Research on the Troubleshooting of "Yanmar 6EY26L" Diesel Generator

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ABSTRACT: The Flying Accident of marine generator is not common. If the flying accident happens in the power grid, it will easily cause the whole ship power loss and engine damage, which will have a great influence on the safe navigation of ships. This paper analyzes and probes into the causes of the flying car accident occurred in 2019 in a round of "Yanmar 6EY26L" type diesel generator, and expounds the correct treatment measures for the flying car according to the treatment methods of the ships, finally, the daily management method of ship diesel generator, the precautions and preventive measures during diesel generator start-up are put forward in order to avoid similar accidents.

1. Introduction
Diesel engine galloping refers to the phenomenon of losing control of the speed, exceeding the rated speed greatly, the engine vibrates violently, making a roaring sound and emitting a lot of black or blue smoke from the exhaust pipe [1]. Flying cars not only damage parts and components, but also may endanger the personal safety of on-site personnel, should cause the engineer's high attention. The definition, cause and harm of diesel engine flying.

Definition, causes and hazards of diesel-driven vehicles
(1) The definition of diesel engine flying
Because the diesel engine load changes frequently, which requires the governor to constantly adjust the fuel supply according to the diesel engine load change, diesel engine can not reduce the fuel supply in time for some reason, it will cause the diesel engine speed out of control, sharply increased to much more than the rated speed, and accompanied by severe vibration and constant noise, that is, diesel engine "flying car".

(2) Reasons for diesel engine speeding. The basic reasons for diesel engine speeding can be divided into the following four categories:

1. The fuel supply quantity is too large; the fuel supply quantity is too large mainly because the fuel supply quantity is too large at the moment when the diesel engine starts or runs, thus causing the diesel engine to fly, fly, diesel exhaust pipe will emit a large number of black smoke, the general method is to cut off the fuel supply pipe or the throttle pull rod system "stop" position, so that the throttle rack to zero, forced to cut off the high-pressure oil pump fuel supply system.

2. The failure of the over-speed protection device is caused by the damage of the spring in the over-speed protection device, which causes the quick loss of the spring tension, the quick push of the clamping claw, the pulling claw from the guiding drum, and the action of the guiding drum causes the overspeed of the diesel engine.
3. Governor internal fault, governor failure is usually due to the governor internal valve failure to increase the oil pressure to increase the governor throttle so as to force the main engine throttle rack also increased, resulting in the main engine over-speed stop [3].

4. When the Cylinder Combustion Chamber Burns Lubricating Oil, a large amount of blue smoke will be emitted from the exhaust pipe. If cutting the fuel supply pipe at this time can not be effectively stopped, so you have to cut the Compressed air and relieve the pressure at the same time to keep it from happening.

(3) the harm of diesel engine flying car, the harm of diesel engine flying car is embodied in the following aspects:

1. As the speed of the diesel engine increases, the heat generated by the friction of the components increases sharply, and the original heat dissipation law is destroyed, resulting in serious stripping, burning or melting of the bearings, the main journal and connecting Rod Journal of the crankshaft and the camshaft journal will also be severely damaged.

2. As the speed of the diesel engine exceeds the limit, the rocker arm, cross arm, valve spring and other parts in the valve train will lose their original movement regularity, thus leading to the fracture of the parts concerned. Because of the disturbance of the Movement Law of Inlet, Exhaust Valve and Piston, the movement track of Air Valve and Piston intersects each other.

3. Overspeed operation will lead to the deterioration of the combustion process, a large number of exhaust pipe smoke, exhaust temperature rise, supercharger overspeed.

4. If the diesel engine flying time is too long, may also make camshaft drive gear misalignment and camshaft bending, resulting in fuel injection timing disorder.

5. If the diesel engine can not stop in time with effective methods, it will cause great property loss and even casualties. After the accident treatment, before starting the generator again, the fuel injection timing and fuel supply should be readjusted to ensure the correct fuel supply. Therefore, it is very necessary to analyze the cause of diesel engine "flying car" and take effective preventive measures.

