

# Heat Treater Eliminates Smoke and Fire from Quenching Operations

*Getting oil performance without oil's smoke and combustion hazards is a common goal, particularly for heat treaters with large quench tanks. Houston's largest commercial heat treater has achieved this by using an aqueous based polyvinyl pyrrolidone polymer.*

Specialty Heat Treat Inc., Houston, TX, that city's largest commercial heat treater, is primarily an "oil patch" operation. Ninety-five percent of its work comes from oilfield equipment manufacturers. The balance comes from military and aerospace applications. The company was founded in 1993, with three 8-ft. furnaces that were well-matched to those leaner times, when parts were quenched either in oil or water.

As Specialty grew, five 25 ft. furnaces and one 15 ft. furnace were added. All are dedicated primarily to austenitizing-quench and temper processing and have a 20,000 lb. capacity. Water quenching was done at first, but the goal from the start was to upgrade to a polymer as soon as the company was firmly established in the 25-ft. marketplace, according to Tom Moore, SHT's owner and president.

## The Quenchant Challenge

But there was a challenge in finding the right quenchant. And that was, according to Moore, a wide and changing range of products, as well as loads that were often mixed. Four and six-inch cross sections are processed together, for example. Materials include 4140, 4340 and 8630 — the latter a rich steel with lower carbon. Parts include mechanical tubing (½-in. to 3-in.), wellhead adapters, valve bodies, casing spools, and machine parts. The parts' cross-sections range from ½ in. to 20 in.

"Machine parts with multiple cross sections were our biggest challenge," says Moore. "And any quenchant we used had to successfully quench everything. Captive shops that do one thing over and over can experiment, and work out problems over time. We're in the opposite camp: what we do has to work **all** the time.

"Twenty five years of experience told us that polyglycols



*The bath is formulated at 15% to 17% concentration. This high molecular weight polymer quenchant was engineered for high alloy steels, and applications where distortion control is critical.*

could never consistently quench our range of parts without a high incidence of cracking," Moore continues. "What we needed was the performance of oil: effectiveness at 1550°F — the austenitizing temperature of 4140 steel — and the ability to hit the brakes hard at 500°F. Traditional polymers tend to keep going at this point, when you want them to stop. They're hard to slow down, or you have to increase concentration so high that you create other problems. Cutting the agitation rate down — *way down* — helps, but as an alternative to oil, common polymers are less forgiving and far from ideal."

## Proprietary Polymer

In 2001, on recommendation from another heat treater, Moore tested a high molecular weight polymer quenchant that had originally been engineered for high alloy steels, and applications in which distortion control was critical. The aqueous polymer based on polyvinyl pyrrolidone, used at 15% to 17% concentration, provided high hardness at high speed, while minimizing the risk of part distortion or breakage.

The cooling mechanism is unusu-



*Specialty Heat Treat processes components for the oilfield equipment, military, and aerospace markets using Parquench 90 from Heatbath/Park Metallurgical.*

## CASE HISTORY, *continued*

ally gentle, with a shorter vapor phase. This allows the vapor blanket that develops around the part to collapse quickly and uniformly, and for heat extraction to begin sooner. During this stage, an insulating polymer film deposits on the part surface. This film moderates the rate of conductive and convective heat transfer, reducing transformational stresses and preventing localized temperature deviations. As a result, the dimensional integrity of the part is protected.

The quenchant, available from Heatbath/Park Metallurgical, is called Parquench 90. It is fully water-soluble up to the boiling point of water, thus providing cooling at all stages of quenching. In this, it offers an advantage over polyglycols, which precipitate out between 145° and 185° F.

"We consider this a 'second-generation' polymer," says Moore. "All our tests showed that, while not a direct replacement for oil, this is an intelligent approach — one that combines performance that's consistent and 'forgiving' like oil, but with safety and good environmentals. We have also proved that you can do the same with this polymer as you can with oil — with just a few considerations.

