EXPERT'S CORNER ▶▶▶

Fire!

Protecting Against EDM Machine Fires

by David Wilhite

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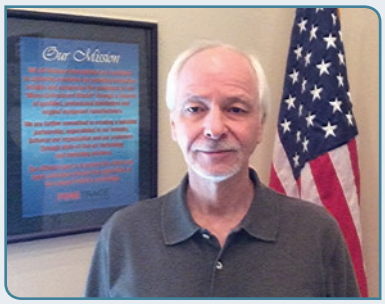

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EDM machines are designed to be as safe as possible from the risk of fire. Many of these machines incorporate sophisticated safety features such as dielectric level monitoring systems, anti-arc controls and fluid over-temperature alarms. Yet in spite of these protective measures, EDM machine fires can and do occur. When that happens, the ready supply of dielectric fluid in the work tank can erupt into a blaze that can cripple or destroy an expensive machine in under a minute and may grow to the point where it can threaten lives and property.

[Editor's Note: EDM's utilizing flammable dielectric fluids will be the primary focus of this article. However, fire hazards from EDM's utilizing deionized water dielectric will also be briefly addressed.]

An EDM fire produces intense high heat and dense black smoke that can be difficult to fight with a fire extinguisher. This type of fire has the potential to spread quickly to the fume extraction ducting and from there to the building's structure, often with catastrophic results. It is very difficult for someone who has never experienced an EDM fire to fully comprehend the speed at which it can spread or the danger it can present.

Some shop owners rely on an overhead water sprinkler system for protection against EDM fires. What they may not realize is that fire sprinklers are not designed to put out an oil fire and will not save a machine – in fact, sprinklers may actually cause flaming oil to spread to adjacent equipment and machinery. Recovering from the collateral damage caused by sprinklers can be expensive and can further increase business downtime.

The best way to protect against EDM fires is to install a fast and reliable automatic fire detection and suppression system, which many shop owners consider mandatory. Several EDM manufacturers agree, which is why many EDM machines now come equipped with automatic suppression systems as standard equipment or as an available option. If your EDM machine does not have an automatic fire suppression system, you can purchase an aftermarket system that can be installed on any new or previously installed machine.

An EDM machine fire can quickly damage or destroy a machine. Left unchecked for even a few minutes, it can cause catastrophic damage. In this article we'll look at some of fire risks inherent in EDM machines and how you can protect against them.

▶ EDM PROCESS HAZARDS

In EDM machines, two metal parts – an electrode (or EDM wire) and the workpiece – are submerged in dielectric insulating fluid and connected to a high current power source. The power source switches on and off hundreds of thousands of times per second, generating an enormous electrical potential between the electrode and workpiece. This potential is discharged as a spark which ranges in temperature from 14,500°F – 22,000°F (8,000° - 12,000° C).

The electrode and workpiece never actually touch each other – the distance between them is called the spark gap, and the dielectric fluid acts as a semi-conductor with pre-determined voltage and amperage characteristics which stabilize the eroding process.

Under normal working conditions the electrical discharges will always remain below the surface of the dielectric fluid. Should the level of dielectric drop below minimum operating levels, the electric arc may reach the ready supply of oil vapors. This is the greatest hazard

associated with EDM operations: the possible ignition of the dielectric fluid and vapor, which could spark a large and potentially very dangerous fire from the large supply of oil in the work tank.

▶ DIELECTRIC FLUID FLAMMABILITY

There are two types of dielectric fluids commonly utilized in EDM machines: hydrocarbon (petroleum) based fluids and synthetic fluids. Of the two, hydrocarbon-based fluids are the least expensive and most widely available, making them the fluid of choice for the many shops. Some manufacturers claim their dielectric fluids are non-flammable. These fluids typically have an open-cup fire point equal to or greater than 572°F (300°C). Although the likelihood of experiencing a fire when using these fluids is slim, they would be better described as "less flammable" rather than "non-flammable." For safety's sake, all EDM dielectric fluid should be considered flammable, even though the flash point is higher for some than others.

▶ ABOUT FLASH POINTS

An oil's flash point is the lowest temperature at which there is enough flammable oil vapor in the air to produce self-sustaining combustion when an ignition source is applied. This temperature will vary according to oil brand, type and viscosity. Ideally, the dielectric fluid used in EDM operations will have a flash point around 250°F (121°C), although flash points as low as 180°F (82°C) are not uncommon.

As a general rule of thumb, always keep your hydrocarbon fluid temperature below 100°F (38°C) when machining. If operating conditions cause the dielectric to go above 100°F, an auxiliary cooling system (chiller) must be used. Be sure to check the chiller is functioning correctly before each use.

