after piping it should be washed to assure that the pipeline is clean. This has a big effect on the life of the gear and the bearing.

- Check and test instrument

1. The reducer may be checked by installing a pressure gauge, pressure switch, flowmeter or thermometer and other test instrument. This way these may show some warning during abnormal conditions.

2. The area to be installed should be free from vibration.

3. Interlock

Testing installation should be interlocking with the motor to prevent any kind of damage.

- Check the direction of rotation

The direction of rotation should depend on the direction as indicated by the gear.

Storage of Gear Reducer

- Always keep the gear reducer indoor. And keep it in a clean and dry place.
- Keep it in a place where temperature ranges from 0°C ~40°C .
- For prolonged storage, it is advised that a waterproof cloth be used to cover the reducer. This is to keep dust from accumulating or damage the oil seal or others.
- Before activating the gear reducer from prolonged storage, check it first for any loose parts or damage on the exterior. And another thing before starting the gear reducer, make sure that there is enough lubricant inside the gear reducer.

Operation Procedure of Gear Reducer

Operation of gear reducer

- Oil filling
 1. The table below indicates the proper lubricating oil viscosity specification with their temperature range:

Viscosity Designation Table

Low Speed Shaft RPM		Usage Temperature Range		
		-10°C ~+15°C	0°C ~+30°C	10°C ~+50°C
100 RPM 以上	ISO AGMA	VG68 2EP	VG150 4EP	VG220 5EP
100 RPM 以下	ISO AGMA	VG100 3EP	VG220 5EP	VG320 6EP

Note: ISO standard on viscosity at 40°C (mm²/s)

2. Suggested lubricant standard usage table as shown in Table 1.
3. Table below indicates the volume of lubricants used in different types of gear reducer for extruder

Lubricant volume needed on different types of gear reducer									
Gear reducer code			Lubricant volume			Gear reducer code		Lubricant volume	
TK-P2A	TK-P3A	TK-P4A	11L	12L	12L	TK-R3A		11L	
TK-P2B	TK-P3B	TK-P4B	16L	17L	18L	TK-R3B	TK-R4B	16L	16L
TK-P2C	TK-P3C	TK-P4C	24L	26L	28L	TK-R3C	TK-R4C	25L	25L
TK-P2D	TK-P3D	TK-P4D	37L	42L	43L	TK-R3D	TK-R4D	40L	40L
TK-P2E	TK-P3E	TK-P4E	55L	60L	62L	TK-R3E	TK-R4E	57L	57L
TK-P2F	TK-P3F	TK-P4F	79L	86L	90L	TK-R3F	TK-R4F	83L	83L
TK-P2G	TK-P3G	TK-P4G	120L	120L	150L	TK-R3G	TK-R4G	120L	120L
TK-P2H	TK-P3H	TK-P4H	140L	155L	180L	TK-R3H	TK-R4H	155L	155L
TK-P2I	TK-P3I	TK-P4I	205L	225L	260L	TK-R3I	TK-R4I	220L	220L
TK-P2J	TK-P3J	TK-P4J	290L	325L	365L	TK-R3J	TK-R4J	310L	310L

4. Make sure that the lubricant specification is correct. Add lubricant through the opening for lubricant filling. (Shown in Drawing 2)
 5. Some reducers have their own lubricant container together with the lubricating system supply, therefore, for gear box without liquid-o-meter or lubricant meter attached to it. There is no need to add lubricant
 6. Different lubricant specification should not be used at the same time
- Preliminary checks
 1. When reducer is not in use for some time, before start-up, check for the condition of erosion (erosion easily damages the gear and the bearing)

2. If there is stress factor, switch and appendix, make sure that installation is stable.
3. Check all installed bolts for proper tightness
4. Check the coupling, check if installation is stable.
5. Check the window lid, check if it is stable
6. Check all wirings and connections for any disconnection.
7. Check all pipeline connections. Check if installation is stable.
8. Check for the direction of rotation. Check if the gear direction the same as indicated on the casing.
9. Inspect the stress switch, temperature switch or other test instrument installed. Double check if everything is set on safe mode (For those with above mentioned instrument)
10. When setting the cooler or cooling coil, inspect the cold water system, double check if the water pressure and volume is enough.
11. Check the oil drainage for any clogging, make sure it is screwed tightly.
12. Check for any leakage of lubricant.

