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Modern Machining Center Fire Suppression Systems

Modern machine tools produce chips at high temperatures that, when combined with oil-based coolants, can present a clear and present danger of fire. One, very up-to-date shop we studied had suffered twelve fires in the past eighteen months. The first fire, fortunately, did not cause much damage because the operator was standing there with a run-of-the-mill extinguisher nearby. Had this occurred during a Lights-Out production, the results could have been catastrophic. The remaining eleven fires were mildly interesting.



An overhead installation with the pressure gauge available for checking as part of the daily operation.

What made these subsequent fires non-events was the installation of fully-automatic, Halon based extinguishing systems on all twenty-six of their machine centers.

The Nature of the Beast

Let's back up a bit and discuss the nature of fire. Contrary to popular opinion, oxygen does not burn; fuel burns when given sufficient heat and oxygen. Take away any one of those three elements and no fire. If the fuel-oxygen combination generates enough heat, the process becomes self-sustaining. If it doesn't, the fire goes out.

Another wrinkle starts with the fact that the process of combining oxygen with a material is called oxidation. Do it slow and it's called rust; do it fast enough and it's called fire. What has made gold so valuable over the centuries is it's resistance to this "rust". All other metals, however, will succumb in greater or lesser degree to the ravages of oxygen. In fact, the dull patina that freshly-cut aluminum gets in a just a couple of hours is aluminum oxide, another form of rust.

With that in hand, we can see that virtually any material can burn given enough heat and oxygen – witness the oxy/acetylene torch. We heat the steel to a bright yellow glow and hit the trigger to inject pure oxygen. Sparks go flying, the metal literally burns, and there's a hole where there was once solid metal. The oxygen is not just pushing the molten steel out of the way; if that were all that was needed, a push by any gas would work.

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Steel, however, is not a good fuel in that when it burns it doesn't generate more heat than is needed to sustain the process, so we have to keep the heat of the torch on it, and the oxygen trigger down to continue the burning.

When we cut off the oxygen the process stops and, when everything cools, we find lumps of slag, not steel all over the shop floor. We have, quite literally, burned the steel in exactly the same fashion as you would burn a log – the slag is the ash.

And lest you think that a discussion of metals is going too far out in a discussion of burning, I'll direct your attention to magnesium and zirconium. Both will sustain a burn once lit, and it doesn't take much with zirconium; in the days before strobes were used on cameras we used flash bulbs. The thin wire inside the bulb was heated with a small battery until it ignited in a pure oxygen atmosphere resulting in an extremely rapid, self-sustaining burn of a metal.

In the more common form, a fire occurs because fuels, such as oil-based coolants, are heated to the point that they combine with the ambient oxygen. This usually starts within the mist, but the process can produce sufficient energy to ignite the liquid coolant as well. If you're machining a metal with a low flash point the cascade is catastrophic.

What to do about it.

That said, you can see that there have been traditionally only two ways to stop a fire: separate the oxygen and fuel, or cool the fuel/oxygen mixture below the ignition point.

Powder-type systems simply put a blanket on the burning material thereby depriving it of oxygen. It's not a good system for expensive machine centers because the powder is extremely corrosive; while it will most likely stop the flames from spreading, the damage to the machine tool can be significant.



The business with the heat-sensitive injection nozzle and a pressure switch that can send an "Emergency Stop" signal to the machine.

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The bottle can be easily modified for mounting in any position. Removal of the flagged safety pin will arm the system.

The two most common forms of it are Halon 1301 and Halon 1211. The numbering system is fairly simple; The numbers simply give you the recipe. In H1301 you have one carbon atom, three fluorine atoms, zero chlorine atoms and one bromine atom.

“Fine”, you say, “Which should I use?”

In an election season filled with caveats, oblique responses and prevarications you’ll be pleased to hear a straightforward answer: Use H1301 in fixed-position systems such as in the machine tool compartment, and H1211 in hand-held units.

The reason for this is also easy: H1301 comes out as a colorless, odorless gas and is 50% discharged in less than three seconds; H1211 comes out as a low-velocity liquid allowing you to see where it’s going and gives you about fifteen seconds to direct it appropriately before it turns to a gas.

Choices and tradeoffs

Going back to the issue of flame propagation, let’s look at a worst-case scenario, that is, a liquid that’s intended to burn: Gasoline. It has a rate of flame spread between 700 and 800 feet per minute. Although that’s only about 8 mph, if you’ve ever used a fire extinguisher you’re probably astonished and/or skeptical of a system that claims to put out a fire such as this in less than one second.

Halon is able to do this for a couple of reasons. First, the flame-front, as noted previously, is moving at a bit more than ten feet per second while the contents of the bottle are traveling much faster than that. Second, a concentration of 3-4% is all that’s required so you don’t have to bury it as you do with other systems.

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At about 350 degrees Fahrenheit, machine tool coolant has a flashpoint much higher than gasoline, so the performance margin is even greater. Nevertheless, when trying for maximum production, the mist generated by aggressive operations can easily approach these temperatures.

The result is that mist is an additional factor in that it can become a near-explosive brew requiring equally fast action. This is where the automation aspect joins with the inherent speed advantage of the Halon.



Within the closed environment of the typical machine tool a single injection nozzle is typically all that is needed to suppress almost any fire.

Although a manual pull or push handle is usually included with an on-machine fire suppression system, a better option is to rely upon an automatic system. One popular configuration is to terminate the injection line with small glass bulb that is designed to break at a chosen temperature, usually 175F and, thereby, allowing the Halon to attack the fire.

With that fast a dispersal rate, and an ability to contain the conflagration at such a low concentration you'll be amazed to hear that you can breathe it at a 10% concentration. Remember now, this is possible because it does not remove the oxygen from the fire; it stops the chemistry of combustion, that is to say, it goes right to the nature of the fire, high-speed chemistry, instead of attacking the results of the chemistry.

The right stuff

When choosing a system you should evaluate three things: first, and foremost, how well does it work; second, does it cause any secondary damage; third, what's the downtime for re-setting the system after a fire; fourth, what's the downtime associated with installation.

These criteria are in this order for a reason. First, if it's not effective, don't bother; Second, if the consequences of it's use cause more damage than would a small fire, it might not be cost-effective;

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Third, if you, like the shop we studied, have the potential for repeated fires, you'll need to consider the costs of re-setting the system; Fourth, while installation occurs only once, it is still downtime.

Having addressed those first and second issues, let's look into installation and re-set.

Installation is surprisingly simple for the self-contained bottle systems. The bottle can be mounted entirely within the potential fire zone, but a more elegant, i.e. cleaner, position will require only a one-inch, gasket penetration through an appropriate wall of the machine. A couple of 10-32 screws to hold the bottle bracket and appropriate mountings for the optional manual control are all that's needed. The effectivity of Halon is such that this central-point approach is all that's required.

A complete bottle system costs is low cost and the installation is easily place on a wide variety of machines. Because of its compact and self-contained configuration it's also possible for it to be installed by the shop owner.



Coolant spray does not affect the (yellow), heat sensitive glass bulb that breaks, allowing the Halon to disperse through the red, protective housing.