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Case Study: Broken Water Valve

By

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Subject

Examination of a Viega ASTM F877 dahl NO76 water valve to determine the cause of failure. The examination was limited to non-destructive testing due to a class action lawsuit involving similar valves from this manufacturer. A partial water analysis was provided. The broken valve was examined by visual and microscopic examination. This is a good example of restraints being put on the scope of examination, but the likely cause of failure may still be determined within those restraints.

Water Analysis

The water analysis showed that the level of nitrogen compounds in the water were very low at 0.058 parts per million. The threshold level at which nitrates cause stress corrosion cracking in copper and brass alloys is 0.75 parts per million. Therefore, stress corrosion was not a likely cause of failure. Nitrates and ammonia are the two most common causes, but not the only possible causes of stress corrosion.

The water analysis was limited to nitrogen compounds, coliform bacteria, and lead. Some sulfur compounds and high oxygen levels in water (not checked for) can also cause stress corrosion in copper alloys.

Low water flow rates can also cause dezincification of some copper alloys, such as C36000. This was likely the copper alloy that this valve was machined from.

Stress corrosion can also result from chemicals leached from plastics, rubbers, etc. This is a potential problem where water flow rates and usage are low, such as a refrigerator connection.

A full water analysis would have been more helpful in this evaluation.

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Visual Examination

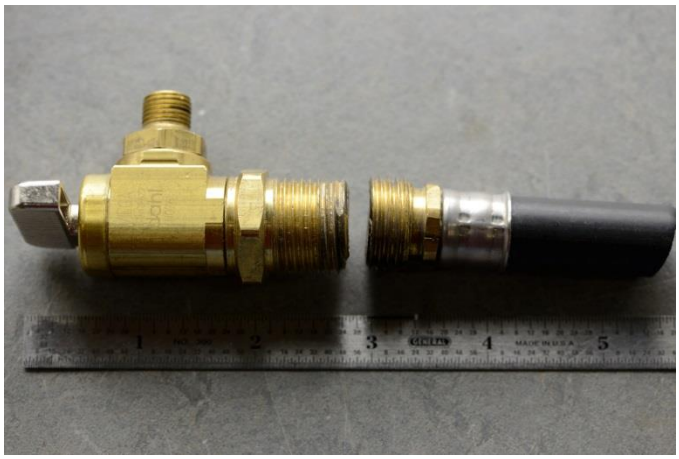

Figure 1 – Viega ASTM F877 dahl NO76 Valve

Figure 2 – Viega ASTM F877 dahl NO76 Valve

Figure 1 shows the broken valve. There was no visual evidence of any mechanical damage that would have led to the valve failure.

Figure 2 shows the identification on the valve.

