Inspection of Oil Field Tubular Goods

By HAROLD J. SCHNEIDER and CHARLES R. KROMER
Tuboscope Company

INTRODUCTION

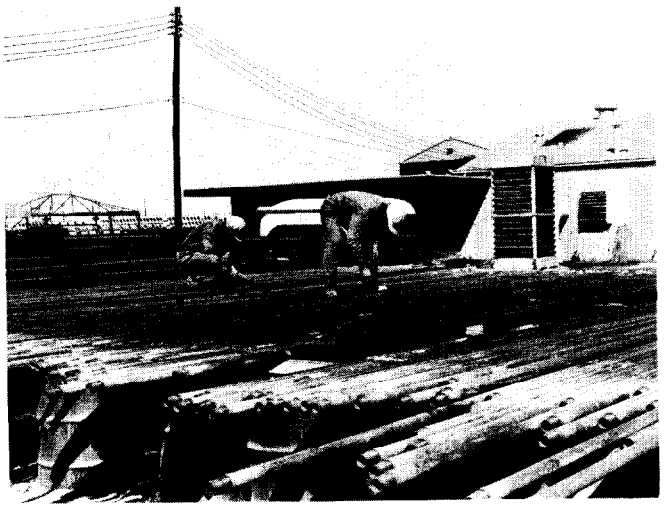
Despite preventive measures taken during the manufacture of oil field tubular goods some defective lengths are produced. Other lengths become defective as the result of damage occurring during shipment or handling, or because of service conditions to which they are subjected. Failure to detect and properly dispose of these defective lengths before failure occurs has and can become costly and dangerous.

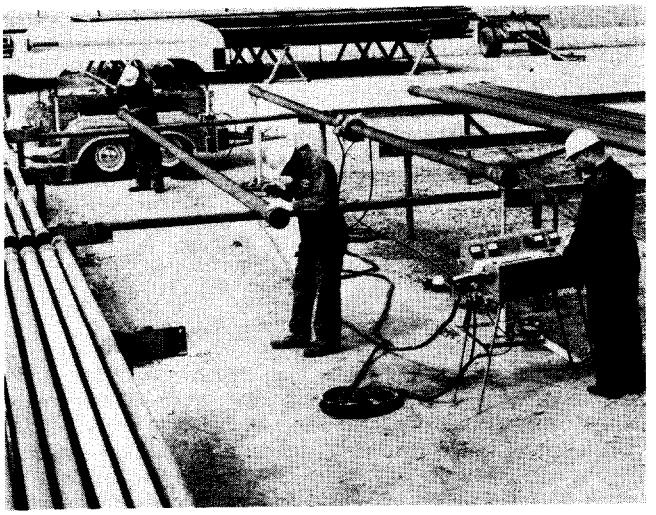
Before detection and disposition of unserviceable lengths can be accomplished we must first know what constitutes an injurious defect, and then employ means of detecting and evaluating existing defects. When material standards have been established, the injurious type of defects are fairly well defined so that any one of several types of tests may suffice, provided the type of test selected develops a proved correlation between the property actually tested and serviceability of the tube.

It should be recognized that no single test can be expected to reliably measure all properties of the material being tested. For maximum protection against unknowingly using unserviceable tubular goods, a series of tests should be performed that will insure the tubes' compliance with all specifications relating to soundness of the material. The specifications being complied with must also be sufficiently detailed and current to accurately reflect expected serviceability of the tubes under given conditions.

In evaluating test methods one must realize that a difference does exist between the reliability of the test method and the judgment exercised by the inspector. To be both economical and effective the test must:

1. Produce accurate, complete and reproducible data rapidly.
2. The inspector, having full knowledge of the service to which the material is to be subjected, must rapidly evaluate this data, applying knowledge gained while performing similar operations under the same service conditions.





In this paper an attempt will be made to describe briefly the practical aspects of some of the accepted methods used in field inspection and testing of oil field tubular goods, as follows:

1. Magnetic Particle
2. Visual and Optical
3. Electromagnetic Induction

MAGNETIC PARTICLE INSPECTION

Magnetic particle inspection of new and used tubular goods is one of the oldest developments in the field of non-destructive testing. It has for years been one of the most common methods used in both the mills and the field for determining the presence of injurious surface defects such as cracks, laps, slugs and slivers.

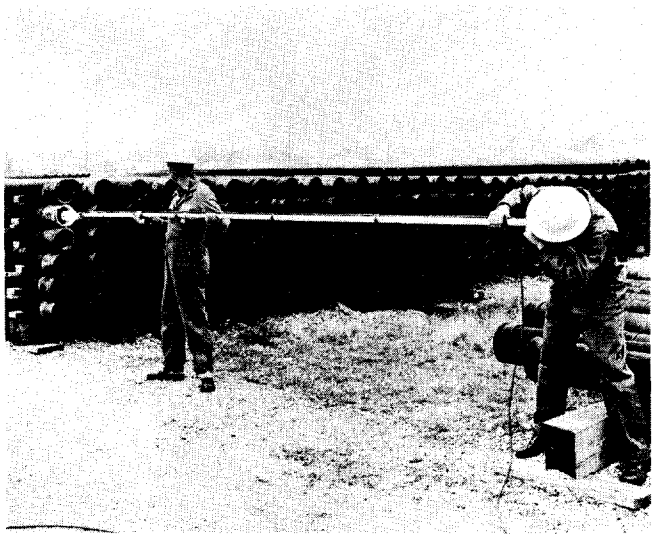
The principle of magnetic particle inspection is based upon the change in permeability of the magnetic flux path that occurs when defects are present. When the pipe has been properly magnetized, the magnetic lines of force must spread out in order to detour the areas of low permeability (defective areas), after which they tend to resume their original path in the steel.

