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The Use of Primary and Secondary Contactors in Electric Immersion Heating Systems Applications

For the past 35 years I have been involved in the plating, metal finishing, and printed circuit board processing industries. In the time I have seen my fair share of plastic tank fires.

Electric immersion heaters are typically connected in a temperature control box to an electro-mechanical contactor. There is a set of three screws or lugs (depending on the wire size) on the top for the power, and an opposing set on the bottom for the heater connection.

The contactors that are typically used are a three pole design, where there is a set of opposing contact points, one on the top and one on the bottom of each section that has a parallel contact bar. The contactors are a normally open circuit. The parallel contact bar in each of the three sections is connected to a laminated metallic device that is “pulled in” when a magnetic field created by a copper coil winding, which is embedded behind the opposing contact points, is energized by the applied electric current from the temperature control.

There are several items that are usually wired in series with this coil winding circuit. Electric heater thermal cutoff devices, liquid level controls with manual reset buttons, and 7 day timers to just to name a few.

The contactor has a set of contact points that have slight arc) (in them when they are new. After the coil is energized the points come together and transfer the voltage and the amperes as required.

After several hundred or even several thousand cycles the contact points have burned away and have become like dimpled circles. As the dimpled circles begin to close and reopen the contact surface has become significantly larger and more voltage is created as the points flash open. The dimples have become so large that upon closing the voltage and arc from closing have become so hot that they finally weld shut. The heater stays on even though the temperature control has already opened. The cutoffs have opened and don’t work, the level safety is useless, and the 7day timer has already opened the circuit with no avail.

The tank evaporates away, the heater melts the plastic, a chemical change takes place in the plastic drips, touches the heater and ignition starts.

To greatly reduce the chance of having a fire, your first line of defense is good routine maintenance. The second is to implement a dual contactor control system. This is nothing new. Boeing, Texas Instruments, Bosch and several other large companies implement this electrical design in there heating systems.
By using a primary contactor that is operated by the liquid level control, that opens and closes typically 1 time per day, followed by a secondary contactor that is operated by the temperature control, that repeat cycles throughout the day (some time up to 100 times) causing the contacts to burn, wear and weld shut.

In primary/secondary scenario, the secondary contactor welds shut, the heater is on, and the level control is exposed from the evaporating liquid, causing the primary contactor to open. Safety, about as good as it gets.