- Starting

1. For oil pump motor activation, first start the motor and check if the oil pressure is in normal condition.
2. For oil pump gear activation, unload before starting and check oil pressure for normal condition

- Break-in Running

1. When using it for the first time, the load should be portioned. First operate with 1/3 of the load for some hours. Then run it with 2/3 of the load for another few hours. If there is no problem, the whole load may be used. Proper adjustment may depend on the actual condition.
2. After running it for 50 hours, recheck for any loose bolts and connections and tighten it accordingly.
3. After running it for 2 weeks, coupling should be re-aligned.

- Check during operation

Items include:

1. Check the oil level
2. Make sure that the pipeline is clog free (Check for the pressure and volume, if it exceeds the normal operating range too much, please contact our company)
3. Check the lubricant temperature reading. Normal condition is below 70°C. Investigation is needed if the lubricant temperature reading rises abnormally during normal operation.

Maintenance and Testing

Maintenance

Important items for the maintenance of the gear reducer for extruder as follows:

1. Air Vent

Clean the air vent regularly with solvent, and always keep it clear from anything.

2. Filter

If there is a filter on the returning passageway of oil, it should be cleaned every week for the first few months of operation,

3. Oil change

After the first 300~500 hours of operation, clean the gear, gear casing and the bearing with the appropriate cleaning solvent and change the lubricant. After which, the next lubricant change will depend upon the level of impurity of the lubricant or any oxidation deterioration. One may also have a regular lubricant change schedule of changing lubricant for every 3000~5000 runtime hours to maintain the quality.

Trouble shooting

Lubricant passageway possible problems and their solution as shown on the table below:

Problem	Reason	Solution
Oil pump unable to suck oil	(1) Lubricant inside the gear box is too few (2) Leak on some part of the passageway (3) Clogged up filter (4) Oil pump leakage or oil loss	Add lubricant Find the leak and seal it Remove and clean Fill lubricant on the upper side of the pump and check the pump Not sealed well
Oil pressure too low	(1) Leakage on passageway (2) Damaged bearing of the pump (3) Damaged pump (4) Clogged up filter	Find the leakage and seal Replace the bearing of the pump Replace pump Clean

Note: If there are any other questions, please contact our company for advice.

Regular Maintenance

Daily, Weekly, Monthly Maintenance Schedule Items of the gear reducer for extruder are shown on the following Table 3.

Our valued customer, please practice the following to protect the gear reducer and to achieve normal operation

Handling of Abnormal Conditions

Abnormal conditions of the gear reducer for extruder do not only depend on maintenance and lubricant passageway system problem. Leakage, heating-up of casing, vibration, noise is also a common occurrence of abnormal conditions for the gear reducer. The possible reasons and its solution are shown on the table below:

Possible reasons and solutions of abnormal conditions of a gear reducer for extruder			
Abnormal condition	Possible reason	Solution	Remarks
Lubricant Leakage	<ul style="list-style-type: none"> a. Too much lubricant b. Damaged Oil seal c. Loose pipeline connection 	<ul style="list-style-type: none"> a. Follow the level of lubricant when adding as instructed in the manual b. Replace immediately c. Inspect various pipeline connections and lock tight 	
Heating-up of casing	<ul style="list-style-type: none"> a. Motor is too large, heat dissipation not enough b. Incorrect Lubricant specification c. Cooling system malfunction d. Not enough lubricant 	<ul style="list-style-type: none"> a. Must check if the safety factor of the gear reducer is enough, or if it is overloaded. Please contact our company for assistance. b. Replace it with a correct lubricant c. Check the oil passageway for any particles and clean the pipeline from clogging. d. Check if the lubricant level is low (refer to the manual) 	
Unusual Vibration	<ul style="list-style-type: none"> a. Damaged bearing b. Damaged bearing c. Motor too large d. Design Error 	<ul style="list-style-type: none"> a. Replace with a new one b. Replace with a new one (should reproduce one) c. Must check if the safety factor of the gear reducer is enough, or if it is overloaded. Please contact our company for assistance. d. Contact the company design personnel for assistance (if needed, send it back to the company for inspection) 	
Noise	<ul style="list-style-type: none"> a. Not enough lubricant b. Unwanted object inside the box c. Damaged bearing d. Damaged Gear e. Motor too large 	<ul style="list-style-type: none"> a. Check the lubricant level if enough (refer to the manual) b. Disassemble the gearbox, and check all bearings. Check for any foreign objects, clean and change the lubricant. c. Replace with a new one d. Replace with a new one (should reproduce one) e. Must check if the safety factor of the gear reducer is enough, or if it is overloaded. Please contact our company for assistance. 	

