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# Mechanism and control system of Damping Diverters in Heat Recovery Steam Generator (HRSG) at PT. Indonesia Power, UPJP Priok, DKI Jakarta, Indonesia

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## ABSTRACT

Heat Recovery Steam Generator (HRSG) is one of component in PLTGU, HRSG used the remaining heat energy to circulate a gas turbine unit to heat the water and convert to steam, and then activate it to move the steam turbine. Water heating in HRSG is done by utilizing exhaust gas as much as possible from the gas turbine. In HRSG there is one component that is a diverter damper that functions as a diverter or regulates the amount of residual combustion gas flow from the gas turbine generator step into HRSG.

**KEY WORDS:** *System Control, Heat Recovery Steam Generator, Diverter Damper*.

## 1.0 INTRODUCTION

Diverter had function to regulate flow of the flue gas from the turbine gas is distributed into the HRSG boiler unit or taken directly to atmosfer through the bypass stack, so that the gas turbine unit can still be used according to the needs of the HRSG boiler unit needs to be stopped. Diverter also serves to divert slowly and regulate the flow of exhaust gas from the by-pass stack to the HRSG boiler room when starting to run HRSG, or when stopping (shutdown) operations of HRSG.

Diverters must be completely closed or isolate the exhaust gas flow so that there is no leakage of gas thermal to the by-pass stack when HRSG is operating to achieve maximum efficiency; or there is no leakage of gas thermal into HRSG boiler unit when it stops so it's not to damage and hazard the HRSG.

In the diverter damper, to monitoring and control the step of a process requires some quantity information. To control diverter damper, there are two systems that must be fulfilled, it is: hydraulic and electrical. This utilization will be used as a reference for maintenance and control to improve the capability application of diverter damper and produce an efficient and valuable result. The purpose was obtained is to know about function and control system of diverter damper in heat recovery steam generator, mechanism, principal and troubleshooting in diverter damper.

## 2.0 BASIC THEORY

Gas-steam power plant are a combination of a gas and steam, when the heat from the exhaust gas from GTG is used to produce steam which is used as a working fluid in a steam turbine and the part used to produce steam is HRSG (Heat Recovery Steam Generator). PLTGU is one of the equipment installations to convert heat energy into electrical energy. Dry saturated steam is will be used to turn the blade. Gas produced in the combustion chamber in the gas power plant will drive the turbine and turn on the generator, which will produce electrical energy. Similar with steam power plant, gas power plant fuel can also from HSD nor natural gas. The use of fuel determines the level of combustion efficiency and the process. In HRSG there is one component that function to regulate the amount of residual gas flow from GTG, it is diverter damper. The mechanism of diverter damper when the pressureized fluid in actuator convert into mechanical force to drive the arm torque and the flap damper will opened (combine

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cycle) as shown in Figure 1. Whereas for illustration of the position of the diverter damper can be seen as shown in Figure 2.

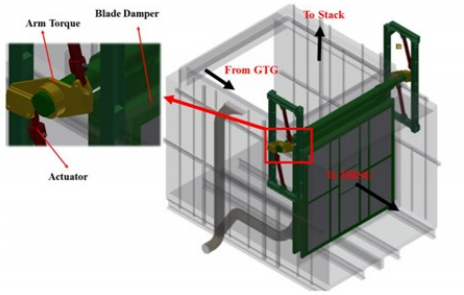


**Figure 1:** The mechanism of diverter damper

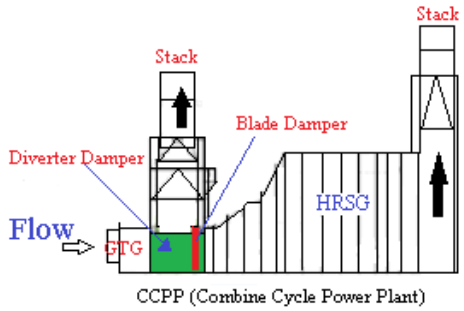


**Figure 2:** Illustration of diverter damper position

Inside diverter damper there is a flap damper, the function changes the direction of the turbines exhaust gas. Flap damper works by open and close into HRSG or into bypass-stack. In open cycle, the flap damper in close position to HRSG and open to bypass-stack. However, in combined cycle flap damper will close position to bypass-stack and open to the HRSG.

