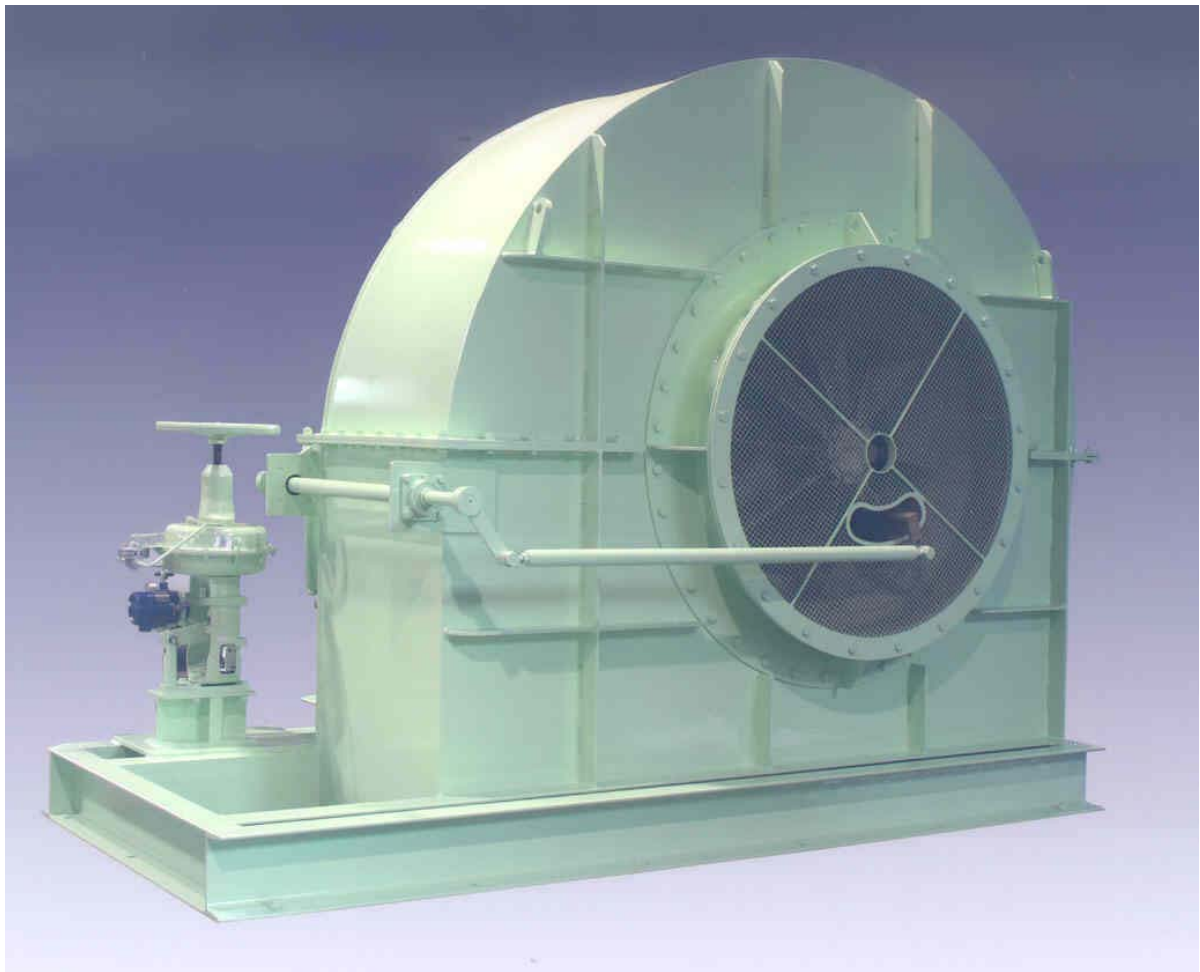


OPERATING & MAINTENANCE OF INSTRUCTION MANUAL FOR F.D FAN



HYUNDAI MARINE MACHINERY CO., LTD.

現代船機株式會社



ADDRESS : 602-15, GAJWA-DONG, SEO-GU, INCHEON CITY, KOREA

TEL : +82-32-583-0671 / Fax : +82-32-583-0674

URL : <http://www.hmmco.co.kr>

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1. OPERATION MANUAL

1-1 Cautions prior to Operation

Treatment, transportation, installation, operation, and maintenance of the all devices should be performed carefully in the right sequence.