2. The cause of the generator runaway accident and its analysis and handling

(1) The cause of the accident: due to the weak sense of duty of the on-duty crew and the on-duty three-pipe engineer, the oil level of the DO (diesel) daily tank of the generator was too low for a ship sailing in heavy winds and waves, due to excessive shaking of the oil tank, the bottom of the oil tank was turned over. The bottom-turning of the oil tank is due to the low oil level, which does not have enough pressure to hold the oil sludge and oil residue deposited at the bottom of the oil tank, making a large amount of oil sludge and oil residue floating in the motor fuel, resulting in serious blockage of the motor fuel filter, in order to maintain the rotation speed of the No. 1 and No. 2 generators in operation, the throttle of the No. 2 generator was automatically pulled too far, resulting in the throttle lever of the diesel engine being stuck in the maximum position of the throttle, cause 2 # generator to run continuously (rated speed is 720RPM, measured 900RPM, about 3.8 minutes). 2 # dynamotor speed is too high, diesel engine load capacity is greatly improved, 1# dynamotor load is automatically transferred to 2 # dynamotor, resulting in 1 # dynamotor no load and automatic power trip, caused the serious accident of 2 # generator carrying the full load of the ship. 2 # The emergency stop button, the throttle lever and the fuel pump were shut down and the fuel inlet valve was shut off, which caused the power loss of the ship. 1 # generator after automatic power failure due to serious filter blockage, about 5 minutes after the automatic shutdown. It caused the ship to lose power for nearly 30 minutes during the rough sea voyage, which at one time was considered highly dangerous. After nearly 23 minutes of emergency treatment, DO daily tank barge oil to 70% of the oil level, after cleaning 1 # , 2 # generator fuel filter and fuel pipeline drain clean, in the absence of a comprehensive inspection of the diesel generator components, hastily start 1 # , 2 # generators, re-integration into the power grid, found 2 # generators No.3, No. 4 exhaust temperature meter damaged, No. 1, No. 2, No. 5 cylinder exhaust temperature up to 436 °C, 462 °C, 458 °C, normal operating temperature around 330 °C. The following table shows the exhaust temperature of each cylinder when the diesel engine is in normal operation and when the diesel engine is flying:


2 # diesel generator after a serious failure can not normal use, can only start 3 # backup generator, after normal test operation, the 2 # generator was put into the power grid. After load transfer, power off and shutdown, the 2 # generator was thoroughly checked and the damaged parts and components of the 2 # diesel generator were found as follows: 1. All 6 cylinders Exhaust Valve tappet bent deformation, No. 1, No. 2, No. 5 Cylinder Exhaust Valve have obvious ablation phenomenon, No. 2, No. 3 and No. 4 Cylinder Inlet Valve Tappet bent deformation; < URL > . 2 generator timing misalignment (scale gears stagger 1.8 grid teeth) ; 4. No. 2, No. 3 and No. 6 cylinders rocker arm valve plug disengaged, valve clearance adjusting bolt damaged; 5. Each cylinder camshaft and Roller Eye has drag marks; 6. All 6 cylinders have valve knock marks on top of piston head; < URL > . 3, No. 6 cylinder connecting Rod has obvious Bend Deformation; 8. No. 1, No. 5 and No. 4 Crank Upper Bush has pull marks. (2) analysis and treatment: due to the low oil level of the daily oil tank of the diesel generator DO, the daily oil tank of the generator will turn over, causing the No. 2 generator to drive for 3.8 minutes continuously, causing damage to some parts and components of the diesel engine; The equipment damage was aggravated by the second start-up and load operation. Rushing to restart the diesel generator without a thorough inspection, test and commissioning of the site, and rushing to integrate the diesel generator into the grid under load without a thorough inspection after the generator starts up and operates, it was a serious technical accident; the diesel generator caused a total loss of power, mainly due to improper management and operation of the crew. The main performance in: 1. The crew on duty and the three on duty on duty shift technology is not good, the sense of responsibility is not strong, did not realize that the ship in the wind and waves, diesel generator oil tank level is too low will cause.

