

*Techtips is a collection of useful ideas, techniques, and procedures designed to further EDM knowledge.*

## TechTips



*by Roger Kern*

# Safe & GREEN EDMing

In contrast to many of the chipmaking manufacturing processes, EDM is considered to have a low incidence of operator injuries combined with a minimal impact on the environment. *This article will explore both the safety and environmental aspects of EDM.*

### — SAFETY —

Safety should be the foremost concern in every job. The fact that EDM is not a dangerous process should not lull us into complacency about EDM safety. Let's examine some of the more significant hazards associated with EDM.



### Electrical Hazards

Grounding: The best protection against electrical shock is to be sure that the machine is properly grounded. Most EDM manufacturers recommend driving a copper clad ground rod through the cement into the earth adjacent to the machine, and bonding the machine to the rod with a heavy gage copper wire. If this is not possible, a heavy gage copper wire should be routed to the nearest reliable earth ground in the

plant. Do not rely on metal conduit or the jacket of BX cable to give a reliable ground. Also, if utilizing a water pipe as a ground, be sure to bond the ground wire to the pipe where it enters the building, before the water meter or any water filter, as plastic components in those elements may break the electrical path to ground.

Line voltage hazards: Most EDMs are supplied by 240 or 480 Volt 3 phase AC power. These voltages can easily kill you if you inadvertently come in contact with them. Line voltage power is present at numerous contact points in the Power Supply, Machine Tool, CNC, and Dielectric system control cabinets and junction boxes. Always be certain to cut off the AC power at the disconnect on the wall before opening any of these cabinets or junction boxes.

High voltage hazards: Inside the power supply cabinet you may find DC voltages as high as 300 Volts. This type of direct current is even more dangerous than line voltages, since contact with direct current will likely "freeze" your muscles and not allow you to let go.

Cutting voltage: Contact with the spark erosion pulses present on the wire or the electrode can cause serious injury.

Anyone that has been around EDM for any length of time has probably been either "tickled", "zapped", or both. Depending on the machine type, burn parameters, degree, and type of contact, the net result of such contact can range from an annoying jolt, a serious electrical burn, to unconsciousness. In my 43 years of EDM experience, I have been tickled many times, thrown across the room once, and burned once. The burn resulted from adjusting a flushing magnet on a wire machine during a burn, and took more than a month to heal. The best rule is to pause the cutting action while making any adjustments in the area of the cut. It is also prudent to keep one hand behind your back when in proximity to any "hot" EDM components. By keeping one hand behind your back, you will avoid the possibility of

dangerous electrical current passing through your chest from one hand to the other. Also, be advised that it isn't necessary to touch the wire to get zapped. Since de-ionized water contaminated with wire and workpiece debris is somewhat conductive, you can get shocked just by coming in contact with the water near the cut.

## Explosion Hazards

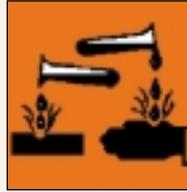
Explosions were once a common hazard when sinker EDMs utilized kerosene as a dielectric. Kerosene vapors can be quite explosive. Today, the hazard of concern with both Wire and Sinker EDMs is that of trapped explosive gases that are a by-product of the EDM process being ignited in blind cavities or fixtures. EDMing with either water or Hydrocarbon dielectric will produce Hydrogen gas. Normally, this gas is vented harmlessly to the atmosphere. However, in certain applications there can be areas in the workpiece or the mounting fixture where the gas can accumulate. If there is also trapped air in the same area that has not been displaced by the dielectric, an EDM discharge can ignite the mixture with violent results. I have witnessed parts being blown off their fixtures, electrodes being blown off their holders, and most of the oil in a dielectric tank being blown onto the operator and the floor. These are very uncommon occurrences, but the potential should always be considered.