When disassembling and inspecting the fan, no one except the related personnels should be admitted, since rotating the impeller by hands can cause injuries.

1) Make sure that every part is thoroughly equipped, clear around the machine, and make sure that there is no foreign matter around the inlet opening or in the suction line piping.

2) Confirm that the power source is normal.

3) Lubricating Oil

Inspect the bearing grease. Excessive filling of grease will cause excessive heat in bearings. The amount of grease required for the lubrication of bearing is sufficient when filled and approximately 1/3 for in the bearing case.

If the pillow type inlet is applied, with Shell Alvania grease No. 2 or Equivalent is already filled, there is no need for further feeding.

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4) Turning by Hand

Make sure there is no unreasonable or forced arrangement in the suction and discharge of ducts or air leakage. Also make sure there are no remainders of material used during installation work. After confirming no irregularity, turn the blower by hand to check abnormal contact in the interior.

5) In case of V-Belt transmission

Even though belt tension and alignment are set before shipping, the alignment and tension can be checked at site before starting as follows :

- * Alignment between both grooved pulleys for V-belts is to be checked either by applying a stretch to the side of both pulleys or by stretching a thread. Adjustment is to be made accordingly by moving the motor body on the slide base.
- * Belt tension can also be adjusted by moving motor slide base back or forward. Care is to be taken to ensure against whirling of overtightness of the belts. As a reference for normal belt tension, 15mm per 1m of span length of deflection is appropriate when 1.5kg for A type, 3kg for B type, 5kg for C type or 10kg for D type is applying on the middle of belt span.

6) Starting

Start the blower with the air control damper closed. Sudden increase of speed should be prohibited. Check the bearing, noise in the casing inside, vibration and temperature, then increase the speed gradually to the speed.

1-2 Start-Up

During the start-up of the trial operation, the bearing temperature, vibration and contact with the rotating member require special attention.

- 1) Check the direction of rotation of the fan.
- 2) Carefully observe the variation of the current during the start, and if any abnormality is found, immediately stop the motor.
- 3) Pay attention the vibration and sound during the start. If any abnormality is noticed, stop the fan to check for causes.
Since the abnormal vibration of casing is usually caused by the seal packing at the center of boss insertion touching the boss strongly, recheck them.
- 4) While carefully observing the variation of the current, gradually adjust the opening of the suction and/or discharge valve to set the current predetermined value.
- 5) If the operation condition is smooth thus far, the bearing temperature becomes constant after half an hour to an hour. Therefore, operate the fan at least for one hour to check the operational condition such as the bearing temperature and vibration.
In case of the rapid temperature rise of the motor, check the followings.
 - ① Check whether there is any flaw or crack on the outer and inner wheel or driving part.
 - ② Check whether the packing materials are in strong contact with the boss.

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1-3 Operation

1) Damper Control

After the machine attains full speed, operating the air control damper closed for a long time incurs danger, because the accumulation of compressed heat within the blower casing may cause heat distortion. Therefore as soon as full speed is reached, when using discharge damper, the air control damper needs to be opened with a minimum amount of air quantity so that surging phenomenon may not occur. Then loading can be successfully increased gradually.

When using the suction damper, there is no fear for surging. Control the damper by watching the ammeter of the motor to make that the motor doesn't overload. Confirm at this time that the motor ampere is below the rated value.

2) Temperature of the Bearing

Confirm the circulation of oil after full speed has been attained and measure the temperature increase in bearing. This should be under 40°C and the bearing temperature should be kept under 70°C under any condition.

The temperature will become constant after one hour from starting.

It is considered safe if you can keep your palm on the bearing for more than 10 seconds. For the blower which is provided with a gland, pay attention so as not to tighten the gland unbalancedly. Then, operate the motor for a moment to ascertain the revolving direction and inner contact.

If the bearing temperature is 70°C or below, it is normal, however, should the temperature exceed that value, carry out an inspection of oil, bearings and the shaft alignment.

(Refer to the paragraph under Inspection and Maintenance.)

Damage in the bearing or oil shortage causes a small metallic noise.