Disassembly and Assembly

When resolving any abnormal conditions of the gear reducer, sometimes we need to disassemble the gear reducer and replace it with some parts to resolve it. The gear reducer is composed of aside from the gear and gear axle, there is also the bearing, oil seal, pipeline cover, O shaped ring, the ring lock used by the axle and other parts. Before disassembly and assembly, refer to the diagrams of the gear reducer below first and understand the structure of the gear reducer. Take note of the different parts their position and specification to properly disassemble and assemble the gear reducer. Other important items are as follows:

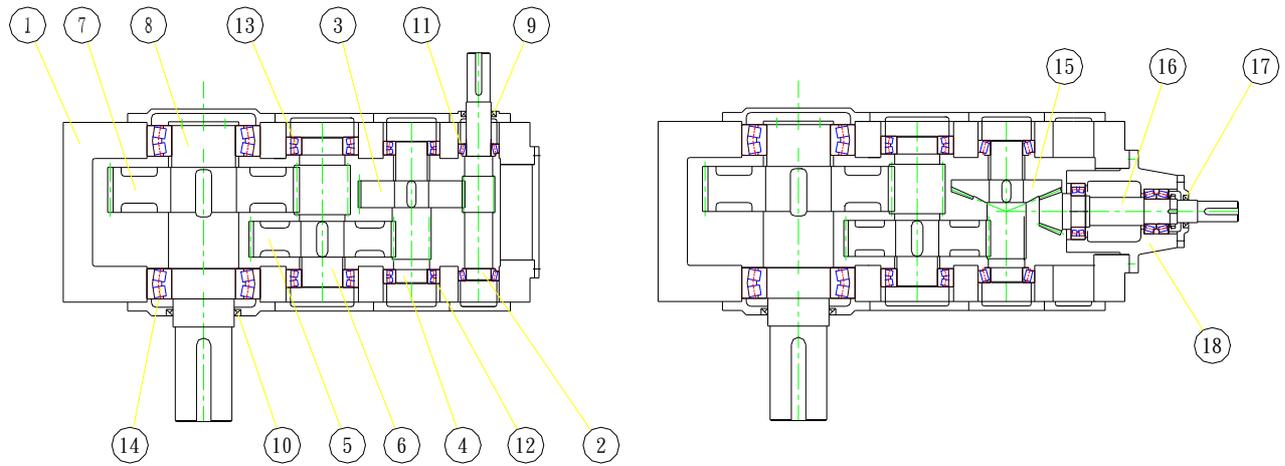
Disassembly

1. Before disassembly, read the instruction manual first and the repair maintenance diagram.
2. Remove the lubricants through the drainage.
3. Have the pipeline, safety gadgets and small particles removed outside the casing to prevent if from damage
4. Separate the passageway
5. Spacer measurements are not always the same, during disassembly, make some indications to prevent confusion.