## Fire Hazards

Fire is normally associated with Sinker EDM. Even though modern dielectric fluids have a flash point in excess of 240°F, once that flash point is reached, a filled dielectric work tank will fuel a raging fire. Numerous shops have burned due to Sinker EDM fires, especially Sinker EDMs that were left burning overnight unattended. A number of Sinker fire safety tips are listed below:

- Always keep a minimum of 1" of oil over the burn area
- Maintain oil temperature at a level no higher than 85°F. Utilize a chiller if necessary
- Install an automatic fire extinguishing system on each Sinker EDM. The best bet is to purchase such a system as an option when the machine is initially purchased.
- Install a central station monitored smoke alarm and heat detector over each machine.
- Inform your local fire department of the location and sump capacity of your EDMs. Give them a tour of your facility.
- Avoid high amperage unattended burns. Anything that can go wrong may. Oil levels drop, and float switches fail. If the machine is unattended, have someone from another area or even a watchman regularly monitor the machine.

Any electrically powered device can catch fire. Since most of us leave our CNC equipment on 24-7, fire is always a possibility. Fans freeze up, capacitors blow, solenoid coils melt, frayed wires short out. I have even seen an idle Jig Grinder catch fire when a column air circulation fan froze up. Continual monitoring of areas containing equipment is a must. Also, it is critical that all fire extinguishers near electronic equipment be either Freon or CO<sub>2</sub>, since dry chemical or water extinguishers will do more damage to the equipment than the fire.



## Chemical Hazards

In a Wire EDM, the primary chemical hazard is from the cleaning solutions some operators use to clean the machine and remove scale from the tooling or the work tank. Many of these solutions contain phosphoric or muriatic acid. Even though many of these chemicals may be available in your local hardware store, their use in an industrial environment is very dangerous and possibly illegal. I once visited a customer whose complaint was that the machine work light was melting. It turned out that the customer was using an acid based cleaner in a spray bottle and the overspray was getting on the lamp. Acid cleaners + spray bottles = lung damage! Read the MSDS carefully before allowing the use of any cleaner in your shop. If it indicates the cleaner contains acid (*See Fig. #1*), or recommends goggles, gloves, face shield, and eyewash stations (*See Fig. #2*), find something else. There are salt based cleaners that will safely do the job.

### 2. COMPOSITION/COMPONENT DATA

Chemical composition: Mix of organic acids, inorganic acid

Hazardous contents: none

*Fig. #1*

### 6. MEASURES TO BE TAKEN IN THE EVENT OF ACCIDENTAL DISPERSION

Individual precautions: Wear gloves, goggles and protection suit. Avoid contact with skin and eyes.

*Fig. #2*

In a Sinker EDM, the primary hazard is that the dielectric fluid may cause skin problems. This is primarily because petroleum based products act as a solvent and remove the fat from the operator's skin. This will often result in dry and cracked skin, which will be the entry point for dermatitis. The other dilemma is that the thinner oils that flush so well, also get into the pores of the skin. In my experience, certain synthetic dielectric fluids made from cosmetic grade materials whose viscosity is adjusted to the point just above skin pore penetration, will solve this problem for most operators.

## Bacteria Hazard

The water in the dielectric tank in a Wire EDM is susceptible to the growth of bacteria. Slime on the walls of the dielectric tank or the sight glasses are an indication of this problem. Operator contact with bacteria laden water is not a good thing. This problem, while not common, is readily addressed by the addition of an ozone generator to the

machine. This option should also be seriously considered if the machine is cutting medical parts.

Bacteria can also grow in dielectric oil. It is a well known fact that bacteria thrives on moisture laden diesel fuel. If the oil in your tank smells, change it!

## Poisoning Hazard?

The possibility of lead poisoning in coated wire was raised in the mid '90s. Extensive research and testing have conclusively proven that the miniscule amounts of lead present in today's plain and coated wires produce no measurable increase in either airborne, waterborne, filter, or resin lead levels.