"First," he explains, "time is more important with this quenchant than it is with oil. A heat treater needs to come up with a time vs. cross section formula and hit that number, plus or minus a few percent, depending on the quality of the metal. A clean, well-reduced piece of steel allows a plus or minus 20% for the same result. Poor quality steel, which is a challenge anyway, gives you a smaller range — plus or minus 1-2%.

"The second consideration is agitation. I have timed a lot of quenches, and the optimum might be any given time at full power, and half way through the quench cycle, knock back 50%. That's critical."

### Agitation

"We built our own agitator," says Moore, and, "given the aggressive turbulence we produce, we expected some foaming." Foaming can be created by equipment issues such as air leaks or pump cavitation, or by contaminants such as cleaners, or metal-working fluids. It is an issue because bubbles adhering to the metal surface allow thermal gradients to develop within the part, thus producing dis-

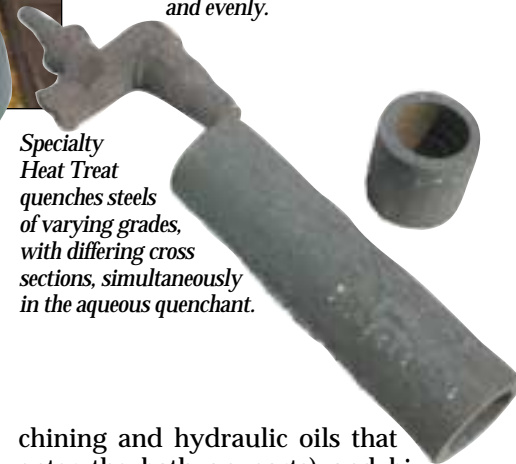


*Aqueous polymer quenchant has a gentle cooling mechanism, with a shorter vapor phase that allows the parts' vapor blanket to collapse quickly and evenly.*

*Parquench 90 is used to quench a broad range of products: 4140, 4340 and 8630 steels; cross-sections from ½ in. to 20 in.*



*Specialty Heat Treat quenches steels of varying grades, with differing cross sections, simultaneously in the aqueous quenchant.*



tortion. But this quenchant has an anti-foaming additive, so distortion from thermal gradients is not a problem.

Proper agitation is also excellent insurance against the biological degradation of the polymer. This can occur because of bacteria that enter the bath on coolants or other process fluid residues.

As an operations matter, one of the notable characteristics of Parquench is its stability, according to Moore. "We've had it three years, and even though it's used continuously, it's so stable, we now only check it twice a week."

### Flexibility and Maintenance

The quenchant also offers flexibility. "We use it between 15-17% concentration, but it's not critical for it to be exact," says Moore. "Polyglycols, on the other hand, force you to pick a number and stay there — or you'd see a lot of cracking. Also, only bath concentration requires monitoring — and that's primarily due to evaporation."

The quenchant offers the flexibility of producing an interrupted quench, without hazard to workers or the shop. This is because there are no aldehydes, ketones, or other dangerous substances generated.

Maintenance on the quench bath is limited to skimming (to remove ma-

chining and hydraulic oils that enter the bath on parts) and bi-annual descaling of tanks. Eliminating scale maintains the heating/cooling potential of the quenchant at a constant level and allows agitation to be optimally effective.

High-speed oil and Heatbath's quenchant deliver the same properties, according to Moore. "Both allow you to 'hit the brakes' at 500°F, with no cracking and no distortion. Heat treaters exist in order to put 1600° F parts into a liquid quench and produce a specific metallurgical outcome. "Twenty thousand gallons of oil making contact with parts that hot is an immediate fire," he adds. "It lasts only seconds, but when oil-coated parts are put back in for tempering, there's more burning. We've found a way to accomplish our objectives without involving 20,000 gallons of highly flammable oil." 

*Edited from information supplied by Heatbath/Park Metallurgical. For additional information call (413) 452-2000 or visit [www.heatbath.com](http://www.heatbath.com).*