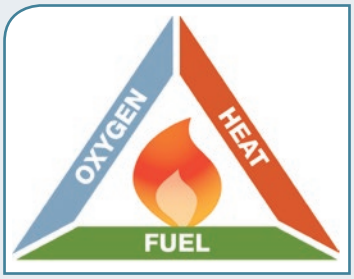
[Editor's Note: For best accuracy, most machine builders recommend that the dielectric temperature be maintained within a few degrees of room temperature.]

▶ THE IMPORTANCE OF MAINTAINING FLUID LEVELS

As previously stated, maintaining the proper level of dielectric fluid in the work tank is the most important factor in preventing an EDM fire. The dielectric fluid level must never be allowed to drop below the point in which a spark from the discharge process could contact oil vapors in the air. Under normal conditions, there will be a sufficient level of oil above the sparking area to prevent this from happening. However, if the oil level becomes too low, the electrode spark can become a potential source of ignition.

[Editor's Note: It is common practice to maintain the dielectric level at least one inch above the area where the discharges occur. This distance should be increased for high amperage burns.]

▶ THE FIRE TRIANGLE



The fire triangle illustrates the three elements necessary to produce a fire. These elements are:

- Heat
- Fuel
- Oxygen

Together, these three elements create a chemical reaction that produces and sustains a fire. Take away any one element and the fire will be extinguished.

There are various chemical gasses and powders are available that can break the fire triangle. These include:

Carbon Dioxide (CO_2)
Carbon Dioxide extinguishes a fire by taking away the oxygen element of the fire triangle and also removing the heat to some degree thanks to very cold discharge. Carbon dioxide is highly recommended for use on Class B and C fires.

Dry Chemical Powder
Dry Chemical Powder extinguishes a fire primarily by interrupting the chemical reaction of the fire triangle. The most widely used type of fire extinguisher is the multipurpose dry chemical which is effective on Class A, B, and C fires. However, dry chemical is not suitable for EDM fires because it leaves behind a residue that will contaminate dielectric fluids.

Clean Agents
Clean Agents include the Halon family of agents as well as the newer and much more environmentally-friendly clean agents such as FM-200 and Novec 1230. Clean agents extinguish a fire by interrupting the chemical reaction of the fire triangle at a molecular level. Clean agents are suitable for Class B and C fires. Clean agents may be a viable choice in some instances for EDM use.

Fire Classifications
Fires are classified according to the type of fuel that is burning. If you use the wrong type of extinguishing agent on the wrong class of fire, you could make things worse. It is very important to understand the four different fire (fuel) classifications:

- **Class A:** Ordinary combustibles such as wood, paper, cloth, rubber and plastic.
- **Class B:** Flammable liquid and gasses. This includes all hydrocarbon dielectric fluids.
- **Class C:** Energized electrical equipment (powered up EDM machine).
- **Class D:** Metal fires. Not to be confused with an EDM workpiece.

EDM fires are a combination Class B and Class C fires. Agents that deplete the oxygen supply, such as Carbon dioxide, work best on Class B and Class C fires.

Fortunately, many of today's machines are fitted with a safety interlock that stops the machine if the dielectric fluid drops to a level that is unsafe. In some cases shutdown will be sufficient to extinguish any flaming. Depending on machine brand, you may need to check and reset the shutdown switch each time you power up the machine. Note that some OSHA type e-stops are designed to kill machine power and de-energize the machine's motors and pumps, but will not shut off the AC's mains power to the machine.

[Editor's Note: There is another situation which can lead to electrical discharges occurring at the surface of the dielectric even when the dielectric level is well above the workpiece. It has been well documented that during extreme abnormal discharge conditions leading to a DC arc, a stalagmite of material will arise from the surface of the workpiece and grow vertically (with the ram backing off all the while) until the discharges between the electrode and the stalagmite reach the surface of the dielectric, igniting the oil vapors.]

▶ GAS IGNITION HAZARDS

Both Sinker and Wire EDM operations can generate flammable gases during machining. The type and amount of gases generated vary depending upon the type of dielectric fluid being used, the type of material being machined, dielectric fluid operating temperature, and the operating current and voltage.

Hydrogen gas can be generated during Wire EDM operations using deionized water as dielectric. It is critically important to ensure that hydrogen gas is not allowed to build up anywhere on the workpiece during machining operations. Hydrogen gas can be easily ignited by EDM sparking or by open flames – even by a lit cigarette.

