Aquarium Fires - Why Water and Electricity Do Not Mix

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Abstract
Large aquariums (25 gallons or more) offer an amazing way to teach electrical safety insofar as the prevention of electric fires is concerned. We report on 4 aquarium fires and their origin. All were started due to the presence of a large amount of water vapor in the air. All were caused by short circuits, which were never truly short circuits in the conventional sense – had they been true short circuits, no fire would have started. All of the fires were put out by the water in the aquarium, though not without terrible consequences. All of these fires could have been prevented if the owners had shown greater care of their aquariums. We cite examples of what such care entails in light of present day electric standards.

Keywords: aquarium fire, electrical safety, water and electricity, electric safety teaching

Introduction

Water and electricity do not mix. To teach this in a course about electrical safety, case studies are important. This paper will introduce four case studies that almost every student can relate to.

Many people have possessed an aquarium at some time in their lives. Most of these are no more than fish bowls with most holding under a gallon of water. However, there are some people who may have a large aquarium in their home or place of business. For simplicity, we define a large aquarium as one holding 25 gallons of water or more.

Surprisingly, aquariums are one of the greatest reasons for the cause of electric fires. The problem is water vapor. Accidentally spilling water on an electric appliance (for example, a heater) may prove dramatic, but there is generally no long lasting damage. In fact, the manufacturers of aquarium equipment are very focused on the issues of electric fires as well as electric shocks. Their insulation of the appliances that must contact water is extremely strong. Recall that a filter, heater, submerged light, as well as other gadgets must actually be in contact with water in order to work properly. The cords and plugs used on these appliances are extra thick and extra strong. We have had no personal experience of these ever causing a fire, and we are not even aware of any reports of such fires in the literature on this subject.

But even though the manufacturers of aquarium goods have done their due diligence, there is still a great deal of room for fires to occur.

The most common cause of an aquarium fire involves light fixtures outside of the aquarium. Water vapor can come off the top of the water and seep into the light fixture. Check the specifications, but there are only a few light fixtures (generally with fluorescent bulbs 4 feet long) that can work in a vapor rich environment without causing some sort of current leakage. Light fixtures that can be used as ceiling lights or overhead lights for aquariums will mention this fact, both on the fixture itself and on the bulb used in the fixture. These bulbs/fixtures have extra

insulation to make them water-proof in a damp environment. Most pet stores/aquarium supply houses will supply you with the equipment to set up the aquarium, but they will neglect to supply the parts or even the advice pertaining to electric fires and light fixtures.

For an electric fire caused by an aquarium, there are 2 causes – a high density of water vapor and a low leakage current. Suppose that a test is made to determine the insulating properties of a light fixture. The resistance between line and ground is infinite (theoretically) or at least 30 million ohms (realistically). Suppose that a short develops – the resistance drops to zero, or realistically it drops to some value just under an ohm. With 120 volts (RMS AC) being the American standard, this would draw a current of over 120 amps. Most fuses are rated at 15 or 20 amps for normal home or business use. With a draw of 120 amps, the fuse (or circuit breaker) would open and the circuit would become "dead" before any real trouble occurred.

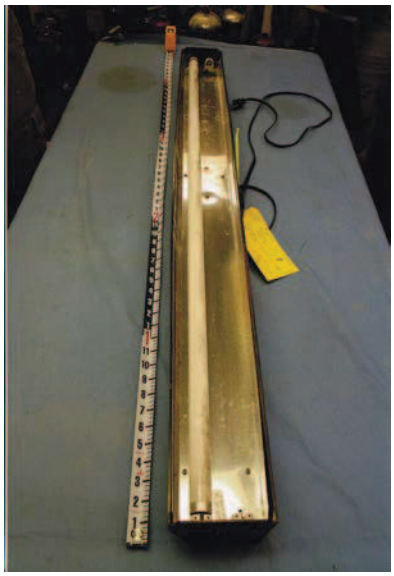
To put this another way, a short circuit (less than one ohm in resistance) would be a good thing to prevent an electric fire. It would indicate a problem immediately. It would call for someone to fix the problem. And there would be no damage.

But a conventional short circuit is NOT common with aquarium fires. What is much more common is to develop leakages between line and ground that are small – of the order of milliamps to start with and gradually increasing to as much as 7 amps. Since the smallest fuse or circuit breaker generally trips at 15 amps, the proper fusing of an aquarium will be of no use in preventing an electric fire. The process for the ignition of an aquarium fire happens according to the following sequence of events. (1) Water vapor condenses between line and ground, forming a thin film. A small current flows (maybe milliamps) through this film. This is hardly noticeable since the average large aquarium my draw 10 or more amps safely. (2) The water film will dry up but leave behind salts and dirt that can conduct. (3) New water droplets will condense on in the same spot between the ground and line voltages. The leakage can now be increased, with this new layer. (4) This process repeats itself, as the leakage gets larger and larger. This process has been known to take up to a month to occur, but it has occurred in as little as a few hours. (5) Ignition of fuel takes place at various temperatures. Paper and wood ignite at 451 degrees Fahrenheit. Most plastics ignite at over 700 degrees F. See [1] and [2]. Over time, the heat from leakage can cause the local temperature to increase to equal or come close to the ignition value. In addition there is a chemical process involved in the ignition of burning called pyrolysis. See [3]. This can lower the ignition temperature. Over time the application of a continuous source of heat can cause a fundamental breakdown in the structure of the plastic or wood or fuel so that its ignition temperature itself is lowered.