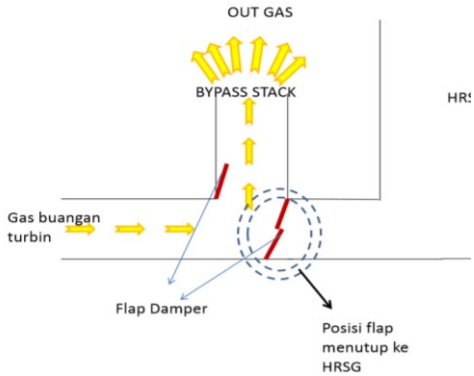


**Figure 3:** Position open cycle

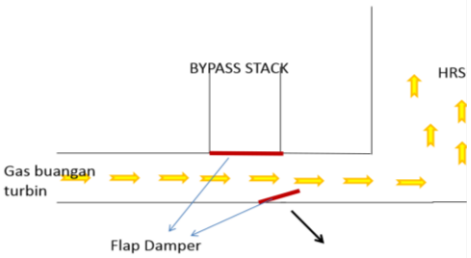


**Figure 4:** Position combine cycle

In diverter damper there are several components as follows:

a. Flap damper
The flap damper function as a change direction of the turbine exhaust gas flow (Figure 5).

**Figure 5:** Flap damper

b. Casing diverter damper
The casing function as a holder hydraulic and mechanic component (Figure 6).

c. Arm torque
Function to change the actuator's translation motion into rotational motion on the flap (Figure 7).

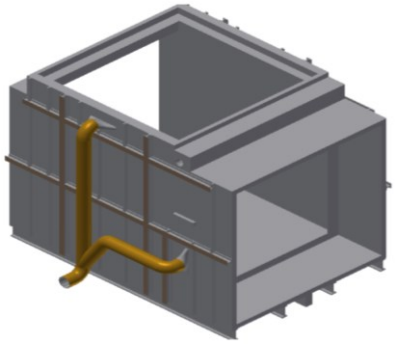

**Figure 6:** Casing

**Figure 7:** Arm torque

d. Seal air fan
Function as a seal and prevents hot combustion gas entering into the HRSG during open cycle conditions (Figure 8).

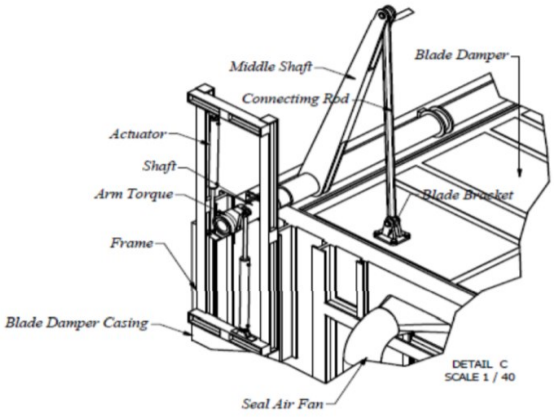


**Figure 8:** Seal air fan


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## 3.0 RESEARCH METHODS

These experimental research activities are carried out at PT. Indonesia Power, UPJP Priok, in Mechanical, Operator and Instrumentation Section, in the area of Tanjung Periuk, Jakarta Utara, DKI Jakarta, Indonesia.
As for the research object is diverter damper. The objective of this research is to explain the principle work of diverter damper and how to work system hydraulic and electric on diverter damper.

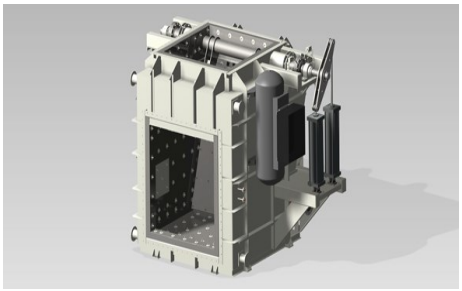

**Figure 8:** Diverter damper

## 4.0 RESULT AND DISCUSSION

The working principle of the Diverter damper, arm movement Diverter damper is controlled by two systems namely, the hydraulic system and the electrical system. The hydraulic system is used as a drive for the diverter damper arm to position open and close the gate, by utilizing the magnitude of the force exerted by liquid fluid to move big and heavy the gate, while the electrical system is used to control the opening and closing of the fluid valve used in the hydraulic system.