▶ FUME COLLECTOR HAZARDS

In many shops one or more fume collectors are used to filter hydrocarbon by-products from the air. Over time, an oily residue can build up on the inside surfaces of these systems, creating a fire hazard. A hot-burning dielectric fluid fire has the potential to quickly spread through the exhaust system to the fume collector, and from there spread to the building structure itself, often with catastrophic results.

▶ CO_2 VS. CLEAN FIRE SUPPRESSING AGENTS

CO_2

A colorless, odorless, inert gas, CO_2 is one of the most effective fire extinguishing agents available. It is especially effective at suppressing flammable liquid fires and electrically energized fires. It is most commonly used today to protect equipment and assets in industrial applications.

CO_2 extinguishes fires by reducing the oxygen content of the protected area below the point where it can support combustion. It is also extremely cold and helps reduce a fire's heat to some degree.

The use of carbon dioxide is governed by its method of application and its intrinsic health hazards.

Exposure to carbon dioxide at high concentrations is lethal. However, because CO_2 is an integral component to human life, exposure to very low concentrations under certain conditions can actually be beneficial.

In EDM applications, CO_2 is applied locally, meaning the work tank area is gently blanketed with the gas to a predetermined concentration. The concentration is sufficient to suppress the fire without threatening occupants in the immediate vicinity.

Although local application of CO_2 in EDM applications is intrinsically safe, exposure to CO_2 should be avoided by shop personnel and CO_2 only be discharged in large, well ventilated spaces.

CO_2 is both abundant and cheap. The cost to charge/refill a CO_2 fire suppression system is well under $10 per pound. However, CO_2 fire suppression systems are typically sized much larger than an equivalent clean agent system in order to ensure that a sufficient volume of gas can be discharged over time to both suppress a fire and prevent re-ignition.

Clean Agents

Novec 1230 and FM-200 are today's "green" fire suppressing agents of choice.

Novec, manufactured by 3M, and FM-200, manufactured by DuPont, are considered "clean" fire suppressing agents because they have zero ozone depleting potential, and therefore do not contribute to global warming.

Novec and FM-200 are equally effective when it comes to extinguishing fires. The primary extinguishing mechanism of both agents is heat absorption. The agents absorb heat at the molecular level so quickly that the combustion process cannot sustain itself.

Novec and FM-200 have safety benefits when compared with CO_2. Both agents are people-safe and can be used in occupied spaces at normal concentrations. Unlike CO_2, Novec and FM-200 are acceptable for the total flooding of occupied spaces when used as specified by the US Environmental Protection Agency.

The cost to charge/refill a clean agent fire suppression system is currently about $75 per pound. However, due to recent volatility in the suppression agent market, the price of clean agents is subject to change without notice.

Clean agents are remarkably efficient at extinguishing certain types of fires, often in less than 10 seconds, and therefore can be sized smaller than an equivalent CO_2 fire suppression system. And because clean agents are intrinsically people-safe, the agents can be delivered at higher concentrations that help prevent re-ignition.

In summary: both CO_2 and clean agents are extremely effective forms of fire suppression.

CO_2 might be best described as a low-cost, non-damaging, non-conductive, multi-hazard protectant that is extremely effective on Class B and C fires. It is the preferred fire suppressing agent for EDM applications when discharged as a local application.

Clean agents such as Novec 1230 and FM-200 can be described as environmentally-friendly, people-safe fire suppression that may be appropriate for certain machining operations.

▶ CO_2 FIRE EXTINGUISHERS

A CO_2 extinguisher can be easily distinguished from other types of extinguishers by its horn-shaped discharge nozzle.

How to Use a CO_2 Fire Extinguisher

Note: *Before attempting to fight an oil fire be sure the extinguisher is rated for Class B and Class C fires.*

- Stand a safe distance away from the fire.
- Remove the safety pin.
- Lift the extinguisher by the handle/discharge lever and the horn handle. Do not grip the horn. It becomes extremely cold during use and can cause severe chemical burns and freezing of body parts.
- Aim the horn at the base of the fire and squeeze the lever to begin discharging the extinguisher. Remember that the contents of a CO_2 extinguisher is stored under pressure and can be dangerous if improperly discharged toward a burning liquid. Standing in front of a tank of burning oil and shooting it with CO_2 extinguisher will splash burning oil everywhere so be careful!
- Move the horn in a horizontal sweeping motion across the flames. As the fire starts to diminish move closer being careful not to cause any oil splashes.
- When the fire is completely extinguished release the discharge lever and back away.
- Check to be sure the fire is fully extinguished before leaving the area as re-ignition may occur.