3) Treatment of Gases of other Temperature than Normal

In the case where the gas has a smaller specific gravity than that of a normal temperature air treated under normal temperature, it sometimes develops an overload.

Pay attention not to commit such an irregularity.

4) Surging

When the fan is operating in the ranges between A and B in Fig. 1, a backward flow is generated among the vanes of the fan and this in turn generates periodic pulsation in the flow. Metallic sound is due to this phenomenon. Since the casing itself will vibrate dangerously, avoid operation in the ranges between A and B.

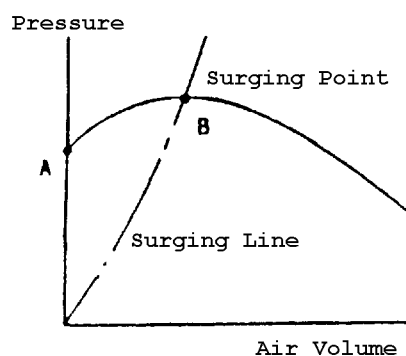


Fig.1 Surging Area

5) Measurement of the Bearing Vibration

Measure the bearing vibration and its amplitude of the fan at the centermost position of each bearing horizontally, vertically and in an axial direction. Use 1/1000 mm as the unit, and express the vibration in total amplitude. Check the reading of the instrument whether it is in half amplitude or in total amplitude.

For everyday inspection, touching by hand may be applied. However, when the

For everyday inspection, touching by hand may be applied. However, when the vibration becomes big, measure it with a vibration gauge. If it exceeds the permissible value of the bearing vibration, stop operation without delay to inspect and adjust.

When vibration starts and keeps of going, it becomes impossible to operate continuously.

Therefore the imbalance should be rectified immediately.

For a reference for permissible vibration, Fig 2 can be used as a guide.

e.g. the limit of permissible vibration is $165\text{ }\mu\text{m}$ with 1750 rpm.

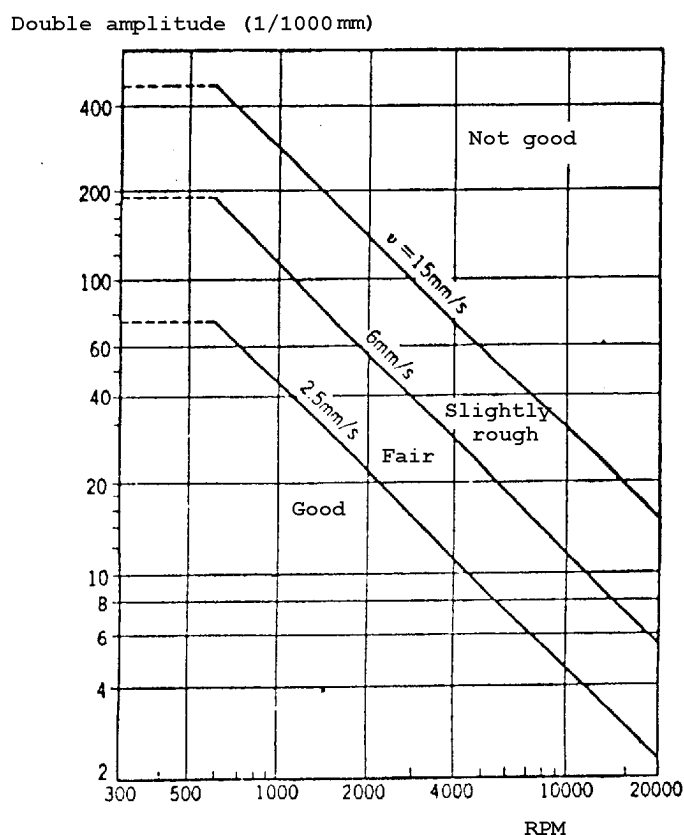


Fig. 2 Vibration Tolerance

1-4 Stopping & Shut Down

After the complete closing of air control damper, stop the main electric motor. Make sure that any abnormal sound is not heard, and that the drop of the number of revolution is not abnormally fast until the rotor is completely stopped.

For a shut down of a long period, drain thoroughly the water such as the cooling water in the bearing housing every part, and also the machine thoroughly. Coat the finished faces of each section of the machine with appropriate corrosion inhibitor. Provide cover over the necessary places to prevent dust, rain, etc., settling in the machine.

