Locating Fatigue Cracks and Other Defects in Sucker Rods by Electromagnetic Inspection

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INTRODUCTION

Since the day of its inception, artificial lifting of crude oil has confronted producers with many and varied problems.

In the early days of oil production a special type sucker, or wooden branch, fitted with iron connections, was used in pumping operations. Many shallow water wells use similar equipment even today. Failures in this type of sucker rod invariably resulted from rotting, swelling, unscrewing of connections and splitting in the bradded areas.

PRESENT DAY PROBLEMS

The present day high tensile strength, special alloy steel sucker rods being used in some of the deeper pumping wells in the industry have increased efficiency greatly. However, no material has yet been introduced capable of withstanding the most common cause of sucker rod failures, fatigue.

Although every factor causing fatigue failures has not been determined, there are numerous contributory factors that can easily be identified. Figs. 1 and 2 indicate some of the areas where fatigue failures occur and a number of the conditions accelerating fatigue. Sharp kinks, corrosion pits, handling defects and rare mill defects, shown in Fig. 1, all serve as stress risers in the body sections of sucker rods. These will almost always result in premature fatigue failures when placed under cyclic stresses.

Fatigue Cracks

Fatigue cracks can occur at a number of places in sucker rod joints, as shown in Fig. 2. Pin failures almost invariably occur from fatigue cracks at the base of the last full thread. Coupling failures can occur almost anywhere, depending upon whether fatigue cracks were initiated by internal or external corrosion pits, rare mill defects or severe hammer blows. Experience and research has indicated that over 95% of all sucker rod failures are the result of fatigue failures. Only in extreme cases, such as pulling a stuck pump, have pure tensile failures occurred.

For years, producers have replaced each broken rod with a new one, and assumed that there were no more bad rods in the string, or had no means of locating weak rods. Consequently, the sucker rods were re-

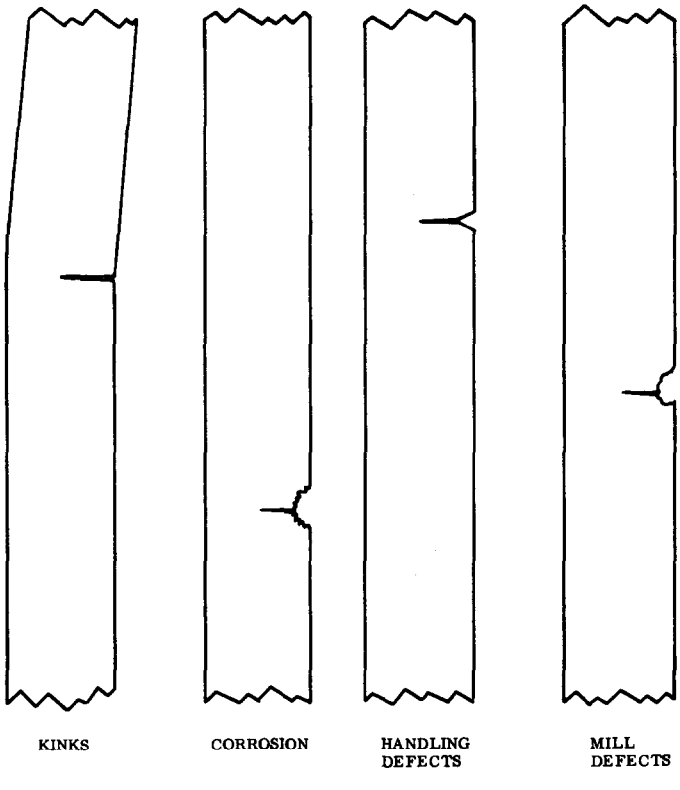


FIG. 1 SUCKER ROD BODY SECTIONS

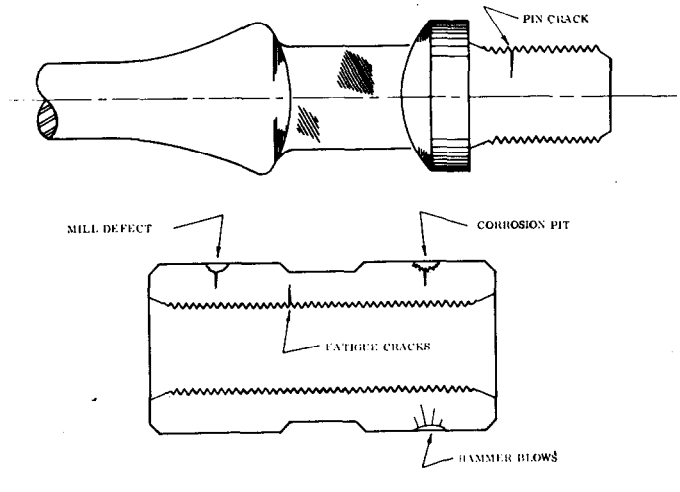
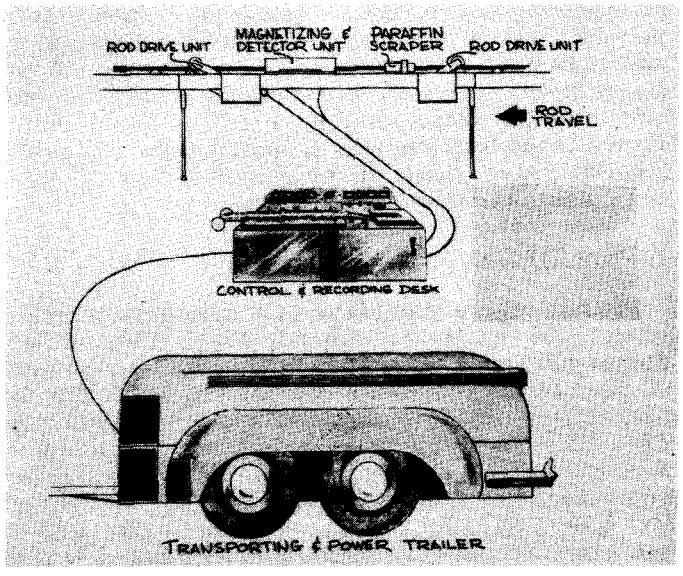


FIG. 2 SUCKER ROD JOINTS

turned to service, in many cases resulting in another costly fishing job after only a short period of time. In practically every instance when a sucker rod parts in a string, there are a number of weak sucker rods which could result in premature fishing jobs.