Assembly

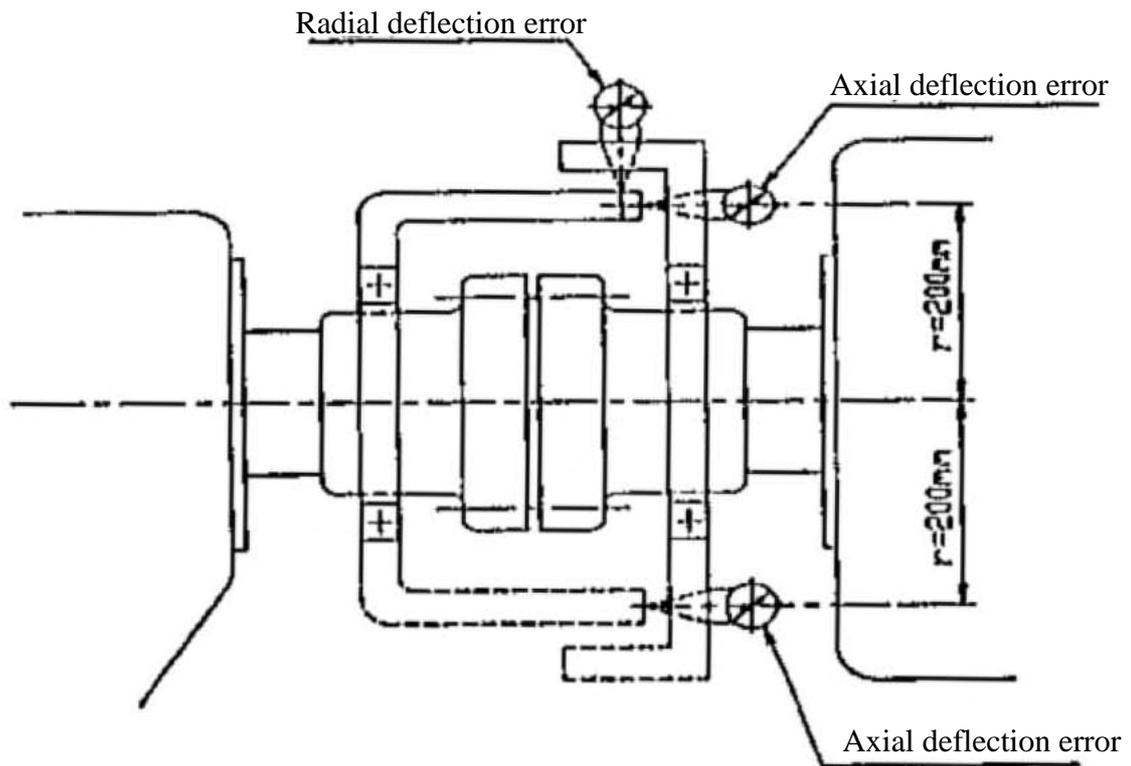
1. Check for any missing parts
2. During installation, as shown in the drawing, adjust the correct bearing endplay
3. During operation, check the surface of the gear teeth for contact pattern
4. As shown in the drawing, tighten up all the bolts and attain the proper tightening strength as indicated in table 4.

Structural Diagram



Item No.	Item Name	Item No.	Item Name
1	Gear Casing	8	Output Axle
2	Input Power Axle	9	Oil Seal
3	Diagonal Gear	10	Oil Seal
4	Gear Axle	11	Bearing
5	Diagonal Gear	12	Bearing
6	Gear Axle	13	Bearing
7	Diagonal Gear	14	Bearing
15	Bevel gear	16	Bevel gear shaft
17	Oil Seal	18	Bearing housing

