



By Brendan Rimetz

Fire has the ability to mystify and amaze us and also scare and horrify us. It can heat our homes and cook our food, but it can also kill us. It is uncontrollable and unforgiving when not properly controlled, and it can spread with overwhelming speed when conditions are favorable. An unforgettable display of the power of fire took place in my hometown of Hartford, CT, on July 6, 1944.

It was a hot summer day in the southern end of Hartford, and the Ringling Brothers and Barnum & Bailey Circus was in town for two shows, which were to be held under the big top.

The show began eight minutes late at 2:23 pm on that fateful day. Minutes later, a flame leapt up from a side wall and quickly began to burn the tent.

The fire started out small, but as it gained oxygen and fuel, it grew to the point where it could be seen clearly by the audience. At first,

many thought it was just part of the show and did not realize that it posed a life-and-death situation until it hit the roof and began to spread rapidly.

People began to panic and rush for the exits. Because the walkways around the tent were narrow, they became crowded and chaotic. Animal chutes also blocked many exits, and once people realized this, they had to turn around back into the bedlam. Within minutes the whole roof was engulfed in fire and the main support poles began to give



ALICE LINDE MACOUR

way and collapse on the people below. The melted burning pieces of canvas fell and stuck to people's skin.

Eventually, the tent collapsed on all of those inside. The incredible heat of the fire cremated many of those who were killed. Although many people did survive, and there were many amazing rescue stories, 167 died in total, and over 700 were injured.

How could something like this have happened!?

Gasoline and paraffin

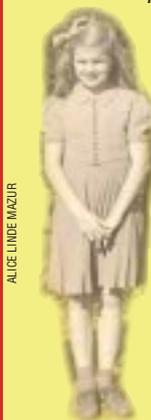
Much of the blame for the rapid spread of the fire and intense heat rests squarely on the choice of waterproofing agent for the tent. Because World War II was still raging and the U.S. military needed as many supplies as they could get, the circus owners weren't granted the use of the safe waterproofing agent they had wanted. The owners would later claim that because there was no other safe, effective means of waterproofing a large canvas, the circus owners had to rely on a mixture of paraffin wax and gasoline to waterproof their tent. Although this mixture had worked well before, it was very flammable and had caught fire many times before the Hartford fire. But if the owners were to hold shows in the rain, to maximize their profits, they had to rely on this flammable mixture.

Waterproofing

To understand waterproofing, you need to understand water. As you know, water molecules are composed of two atoms of hydrogen and one atom of oxygen. Because of the different characteristics of the oxygen and hydrogen atoms, the area of the water molecule near the oxygen atom is slightly negatively charged, and the area near the hydrogen atoms is slightly positively charged. Molecules that have this type of charge separation are called polar mole-

A SURVIVOR'S STORY

My grandmother, 12-year-old Alice Linde was at the circus on the day of the fire. "I went to the fire with my dad, my younger brother, and sisters", she recalls. "We sat up high in the bleachers next to the circus band. While the lion act was just getting over, I looked up over at the reserved seating section of the tent and saw the ceiling on fire. I turned to my dad and yelled "Fire!", and that is when everyone around us looked up and started to panic. My dad sat us calmly in the seats as he looked around. Next, he gave us instructions to exit underneath the bleachers. He dropped us one by one behind the bleachers and told us to head for the nearest exit. I was to hold my 4-year-old sister's hand as we ran toward the exit which happened to be down the hallway of the circus entertainers' dressing rooms. Once outside the door, I turned and realized that it was someone else's hand I was holding and not my sister's. She escaped safely with someone else. All around us were the circus entertainers, some actually naked because they ran out so quickly. My dad quickly found us, and we stood outside to watch. Being only 12 at the time, it was a sad and unforgettable sight to see all the entertainers around crying and frenzied," said Alice, who can still remember it vividly today.



ALICE LINDE MAZUR

cules. Water's polar nature causes its molecules to bond to each other between their positive and negative ends.

Substances such as gasoline and paraffin wax are hydrocarbons, consisting only of carbon and hydrogen. Because carbon and hydrogen have very similar electronegativities, carbon-hydrogen bonds are nonpolar, and the hydrocarbon molecules do not have positively or negatively charged ends. Water molecules would rather adhere to themselves than to a nonpolar wax surface. This is why water beads up on a water-proofed tent. Paraffin is a great waterproofing agent on its own, but it is normally a solid. Gasoline is used to dissolve paraffin, so that the pasty mixture can be "painted" or spread on the tent.