Warning: *CO_2 can reduce the percent of oxygen in air when discharged and can cause injury or death at high concentrations. Use only in well ventilated areas.*

Fume collector fires are difficult to detect and extinguish using conventional fire suppression technology. Fortunately, some fire suppression companies such as Firetrace offer systems that automatically detect and suppress a fire inside the fume collector, right at its source, which greatly reduces the potential for a fire to spread to the building structure.

In the absence of an automatic fire suppression system for your fume collector, ensure that it is clean of residue buildup and properly maintained at all times.

▶ OIL MIST HAZARDS

Most high current EDM power supplies draw cooling air from the surrounding shop environment. If the air contains traces of oil mist, it will be pulled into the power supply and its associated electrical components. As with fume collectors, an oily residue may gradually build up on the inside surfaces of these systems, causing hot running electrical components to overheat, which can ignite the oil mist. To reduce the potential for fire be sure to inspect and clean your machine's power supply and electronics on a regular basis or install a filter on all electronic systems' air intakes.

▶ CONCLUSION

Fire safety should be a top priority for every EDM operation. Any machine fire should be treated as a dangerous and potentially life-threatening event. Therefore, your first concern should be to ensure the safety of yourself and others in the surrounding area. If the fire is too large to fight, evacuate to a safe distance and wait for the fire department to arrive. If you do fight the fire, make sure you have the proper equipment and training beforehand.

All EDM operators should be properly trained in the use of handheld fire extinguishers and the operation of the automatic fire suppression system. Operators should be aware of the potential for burning dielectric fluid to splash and spread from the discharge of a fire extinguisher. Extreme care must be exercised to prevent blowing flaming oil in the direction of anyone in the vicinity.

While an automatic fire suppression system should be considered mandatory for most EDM machines, it does not make up for improper use of these machines. Always follow the manufacturer's instructions and warnings for the operation of the machine. Never circumvent or disable safety features on a machine regardless of the presence of a fire suppression system.

FIRETRACE
AUTOMATIC FIRE SUPPRESSION SYSTEMS

▶ FIRETRACE AUTOMATIC FIRE SUPPRESSION SYSTEMS FOR EDM MACHINES

A Firetrace Indirect High Pressure (IHP) CO_2 system is recommended for EDM machines. (See Fig #1&#2)