Producers have long recognized a dire need for an accurate method of locating defective sucker rods while the rods are on the surface, rather than having to fish them from a deep well. Through research in electronics and magnetics, inspection companies have perfected and field proved equipment that will locate fatigue cracks, corrosion pits, handling defects and many other defects. The equipment discussed in the remaining portion of this paper is patented under the trade name Sonoscope.®

This equipment consists of a portable power supply unit, control and recording desk, detector unit, aluminum loading racks, rubber drive wheels and a set of paraffin scrapers, as shown in Fig. 3.



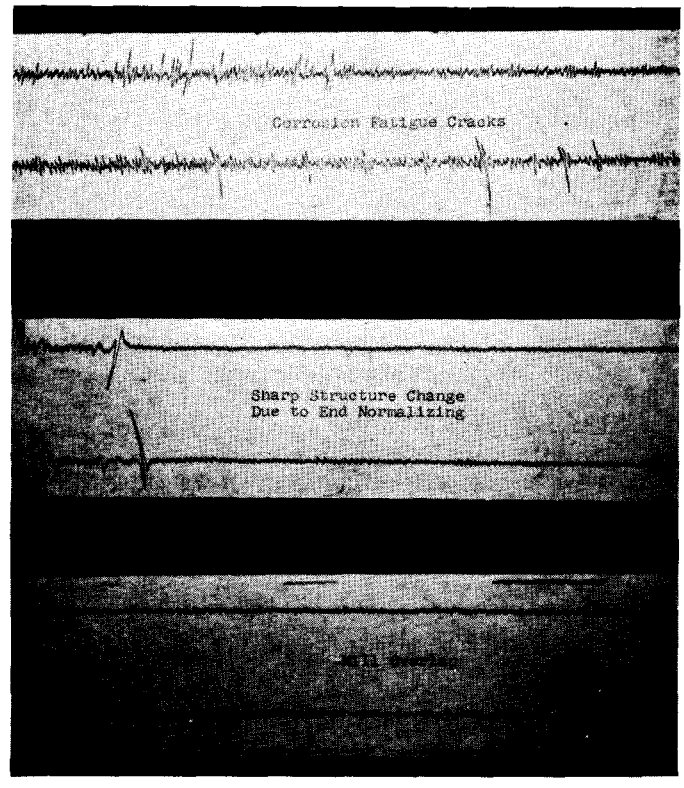
SCHEMATIC DIAGRAM OF

FIG. 3 SUCKER ROD SONOSCOPE UNIT

A sucker rod is first loaded on the aluminum racks, designed to minimize handling damage, and fed into constant speed rubber drive rollers. The rod next passes through a set of hollow-ground paraffin scrapers designed to clean excess material from the rod to insure proper contact with the detector unit. After cleaning the rod enters a magnetizing coil where a uniform magnetic field, close to the saturation point, is induced into the sucker rod prior to entering the detector section. In the detector section, variations of the flux line pattern in the specimen, caused by fatigue cracks and other defects, are intercepted. These are channeled to the recording desk where the signals are amplified and recorded in log form according to location and effect.

Log Travel Speed

The log travel speed is synchronized with the travel speed of the sucker rod, facilitating defect location on the rod from the recorded log. Upon observing unusual indications on the log, the operator stops the equipment and examines the rod for the defects indicated, then classifies the rod for future use. Provided a rod is not used between inspections, it will reveal the same indications, test after test. Sample logs revealing defects located by this type electromatic inspection technique are shown in Fig. 4.



SONOSCOPE LOGS REVEALING

FIG. 4 DEFECTS IN SUCKER RODS

After inspection sucker rods are classified into four groups:

Group #1-White Paint Band - New Rods in Good Condition
Group #2-Yellow Paint Band - Used Rods in Good Condition
Group #3-Blue Paint Band - Limited Service Rods
Group #4-Red Paint Band - Defective or Scrap Rods

Each sucker rod inspected is center-punch marked on the face of a pin end connection for permanent identification.

This inspection can also be performed as the sucker rods are being pulled from the well by mounting the detector unit vertically over the wellhead and pulling the sucker rods through the detector section. During the wellhead inspection no attempt is made to classify sucker rods according to the various grades, and only the immediate potential failures are removed from the string. Tuboscope Company recommends this type inspection only in special cases.

Magnetic Particle Inspection

In wells where producers experience pin and coupling failures in conjunction with body breaks, magnetic particle inspection of pins and couplings is offered as a supplementary inspection after electromagnetic in-

spection of the rod body. In this process the pin and coupling surfaces are thoroughly cleaned and dried. The rod ends are magnetized and sprinkled with sponge iron filings which will outline fatigue cracks and severe hammer marks, Fig. 5. Couplings are also inspected for abrasive wear and corrosion pits.

The electromagnetic sucker rod inspection is a fast, economical, uniform inspection performed with electronic accuracy, enabling producers to obtain the maximum useful life from each sucker rod.

FIG. 5