Drawing 1



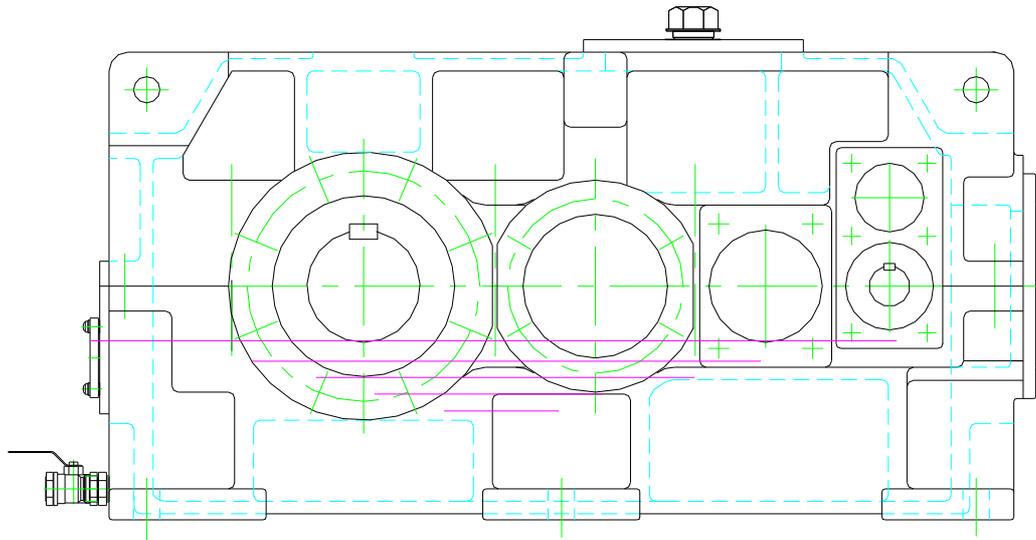
Drawing 1 Coupling Alignment

Allowable deflection error Table

Coupling Type	Radial direction deflection error	Axial direction deflection error
Rigid coupling	0.03mm	0.02mm
Gear coupling	0.05mm	0.05mm
Flexible coupling	0.10mm	0.10mm

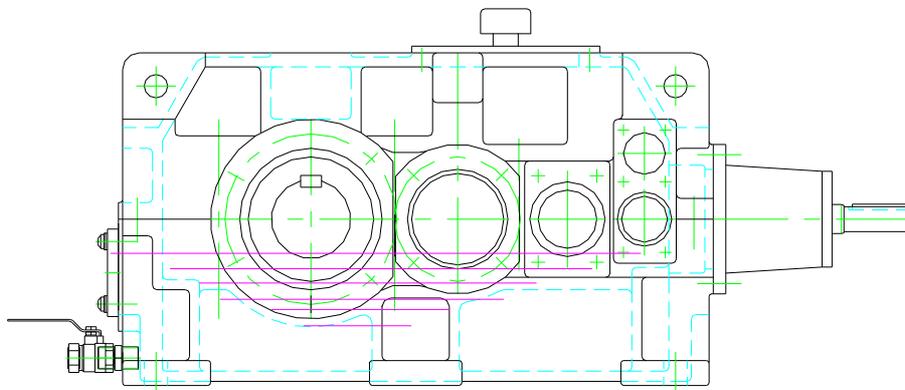
※ The allowable deflection error table above is radius value. It has no relation to the radius measurement. When using, depending on the radius measurement according to the proportion when enlarging or reducing the radial direction error.

Drawing 2



平行軸配列方式油位示意圖

Parallel shaft type Oil level assembly method Schematic diagram



直角軸配列方式油位示意圖

Right-angle shaft Oil level assembly method Schematic diagram

Table 1 : Suggested Lubricant Standard Usage Table

Brand Name	Mineral oil				
mm ² /s/40°C (CST)	ISO VG68 AGMA 2EP	ISO VG100 AGMA 3EP	ISO VG150 AGMA 4EP	ISO VG220 AGMA 5EP	ISO VG320 AGMA 6EP
ARAL	DEGOL BG68	DEGOL BG100	DEGOL BG150	DEGOL BG220	DEGOL BG320
BP	ENERGOL GR-XP-68	ENERGOL GR-XP-100	ENERGOL GR-XP-150	ENERGOL GR-XP-220	ENERGOL GR-XP-320
CASTROL	ALPHA SP68	ALPHA SP100	ALPHA SP150	ALPHA SP220	ALPHA SP320
ESSO	SPARTAN EP68	SPARTAN EP100	SPARTAN EP150	SPARTAN EP220	SPARTAN EP320
FINA	GIRAN 68	GIRAN 100	GIRAN 150	GIRAN 220	GIRAN 320
MOBIL	MOBILGEAR 626	MOBILGEAR 627	MOBILGEAR 629	MOBILGEAR 630	MOBILGEAR 632
SHELL	OMALA 68	OMALA 100	OMALA 150	OMALA 220	OMALA 320
TOTAL	CARTER EP68	CARTER EP100	CARTER EP150	CARTER EP220	CARTER EP320N
CHINA. PETROLEUM COR.(CPC)	HD 68	HD 100	HD 150	HD 220	HD 320
IDEMITSU	DAPHNE SUPER GEAR 68	DAPHNE SUPER GEAR 100	DAPHNE SUPER GEAR 150	DAPHNE SUPER GEAR 220	DAPHNE SUPER GEAR 320