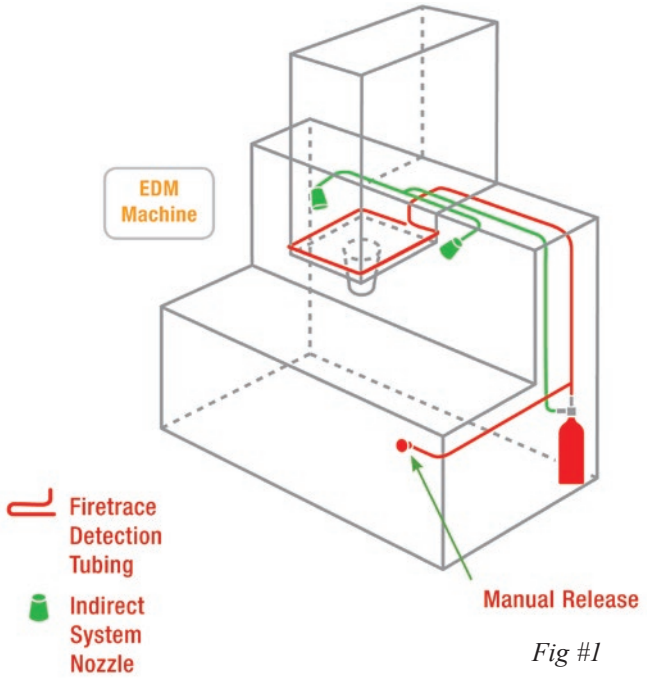


Fig #1

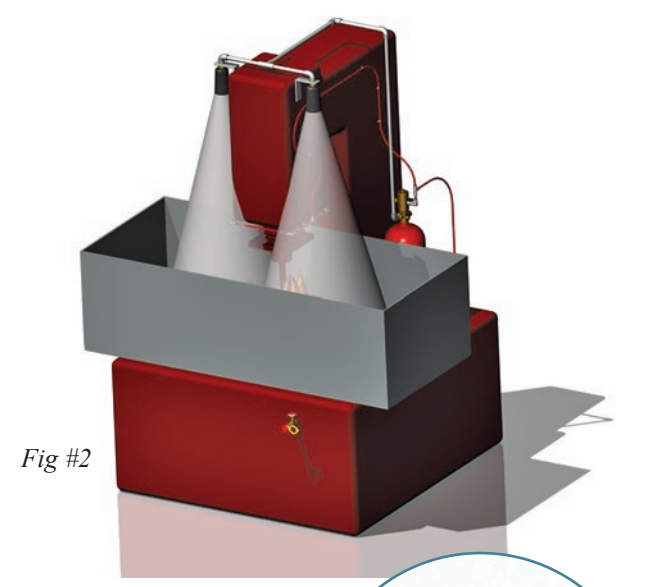


Fig #2

The heart of the Firetrace system is the unique, pressurized red Firetrace Detection Tubing. (See Fig #3) This pressurized polymer tubing is designed to burst when exposed to a fire's radiant heat, which triggers the release of the CO_2 fire suppressing agent.

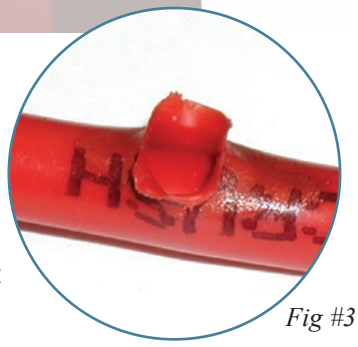


Fig #3

Firetrace System Advantages:

- Fast, reliable and cost-effective system activates automatically in the event of a fire
- Suppresses a fire in seconds, reducing or eliminating equipment damage and downtime
- Pre-engineered system is easy to install on any new or existing machine
- No power required, activates automatically
- Does not interfere with machine operation or maintenance
- Responds only to a fire's radiant heat so there are no costly false discharges
- Manual release option allows operator to activate system at first sign of trouble
- Pressure switch option can be configured to sound alarms and e-stop machines, oil pumps, and mist collectors
- Extinguishing agents are safe for people, leave no residue and will not contaminate expensive metalworking fluids or lubricants
- Stops overhead sprinkler system from activating, which can lead to extensive collateral damage
- Reduced downtime, no damage to machine or workpiece, no clean up, no loss of customer/account, reduced risk to shop personnel

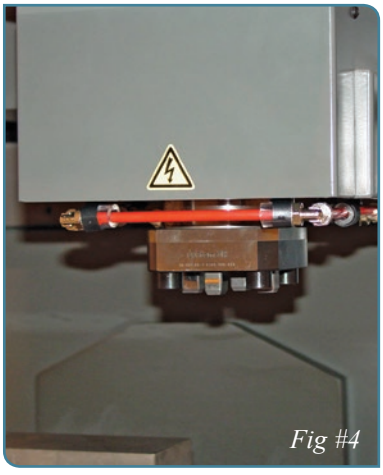


Fig #4

The red Firetrace Detection Tubing is routed around the base of the ram just above the dielectric fluid operating level, providing 360° of fire detection and suppression. (See Fig #4)

The DetectionTubing can also be run to the front of the machine when an optional manual release is required.

Fig #5

Fig #6

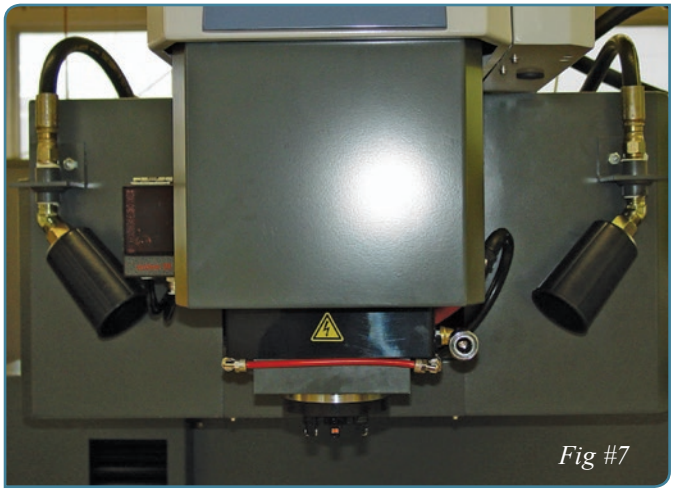


Fig #7

Firetrace offers options for manual activation (See Fig #5) and automatic machine shutdown (See Fig #6) in the event a fire is detected. Firetrace is also an effective fire protection solution for fume and oil collectors, electrical control cabinets and other machine shop risk areas.

Large nozzles installed well above the oil surface on both sides of the ram deliver a high volume of CO_2 to extinguish the fire. (See Fig #7) The CO_2 is delivered as a gentle mist to keep the burning oil from splashing, which would spread rather than suppress the fire.