Shot Peening Cuts Drill Pipe Failures

Shop Tests Indicate Life of Equipment Is Extended by Four Times

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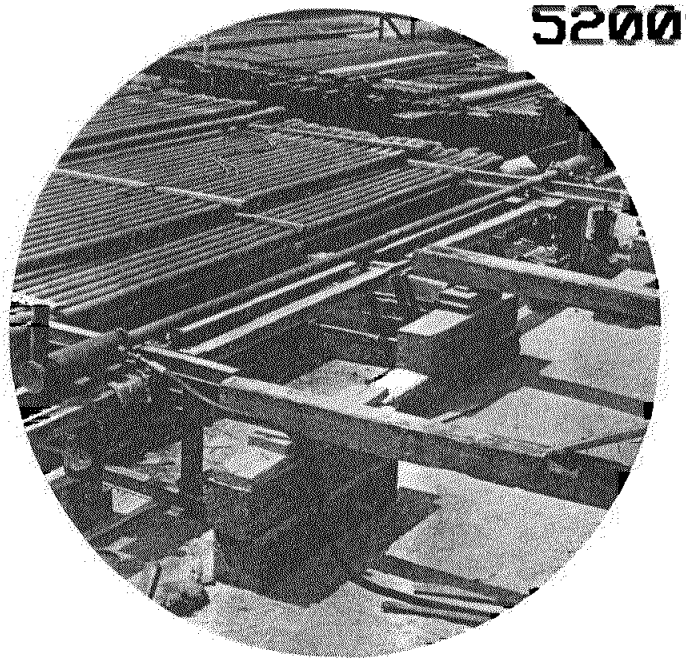


Here's a typical rig for sand blasting or shot peening tubular goods. The process here involves peening outside ends of drill pipe. Air-jetted shot is fed from chamber on extreme right through rubber hose and against rotating pipe. Used shot is trapped by casing segment surrounding pipe and dumped into bucket below.

A SHOT peened joint of drill pipe, compared to a similar joint which has not been shot peened, will withstand more than four times as many cycles of stress before it fails. This fact is quite important during times of tubular goods scarcity plus additional demands placed upon drill pipe in operations below 13,000 feet.

The process of shot peening drill pipe includes blasting the inside surface with round steel shot until dangerous forming tensional stresses are relieved, the surface has been dented and worked so as to interrupt cracks and ridges which formerly provided sensitive failure paths, and the interior surface is placed in the favorable condition of compression.

Sand Blast Before Shot Peening

The objective in sand blasting is to remove mill scale. Sand and grit perform as abrasives to cut away mill scale faster and cleaner than do the round steel shot employed for peening. Blasting abrasives are often selected for their resistance to fragmentation so they can be re-used many times. However, the best abrasive to clean tubular goods is a sand selected because it is definitely fragmentary. Following the initial abrasive grain contact, the fragmented particles ricochet and hit the surface again to remove the mill scale from small cracks and pits.

The round steel peening shot, which are of the optimum size to flatten out, indent and interrupt the surface ridges, crevices and pits, will knock off much of the mill scale but they are too large to get down into and clean out the cracks and pits. Actually, they hammer the remaining scale into the base metal. This remaining scale will weather or spall-off and break the continuity of and squander the peening result. Even though sand produces some peening effect and shot does some cleaning, the desired end result is more rapidly and economically attained if:

- Mill scale is first removed with abrasive sand.
- The clean metal surface is peened with optimum sized round steel shot.

Recognized Industrial Tool

Shot peening is standard practice on many automobile and airplane parts. For years the front coil springs on a popular line of automobiles have been shot peened; they then take more than four times as many cycles of compression before average failure. Improved methods of peening, according to research reports, forecast an increase in that performance to the order of ten. Other familiar steel parts show the following life improvement after shot peening:

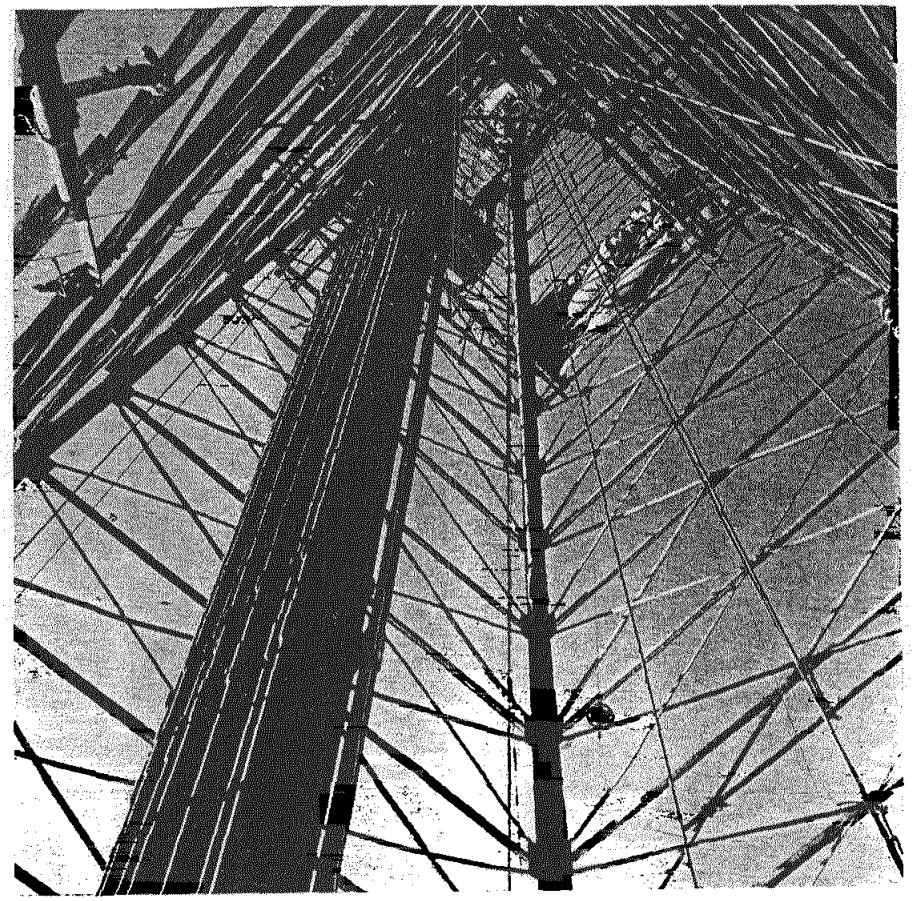
welded joints	310 percent
steering knuckle	475 percent
engine crankshafts	900 percent
gun extractors	650 percent
leaf springs	1300 percent

