ISSUE
0819

MONTHLY
JOURNAL OF
EDM TECHNOLOGY

EDM TechTimes

this issue

Purpose

As you review this newsletter, I hope you can appreciate the time and effort it took to put this together.

Having been in this business for over 30 years I find that over the last several there has been a huge increase in bad, incorrect information and half-truths provided to EDM users.

My salespeople and I experience this every day with clients that have been completely misinformed. My family has and is in manufacturing here in the USA. I believe you become competitive by having solid, documented information to make solid business and manufacturing decisions.

Whether you buy from my company or not, I hope you can use this information to grow your business and bring some manufacturing back to the USA.

Fred A. Wisen

President

North American EDM Supplies Inc.

What Is Tensile Strength.

Tensile strength is a means of determining the maximum load-bearing capacity of a given material analyzed on its ability to resist stretching and breaking. This property is expressed as PSI (Pressure per Square Inch) or N/mm^2 (Newtons per Millimeter Squared) also known as MP_a (MegaPascal). It is calculated by taking the maximum load in pounds per square inch divided by the cross-sectional area of the wire, which will provide the PSI rating.

It is important not to confuse Tensile Strength with Fracture Resistance or Wire Hardness. They are very different, and each has its own importance in the EDM process. This is the point of most confusion and miss information regarding wire. Uninformed / misinformed salespeople and service personnel will either use the wrong terminology or do not have a full understanding of EDM wire and its characteristics.

Wire Type	Tensile Strength (MP_a / PSI)		Common Name
Copper	234 – 420 MP_a	34,000 – 60,000 PSI	
Brass	900 – 1100 MP_a	130,000 – 160,000 PSI	Hard
Brass	490 – 520 MP_a	71,000 – 75,500 PSI	Soft / Half-Hard
Brass	390 – 400 MP_a	56,500 – 58,000 PSI	Super Soft / Soft
Steel Core	2000 MP_a	290,000 PSI	
Bronco Cut X	520 MP_a	75,500 PSI	X Cut Wires
Molybdenum	1900 MP_a	280,000 PSI	Moly
Most Gamma, Double / Dual Coat and Specialty wires are in the 900 MP_a Range			

Sent to you by:

North American EDM Supplies Inc. www.edmsupplies.com (440) 918-3770

EDM WIRE TERMINOLOGY

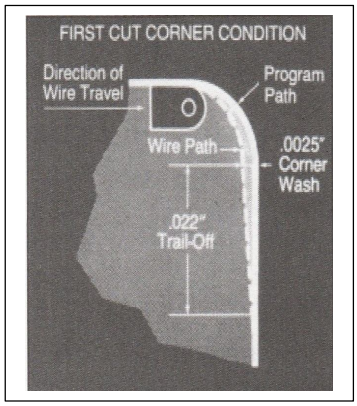
Hardness: Also called the temper of the wire is the measure of its ductility. The ability of the wire to elongate (stretch / compress). Hardness and Tensile Strength are not the same thing. Soft wire can elongate from 15 – 25% and is used for taper cutting above 7 degrees.

Conductivity: is a means of measuring the wires capability to carry electrical current. The higher the conductivity the more power the wire can handle and the faster the cut.

Vaporization Point: Also called melting point. A low vaporization temperature assist in cutting as follows: the faster a wire vaporizes (Sublimates) the faster heat is transferred to the workpiece increasing the cutting speed. Also, the heat is removed from the wire maximizing its working strength. It reduces "dirt" and recast as the wire is vaporized and not melted to the workpiece. The pockets formed on the wire aid in flushing as do the rapidly than collapsing gas bubbles (Vapor Pressure)

Does It Really Matter and If So Why?

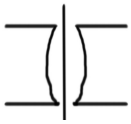
On the EDM machines Tensile Strength comes into play when talking about wall straightness. Even though the wire never contacts the workpiece the process of EDMing creates pressure against the wire from the sparks generated. This causes the wire to lag behind the guides slightly, the less tensile strength the wire possesses the more exaggerated this becomes. It increases dramatically as you increase the part height and forward push of the cut. This can cause a corner washout on the workpiece.



This lag, similar to a truck making a corner, causes the wire to "cut" the corner. This can range from a few tenths on skimming to a couple of thousandths on roughing cuts.

Newer EDM machines have reduced or eliminated this issue in using the processor to 'look ahead" in the program and slow the EDM down as it enters the corner. This slow down allows the wire to catch up and swing the corner accurately.

A second condition that can exist is the "barrel" / "belly" effect caused by the wire vibrating within the cut. Normally occurring at the center of the workpiece and very noticeable on taller workpieces.



Now we are at the point where tensile strength comes into play and moves up the ladder of importance.

Lower tensile strength wires will always cut faster than high tensile strength wires. They allow for elongation and will flush better then higher tensile strength wires.

To remove or eliminate corner wash and barrel effects the wire tension should be set higher. This means that a high tensile strength wire is needed to assist in straight walls and accurate corners. Most importantly on skim cuts.

High tensile wires with the tensioning set to a higher limit will also assist in reducing vibration.

Not Causing My Wire Breaks!

What crazy things are you saying?