In detouring, some of the distorted lines of force enter the atmosphere to bridge the defect. The magnetic poles thereby created attract and hold finely divided iron filings placed in their vicinity, thereby outlining the defect and making it clearly visible to the unaided eye.

The method of magnetization must be carefully selected to insure that the established lines of flux are oriented transverse to the expected direction of the defects. Since defects of mill origin occurring in the tube bodywall generally assume a direction parallel to the longitudinal axis of the tube, a magnetic flux field oriented circumferentially must be employed for their detection.

Conversely, to detect defects oriented circumferentially (such as fatigue cracks and defects created during upsetting operations), a magnetic flux field directed parallel to the longitudinal axis of the tube must be employed.

Two methods of inducing magnetic fields are employed



for performing magnetic particle inspections. One is the continuous method in which magnetic particles are applied while the magnetizing electric current is still flowing; the other is the residual method in which magnetic particles are applied after the electric current has ceased to flow. The effectiveness of the residual method is dependent largely upon the degree of the magnetic retentivity of the steel under test. Generally speaking, the harder the steel the better the magnetic retentivity.

The primary limitation of this type of inspection lies in the fact that its effectiveness is confined to the detection of surface or near surface defects.

VISUAL AND OPTICAL

Provided the inspector possesses normal vision and the surface of the material to be inspected is free of foreign matter (such as rust, dirt, paraffin, thread dope or a heavy rust preventive coating), visual inspection of the outside surface of the tube is not difficult. Considering the rate at which oil field tubes are manufactured and the number of tubes containing visible injurious defects that find their way into the field, it is obvious that the mill inspectors do a good job at this type of inspection.

The limitations of this form of inspection obviously lie in the high degree of human element involved and the type of defects which can be detected. To visually observe defects occurring on the inside surface of tubes, for instance, optical aid is necessary. This optical aid is found in the form of a small telescope-type instrument that is inserted into the tube bore, carrying with it an electrical lamp for illuminating the inside wall.

By sighting through this instrument as it is slowly moved into the tube bore the wall can be scanned 360 degrees for defects visible to the unaided eye. The limitations of this inspection obviously lie in the problem of being able to economically clean the surface so as to view the true characteristics of all defects, the high degree of human element involved, and the limited type of defects detectable by this means.

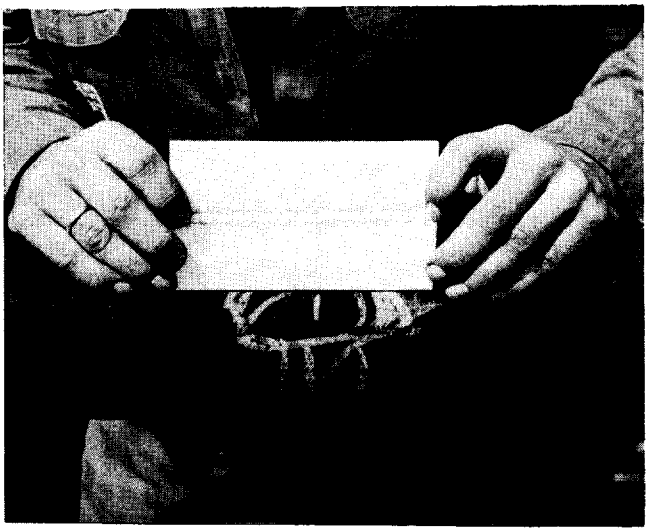
ELECTROMAGNETIC INDUCTION

This method of non-destructive testing was introduced into the field of tubular goods inspection in 1949 by the Tuboscope Company (under the trade name of SONOSCOPE), and has since proved a very popular method of inspecting used oil field tubular goods.

Inspections performed by this method require that the tube first be magnetized using a direct current of sufficient magnitude to approach magnetic saturation. The surface is then scanned with a search coil for magnetic flux emanations from the pipe surface. These flux disturbances (which are created by the presence of defects), generate electrical impulses in the search coil, which are then amplified and recorded for interpretation.

The Sonoscope Unit is constructed so that a search unit containing several search coils scans 100 per cent of the tube surface as it passes the full length of the tube, carrying with it a magnetizing coil. The electrical impulses generated in each search coil are processed continuously through the amplifier unit (independent of signals being received from other coils simultaneously), then through a selector and recorder unit that selects and records only the largest of all signals being received at any one time. Circuitry of the unit is also arranged so that a known relationship exists between the actual defect and the characteristics of the recorded signal. This allows for accurate evaluation of the defect by interpretation of the recorded log.

Inspections utilizing the electromagnetic induction principle and a search coil detection technique generally result in fast, uniform, non-destructive testing that employs a minimum of human element to produce accurate, reproducible results.



Defects frequently found in oil field tubular goods.