Pay special attention to the motor.

2. MAINTENANCE MANUAL

It is important to perform regular maintenance according the right plan for the long life expectancy and the safe operation. Although basic maintenance items are the lubrication and cleaning of the bearing, and regular vibration checking, frequent measurement of the discharge pressure, air temperature, current, and etc can prevent the accidents in advance, since the operation of the fan in worse conditions than specified conditions can causes the accidents. Since the operating conditions or surroundings other than designed specifications can affect the performance of the fan, adjust the operating conditions and perform the regular check-up as early as possible after the first operation.

2-1 Daily Check Points

Pay attention to the following points everyday and carry out the inspection of the blower.

- 1) Is there any abnormal noise ?
- 2) Are the bearing temperature and vibration normal ?
- 3) Is the value shown by the ammeter normal ?
- 4) Is the V-belt correctly aligned and properly stretched ?
- 5) Is the oil quantity proper when using oil bath or oil ring lubrication ?
(Check by means of oil level gauge.)

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2-2 Suspension of Operation

- 1) When the operation of the fan is to be suspended, pay much attention in cleaning, rust prevention of the blower, and be cautious in preventing dust, dirt and water getting into bearings.
- 2) Pay attention to prevent humidity against all electrical parts such as the motor and other parts.
- 3) Remove water completely from the bearing cooling water piping and bearing cases.

2-3 Periodical Inspection

Carry out periodical inspection at least once a year, and inspect the following items:

- 1) Clean disassembled parts thoroughly.
- 2) Replace lubricating oil (or grease) with fresh ones
- 3) Examine the contacting surfaces of the rotating elements and the static sections.
- 4) Examine the condition of play at fitting sections.
- 5) Recheck the alignment.

● Regular check point table ●

Item	Description	Period		Cleaning	Repair	Exchange
		6 months	12 months			
CASING	(1) Foreign substance	○		○		
	(2) Corrosion and wear		○	○	○	
	(3) Stagnant drainage	○		○	○	
	(4) Loosened bolts		○		○	
	(5) Damaged packings		○		○	
IMPELLER	(1) Dust attachment	○		○		
	(2) Corrosion and wear		○		○	○
	(3) Deformation and side plate cone contact		○		○	○
	(4) Loosened bolts & nuts for the attachment of the hub to the mainplate		○		○	
	(5) Unbalance	○		○	○	
INLET DAMPER	(1) Corrosion		○		○	
	(2) Dust attachment		○	○		
	(3) Ease of open / close operation		○	○		

2-4 Operation Diary

Inasmuch as the operation diary is the data for making a diagnosis of the fan, keep a meticulous entry for present and future reference. If the operating record is kept, it is possible to find abnormality in the early stage, and even if trouble occurs, it is easy to find the cause of trouble.

2-5 Causes of Troubles and Their Countermeasures

Even under the strictest observation, there may be a discrepancy the operator may have never expected, which may lead to trouble. We will find out its causes and take proper countermeasure for you provided that you supply us with history of operation since the beginning and current situation of the problem.

See Table 1 where causes of troubles and their countermeasure are listed.

Table 1. Causes of Troubles & Their Countermeasures

Troubles	Causes	Inspection Point	Countermeasures
High Bearing Temperature	1. Surplus or short filling of grease	Bearing	Make the filling quantity proper
	2. Defective fitting of inner ring of roller bearing and shaft	Bearing & Shaft	Adjust shaft
	3. Defective fitting of outer ring of roller bearing and shaft	Bearing & Shaft	Replace bearing case
	4. Damage of roller bearing	Bearing	Replace bearing
	5. Oil deterioration or water blend	Bearing	Replacement or regeneration of oil
	6. Excessively small clearance of metal	Metal	Machining for adjustment
	7. Cooling water for bearing is short	B'rg Housing & Piping	Add cooling water
	8. Defective turn of oil ring	B'rg Housing	Repair or replacement