All too often we hear that the wire is breaking because of tensile strength. Or it is used as the only criteria for wire selection, Many EDMers, Salespeople and Service Technicians believe that the higher the tensile strength the less wire breaks they will encounter. This is true if you are running wire smaller than 0.0024" diameter. But for most of the EDM processes this is not the case. Since most, if not all, wire breaks occur BELOW the actual tensile strength of the wire this logic does not apply. It is a fallacy.

To prove this point. Put a spool of your wire on the machine, turn the tension up to the correct setting, turn on the wire spool, now sit and wait for the wire to break. You will need to go home before the wire breaks.

So tensile strength is not the most important factor in wire breakage.

Wire toughness or resilience is a better metric to use. Described as the ability of the wire to resist the hostile environment that occurs during the EDM process in the spark gap.

Let's talk about what is the EDM process in technical terms: It is the removal of material from two electrodes by vaporization along with the pressure dynamics as established in the spark gap by the collapsing of the plasma channel. Still today there are varying thoughts of what is really occurring in the spark gap. At this time there is not a definitive answer or agreement.

We do know what leads up to a wire breakage and some of the steps that can be used to reduce the occurrence.

As you know when EDMing, the wire leaves the workpiece smaller in diameter than when it entered. The cross section of the wire is reduced by spark erosion as it moves through the workpiece. This provides a considerable amount of stress to the wire. At the same time, craters are being burned into the wire, many larger than those on the workpiece. These craters become flaws in the wire and begin to create cracks reducing the fracture resistance of the wire. Toss in too much current, poor flushing, insufficient wire travel speed and secondary discharge and you will exceed the stress capability of the wire, resulting in a wire break.

Now we know that toughness not tensile strength is important in wire selection as related to wire breakage.

EYE ON IT

Current Industry Trends

There are a number of new and very high-tech wires being developed for the wire EDM process.

Some of these can be quite exotic as in a titanium coated brass alloy wire.

You have Brass Wire, Zinc Coated, Gamma, Gamma Coating on Beta brass, Brass Alloy Core with Epsilon / Gamma coating, Brass Core with a Brass Alloy Coating and of course a number of Stratified wires.

A difficult decision for most shops as you balance cutting performance (parts out the door) with initial cost.

Let's Get Technical

The high-speed and high-precision machining can be realized through improvement of the electrical discharge machining performance since; the important process variables have direct effect on performance characteristics such as machinability, machining speed etc. For high speed cutting and high precision machining any wire electrode should have physical properties IE: high conductivity, tensile strength, elongation, straightness etc. In wire EDM, tensile strength has only a minimal impact on wire breakage while toughness controls its frequency. However, the material characteristic such as fracture toughness has been shown to control wire breakage frequency. An EDM wire will break when a discharge (or DC arc) introduces a flaw in the wire which is greater than the critical flaw size necessary to produce catastrophic failure under the preload tension that has been applied. Many high strength materials, including EDM wires, are notorious for their low fracture toughness, that is, their inability to withstand relatively small flaws without failing. Each and every discharge in the EDM process makes a crater, which is termed as defect or flaw, in both the wire and the workpiece. As flushing conditions deteriorate, those flaws tend to become larger and larger, eventually causing catastrophic failure of the wire.

CONCLUSION:

Plain brass was an advance over copper wires. Composite wires have replaced zinc-coated as the wire of choice for workpieces. The Composite wires have a brass or copper alloy core that is surrounded by a layer of pure copper and / or brass alloy and coated on the outside with zinc-enriched brass. Wires with greater tensile strength can be made, but they face diminishing benefits in terms of increased resistance to breakage, and greater tensile strength is usually obtained at the expense of fracture toughness. For tall work pieces copper clad steel wires are used. The zinc-enriched outer coating of brass improves flushability, its thickness determines how long it will last in the cut. Diffusion annealed wires offer resistance to breakage. Alpha phase, beta phase and gamma phase coatings have significant improvement over plain wires. These high-performance wires significantly increase wire EDM productivity but are associated with certain limitations such as high cost, flaking, straightness and possible damage to scrap chopper and may not be used on all the wire EDM. Caution should be taken before putting a new hybrid wire on the machine.

References: Pandey P. C. and Shan H. S. "Modern Machining Processes", Tata McGraw-Hill Publishing Company, 1980, pp. 79-80. [2] "New EDM wire is tough to break - electrical discharge machining wire", Rea Magnet Wire Co. Inc, Modern Machine Shop, Feb, 1997 [3] "Choosing High Performance EDM wires", Chirtopher Wilkins, GISCO Product manager [4] Albert M. "Reaching New Heights with Wire EDM", Modern Machine Shop 1997 [5] Kern R. "Techtips" EDM today, 2007 [6] Aoyama, S., et al "High-performance Coated Wire Electrodes for High-Speed Cutting and Accurate Machining" Hitachi Cable Review No.18 (Oct.1999) [7] Kuroda H, et al. , "Development of High Performance Coated Wire Electrodes for High-Speed Cutting and Accurate Machining" Hitachi Cable Review no. 22(Aug. 2003), [8] S. Aoyama, et al.: Hitachi Cable Review, No. 13, 75, (1994) [9] US Patent No.1896613-1933

Presented for your enjoyment and information by ProSource EDM Consumables Inc.

Please send your comments, questions or ideas for future newsletters to Sales@prosourceedm.com