Desirable General Corrosion

The actual weight loss of steel in corrosive environments is still so small that if that loss is encouraged to take place as general, evenly distributed corrosion, drill pipe or tubing can last ten times as long before failure as it will if the corrosion is allowed to concentrate and produce failure in spots.

The first control operation is to sandblast the inside of the pipe to remove the mill scale. A mill scale free surface allows corrosion to:

- Affect the whole surface simultaneously, or



The present scarcity of tubular goods points up a need for regular maintenance programs. Test records reveal many advantages in increased pipe life through use of sandblasting and shot peening processes. Use of these processes removes mill scale and conditions the metal for longer use.

- To migrate over the surface as each anodic area becomes protected or passivated by oxide film to result in general or unlocalized attack.

When mill scale is permitted to weather-off out of control, on the contrary, it spalls off in chips, exposing freshly disturbed activated spots, scratches or crevices adjacent to large mill scale insulated or oxide film protected or passivated cathodic areas. Once anodic corrosive attack has started at the preferentially sensitive areas on this dissimilar surface it ceases to migrate; it takes up residence at these spots and concentrates and continues there in preference to others; it becomes autocatalytic to produce pits or other localized early failure channels.

When stress is applied the probability of failure is multiplied, since the mechanical stress may break chemically resistant bridges in the metal, and the chemical corrosive attack may break mechanically resistant bridges.

Only a limited number of these influences need line up to produce stress corrosion failure. Where small steel coupons do not show advanced corrosion while sections of a long heavy string of tubing do, for instance, it is suspected that stress is the critical factor.

A cleaned or a cleaned-and-peened surface obviously will reduce the physical and potential dissimilarities inhibitors must combat. Just as pipe line coatings reduce cathodic protection input requirements, properly prepared surfaces may similarly reduce inhibitor requirements and costs.

Corrosion fatigue failure, characteristic of drill pipe, is achieved by alternating stresses which produce disarrayed material which is corroded as it is formed. Although corrosion fatigue is complex and serious, the operation to control it is simple; it is shot peening.

Shot Peening—A Final Step

Shot peening, then, is a second corrosion control operation. Most of the standard practice shot peening, or its alternates, rolling as on threads, or honing as on tools, have been applied to machined surfaces which, obviously, were free of mill scale. However, it may be generally stated that:

- The first corrosion control operation, sandblasting, is a beneficial control of chemical corrosion.
- The second corrosion control operation, shot peening, is a beneficial control of mechanical corrosion.

But peening, without first removing the mill scale by sandblasting may stimulate bad localized spot corrosion if contaminated abrasives and hammered-in inclusions are factors as they are when the mill scale is sandblasted off to achieve more noble passivated stainless steels. Like painting over mill scale for the decorative purpose of hiding what is going on underneath, it may contribute to, rather than defer, corrosion failure of the steel.

Tests Prove Worth

Simulated drilling condition tests show that peened drill pipe compared to unpeened withstands more than four times as many cycles of stress before average failure. Because it is difficult to simulate the complex wet conditions of actual drilling on full-sized joints, these usually have been dry runs which show only improved resistance to pure or dry fatigue. They show only how much longer pipe can last in areas where failure is assumed to be due to mechanical fatigue because no pits or obvious chemical corrosion patterns occur.

To observe the compounded progress of mechanical fatigue in the presence of wet chemical corrosion particular attention is being given to field service data on a carefully numbered string now drilling in West Texas. In this string one third of the joints have been left untouched as a control; one third have been sandblasted only; and one third have been sandblasted and shot peened.

Completion of this test, it is expected, will provide reliable field service data to confirm again that the first control operation, sandblasting to remove the mill scale, increases pipe service life more than 50 per cent; and that the second operation, shot peening, places the peened surfaces in such favorable condition that they withstand more than four times as many cycles of stress before failure.

REFERENCE

[1] Removing Mill Scale Increases Pipe Service life, Ralph Irving, WORLD OIL—October, p. 140.