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Crucible Tech Talk

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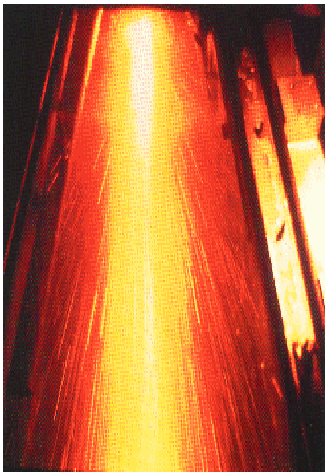

Atomization of molten metal in the CPM process

Abrasive Wear-
\a-'brā-siv 'waer/ *verb*

The removal of material from a surface by mechanical action of abrasive (hard) particles in contact with the surface.

Inside this issue:

Wear Testing: How is it Done?

The wear resistance data in our data sheets and literature comes from either the cross cylinder wear test or the pin abrasion wear test. The cross cylinder wear test is the most predominantly used test by Crucible and measures metal to metal or adhesive wear. The pin abrasion test measures abrasive wear.

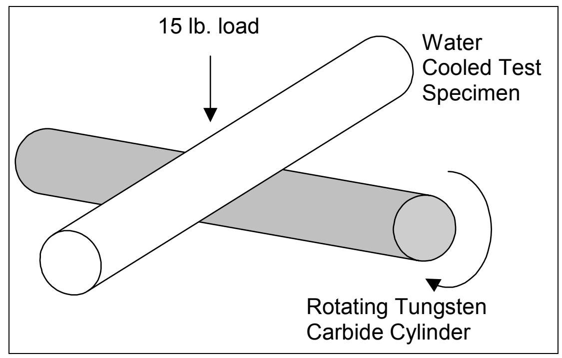

Fig. 1 Picture of cross cylinder wear test

The cross cylinder wear test schematic is shown in Fig 1. The specimen is an internally water-cooled cylinder that is the stationary wear member. The reference member, positioned perpendicularly to the specimen, is usually a tungsten carbide cylinder. The tungsten carbide cylinder is rotated at 667 rpm with a steady load, usually 15 lbs. applied with weights. No lubrication is used.

As the test progresses the specimen is locally worn off in the contact area. From time to time the extent of the wear is determined by measuring the depth of wear and converting it into wear volume by a relationship specifically derived for this purpose. The wear rate can then be computed as:

$$\text{Wear Rate} = \frac{\Delta v}{L\Delta s} = \frac{\Delta v}{L\pi d\Delta N} \qquad \text{Units} = \frac{in^3}{(lbs)(in)} = \frac{in^2}{lbs}$$

Where: v = wear volume
L = applied load
s = sliding distance
d = diameter of rotating member
N = number of revolutions of rotating member

The results in our data sheets are expressed as the reciprocal of the wear rate in pounds per square inch or psi units. The higher number indicates a higher degree of wear resistance.

The pin abrasion test is performed by pressing a 1/4 inch diameter test specimen against a dry 150 mesh abrasive cloth which is attached to a movable table. The table moves back and forth and indexes automatically to allow the specimen to transverse the abrasive in a non-overlapping pattern for 500 inches. A load of 15 lbs. is applied to the specimen and the specimen rotates around its axis at 22 rpm. The weight loss is determined and using the density, the volume loss can be calculated. In this test a lower number indicates a higher degree of wear resistance.

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Material Fatigue

Many people have heard of the term fatigue, but don't really know what it is. A material fails by fatigue when an alternating stress is applied which is greater than the yield strength of the material. A material can fail in fatigue in less than 100 cycles or millions of cycles depending on several factors. The fatigue crack will typically start at the area of highest stress and lowest local strength. Normally this is at or near the surface. Once the crack is started the crack travels a bit further during each cycle until the remaining metal is not strong enough to support the load and the part fails.

Fatigue failures are often easily identifiable. The surface of the fracture near the origin is typically smooth and the surface will typically exhibit lines called *beach marks*. These *beach marks* are formed when the load is applied in a cyclic manner. The observation of beach marks suggests a fatigue failure, but the absence of beach marks does not rule out fatigue failure.

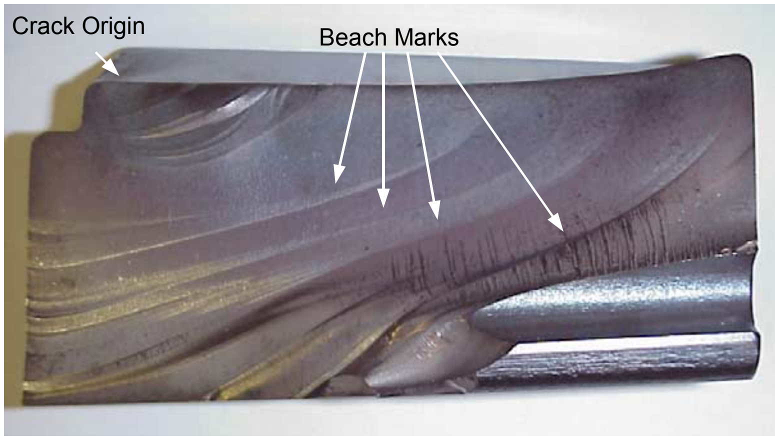

Figure 1. Example of a fatigue failure

Hardness vs. Strength

The metallurgists at Crucible Service Centers continually receive questions regarding the tensile strength and yield strength of materials. Usually it's for someone using some sort of finite element analysis to determine the forces and stresses on a particular part with the help of a computer. The strength of a material is directly related to the hardness, and is independent of the grade. For example, if you have S7 at 48 HRC and H13 at 48 HRC they will have similar ultimate tensile strengths. The yield strength which is the stress that begins to cause permanent deformation is going to be approximately 80-95% of the tensile strength for most tool steels. A less ductile material will have its yield strength closer to its tensile strength due to the lack of elongation and reduction of area during the tensile test. The relationship to hardness and tensile strength can be found in the tables section of our ***Tool Steel and Specialty Alloy Selector.***

The strength of a material is directly related to it's hardness, independent of the grade.

Steel Specifications

How can you tell if our steel meets the specifications a customer puts on a purchase order?

You can't, unless you review the specification information entered in our certification system when we put it into stock. When we receive any material into our inventory, it has to be supplied with a certification from the manufacturer, stating what specifications the material will meet. If the supplier's certification information does not include a certain specification, then there is a chance the material does not meet that specification, and might not be suitable for the customer. If you get a purchase order from a customer with a specification you don't recognize, call the technical department in Camillus. Often we can get the supplier to review the material and issue a new certification for us, and when we can't, it is probably because the material doesn't meet that specification in the first place!