A bad combination

Because the whole top of the tent was covered in the gasoline and paraffin mixture, it provided a large amount of fuel; up to 800 pounds of paraffin wax and 6000 gallons of gasoline by some accounts.

The two substances are combustible, but their properties vary. Although paraffin is combustible, it needs to be heated to burn.

Paraffin wax is the slow-burning fuel that keeps candles burning for hours. But you can drop a cigarette or match next to paraffin and not have it ignite.

Gasoline, on the other hand, is very flammable, which means it has a low flash point and is easily ignited. The flash point is the lowest temperature at which a liquid can form an ignitable mixture in air near the surface of the liquid. The lower the flash point, the easier it is to ignite the material. Gasoline has a flash point of -40°C and is more flammable than paraffin wax which has a flash point of $204\text{--}271^{\circ}\text{C}$.



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Gasoline provided the flammable vapor that started the fire and heated the paraffin, which, in turn, ignited and kept the tent burning.

Problems fighting the fire

The reaction that took place in this event is classified as a combustion reaction. In a combustion reaction, a compound or element, in this case, gasoline and paraffin, reacts with oxygen to release energy rapidly in the form of heat and light, hence, the fire. Because the tent was outside and there was plenty of available oxygen, the fire spread quickly.

As mentioned before, gasoline and paraffin are both nonpolar and mix together well, but they don't mix well with polar water. This caused a great setback for those who tried to put the fire out using the fire hoses and dousing the flames with buckets of water. The flaming mixture of paraffin and gasoline simply floated on the water and continued to burn. In fact, the flowing water actually spread the fire around and worsened the situation.

The fire needed to be smothered or cooled, but water could do neither, and modern equipment and fire-fighting foams (see *ChemMatters*, April, 2001) were not available at that time. This made it virtually impossible for the firefighters to extinguish the fire.

Aftermath

Immediately after the disaster, Ringling Brothers and Barnum & Bailey Circus announced that it would not use the big top tents until they could be rebuilt and fire-proofed. By the time of this announcement, they had already purchased a waterproofing agent that was also fireproof. Hooper Fire Chief fireproofing was purchased

by the circus and used to fireproof the side walls of the dressing rooms and sideshow tents. The substance was a thick, milky substance that had been successfully

used by the U.S. military to fire-proof truck and boat covers. It was advertised as waterproof and resistant to mildew. The advertisements pointed out that "...for nearly a minute a blowtorch was applied to a section of the chemically treated sideshow tent. As the first flames touched the canvas, it began to glow a bright red When the flame was removed the glow died out, leaving a blackened charred-edge hole in the fabric."

It still would be a long time until Ringling Brothers and Barnum & Bailey Circus would overcome the bad publicity from the fire. After the fire they were sued and ended up paying 10 years' worth of profits to fulfill claims by the victims' families. The company never fully recovered from the fire and its

A SHOCKING SIMILARITY

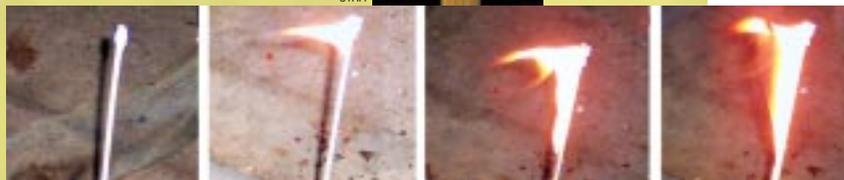
The paraffin and gasoline mixture used to waterproof the tent shares some similarities with a notorious substance. Ever heard of napalm? It's best known for its

use in bombs during the fire-bombing of Tokyo, Japan, and Dresden, Germany, during World War II, as well as

its use during the Vietnam War. The military discovered that traditional bombs, and bombs with just gasoline, explode and burn too quickly to be effective at starting fires on the ground. Napalm was a jellied gasoline formulation originally made from gasoline, naphthalene, and palmitate. It was sticky, highly flammable, but also slow burning. Sound like any waterproofing agent you've just read about?



Similar to napalm, when a small amount of the tent waterproofing agent is ignited; it rapidly drips and spreads a sustained fire down a stick.



The waterproofing agent used on the circus tent was a dangerous combination of gasoline and paraffin. When a quarter-sized dollop ignites, it melts and spreads rapidly.

repercussions. Shortly after the fire, it stopped using big tops and tents for the circus shows. Instead, the circus company decided to perform in arenas and stadiums. In 2000, the Ringling Brothers and Barnum & Bailey circus was preparing to tour the United States under a tent for the first time in more than 40 years. Since the fire, Connecticut and many other states have passed fire pre-

COLLOIDAL DISPERSIONS— OIL AND WATER MIX!?

