

CRAFTSMAN'S CRIBSHEET

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Miles Free – Director of Technology and Industry Research Technical Regulatory Quality Management

Seven Causes for Quench Cracking in Steel

Failures of steel parts in service or production occur infrequently. However, when steel parts fail, the consequences are dire. Here are seven ways that steel can fail as a result of quench cracking from heat treatment.

1. Overheating during the austenitizing portion of the heat treatment cycle can coarsen normally fine-grained steels.

Coarse-grained steels increase hardening depth and are more prone to quench cracking than fine-grained steels. Avoid overheating and overly long dwell times while austenitizing.

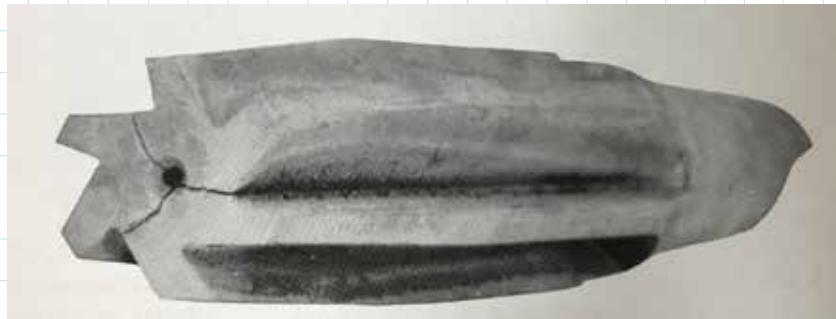
2. Improper quenchant. Yes, water, brine or caustic will get the steel harder. If the steel is an oil-hardening steel, the use of these overly aggressive quenchants will lead to cracking.

3. Making an improper selection of steel for the process.

4. Too much time between the quenching and the tempering of the heat-treated parts. A common misconception is that quench cracks can occur only while the piece is being quenched. This is not true. If the work is not tempered right away, quench cracks can (and will) occur.

5. Improper design. This includes sharp changes of section, lack of radii, holes, sharp keyways, unbalanced sectional mass and other stress risers.

6. Improper entry of the part/delivery of the quenchant to the part. Differences in cooling rates can be created, for example, if parts are massed together in a basket. This can result in the parts along the edges cooling faster than



This 1 1/2-inch diameter high speed steel reamer cracked because of excessively high quenching temperature.

those in the mass in the center. Part geometry can also interfere with quenchant delivery and effectiveness, especially on induction lines.

7. Failure to take sufficient stock removal from the original part during machining. This can leave remnants of seams or other surface imperfections that can act as a nucleation site for a quench crack.

Finally, materials that are heat treated to high strength levels, even though they did not quench crack, may contain localized concentrations of high residual stresses. If these stresses are acting in the same direction as the load applied in service, an instantaneous failure can occur. This will be virtually indistinguishable from a quench crack during an examination, because of its brittle failure mode, lack of decarburization on surface of the fracture or other forensic evidence of a process failure.

When looking at quench cracking failures under the microscope, cracks and crack tributaries that follow the prior austenitic grain boundaries are a pretty good clue that grain coarsening and/or its causes, such as overheating or too much time at a certain temperature, have occurred. Temper scale on the fracture surface helps the metallurgist know that the crack was present before tempering. Decarburization may show that the crack was open prior to quenching.

All Craftsman's Crib sheets are available for viewing and download at short.productionmachining.com/cribsheets.