The overspeed operation of the diesel engine will lead to the deterioration of the combustion process, which will lead to each cylinder working under excessive heat load and mechanical load, and the average indicated pressure of each cylinder greatly exceeds the normal service pressure, the average indicating pressure Pi can be easily obtained from the measured p-V indicator diagram. The methods are as follows:

(1) area method

The area of the indicator diagram is f (mm²), the length of the indicator diagram is l (mm), and the average height of the indicator diagram is hi = f/l (mm), then the average indicating pressure is:

$$p_i = \frac{h_i}{M} \text{(MPA)}$$  \hspace{1cm} (1)

The formula is as follows: the proportion of the working spring (i.e. the proportion of the vertical coordinates of the p-V indicator, indicated on the working spring), MM/MPA.

(2) bisection

If the area meter is not used, Pi can also be obtained by drawing the P-V indicator diagram. See figure 1-1-1. Divide the length L of indicator diagram into 10 equal parts, measure the height of indicator diagram y 1, Y 2, Y 3... Y 9(mm) at each dividing point, and attach two indicator Diagram Heights y 0 and y 10 at the distance of top and bottom dead center l/40, average height of indicator chart. as in [4]:

$$h_i = \frac{1}{10} \left( \frac{y_0 + y_1 + y_2 + \cdots + y_9}{2} \right) \text{(mm)}$$  \hspace{1cm} (2)

The resulting hi is accurate enough. The range of the average indicated pressure Pi of the Reciprocating diesel engines under calibration conditions is shown in table II.
Table II. PI,PE VALUE STATISTICAL TABLE

| Type of aircraft                | $p_i$ | $p_e$ |
|--------------------------------|-------|-------|
| Four-stroke, unpressurized     | 0.75–1.1 | 0.60–0.9 |
| Four-stroke, supercharged      | 0.95–3.0 | 0.8–2.5 |

Figure 1. Plotting of indicator diagram

Indicating Power $N_i$ indicating power refers to the indicating work done by the working medium in the cylinder of the diesel engine pushing the Piston in a unit time. The indicated work for each cylinder and working cycle of a diesel engine is

$$L_i = \frac{\pi D^2}{4} p_i S = p_i V_S \quad (J) \quad (3)$$

The indicated power of one cylinder of the diesel engine is $N_{i1}$

$$N_{i1} = \frac{p_i V_S n \tau}{60} \quad (N \cdot m/s) \quad (4)$$

Therefore, the general formula of indicating power for the whole diesel engine is

$$N_i = \frac{p_i V_S n \tau}{60000} \quad (kW) \quad (5)$$

Among them: average indicated pressure, PA or N/m²; working volume of Cylinder, m³; speed of diesel engine, R/min; number of working stroke, four-stroke engine = 1/2, two-stroke engine = 1; It is often necessary to measure the indicator diagram and calculate the power of the diesel engine on board. C = VS/60000, C is called the cylinder constant for a given value of VS and for the sake of reducing double counting. In this way, the formula of indicating power for the whole diesel engine can be simplified to

$$N_i = C p n i \quad (kW) \quad (6)$$

If the output power of each cylinder is not uniform, the indicator diagram should be measured in one cylinder, and $N_{i1}$ should be obtained respectively.

In recent years, the ship is less equipped with generators, many crew members are not familiar with the characteristics of this type of machine, so the competent personnel (two pipe round) to carefully read equipment specifications, strengthen equipment maintenance, try to avoid human failure.

3. How to handle diesel generator

The marine engine operation and management personnel must install, maintain and debug the fuel injection pump, governor and other devices strictly in accordance with the technical requirements of the diesel engine specifications, the lubricating oil used in diesel engine must be of good quality. When the diesel engine once appears the phenomenon of flying cars, the operator must not panic, should immediately take the corresponding correct treatment method, causes the diesel engine rapid stop rotation, otherwise, when the speed of diesel engine increases to a certain extent, it will cause damage to the operator and the safety of the ship will cause irreparable property loss. Then our operators in the actual operation if there is flying car should be the following emergency handling operations.

(1) Quickly pull the diesel generator lever to the stop handle position so that it is in the stop position.

(2) Shut off the gas supply pipe of the diesel engine immediately to prevent the outside air from entering the cylinder, which can cause the diesel engine to stop the combustion of fuel automatically due to lack of oxygen.
(3) If the engine has a pressure-relief device, the pressure-relief handle can be quickly pulled to the pressure-relief position to slow down the engine speed, in order to take other emergency measures to buy time.