Troubles	Causes	Inspection Point	Countermeasures
High Bearing Temperature	9. Overheat of bearing 10. Defective alignment of coupling 11. Excessive tightening of V-belt 12. Vibration	Coupling V-belt Bearing	Replacement of Metal Additional tightening of bolts and nuts Correct the tension Refer to "Vibration"
Excessive Vibration	1. Unbalance of impeller 2. Defective fitting of impeller boss and shaft 3. Unbalance of shaft coupling 4. Bending of shaft 5. Defective centering 6. Excessively large clearance in metal 7. Contact of rotor and Casing 8. Abnormal contact of gland packing 9. Defective foundation 10. Defective tightening of fitting belts 11. Surging 12. Concurrence with critical speed	Rotor Rotor Coupling Shaft Coupling B'rg Housing Casing interior Gland packing Common bed V-belt	Correct balance & clean adhered matters Replace boss or shaft Replacement of coupling & check alignment Repair or replacement Repair Repair or replacement Re-installation of casing Repair Reinforcement of foundation Additional tightening of bolts and nuts
Abnormal Noise	1. Contact with static section 2. Existence of foreign matter 3. Damage of roller bearing	Bearing	Alter the position of oil thrower collar, adjust the contact of impeller & suction cone. Remove foreign matter Overhaul inspection

Troubles	Causes	Inspection Point	Countermeasures
Abnormal Noise	4. Vane control device 5. Damper		Inspection of lever and connecting rod, inspection of wear of the pin of sliding ring Inspection of the play between lever and connecting rod.
Deterioration in performance	1. Drop in rpm, drop in power cycle 2. Reverse revolution 3. Adherence of foreign matters to impeller, wear and corrosion 4. Clogging of suction filter 5. Defective opening / closing of suction & discharge valves 6. Accumulation of dust in casing duct 7. Leakage through drain hole & other sections 8. Difference in the gas specific gravity 9. Excessively large actual resistance		Adjustment required Change the motor wiring Cleaning, repair or replacement Repair Repair Cleaning Repair Measurement of the specific gravity of gas and analysis of gas Planing of gas booster replacement of impeller
Vane control device	1. Rusting of sliding ring 2. Rusting of lever pin		Disassemble, feed grease and repair Disassemble, feed grease and repair

Troubles	Causes	Inspection Point	Countermeasures
Suction damper	1. Rusting of lever 2. Rusting of bearing 3. Contacting of blades		Disassemble, feed grease and repair Disassemble, feed grease and repair Repair the distortion of blades, inspect its contact duct

3. DISSEMBLY AND REPAIR

3-1. Precaution when dissembling

- 1) The inner structure of the fan and the dissembling procedure should be well identified through sectional drawings before dissembling, and for the easy reassembly later, match marks should be recorded.
- 2) Take good care of the dissembled parts not to be damaged, and wrap them with vinyl cover not to be attached by water, dust and sand.
- 3) Record the installation dimension for the fan and clearance dimension of the inlet cone for the later reassembly.
- 4) Perform regular maintenance job to each part. Foregoing consideration concerning the treatment method can make reassembly procedure faster.

3-2. Precautions when reassembling.

- 1) Assembly procedure is the reverse of the disassembly procedure, and match mark should be always confirmed before assembling.
- 2) If there is damage, color change, or scratch of paint, repaint the rust resisting paint.
- 3) Packing material should be inserted into the contact surface of the casing for the sealing purpose.
- 4) Check loosened bolts, and tighten them if any. Paint the bolts and nuts with the rust resisting paint.

5) After assembling parts, check whether any part remains, and measure the clearance dimension between the impeller and the suction cone. Check the operation by manual rotation, and perform the test operation.

6) The test operation should be performed before the real operation.

3-3. Checking the impeller

1) If the impeller is damaged by corrosion, wear, or dust attachment, it causes the unbalance, which becomes the source of the abnormal vibration.

Therefore, the impeller should be checked regularly. In case of the abnormal vibration due to the foreign matter attachment, attached matter should be cleaned completely, but in case of the corrosion or wear, it should be repaired or exchanged. Since the repair or balance weight welding can cause cracks on the materials, it should be performed by an expert.

2) When assembling the impeller to the shaft, paint the overheating resisting paint on the shaft surface where the hub is inserted on, and apply 125~135°C heat to the impeller hub surface by the burner or its equivalent, and insert the hub to the shaft until the stop of the shaft with the consideration of the key and the groove. Check whether there is any gap between the shaft's stop and the hub. After assembling, fit the nuts, and tighten the set after the hub is cooled down.

4. SECTIONAL DWG. OF F.D FAN