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## — EDM and the Environment —

As an avid high performance car and boat owner, it is unlikely I will ever be nominated to the Greenpeace board of directors. However, as socially responsible manufacturers, we are entrusted with the stewardship of this planet for both our own benefit as well as future generations. We are also operating under the scrutiny of State and Federal EPA rules. These rules essentially say that you are financially responsible *without limit* for the waste you generate *forever*. Regardless of your environmental ardor, the previous sentence should make you a believer. Let me reinforce this concept with a brief story:

In the eighties, my company utilized 1-1-1 trichloroethane as a degreaser to clean the dielectric oil from parts after EDMing. We purchased this product from a reputable dealer of a national chemical company, who also handled the recycling of this product for us. They relied upon a recycling company that was fully permitted by both the state of Massachusetts and the Federal Government. Unfortunately, the recycling company disposed of the tailings from the distillation process by dumping it into wetlands between two major rivers. The recycling company ultimately went bankrupt, leaving a \$24,000,000 Superfund reclamation project in its wake. *The customers who sent materials to this site to be recycled were held financially responsible for the entire clean-up cost.*

Fortunately, EDM is one of the more environmentally friendly manufacturing processes. Its dielectric systems are closed loop and most of its consumables can be recycled. Let's examine in detail the environmental impact of some of the components of the EDM waste stream.

## De-ionized Water

The de-ionized water that serves as the dielectric in both wire EDM and most small hole systems is one of the most harmless of the machining fluids. However, occasionally the fluid needs to be replaced. It would seem logical that the disposal of filtered and de-ionized water should not be a prob-

## Other Hazards

- Spilled dielectric, especially on a coated concrete floor, turns the floor into a skating rink, whether the dielectric is water or oil.
- Spilled resin beads are like having a million ball bearings on your floor, except you can't see them until after you fall.

The EDM Department is probably one of the safest places in the shop to work. However, one can never be too safety conscious, and a little extra attention to these details can make it significantly safer. No job is worth getting hurt for.

lem. However, some municipalities consider even minute amounts of Zinc to be a pollutant, and do not allow EDM water to be disposed into their sewer systems. If you are faced with this situation, you can either evaporate the water in an on-site commercial evaporator, or barrel the water and pay to have it removed by a reputable recycling company who will likely evaporate it for you.

## Dielectric Oil

The dielectric oil from an EDM machine is typically classified as a regulated waste (and possibly a combustible waste). While some shops burn this oil in their own waste oil furnace (which can have unforeseen complications with regards to air quality permits and emissions), a better plan is to engage a reputable waste management company to remove it from your premises. They will likely blend it as fuel for a cement kiln, whose high temperature combustion will safely dispose of it.

## Degreaser

Sinker EDMers are still faced with the problem of removing the dielectric oil from workpieces. Many use some form of degreaser. The only safe and legal methods of dealing with the disposal of contaminated degreaser are either a degreaser recycling program or disposal by a reputable waste management company.

***Important Note:*** Almost all shipments of waste fluids must be accompanied by an EPA Manifest. (*See Fig. #3*) The manifest details the contents of the shipment and remains on file with Federal and State EPA offices *forever*. Often, the waste management company will produce the manifest for you and require you to sign it. It is important that you carefully read the manifest that you are signing. If you sign a manifest that incorrectly describes the material you are shipping as hazardous waste, your real estate could be improperly classified as a potentially contaminated site that has produced or stored hazardous materials, which could make it difficult or impossible to sell the property in the future. (In the State of Connecticut, the Environmental Transfer Act severely impacts the transfer of properties that have manifests on file indicating that hazardous waste was shipped from that property. The act assumes that the property is contaminated unless you *prove* otherwise!) Save your copy of any waste manifest *forever*.