(4) Stop the fuel supply pump, cut off the fuel line and shut off all fuel supply to the cylinder.

(5) Rapidly actuate the local emergency stop solenoid valve so that the Compressed air can enter the high pressure oil pumps to actuate the stopping piston cylinder and push the throttle rack scale to zero [7].

(6) When the diesel engine stops running completely, open the dynamotor indicator valve of the diesel engine and quickly organize the personnel to turn the diesel engine to prevent the diesel engine from stopping suddenly at high load operation, and the Piston will pull the cylinder because of the higher internal temperature of the engine body, cylinder liner and Piston Ablation due to overheating of lubricating oil.

4. Measures and matters needing attention for preventing ship generator from flying

1. When the diesel engine stops, the temperature of the warm water in the cylinder is kept between 65 °C and 75 °C.

2. The long-term parking of the diesel engine, before starting, should check the governor of the relevant parts, remove rust after use.

3. Clean the filter with light oil, be sure to shake off the light oil, and in the atmosphere will be full evaporation of oil can be installed in the filter.

4. Every three months to conduct an over-speed stop function test, to the safety protection of the parking device to the air piston introduction of the specified pressure of air, test the throttle lever action, to ensure normal function.

5. Do not arbitrarily adjust and remove the high-pressure oil pump, really need to adjust, should be carried out on a special test bench.

6. Every 4000 ~ 5000 hours of operation, the Generator Disintegrates, inspects, cleans the high-pressure oil pump, removes the scale. Kill.

7. 200 hours of operation of the generator, check the cylinder high-pressure oil pump rack active condition, often on the oil supply rod support roller and fuel injection pump rack for oil supply maintenance, so that the action is flexible not stuck. Add Oil Lubrication, after the inspection must be sure that the cylinder fuel injection pump rack has returned to the parking position [6].

8. It is forbidden to start the diesel engine by pulling the oil supply lever. In case of emergency, the operator must cooperate closely and pay attention to the change of the speed of the diesel engine, and stop the diesel engine immediately if there is any sign of the speed rising.

9. Every 200 hours of operation, (in operation) check the high-pressure oil pump internal pinion lubricating oil, if necessary, according to the instructions of the procedure adjustment, it is recommended that the amount of lubricating oil slightly larger than the manufacturer's recommendation [5].

10. Do not use the oil supply tie rod as a fulcrum to pry other parts. Do Not Pedal the oil supply tie rod while the diesel engine is being serviced. Before starting the diesel engine and during the operation of the locomotive, check the connection status between the components of the diesel engine control system according to the regulations, so that all kinds of pins and pads are complete and the connection status is good, and any loose or cracked places are found and dealt with in time, prevent the relevant parts and components from breaking, loosening and sticking the pull rod.

II. The daily oil level of the generator fuel tank should be kept at 60%-70% in strong wind and waves. It is easy to spill oil if the oil tank is too full. Special attention should be paid to prevent the oil tank from turning over and causing the filter to be blocked, causes the diesel engine not to absorb the fuel oil to pull the throttle automatically, easy to cause the diesel engine to fly or to stop automatically.

12. When FO generators are switched to DO, it is best to switch the fuel valve in operation and stop the diesel engine after the fuel system is fully filled with DO.
13. Because this type of generator throttles pushed to the maximum, there is no automatic return of the risk, it is best to make a warning sign "do not push the throttles to the maximum" , posted next to the generator.

5. Conclusion

Through the analysis and treatment of the example of generator flying car, this paper summarizes the fault analysis and treatment methods of the generator flying car, and some problems that should be paid attention to in the actual work, and the causes of the fault are also various, but there are a lot of malfunctions caused by human factors. Therefore, in the routine maintenance and management of the marine generator system, it is necessary to operate strictly according to the operating rules, pay attention to the important parameters of the system, such as pressure and smoke exhaust temperature, and check frequently the parts prone to failure, if abnormal phenomena are found, correct countermeasures should be taken in time to avoid the fault spreading or worsening, so as to prevent the trouble before it occurs and ensure the normal and reliable operation of the system, but in the diesel engine operation management, also must avoid the incorrect operation method.

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