Important Items:

- (1) Room temperature at 10°C~40°C
- (2) When room temperature is at extreme high (or extreme low), please contact the company to determine the suitable oil viscosity.
- (3) Oil temperature an handle sudden temperature change up to 120°C , Common oil temperature usage is at around 80°C . If used at 100°C , oil changing should be frequent.
- (4) If there is any further question, please contact our design department

Table 2 : Suggested Grease for Reducer Machine

Brand Name	Grease used in Gear	Grease used in Bearings
ARAL	Aralub FD 00 FDP 00	Aralub HL 3
BP	Energrease HT 0 HT-EP 00	Energrease LS 3 LS 3 LS EP 2
ESSO	Fibrax EP 370	Beacon 3 Beacon EP 2
MOBIL	Mobilplex 44 Gargoyle Fett 1200 W	Mobilplex 48 Mobilux 2
SHELL	Simnia 0 Shell-Spezial Getriebefett H Shell Grease S.3655	Alvania R2 Alvania EP2
KUO KUANG PAI		All purpose grease NO.2 High pressure grease NO.2

Remarks:

- (1) Different brand name or specifications of grease should not be used at the same time
- (2) It is suggested to use the lithium base grease when using grease in bearing. The specification matches the NLGI rank 2-3.

Table 3 : Maintenance Timetable

Maintenance Time Interval	Items for Inspection	Solution to the problem
Daily	Oil Leakage Noise Lubricating system oil pressure Overheat	If any one of the items occurred, slowly stop the machine for inspection. Find out where the problem is and resolve it. If there is any change in the reading, stop the machine for inspection. Find out where the problem is and resolve it.
Weekly	Oil level	If needed add oil
Monthly	Clean the Filter	
Every two to three months	Visual inspection and send to chemical examination and analysis for solution Lubricants deterioration level Clean the air vent and the filter Check testing instrument, electronics and control Add grease	Change oil if needed
For every 3000 to 5000 hours of operation	If the above mentioned lubricant inspection schedule is not practiced, Then lubricant should be changed during examination and analysis	
Yearly	Check gear and bearing abrasion condition	

Table 4 : Bolts Tightening Torque

Bolt Class	4.8	8.8	10.9	12.9	4.8	8.8	10.9	12.9
Bolt Specification	TENSION FORCE (KN)				TIGHTENING TORQUE (N-m)			
M10	10.0	26.6	37.3	44.8	16.9	45.1	62.8	75.5
M12	14.5	38.7	54.4	65.5	29.4	78.5	108	132
M14	19.9	53.0	74.6	89.6	46.1	123	177	211
M16	27.6	73.6	103	124	71.6	191	270	324
M18	33.3	88.8	125	150	99.4	265	383	446
M20	43.1	115	161	193	142	378	530	638
M22	53.3	142	201	240	188	500	706	853
M24	62.3	166	232	279	243	647	912	1079
M27	81.4	217	305	367	360	961	1373	1619
M30	99.0	264	372	445	497	1324	1815	2207
M36	115	307	542	651	868	2315	3247	3904
M42	200	532	748	897	1391	3708	5209	6259
M48	262	699	986	1182	2097	5592	7868	9447

Note: Bolts needs lubrication, friction factor $\mu=0.125$