Measuring Plating Thickness on Fasteners

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Over the past six years one of the most frustrating pursuits I have experienced has been to find an economical, accurate, and fast plating thickness tester for fasteners to offer to our customers. There are testers which are fast and economical, but they are inaccurate. There are testers that are fast and accurate, but are not economical. Below I will disclose the findings of my search for the ideal fastener plating thickness tester for electroplated finishes on magnetic fasteners. I will briefly give the types of testers and comment on their accuracy, speed, and approximate cost.

Before discussing the various equipment for testing fastener plating thickness a few things about the details of testing fasteners need some explanation. First of all, it should be noted that parties need to agree on where the plating thickness on fasteners will be measured. The plating thickness on fasteners is to be measured on "significant surfaces." That is described as a fastener surface that is visible after the fastener is installed in its assembly. This is most commonly the top of the heads of externally threaded fasteners.

This agreement is important because electroplating does not deposit evenly on fasteners. On externally threaded fasteners the plating is thicker on the ends than in the middle and on internally threaded fasteners the plating is thicker on the outer surfaces than on the inner surfaces. Two different measurements of thickness taken in two different locations can both be accurate, but dramatically different. This leads to a lot of controversies between suppliers and users that can be avoided by agreeing on the location to measure thickness.

Next, it should be realized that the general configuration of most fasteners makes the accurate testing of thickness much more difficult than the testing on other products. This is because it is rare to have a relatively large flat surface on a "significant surface" of a fastener. A lot of relatively inexpensive testers, such as magnetic types, are accurate on large flat surfaces, but totally ineffective on small contoured surfaces that are common to most fasteners.

X-Ray Method

X-Ray equipment is felt to provide the most accurate and one of the fastest methods of inspecting the plating thickness on fasteners. The size and configuration of the specimen fastener surface does not affect measurement results. This is a non-destructive test. Sample parts do not have to be discarded after measuring. Correlations among measurements is excellent. Measurements are instantaneous.

The disadvantage of this equipment is its cost. Basic X-Ray plating thickness equipment starts in cost at about $20,000 and goes up depending on various options one chooses to add.

Coulometric Method

Coulometric testing equipment performs the opposite process of electroplating. It is sometimes referred to as deplating. In this process a small electrical current is passed through the specimen while a confined surface is subjected to chemicals that eat through the plating. The length of time it takes for the plating to be removed is measured. That deplating time is then translated into the plating thickness on the measured specimen.

Coulometric equipment does provide accurate plating thickness results on fasteners when it is properly used. The measurement results of this equipment correlate closely with plating thickness measurements obtained by X-Ray. The basic equipment cost is about $5000.

The minor disadvantage of this equipment is that each measurement takes about 30 seconds. This is not necessarily exceedingly long, but it is less desirable than instantaneous measurements obtained by other methods. This is a destructive test method. Sample parts must be sacrificed to make measurements.

Metallographic Method

This thickness measurement is done by cutting the fastener in half longitudinally, mounting it in plastic, polishing the surface, etching the surface with chemicals, and then measuring the plating thickness visually through a microscope. This method is considered the referee method of measurement in some specifications. It is accurate if all of the steps are done properly. There is a lot of technique involved in doing this correctly. Improper sectioning and over heating of the fastener during polishing can cause distorted results.

The disadvantages of this method are equipment cost and measurement time. This method requires several pieces of equipment the total cost of which is about $10,000. The time required for the measurement of each specimen is about 20 minutes. This is a destructive test meaning that sample pieces must be sacrificed to make plating thickness measurements by this method.

Eddy Current Method

Many people mistakenly refer to this as the "Dermitron" method. When using the eddy current method a probe that is connected to the machine is touched to a fastener and instantaneously a measurement appears on a display. The speed of testing and the simplicity of the technique account for its appeal to its users.

Unfortunately, when this method is used on most fasteners the accuracy and repeatability are very suspect. There are two reasons for this. First, the equipment must be calibrated by the use of a plating thickness "standard" as are most other types of equipment. The problem with eddy current is that the standard must be made from the exact type of plating bath as that in which the

fasteners were plated or the measurements are likely to be inaccurate. This is not particularly a problem when the fastener supplier is doing their own plating and are in control of their bath composition, but if the supplier is using a variety of plating vendors the measurements will frequently by flawed.

The cost of eddy current plating thickness testing equipment is approximately $5000. Some units are changeable from eddy current to magnetic testing modes. As stated above, eddy current seems to work fairly well when only one plating source is used and the plating standards are properly matched to the bath composition being used. This method does not seem well suited for the typical fastener distributor operation where a variety of plating sources are used because parts come from a variety of vendors.

Magnetic Method

Magnetic plating thickness testing on fasteners is not very applicable from what I have seen in the past. This method seems to work well on painted and plated surfaces where the surfaces of the parts being tested are large and relatively flat such as on sheet metal, but on fasteners where the surfaces are small and contoured the accuracy seems to be very poor and unreliable.

Many people want to try to use this method because their are some very small, simple, inexpensive pencil or gun-like testers available. Unfortunately, these are not at all accurate in the thickness ranges used on fasteners. The magnetic equipment that might be suitable for these thickness ranges, but which do not resolve the surface size and shape problems, costs about $5000.

Drop Tester Method

The equipment used for this method drips chemicals at a regulated speed. The inspector starts a timer which in turn releases the drops onto the fastener's surface. The inspector observes the appearance change on the fastener's surface and stops the timer when he feels he first sees bare metal. This is a very subjective test, because it depends on the inspector's judgment as to when he sees the bare metal.

This method has been a standard practice for in-process inspection in plating operation for many years. People who use this method constantly can become fairly consistent, but the reproducibility of measurements among inspectors is a constant problem. It was a major improvement when it was introduced 30 or 40 years ago, but other methods are now known to be much more accurate and reliable.

Drop testing equipment costs less than $1000 which is inexpensive relative to other equipment described above. It is somewhat hazardous to use however, because if inspectors are not extremely careful they can get the testing chemicals on their hands, that can cause burns and skin irritations. This is the messiest method of all those discussed.

The results of our search for the best methods of plating thickness measuring equipment for fasteners over the past several years has lead us to the following conclusions:

1. If you can afford it, purchase an X-Ray plating thickness tester. It will provide the most accurate, and repeatable measurements of both platings and coatings on magnetic and non-magnetic fasteners. Its results are not influenced by the shape or size of fastener surfaces. The measurement results are instantaneous and, because it is a non-destructive test sample parts do not have to be sacrificed.

2. If you can not afford X-Ray equipment purchase a coulometric tester. It is applicable to all fastener shapes and sizes. It is versatile and it costs about 25% as much as X-Ray equipment. It provides accurate, and repeatable results. Its disadvantages over X-Ray are that it is slower and it is destructive. Other than that it is a good second choice.

We are hearing of a lot more arguments between fastener buyers and suppliers now over plating thickness. Suppliers need to look seriously at these different testing methods and be prepared to discuss them with customers so that agreements on methods and equipment can be made to avoid unnecessary controversy. This is another example of finding that the proper evaluation of fasteners is much more difficult and complicated than people think before actually delving into the exact details of the requirements and what it takes to comply with them.