Analysis

In three of the fires that we studied, the ignition point was in a light fixture. The light fixture was NOT rated for use in a damp environment. Burning is evident throughout the fixture. A typical fixture for aquarium use is shown in Figures 1 and 2. Another light fixture, not rated for use with an aquarium, is shown in Figure 3, following a fire that started in the fixture from water condensation. In Figure 4, we show a different kind of ignition, the ignition of a power strip. Power strips were bought by a homeowner at the local store (like Radio Shack or Lowes or Home Depot). These are great for use with computers and televisions, so long as you draw a

current for which the power strip is rated. However, they are NOT designed for use in damp environments. In fact, some manufacturers of power strips now list the following warning: “NOT for use in a damp environment – NOT for use with an aquarium”. The reason for this warning is simple. Aquarium fires are a very common form of fires, and the manufacturers of these power strips have been sued for their role in said fires.



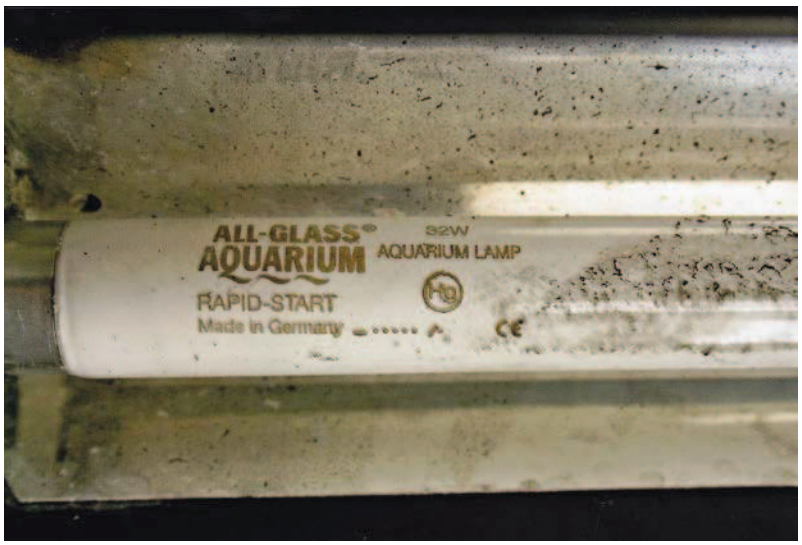


Figure 1 and 2. Typical light fixture for aquarium use

Figure 3. Light fixture following a fire that started in the fixture from water condensation.

Figure 4. Two power strips – The left one is completely burned; the right one is not changed.

In Figure 4, two power strips are shown. These ran the filters, lights, and heaters for a large aquarium. The power strip on the left is completely burned; it vaporized. No melt was found near the strip. Only by luck, the second strip did not ignite.

What is also common in the fires that we investigated is the fact that damage to the home from fire is almost nonexistent. Also, death or damage to the human is almost nonexistent. Simply put, the water in the aquarium inserts itself into the accident such that it puts the fire out. This does not mean that the accident is trivial. In one case, a man had spent $10,000 for rare tropical fish. The fire caused the water in the tank to heat up and explode the glass. The flooding caused major water damage in the house. Also, the explosion tossed fish up to 20 feet. Some were found embedded in window screens. In addition to the $10,000 loss of fish, the homeowner paid $80,000 to fix flooding damage and smoke damage.

To sum up our observations of these 4 fires:

Electric shock or death – not likely, but it can happen.

Fire damage – can happen but not likely.

Flooding damage – very likely and very serious

Smoke damage—very likely and serious.

One other thing should be mentioned here. In two of the accidents, the homeowner/business-owner noted a “smell” for several weeks before the fire. The smell was of something burning. In one case, he called in an “expert” who checked all currents and voltages and gave his aquarium-system a clean bill of health. In these cases, the sense of smell trumped electrical knowledge.

Conclusion

We note that aquarium fires are a very common form of electric fires. We note that their prevention is quite simple – use only appliances specifically made for use in a damp environment. Trust your sense of smell over your meter readings. Know that fusing the aquarium and buying quality appliances are a good start, but they are no protection against these fires if you have any light fixture or power strip in the vicinity that is not made for use in a damp environment. Further specifications about the use of items in or near an aquarium can be found in the National Electric Code[4].

References

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