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Curtis Goad, CEF, is President of GOAD COMPANY, located in Kansas City, Missouri. He grew up in the family business, attending his first AESF National Convention at age 12, and working summers through his school years. From GOAD's early lead-burning days, the company progressed through a multitude of material advancements.

Curtis has authored published articles, has a patent on detecting leaks in full tanks to prevent downtime, and multiple patents and patents pending on tank lining and plastic welding technology breakthroughs. He degreed at both Miami University (Ohio) and the University of Missouri, Columbia and is a longtime member of NASF (now serving as a Director), NACE, SSPC, and AWS (now serving on plastic welding subcommittee) and the Missouri Bar.

GOAD COMPANY is also a member of the American Galvanizers Association, The Electrocoat Association and the Missouri Manufacturers' Association, where GOAD won the "New Product Excellence Award" in 2016.

Preventing Tank Catastrophes

Tanks are a necessity, providing critical service to plating and pickling operations, yet have often been implicated in accidents, leaks, catastrophes, and fires. Associated risks can threaten both worker safety and groundwater contamination draining profit and reputation.

A valuable old quotation should guide us here: "A prudent man learns from his experience; a wise man learns from the experience of others." The purpose of this article is to raise awareness by sharing "learning moments" over the past forty years in our industry. Rather than focus on technical or scientific issues we will share survey results and cover real-world stories to provide you an opportunity to become wiser without experiencing your own major loss.

We believe worker safety is the top responsibility for any business and don't want to see anyone get hurt. Unfortunately, accidents can occur though most are preventable. Please read and share the

“Safety Tips and Tanks” graphic at the end of this article. Following these simple DO’s and DON’Ts can prevent workers from falling into an acid tank, or even worse – a fatality from not following confined space protocol (we personally know of too many of these unsafe catastrophes).

Since no “silver bullet” material exists, and any tank is only as good as its weakest element, the vast majority (75%) of process tank users have reported experiencing tank leaks. With this fact in mind, tanks should not be viewed as a commodity nor taken for granted. Proper material selection and advances in fabrication/welding methods and technologies can greatly reduce premature failure. Welding machines provide the highest strength welds. Plastic shops should have quality assurance programs and qualified welders based on AWS b2.4 standard specification for plastic welding. “Hand” welds are tedious with intense focus required. Since long hours or days of welding are necessary with large tanks, tiring and reduced concentration is likely. Because poor welding is a common cause of tank failure the fewer “hand” welds – both in linear feet and number of passes the better.

Though leaks can often be repaired, lost production and loss of chemical can be costly. In a recent survey 67% rated their leak a major cost or burden and 18% have experienced catastrophic tank failure. These latter companies reported dire consequences: worker exposure, overcoming secondary containment and environmental liability or clean-ups.

In one instance, a well built, 7-year old polypropylene tank which had NEVER leaked, experienced a side wall “blow out” due to hidden structural steel corrosion from acid drips at the tank’s top rim. A fume collection hood was mounted on the tank rim and the plastic encapsulating the steel structure was evidently compromised. Hot fumes will condense to liquid and even extremely slow drips will create gallons of acid over time. One drip per minute = one gallon per week (364 gallons over 7 years), so even one drip per hour over 7 years would create 6 gallons of acid. In this case, the actual quantity to dissolve the steel is irrelevant, as whatever it was, the steel was fully corroded away.

“Hidden” corrosion under the encapsulated polypropylene caused this catastrophic failure/tank wall “blow out”.

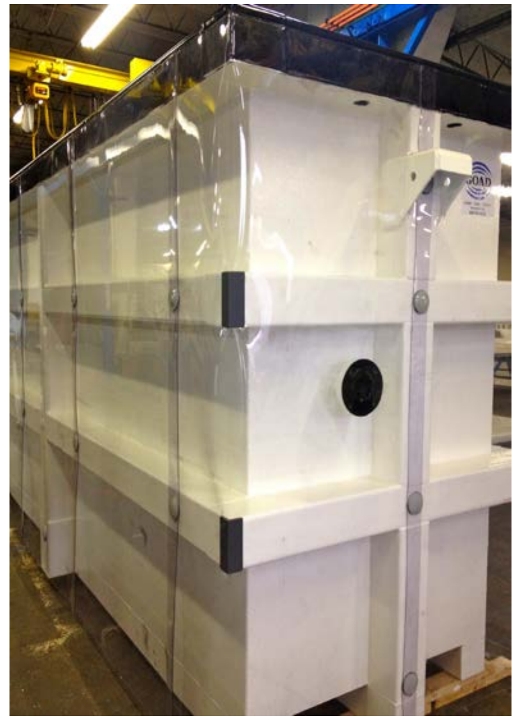
 

Fortunately, this incident happened on a weekend, when no one was at or near this heated tank full of "mean" acid when it had its wall "blow out". Had someone been on the catwalk next to this tank, we can only imagine the worst.

Therefore, we offer the following suggestions for preventing a similar catastrophe:

1. Monitor the deflection or bowing of each tank wall. By using a laser measurement device, you can shoot the laser beam from one end of the wall to its other end. If you must move out from the edge to get to the other end that distance represents how much the wall has deflected or bowed. Full tanks want to be round so structure is required to stiffen the wall and without structure, as shown in these pictures, the plastic itself can break apart. (Note: the tank needs to be filled to its operating level to measure the deflection.)
2. Inspect the integrity of the structural steel itself. This may sound easy, but often a visual inspection is not possible due to the steel being encapsulated in plastic to prevent it from corroding from splashes or the atmosphere itself. And if lateral hoods or a catwalk or other items are at the tank the above deflection may be difficult to measure. A) Spark testing may be a possibility and DC spark testing is the best and safest method (over AC spark testing) but it requires grounding to the steel, which complicates matters. B) Another option (except for stainless steel) is to use a large on/off welding magnet to check if the mild steel has been eaten away – as occurred in this case. A strong magnet will connect to the steel, if it's there, even through the plastic encapsulation. C) Another idea is to use clear see-through vinyl to protect the steel yet be able to visually see if it is being corroded away.