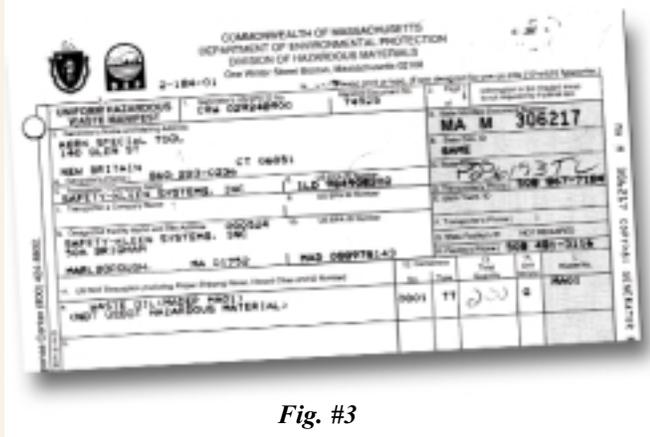


Fig. #3

## Dielectric Filters

### Wire EDM Filters

The most common method of disposal of Wire EDM filters is to toss them into the trash. However, if your filters contain such metals as chromium (from cutting tool steel or stainless steel) or cobalt (from cutting carbide) and if they are ultimately disposed in a landfill, ground water pollution may result. (Many of the more popular style filters are now made with no metal components to facilitate disposal by incineration.) Here again, a reputable waste management company can take them away for proper disposal. One vendor (Ebbco) offers special cleanable filters along with a filter cleaning program. They will clean your filters and return them to you, as well as replace them on a regular schedule. With this program, your machine either has to have or you must convert to Ebbco housings. If your company is looking to eliminate filters from your waste stream, this type of program may be of interest.

### Sinker EDM Filters

The only accepted method of disposing of Sinker EDM filters is by hiring a reputable waste management company to take them away for proper disposal (usually by incineration). Sinker EDM filters should never be disposed into the trash.

## De-ionizing Resin

Virgin de-ionizing resin is a not a hazardous material. Exhausted de-ionizing resin is quite another matter, since it has chemically absorbed all sorts of metal ions from the dielectric. You must never dispose of exhausted de-ionizing resin in the trash! In my opinion, regeneration of your bottles and bags is the best way to go, since you never touch the resin and all the EPA compliance issues disappear. Some purists still insist on using only virgin resin, but they too have the option of having an outside firm refill the bottle or bag and safely dispose of the exhausted resin. If you insist on purchasing virgin resin and changing the resin out yourself, make arrangements with your virgin resin supplier to take the exhausted resin back. They will often do this at no charge, since they can regenerate the resin and re-sell it.

Remember to carefully check your resin service provider's permits and credentials, since as with fluids, you are ultimately responsible for the proper handling and treatment of your exhausted resin.

## Wire

Used wire is 100% recyclable. With today's inflated commodity prices, used wire has considerable value, so shop around for the best price. Some metals recycling companies will offer less per pound for coated wires, mistakenly thinking that the coating is a contaminant to the base brass or copper wire. If they understand that the coating itself is either zinc or alloy brass, they will not likely penalize you for it. Moly and Tungsten wires are both very valuable as scrap. An internet search will yield numerous companies willing to pay considerable sums for Moly or Tungsten wire.

## Spools

Unfortunately, I am currently not aware of any company that collects and recycles plastic wire spools. Spools are bulky items, and the cost of transportation often exceeds their value. They usually are discarded with the trash. Shops with large numbers of spools should contact a plastics recycler.

## Radio Frequency Emissions

Have you ever noticed the interference that an EDM which is cutting causes to an AM radio? While this may be "music" to your ears, neighbors to your shop may not share your enthusiasm when they're trying to tune in the game of the week. EDM discharges generate radio signals. In fact, the first radio signals were produced by electrical discharges.

In order to minimize these emissions, some machine manufacturers include elaborate and expensive plans for shielding the entire EDM room. In practice, this is seldom done. However, a few simple steps can be taken to reduce the electromagnetic footprint of your shop:

- First and foremost, properly ground your machine as was described in the safety section of this article.
- If your machine does not have a wire chopper and coils the used wire into a plastic basket, consider surrounding it with a grounded, expanded metal (Faraday) cage. (Some machines used to come standard with Faraday caged used wire baskets.) Otherwise, the unshielded miles of wire in the basket can act as a huge antenna which will propagate discharge radio frequency emissions.

*With a little effort and common sense, our wonderful EDM technology can generate profit, while ensuring your safety as well as protecting the environment.*

*Next (IMTS) Issue: A compendium of operational and maintenance tips.*

*Any suggestions for future topics are welcome. Tell us what you would like to read about.*

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