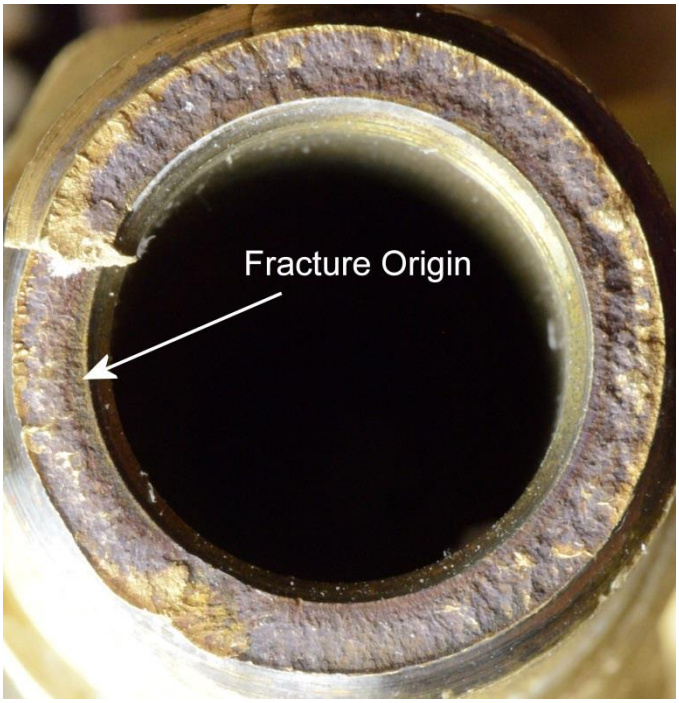

Figure 3 – Fracture, Valve Body Side

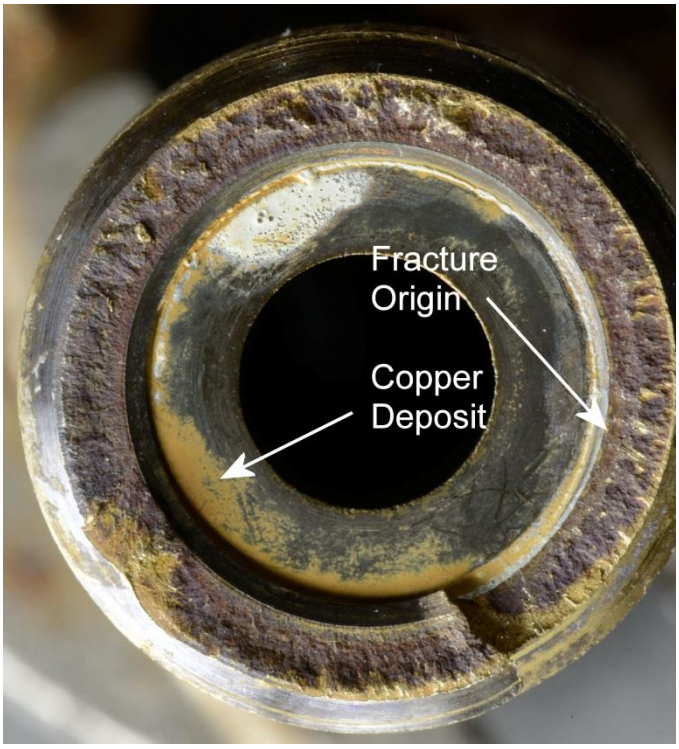

Figure 4 – Fracture, Hose Side

Figures 3 and 4 show the fracture surfaces, and the location of the fracture origin. Figure 4 shows an orange-brown stain, which is shown in Figure 6 at higher magnification. The fracture characteristics shown in these two photos are typical of de-alloying, dezincification, fatigue, and stress corrosion. The orange and red-to-purple colors indicate the presence of dezincification.

The visual examination showed that dezincification was present.

Microscopic Examination

Figure 5 is an optical photo of the fracture surface. The yellow areas are brass. The pink and salmon colored areas are copper, indicating dezincification. The black areas are copper oxide.

Figure 6 is a microscopic photo of the deposit shown in Figure 4. The salmon color indicated the presence of pure copper. Viewing at much higher magnification showed the presence of very fine copper flakes. These flakes are characteristic of dezincification of the brass valve. The dezincification was the primary cause of failure of the valve.

It should also be noted that dezincification is sometimes present when stress corrosion occurs. The extent of dezincification is usually identified by making a metallographic cross section, a destructive test, of the suspected area.

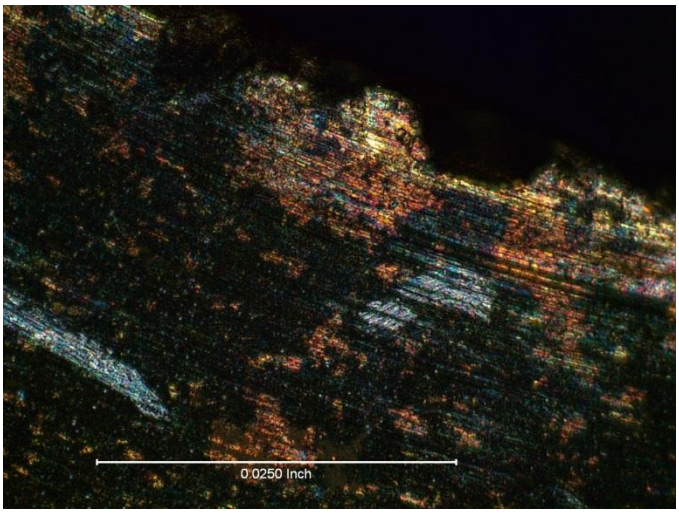

Figure 5 – 100X Fracture Surface

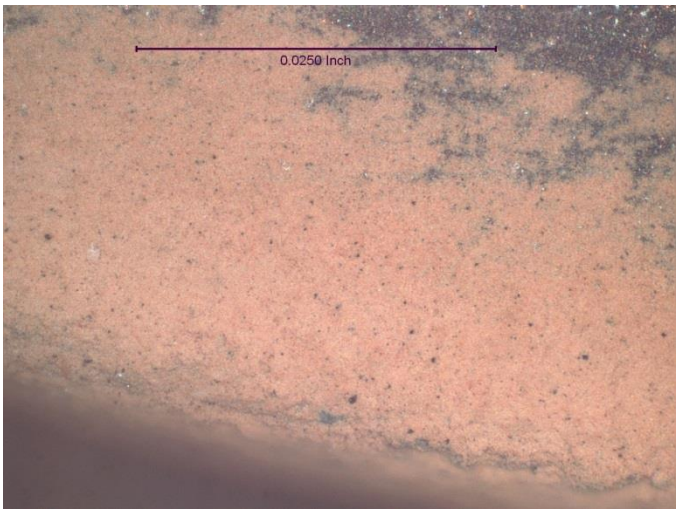

Figure 6 – 100X Copper Deposit

Opinion

It was my professional opinion to a reasonable degree of scientific certainty based on the information available and discussed in the report, that the Viega ASTM F877 dahl NO76 valve had dezincification that was the primary cause of failure of this brass valve.

In order to verify the cause of failure, destructive testing would have been required. The valve segments were too large to fit into a scanning electron microscope to verify the fracture mode, and metallographic cross sectioning would have been required for verification of the copper alloy used, and the extent of the dezincification.