A Report Of The Examination Of Yanmar 1GM10 Diesel Engine Exhaust Ejector Elbows

By Mike Hill, Shrimper 372 *Veronica* (2003)

An examination was carried out, during April 2003, of three specimens of the exhaust ejector elbows removed from Yanmar 1GM10 diesel engines after reported failures of the engine cylinder heads due to severe corrosion. Specimen 1 was removed from a diesel engine experiencing no defects and was studied to gain a better understanding of, and identify, the possible magnitude of the problem at an early stage. Specimens 2 & 3, it is understood, were removed from engines experiencing problems from corroded cylinder heads.

Brief description of system

The exhaust ejector elbow, which is manufactured from stainless steel, consists of two tubes one within the other, with a space between the tubes (the annulus), sealed at one end against a flange, and open at the other end. The overall length of this assembly is approximately eight inches. The open-end outer tube is connected to a flexible hose, which leads away to the boat exhaust system. The flange end is bolted to the engine cylinder head exhaust port where exhaust gases pass through the center tube exiting into the flexible tube and away to the boat exhaust system. The cooling water return from the engine discharges into the annulus, via a small rubber tube. The purpose of this arrangement is twofold, firstly to cool the elbow assembly to achieve a temperature commensurate with the operating temperature of the rubber connections, and secondly to eject the by now hot water from the system. On the Yanmar 1GM10 diesel engine, there is no calorifier and therefore the cooling water is saline when the boat is operated in the sea.

Examination: Specimen 1

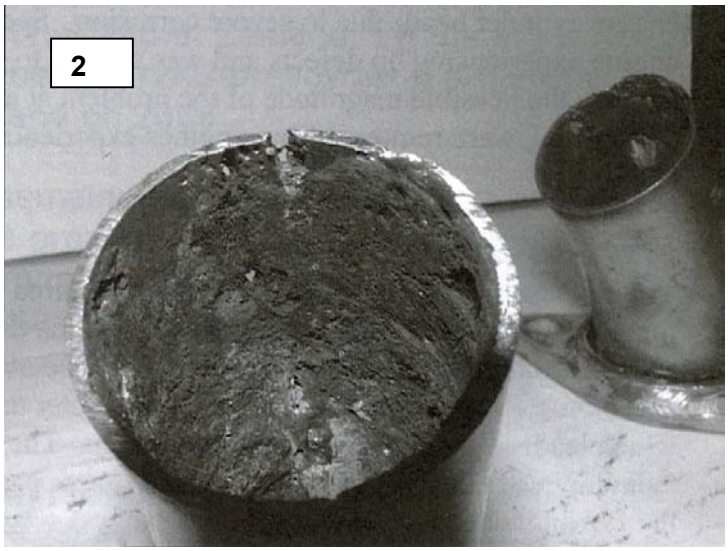
The first sample was removed from "Veronica" after reports of a possible problem with these elbows allowing cooling water onto the cylinder head, resulting in some cases of severe corrosion necessitating the replacement of the head at considerable cost. This first specimen, which had seen some twelve seasons, was found to be perfectly serviceable. Some pitting corrosion was evident on the inner tube but no perforation had taken place.

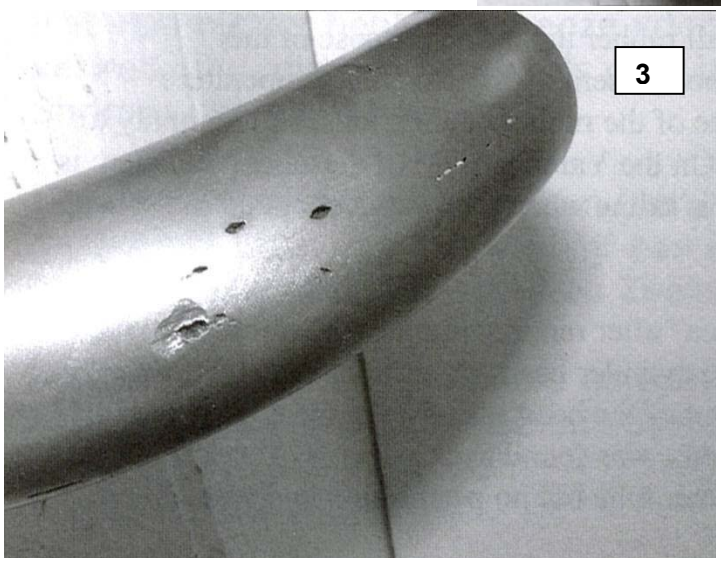
Specimen 2

The outer tube of this specimen was cut away from the flange to facilitate examination of the inner tube.

