

Gas Valve Failure Analysis*

By

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Gas valves are installed in many appliances such as dryers, water heaters, furnaces, and industrial machinery. The purpose of the gas valve is to reduce the gas line pressure to a level required by the using appliance. The gas valve also acts as a safety device to shut off the gas automatically in case of flame failure. Modern gas valves incorporate pressure regulation for reliable burner operation. A diaphragm connected to a valve controls gas flow and pressure. A thermocouple senses heat from a pilot flame and generates a current that holds open a solenoid valve. If the flame near the thermocouple is extinguished, the current from the thermocouple stops and the solenoid valve closes off gas flow.

Although relatively rare, gas valves can fail causing a fire or explosion. Gas valves can fail from a variety of causes including contamination, product deficiency, and misuse.

CONTAMINATION

Most building mechanical codes require a sediment trap in the gas line, often called a drip leg. Figure 1 is a view of a typical drip leg. Theoretically any debris that flows toward the gas valve will be snared by the drip leg. Figure 2 is a view of contaminants in a water heater gas valve. These contaminants accumulated on



Figure 1

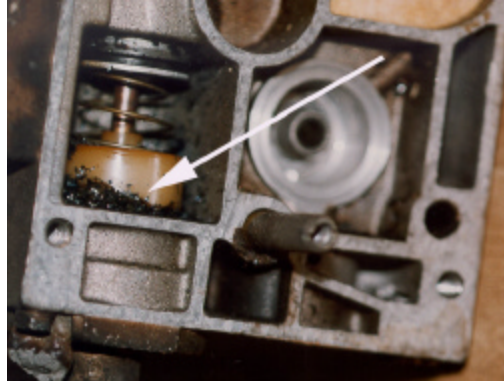


Figure 2

valve seats allowing gas flow when the heater was in the off position. This resulted in gas leakage and an eventual explosion. The contaminants were analyzed and found to be copper sulfide, a byproduct of the reaction between odorant in the gas and copper. It was found that a copper tube was used to connect the gas service to the water heater without using a drip

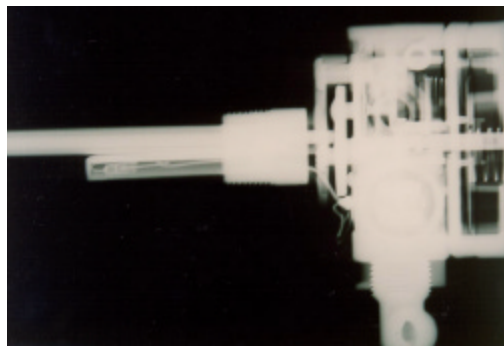


Figure 3

leg. In this case, the two deficiencies were the use of a copper line in gas service with a sulfur based odorant and the absence of a drip leg. Figure 3 is the radiograph (x-ray) of the water heater gas valve showing internal components. An x-ray is a valuable tool in analyzing the condition of a gas valve prior to disassembly since it is a nondestructive testing method.



Figure 4

PRODUCT DEFICIENCY

Figure 4 is a view of a home that sustained an explosion in the basement. The arrow points to structural damage at the wall. Figure 5 is a view of the water heater which was being lit by the home owner when the explosion occurred, causing serious burn injury. Apparently the home owner was in the habit of allowing the



Figure 5

propane gas tanks to become empty before calling for a refill. The gas valve on the water heater was an old design that had been recalled because of intermittent operation of the flame failure safety shut off. With this particular valve, one could turn the gas valve control knob from pilot to on when the pilot light was out. This caused damage to the valve which did not close during flame failure. When the homeowner went into the basement to light the water heater, he was unaware that gas was flowing through the gas valve due to an open main valve. An unfortunate synergism had occurred in that the propane gas that had just been delivered was not supplied with odorant. Consequently, he did not smell the leaking propane.

Since propane is heavier than air, a pool of gas had accumulated on the floor which initiated an explosion when a flame was struck to light the water heater.



Figure 6

JURY-RIGS

Some gas valve related failures are a result of field expedients often called "jury-rigs." Figure 6 shows a flattened tin can being used as a baffle to prevent the pilot flame from being extinguished by down drafts. The problem with this "new design" is that when the thermostat calls for heat and the gas valve opens, it becomes very difficult for the pilot flame to communicate with the raw natural gas at the burners. Consequently a large amount of natural gas flows from the burners before ignition occurs. This results in several large flash ignitions of the natural gas, with one such ignition finally igniting nearby combustible materials.

Gas valve malfunctions can cause property loss and personal injury. Statements as to activities by people near the appliance can be helpful such as the information on the habit of the homeowner who allows the gas to run out before reordering. Testing for the existence of odorant in the gas may explain why the leakage may not have been detected. Review of product recalls may show a deficiency in the gas valve. Finally, testing of the valve may be required for further insight as to the cause of the accident.

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