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| **Technicalities in Arson Investigations** |

**Smoke Inhalation and Death**

Fire is a result of a [combustible](https://www.britannica.com/science/combustion) material that has reached an ignition temperature from some source, such as matches, torches, an open flame, or a heating element of some sort, which allows the combustible material to become fuel in a chemical reaction called [oxidation](https://www.merriam-webster.com/dictionary/oxidize) (combining with oxygen). In a perfect environment, the end result is the production of water and carbon-dioxide. However, almost no fires in arson cases have sufficient oxygen present to meet the production of carbon-dioxide, so instead, they produce [carbon-monoxide](https://www.epa.gov/indoor-air-quality-iaq/what-carbon-monoxide), which is highly toxic. That is why most fire victims die of smoke inhalation of toxic gases that are composed mostly of carbon-monoxide.

**Understanding Chemical Reactions in Fire Investigations**

Oxidation occurs at various rates, which causes a reaction. For example**:**

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|  | When an apple is cut in half, the inside begins to slowly turn brown**:** That is the same chemical reaction that results in an exploding stick of dynamite. The difference is the speed at which the combustion-oxidation occurs. An apple oxidizes slowly, while a stick of dynamite explodes-oxidizes very quickly, but the chemical reaction or process is the same.  |  |
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The physical properties of fire are light and heat. The chemical reaction that causes fire is called an [exothermic reaction](https://drive.google.com/file/d/1WYsB_cPo1CO_HtMb14twwFuZxWt21Kd9/view?usp=sharing).This means that the reaction of oxygen, mixing with the fuel source (such as wood, gasoline, propane gas, etc.), is giving off heat as a byproduct of the burning/oxidation.

The [fire tetrahedron](https://drive.google.com/file/d/1Hx41ccEQyL3QEEmIe5vda80TvgofwjKe/view?usp=sharing) requires fuel, oxygen, and heat (*Note: heat is an ignition source*). The fourth component is the chemical reaction, which converts the heated fuel into a gaseous form – and then it is combined in the chemical reaction with oxygen.

**Pour Patterns**

Most accelerants are [volatile liquids](https://www.dictionary.com/browse/volatile) that are poured on debris, which is intended to burn and to start an arson fire. Accelerants can also can be poured in a stream, trail or pathway, that leads up to a pile of debris. The stream, trail or pathway is used as a fuse, which allows an arsonist to light one end of the fuse (poured accelerant) – and then the fuse follows the intended trail, all the way to the debris material, which is designed by the arsonist to be ignited. The debris material is also normally soaked in the accelerant. This stream, trail or pathway (the fuse) leaves [pour patterns](https://drive.google.com/file/d/1Q_-TD0UhtwC4jOaUxs5vlkU5TT1YrSBL/view?usp=sharing) as evidence on the [substrate](https://www.biologyonline.com/dictionary/substrate) (or on the floor of the arson scene).

If the ignited material is against a wall in the arson scene, it will cause a [V shaped pattern](https://drive.google.com/file/d/1B9x1Aijw1N8zLs8WQUndqTkp4eFE7GEj/view?usp=sharing) in soot on the wall, which will lead to the location of where the fire(s) were started. This is helpful in identifying the fire as an arson and indicating where the fire started from at a scene.

**Types of Accelerants**

The majority of accelerants used are some form of liquid petroleum product like gasoline, diesel fuel, brake fluid, etc. Sometimes paint thinner, mineral spirits, alcohol, and other volatile fluids are used. Occasionally a solid fuel like [phosphorus metal](https://drive.google.com/file/d/1mvR7bsx2v0u0kEpLNj2kQ_YLYOo7xxDm/view?usp=sharing) or magnesium is used. A common solid material accelerant is known as [excelsior](https://drive.google.com/file/d/11Yz4wrzjy_ThA_HTc8xn21KC_uTai8YT/view?usp=sharing)is oftentimes used in arson. Excelsior consists of finely shredded wood slivers that can be ignited easily with a match or lighter. Occasionally, unusual accelerants will be used, like vegetable oil or liquor (such as ethyl alcohol).

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|  | **Factoid** – Remember, solids and liquids have to be heated sufficiently to *produce a gas that will ignite*. Solids and liquids in their original state will not burn (even things like gasoline).  |
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Some chemicals, like phosphorus, will ignite on their own by using the oxygen in the air. Oddly, white phosphorus is safely stored in water or kerosine, to keep it from exposure to the air, so that it will not combust.

Red phosphorus is much more stable, until it is used in [clandestine laboratories](https://legal-dictionary.thefreedictionary.com/Clandestine) to make methamphetamine (an illegal drug). During the production process, the air in the clandestine lab may become explosive – and an accidental spark can cause the methamphetamine lab to explode. This type of arson crime scene is extremely dangerous to process forensically, due to the toxic environment and the dangerous chemicals that are present. A [decontamination unit](https://www.safeopedia.com/definition/5700/decontamination-unit-dcu) and medical assistance are normally requested, when executing a warrant on a clandestine methamphetamine laboratory.

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|  | **Factoid** – When accelerants are used, there is often residual liquid that remains in containers that were thrown away at the arson scene.  |
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**Searching for Traces of Accelerants**

When a fire is set in an arson scene using petroleum-based accelerants (gasoline, diesel fuel, turpentine, mineral spirits, brake fluid, etc.) The burning/oxidation process leaves behind hydrocarbons and other residual chemicals that can be used to identify the type of accelerant used. Material that is burned (especially partially burned) should be placed in a sealed commercial [arson can](https://drive.google.com/file/d/1abWZTj3f0koyod6lklxEXXBS3ga2GT1x/view?usp=sharing), which is like a paint can without any lining material. It is airtight. Also, there are gas sampling devices that can take samples of the air, over piles of burned materials, that indicate where the fire started (ignition points). In a lab analysis, this gaseous material can be used to determine the type of accelerant that was used. Hydro-carbon sniffers, which are called [Photoionization Detection Units](https://drive.google.com/file/d/1krv0UiJY01oiEdi6jslAnxXft7FAGp72/view?usp=sharing)(PID), are used to identify locations of high concentrations of accelerant at an arson scene. That will help to identify the location of material that should be collected for analysis of accelerants. Also, the use of [arson trained canines](https://drive.google.com/file/d/1bwxzvKW-rtiE9vPpylaOkit5tUeR5HS0/view?usp=sharing) can be used for identifying where the concentrations of accelerant residue are most prevalent.

Keep in mind that materials that are bunched together in a location, where it is indicated the fire started, should have samples taken to the lab for analysis. Oftentimes, pour patterns that lead to the location of such materials are good indicators of an arson fire. When a structure has multiple fire breakouts, in different locations in the structure, that is almost always a sign of an arson fire.

Sometimes an accelerant can be smelled in the air by the investigators at the scene. Caution should be taken, in the event that the odors are toxic. Finally, if the telltale “V” pattern is observed, then it is likely that the material at the bottom of the “V” pattern contains accelerant residue. “V” patterns are found on walls, doors, or windows in most cases. It is a result of soot deposits in the pattern of a large “V” shape. The point at the bottom of the “V” pattern is where a fire started (ignition point). It is important for the reconstruction of the fire scene.

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