PPL tank with steel structure, insulation and clear vinyl protection



Carbon Steel Lined Tank with 100% sealed clear vinyl exterior protection

3 Consider using solid wall steel tanks over free standing plastic tanks with encapsulated structure. Steel tanks can have either a patented bonded lining (no problematic hand welds with seam strips) or a machine welded box liner dropped into it. We have never heard of this type of tank experiencing a complete wall blow out. The steel exterior can be lined (which allows for easy spark testing) or covered with the see-through clear vinyl as mentioned above.

In a discussion of tank catastrophes, we would be remiss if we did not address plastic tank fires. When we started fabricating machine built polypropylene tanks in the early 1980's, using German machines and methods, we thought they were great and so did our customers. After a devastating process line fire at a captive shop, the plant manager regretfully sobbed "I wish I had known", and we honestly replied that we didn't either. Now we know! Of thirty plastics tested, polypropylene (PPL) was rated worst as a fire hazard. PPL has been called "diesel fuel in the solid state" (almost all hydrocarbon) and it burns with a maximum heat release rate approaching that of gasoline when burning. Temperatures up to 1093 degrees C (or 2000 degrees F) are reached, sufficient to cause steel to lose strength and buildings collapse. Firefighting is made more complex by the presence of hazardous materials. Some plants have been a total loss.

FM Global Property Loss Prevention Data Sheets recommend using "noncombustible construction for all pickling and electroplating tanks, fume collection and exhaust equipment and ducts". The fire protection sprinkler systems, hose streams (500 GPM), water supplies, alarms and interlocks, containment systems and minimum 1-hr fire separation between combustible plastic tanks and the surrounding occupancy is exhaustive, costly, and stringent.

Polyvinyl Chloride (PVC), Chlorinated PVC (CPVC) and Polyvinylidene Fluoride (PVDF) all offer excellent fire properties as they are among the least easily ignitable plastics and are self-extinguishing (they will not continue burning unless a large, continuous heat source is applied to them). They have low flame spread ratings due to drastically lower heat release ratings. Tests have shown that burning PPL releases 14 times more heat than PVC.

Following are some instructional "experiences of others" involving the ever-present human element:

1) A slow draining plastic cylinder in a treatment system has air added at an inlet to speed up the draining only to have the vessel burst from the added pressure.

2) We hear about a "catastrophe" involving our large steel lined zinc-nickel plating tank – it lost all of its' precious contents – from being accidentally drained.

That's why Frank Altmayer, Educational Director of NASF, advises our industry to NOT have drain valves in plating tanks. And remember, since any tank is only as good as its weakest element, all penetrations that may entail hand welds or expansion stress lessen the chance of trouble-free service life.

3) A PVDF tank, which earns it place as among the best for acid service, is repurposed for a high pH solution (its Achilles Heel) and fails. Don't assume a great tank can hold any solution, but instead rely on the expertise of your supplier.

4) An anodizer was using a caustic etch tank along with a domed side tank to collect and separate the sludge. The etch solution produced a large amount of foam containing hydrogen gas, which accumulated in the dome of the tank (only a small pipe ventilated the dome). A spark from an unknown source at the etch tank (probably metal against metal from the hoist work bar), set off the hydrogen in the foam and the clarification tank took off like a rocket, blasted through the wall of the building and landed in the parking lot, flattening a car, which was thankfully un-occupied.

Tank “rocket” – approx. 15’ tall X 12’ diameter

In conclusion, please learn from the suffering experiences and catastrophic failures of others; be wiser from their losses and not your own.

SAFETY TIPS AND TANKS

DO

- PROPERLY PLANK TANKS BEFORE WORKING OVERHEAD
- MAKE SURE THAT A PROPERLY FUNCTIONING SELF-CONTAINED BREATHING APPARATUS, AND AN OPERATOR TRAINED IN ITS USE, IS AVAILABLE FOR EMERGENCY RESCUE
- MAKE CERTAIN THAT ALL EQUIPMENT IS PROPERLY LOCKED OUT / TAGGED OUT BEFORE WORKING
- INSPECT TANKS AND PIPING FOR LEAKS AND CORROSION AND DEFLECTION (BOWING)

DON'T

- LEAVE SPILLS FOR CLEANUP LATER. CLEAN UP SPILLS IMMEDIATELY – BEFORE AN ACCIDENT RESULTS
- ENGAGE IN HORSE-PLAY AROUND TANKS. A SPLASH OR TRIP COULD GIVE YOU A BAD CHEMICAL BURN
- CLIMB OUT OVER, LEAN OVER OR WALK ON TANK RIMS OR ANODES RODS – SLIPPING INTO A TANK IS A LEADING CAUSE OF VERY SERIOUS INJURIES
- CLIMB INTO A TANK, OR ENTER A CONFINED SPACE, WITHOUT EMPLOYING THE BUDDY SYSTEM, ENSUING PROPER VENTILATION, AND FULLY COMPLYING WITH YOUR PLANT'S "CONFINED SPACE RULES"
- EVER LIFT A BAG OR DRUM OF CHEMICALS ABOVE THE TANK RIM. THE WHOLE CONTENTS COULD FALL IN, CAUSING A "BLOWUP"

UNDETECTED AND SILENT LEAKS