MISTRAS
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Products & Systems Division

Application Brief

M100A Metal Inspector: Heat Treating

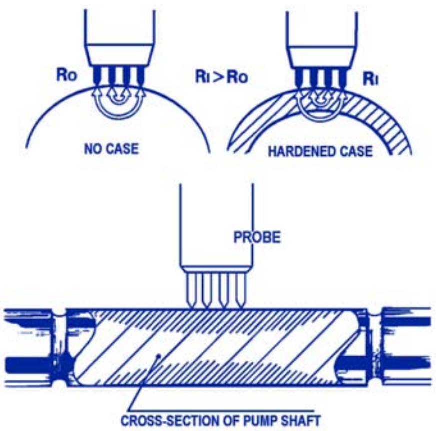
The Model 100A Metal Inspector uses resistivity to help determine the case depth and hardness of metal. It pulses a rapidly reversing direct current into metal through a 4-point probe, and measures the metal.s resistance to the current flow.

Here's how to use the Model 100 on production samples from your factory. First, place the probe squarely down on a piece of untreated metal and take a reading. Some resistivity is measured. Then take a reading on a similar part that has been heat treated. A higher resistivity is measured.

Metal in a martensitic (hardened) state will always exhibit a higher resistivity to the flow of electricity than ferrite (unhardened) metal because its grain structure has become more tightly packed through heat treatment. The greater the case depth of any given part, the higher the resistivity reading on the Model 100 display screen. Likewise, annealing will bring the resistivity back down.

Greater Case Depth = Higher Readings

The fact has been proven out repeatedly. For example, if Part #1 produces a resistivity reading of 60, and traditional cutting and measuring reveals a case depth of approximately 0.200 inches, then Part #2 will produce a reading of 60 (within 3%) if it, too, has a similar case depth. If it has a more shallow case, it will produce a reading less than 60. A deeper casing will produce a reading in excess of 60. If the readings go too high, it indicates micro-cracks, or over-hardening.



HOW MEASUREMENTS WERE TAKEN

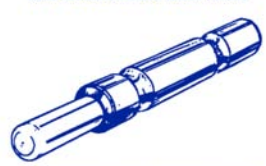
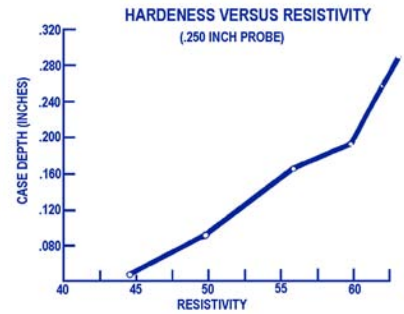


ILLUSTRATION OF WATER PUMP SHAFT

Developing a Graph

A graph of the individual case depths of a small batch of a typical automotive part, a water pump shaft, best illustrates the relationship between Model 100A readings and case depth. The material in this case was 1070 steel rod stock, that after machining was induction hardened. An untreated shaft produced a resistivity reading of 45. After induction hardening of several samples, case depth ranged from .080 to .280 inches. Note how the resistivity readings increased with case depth: The graph was created using the following procedure:



(1) The proper probe cartridge was selected. This is an important first step for any application. Probe pin spacing controls the depth of electrical current penetration. Typically, the penetration is about 1.5 times the spacing. We used this guide:

Probe Cartridge	Maximum Case Depth
50 (.050 inch)	.075 inches
100 (.100 inch)	.150 inches
250 (250 inch)	.375 inches

(For the water pump shaft, the 250 probe was used. Custom probes are available.)

(2) Readings were taken on the untreated sample. Several readings were taken on the part, averaged and graphed. The average resistivity was 45.

(3) Each hardened sample was tested in a similar manner. The resistivity averages ranged from 50 to 65.

(4) Each hardened sample was cut, polished and measured for case depth.

(5) The individual readings were plotted on the graph.

Establishing an "Accept/Reject" Threshold

Establishing a dividing line for good and bad heat-treated parts is a matter of experience with the Model 100A and the manufacturing quality that.s being sought. For example, if you were hardening water pump shafts and your specifications called for a minimum casing of .160 inches, a resistivity reading (based on our study) of 55 would be the cut-off between acceptable parts and scrap. On the other hand, if the part became too brittle with a case depth in excess of .240 inches, a cut-off of 62.5 could be established on the high side. Of course, doing your own study is the only way to determine what points are best for your application.

If your results are erratic, perform another correlation study using a different probe cartridge, or call for assistance at 609-716-4000, fax: (609) 716-0706, or e-mail us at sales.systems@mistrasgroup.com.

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