Surging Phenomenon in Gas Engine Crankcase

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Abstract. An internal combustion engine is an engine whose combustion process is inside a closed room or often referred to as the combustion chamber. The Wartsila W20V34SG engine is one of the internal combustion engines used to turn generators to generate electricity, over time some new problems arise that cause engine trip. One cause of a sudden increase in crankcase pressure is the occurrence of the phenomenon of surging in the crankcase. The causes of surging originating from the phenomenon of bursts of engine exhaust gas leaks to the surface of the oil mist pipe. Where the average temperature of the exhaust gas is approximately 530 ºC so that the hot gas burst increases the temperature of the oil mist pipe and result in lower gas density and oil vapor. This phenomenon causes the air to become lighter and rise to the top and make the room in the crankcase more vacuum up to -6.29 mBar at which point the pressure will rise significantly up to ± 25 mBar. This value has exceeded the limit of the crankcase pressure protection setting which is 5.57 mBar causing the engine to trip.

Keywords: Bellows Leakage, Pressure Crankcase, Wartsila Engine, Surging Phenomenon, Active Protection

1. Introduction

An internal combustion engine is a heat engine that functions to convert the chemical energy contained in fuel into mechanical energy and the process occurs in a closed combustion chamber. Chemical energy in the fuel is first converted into thermal energy which is produced will increase the pressure which then moves the mechanism on the engine such as piston, piston rod and crankshaft.

All reciprocating engines need crankcase ventilation. This is because of the high gas pressure in the combustion chamber, which cannot be totally sealed off. Because the combustion chamber cannot be completely sealed, a small amount of gas escapes as "blow-by", through the piston/ cylinder liner the crankcase. In turbo-charged engines, there is also blow-by gas entering through the shaft sealing in the turbocharger into the crankcase. Since the crankcase is and the piston rings, into gap not designed for high pressures, it requires a ventilation pipe to prevent pressure from building up inside. Because the gas pressure is very high during piston blow-by, it violently tears the lube oil from the walls, breaking into small oil droplets to form a fine oil mist. Very small oil droplets escape the crankcase through the ventilation pipe.
One of the safeguards to maintain security and safety in the operation of the Wartsila W20V34SG gas engine is to maintain a crankcase pressure below 5 mBar, this aims to prevent the onset of flames or explosions due to combustible gas in the crankcase while operating. To create a vacuum condition on the crankcase, a gas discharge mechanism and an oil mist separator are added which use the working principle of the pressure difference due to height factor. Where the position of the gas discharge line is placed far above ± 25 meters from the position of the suction / crankcase gas engine.

This study aims to determine the relationship between the effect of exhaust gas bursts into the oil mist pipe on surging that occurs at the crankcase pressure.

2. Method
The crankcase chamber is connected by a pipe which has a diameter of 150 mm meters where the pipe connects the crankcase and oil mist outlet out as high as ± 25 meters above the ground. Crankcase pressure during normal operation is an average of -2 mBar, this is due to the difference in pressure between the crankcase chamber and the oil mist outlet. According to the theory the higher air pressure will decrease where each 10 meter increase in air pressure will decrease ± 1 mBar, due to the height of the oil mist outlet pipe which is ± 25 meters high from the crankcase so that the gas and oil vapor in the crankcase rises naturally due to differences in pressure between the crankcase and outlet. Because of the difference in the height of the crankcase and oil mist outlet ± 25 meters resulting in normal pressure on the crankcase when engine running is -2 mBar.

The design of the oil mist line on the Wärtsilä W20V34SG engine uses a DN 150 pipe that connects the crankcase chamber to the oil separator module and then is connected again with the DN 100 pipe to the outside of the engine building with a height of ± 25 meters, as for the schematics and pictures at local shown at figure 1, 2, 3 and figure 4.
Figure 2. Schematics oil mist at engine W20V34SG

Figure 3. Line oil mist line at local

The hit area by exhaust gas leakage
Figure 4. Oil mist separator

Figure 5. Outlet oil mist line at outdoor

Reference used in making oil mist lines on the W20V34SG engine using the Safety standard:
- EN 292, Safety of machinery
- Piping standard: EN 13480
- Enclosure class: IP54 + drip water safe

The test carried out aims to determine the cause of the occurrence of surging on the engine crankcase, causing the engine trip. As has been explained that the sudden increase in pressure crankcase causes active protection of the crankcase.

Research on the occurrence of the phenomenon of surging on the engine crankcase is done based on direct observation and through several stages of observation of engine parameters that
exist in WOIS (CCR) as well as direct temperature measurements in hotspot areas. The study begins by conducting a study and gathering references about the risks occurred from an increase in crankcase pressure.

3. DISCUSSION
Under normal operating conditions, the height difference in the oil mist drain pipe results in values of -0.2 mBar to -2 mBar depending on the engine operating conditions. In certain conditions, namely when there is a disruption of exhaust gas leakage where the temperature reaches 538 °C and the gas bursts hit the pipe in the oil mist, then the phenomenon of pressure on the crankcase will continue to decrease until at a critical point which in the end the pressure becomes suddenly increased until up to reach > 25 mBar. A sudden increase in pressure results in crankcase pressure protection on the working gas engine which causes the unit to trip. The high temperature of the exhaust gas burst and engine exhaust gas temperature can be seen in the picture below:

Figure 6. Temperature data retrieval using infrared thermography on bellows leakage
Figure 7. Engine exhaust temperature

The figure 6 and 7 shows the high temperature in the area around the oil mist pipe due to leakage of exhaust gas. The exhaust gas leak heats up the pipes and other equipment around it. When there is an exhaust gas leak that burst towards the oil mist pipe, there is a gradual decrease in the pressure crankcase where during normal operation the average pressure crankcase is –2 mBar and when there is a leakage of the exhaust gas that burst towards the oil mist pipe, the pressure crankcase drops down to –6.29 millibars (Figure 3) where the condition is a critical point, causing a surge phenomenon that is a sudden increase in pressure (in the case of Arun GEPP crankcase pressure reaches > 25 mBar). The impact of the surge occurs, if the pressure exceeds the crankcase pressure protection setting, the engine will trip. In this case the crankcase pressure protection setting at the Arun GEPP is a high alarm at 3 mBar and a trip at 5 mBar.

Figure 8. Surging phenomenon
4. Conclusion
With the occurrence of exhaust gas leaks hitting the oil mist pipe, it can cause the phenomenon of a pressure spike in the crankcase. This incident was preceded by a decrease in crankcase pressure from its operating pressure (-0.2 to -2 mBar) to a critical pressure (-6.29 mBar). After reaching the critical vacuum pressure, a phenomenon occurs when the outside air is drawn back into the crankcase, causing the crankcase pressure to rise suddenly (up to >25 mBar) or known as surging. In the operation of the gas engine, positive pressure in the crankcase is avoided to protect the gas engine from further damage (explosion). For this reason, each gas engine is equipped with a safety device in the form of protection from positive pressure in the crankcase. In the case of Arun GEPP, the maximum positive pressure setting is 5 mBar. To solve the problem of pressure spikes in the crankcase due to exhaust gas leaks, the surface of the oil mist pipe in the exhaust jet area must be protected with heat-resistant material or removed from potential exposure to the exhaust exhaust gas.

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