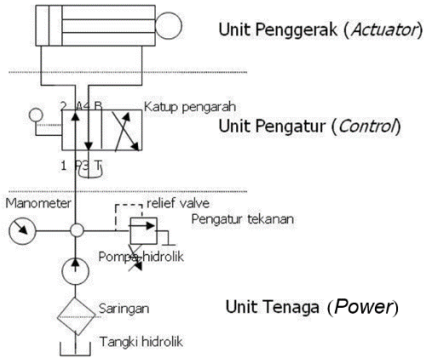


**Figure 10:** Hydraulic system diagram on diverter damper

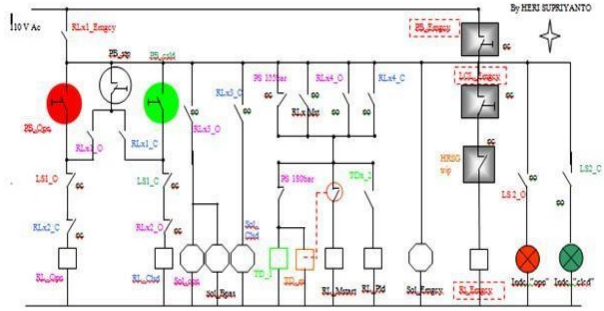

**Figure 11:** Electrical Control system diagram on diverter damper

### 4.1 The process of opening on the diverter damper

1. When the open button is pressed (PB_Open), there will be a voltage switch (RL_Open, RLx3_O, and RLx4_O).
2. After the switch is voltage, the relay RL_Open will be voltage. After relay RL_Open, the RLx3_O voltage switch will activate the open solenoid to open the fluid path to the hydraulic piston to open the gate.
3. At the same time, the voltage RLx4_O switch will turn on the pump to pump fluid into the path that has been opened by the open solenoid to open the gate.
4. Therefore, the pumped fluid will flow into the path that has been opened by the solenoid to move the gate to open.

### 4.2 The process of closing on the diverter damper

1. When the close button is pressed (PB_Close), there is a switch that will be a voltage (RL_Close RLx3_C and RLx4_C).
2. After the RLx3_C switch is active, the RL_Close relay will also be active to activate the solenoid close to open the fluid path to the hydraulic piston to close the gate.
3. At the same time, the RLx4_C switch is also active which will turn on the pump to drain the fluid to the path that has been opened by the solenoid close to close the gate.
4. Therefore, the pumped fluid will flow into the path that has been opened by the solenoid close to close the gate.

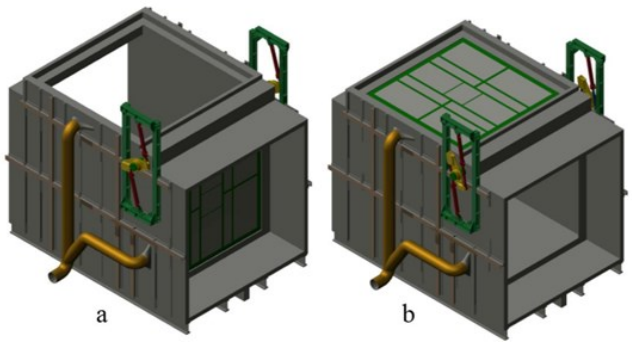


**Figure 12:** Blade damper position, (a) Closed (*Open cycle*), (b) Open (*Combine cycle*)

### 4.3 Operation Procedure on Diverter Damper

1. Work step
   After the hydraulic unit is ready and the pressure has increased, then damper is ready for operation after pulling out the locking pin. The boiler has been closed by flap damper.
2. Seal air fan
   If gas from the turbine is move, seal air fan will only work during the testing process. It means the boiler and by-pass are closed.
3. Seal air valve
   The valve of the boiler opens when seal air is tested. The valve of the boiler is closed when the test has been completed.