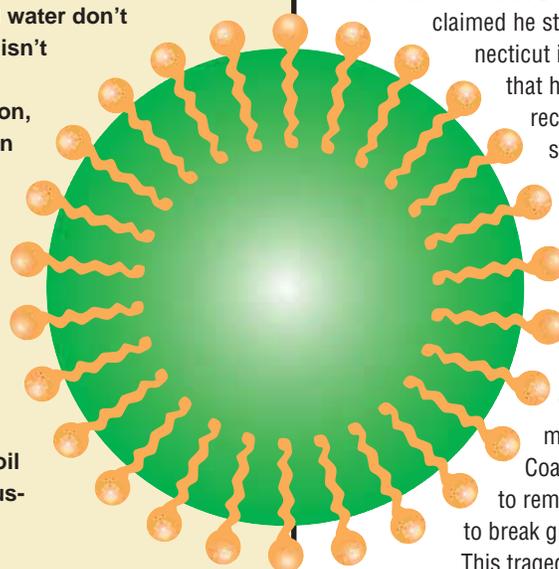
Instead of dissolving paraffin or some other oil-based waterproofing agent in gasoline, why not dissolve it in water instead? Water is cheap and, most importantly, nonflammable. But is this possible? You've probably already heard that "like dissolves like" or the more common "oil and water don't mix." Sometimes, this helpful rule isn't exactly true.

In the presence of soap solution, oil from your clothing can be drawn into water to form a colloid. A colloid essentially consists of particles of one substance dispersed throughout another. Soap molecules are able to form spherical structures in water, known as micelles, with hydrophobic (water-fearing) tail interiors and hydrophilic (water-loving) head exteriors. A soap micelle, with an oil droplet in its center, can remain suspended in water indefinitely.

The difference between a solution and a colloid is somewhat arbitrary. In a solution, the different ingredients dissolve into tiny particles less than 1 nanometer (nm) in diameter. In a typical stable colloid, the particles are larger, up to 100 nm, although they are still invisible without an optical microscope.

Milk is a familiar liquid-in-liquid dispersion (emulsion) of protein and fat in water. In fact, before commercial paint was available, people used to paint their houses with homemade formulations of milk, lime (CaCO_3), and available pigments. Depending on the number of coats given to bare wood, milk paint can be a very water-resistant coating.

The exact ingredients of Hooper Fire Chief Fireproofing are unknown today, but the description of it as a thick milky substance suggests that it was similar to water-based paint, which is a solid-in-liquid colloid.



A soap micelle, with an oil droplet in the center, can remain suspended in water indefinitely. Without soap, the droplet would merge with others of its kind, making a large pool of insoluble oil.

vention laws that strictly regulate the way circus tents are constructed.

Many questions remain about how the fire started. To this day, no one is really quite sure about how or where the fire started. Many blame a carelessly tossed match or cigarette. Still others, think it was arson. In 1950, a mentally unstable

man named Robert D. Segee

claimed he started the fire, but Con-

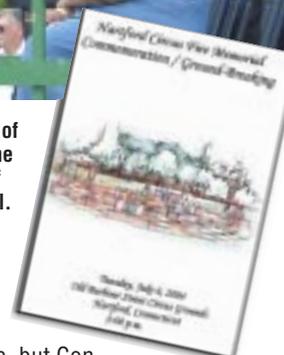
necticut investigators were never able to prove that he was in the state that day, and he later recanted. We may never know who or what started this disaster.

The fire is still a very painful memory in Hartford. Almost all of the 167 victims of the fire were eventually identified, yet six remain unidentified to this day.

After 60 years, a monument at the site of the fire will finally be erected for the victims. On July 6, 2004, I joined with my high school chemistry teacher, Ms. Coan, survivors, and the citizens of Hartford to remember The Great Hartford Circus Fire and to break ground for the new memorial. This tragedy should never be forgotten. 🇺🇸



Mayor Perez of Hartford at the dedication of the memorial.



Brendan Rimetz is a high school junior at East Catholic High School in Manchester, CT. He enjoys writing about chemistry and sports. He would like to thank his chemistry teacher, Mrs. Amy Coan, for all of her assistance.

FURTHER READING

O'Nan, Stewart. *The Circus Fire*. First Anchor Books: New York, 2000.