Picture 1 shows the inner tube of the annulus with a distinct "tide mark" of iron oxide and general local corrosion. This tidemark would seem to indicate the level of cooling water that remains in the annulus when the diesel engine is static.

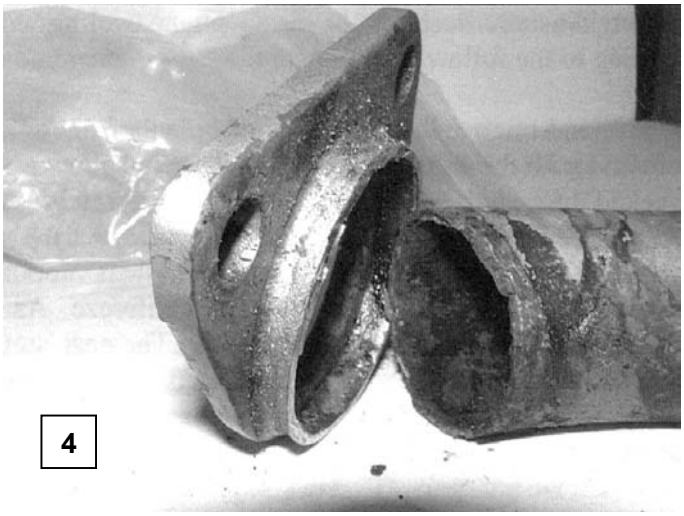
Pictures 2 and 3 are of the same specimen, sectioned and polished. It can be clearly seen that this tube is severely corroded internally and externally to the extent that it has become porous. Any water present in the annulus would be free to pass into the exhaust tube.





Specimen 3

As on the previous specimen, the outer tube was cut away from the flange to facilitate examination.



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Picture 4 shows the inner tube, which had become completely detached from the flange due to severe corrosion of the weld metal. The exhaust tube itself showed signs of corrosion similar to specimen 2. Here water would be able to contaminate the engine internals, via the failed weld, immediately the engine was stopped.

CONCLUSIONS

It is felt that the manufacture of these exhaust ejector elbows is carried out using a low-grade stainless steel containing inclusions of free iron within the material, implicit with such a choice of material. (This grade of material can be quite commonly seen on poor quality deck fittings exhibiting what appears to be "rust" staining). These impurities are reacted upon by a combination of salt water and the exhaust gases from the diesel engine, resulting in "corroding out" of the iron, leaving voids and holes in the parent material.

During operation of the diesel engine the porosity of the exhaust tube should not present a problem. However, once at rest and given the level of static water indicated by specimen 2, particularly during lay up periods, salt water can freely permeate into the engine via the exhaust port. The resulting corrosion to the cylinder head and generally to the engine internals under these conditions is obvious.

The exhaust ejector elbow, which was still serviceable after some twelve seasons, was the subject of a strict fresh water washout and refill with an antifreeze and corrosion inhibiter during lay up periods.

RECOMMENDATIONS

Because the removal of the exhaust ejector elbow is a relatively simple task, it is recommended that it be removed at least once a year for examination and test for corrosion and or porosity.

It is further recommended that a strict procedure is adopted at time of lay up to remove

as much salt water as possible by means of flushing with fresh water and then application of an antifreeze corrosion inhibitor.

ADDENDUM

I have found that the following washout procedure has stood "Veronica" in good shape over the last twelve seasons.

As soon as possible after the vessel is brought ashore flush out the diesel engine cooling system and inhibit with antifreeze according to the following procedure.

1. Close the engine cooling Kingston valve and remove the debris filter inside the boat.

2. Using a funnel into the filter aperture and with the engine running at idle speed allow at least 10 litres of fresh water to be sucked through the engine cooling system. (Watch out to the rear of the vessel, as water will be ejected quite strongly from the exhaust).

3. Allow the engine to continue running dry for approximately 30 seconds and then slowly introduce into the funnel approx 500 ml. of a corrosion inhibiting antifreeze. As soon as the last of antifreeze has passed out of the funnel, stop the engine. The neat antifreeze mixes with the residual water in the cooling system and acts as both an antifreeze and corrosion inhibitor. "Veronica" has happily survived a temperature of minus 17 degrees Celsius under this mix.

If in doubt, I am happy to examine/test SOA member’s ejector elbows.