Inside the damper diverter, there is a flap damper that serves to change the direction of the turbine exhaust gas. The way the flap damper works is by opening and closing in the direction to HRSG or the bypass stack. For PLTGU operating in open cycle conditions or only PLTGs operating while HRSG is not operating, the position of the flap damper closes the direction to


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the HRSG and opens to the bypass stack. However, if the PLTGU operates in a combined cycle, the PLTGU and HRSG both operate with the position of the flap damper opening towards the HRSG and closing to the bypass stack. Flap damper which functions as a component of the diverter damper to change the direction of turbine exhaust gas flow, the flap damper is driven by using a shaft rotated by a hydraulic piston. The working mechanism of the hydraulic piston is regulated by a hydraulic system that uses a working pressure of 155-200 bar. In carrying out a work operation, the Diverter Damper must meet the permitted requirements. The requirements are that the hydraulic pressure must be according to the standard, Low Pressure (LP) and High Pressure (HP), and Pressure Discharge. The pump is used to pump the pressure to reach the hydraulic pressure according to the standard, if it has not reached the pressure according to the standard then the other pump is used to pump again until it reaches the hydraulic pressure according to the standard.

### 4.4 Problems and Solutions on the Damper Diverter

A. *Problem* : There is no pressure or the pressure is too low on the system
1. *Cause* : The pump is not working properly
*Handling* : Check the motor at the pump.
2. *Cause* : The bypass valve is open at very low pressure, and a weak spring can also be one of the causes.
*Handling* : Adjust valve settings, (it is possible to check the appointment at the same time or replace the spring of the valve) bypass.
3. *Cause* : Damage to the piston caused by the internal seal on the piston.
*Handling* : Check the connection at the opening from the back side of the piston. Change the packing.
4. *Cause* : The pump motor cannot provide a maximum pressure capacity input when the viscosity of the oil is low at high temperatures
*Handling* : Repair or replace the pump with a new one
5. *Cause* : The electric motor does not provide full torque
*Handling* : Check the electric motor power supply and ensure the cable connection.

B. *Problem* : Damage from the solenoid valve that is not functioning properly
1. *Cause* : The solenoid is on fire.
*Handling* : Replace the coil with a new one. Re-check the voltage required.
2. *Cause* : The piston is not good.
*Handling* : Clean the valve, check the solenoid may not be installed in place.
3. *Cause* : Electrical damage.
*Handling* : Test with manual operation until the hole at the end is closed.
4. *Cause* : The valve does not want to operate manually or electrically.
*Handling* : Check the circuit for the desired pipe, check if the pipe is damaged by a very high back pressure.

C. *Problem* : Pressure fluctuations or turbulence of flow
1. *Cause* : Speed control valve or throttle is damaged by dust sand
*Handling* : Clean and rearrange the valve.
2. *Cause* : There is air in the piston pipe due to excessive piston during operation.
*Handling* : Eliminate from system.

D. *Problem* : Pressure sending pump has no fluid
1. *Cause* : The fluid level of the liver fluid level is too low.
*Handling* : Add more fluid after testing due to oil loss.
2. *Cause* : The pump does not work until the assembly of the clutch.
*Handling* : Arrange clutches and clutch rafts, bolts, and carriers
3. *Cause* : The pump is working in reverse rotation or a speed error.
*Handling* : Check the direction of rotation and check the speed.

E. *Problem* : Damage to the pilot operating valve that is not functioning properly.
1. *Cause* : Jams in the piston.
*Handling* : Check and clean the valve. Make sure the piston is free before assembling again.
2. *Cause* : The valve did not work manually or with a signal from the center.
*Handling* : Check the circuit in the correct pipe. Check pipe joints if they are disconnected due to too high back pressure.

## 5.0 CONCLUSION

From all the discussion, diverter damper is one of component in heat recovery steam generator to divert exhaust gas into hrsg or by-pass stack. Diverter damper is operated by 2 system, it is electrical system and hydraulic system. In hydraulic system, the pressure must reach standard is 155-200 bar.

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