



Auto Shredder Residue Fire Extinguishing Study

Momar, Inc.

December, 2013

SUBJECT

Field trial to compare fire extinguishing agents in auto-shredder residue (ASR) fluff fires.

DATE AND LOCATION OF STUDY

December 5th, 2013
Automobile Recycling Facility

PRODUCT EVALUATED

A 3% solution of Flame Freeze was evaluated against water



OBJECTIVES AND METRICS OF COMPARISON

The objective of this test burn was to compare and evaluate the effectiveness of using water alone to the effectiveness of using a 3% solution of Flame Freeze to extinguish a fire.

Metrics of comparison include:

- Time required to extinguish the fire
- Volume of solution required to extinguish the fire
- Temperature reduction of substrate and nearby metal surfaces
- Likelihood of substrate to reignite after being extinguished
- Smoke opacity and steam opacity during and after extinguishing



SETUP

- Two fire departments were onsite to approve the test setup, to light the fires, and to extinguish the fires
- Auto-shredder residue (ASR) fluff was the substrate used for the test (approximately 15 yd³/test)
- Two 30 yd³ open-top, roll-off containers were used to contain the substrate
- Flares were used to ignite the ASR
- The test area was positioned away from structures and machinery, and a fire hydrant was in close proximity to supply water.
- An in-line educator was used to draw Flame Freeze into the water stream, and the educator was set to the 3% position
- A ½" standard, non-adjustable stream-type nozzle was used (the adjustable foam nozzle was not able to be used due to not having the appropriate adapters)



WEATHER CONDITONS

It had been relatively dry for several days leading up to the test, and the ASR had been stockpiled under a roof so that it would be at normal processing temperature and moisture content.

During the trial, the weather was mostly clear with sunshine, there was a slight easterly breeze that intensified during the course of the trial, and the temperature was 65°F – 70°F.

TEST #1 – FIRE EXTINGUISHED WITH WATER ONLY



9:20 AM

The substrate had an ambient temperature of 71°F, and the metal walls of the container had an ambient temperature of ~100°F as shown in the thermal image above (source: FLIR E40). Safety flares were lit and placed on the top of the ASR fluff.

Observations:

- Material ignited faster than customer expected and produced a thick gray smoke that evolved into a heavy black smoke
- Fire spread quickly from the flares to the surrounding areas
- The low-density of the substrate combined with the large airways allowed the fire to penetrate and spread faster than other types of substrates (i.e. coal, wood, paper, etc.)
- Within minutes the odor of burning rubber and plastics was very strong around the test area

9:25 AM The surface temperature of the substrate was measured at 927°F. The temperature of the metal container walls was measured at 286°F (source: Bullard TIC).

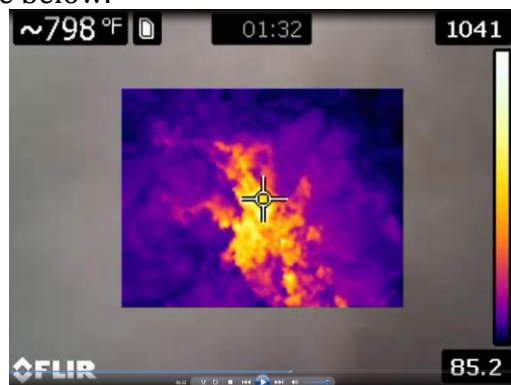
9:27 AM The temperature of the fire was recorded at greater than 1,238°F as shown in the image below.



9:28 AM 8 minutes after ignition, the smoke was incredibly black and thick and the wind was increasing so direction was given to begin extinguishing the fire. Water was applied at high pressure to the pile. A large volume of smoke was produced that gradually turned to steam. Flames were readily extinguished in 15 seconds, but water was applied for a total of 52 seconds until all black and dark gray smoke had been eliminated.

9:31 AM Immediately upon extinguishing, thermal readings were taken of the extinguished substrate. The Captain was using a Bullard thermal imaging camera (TIC), and he noted the surface temperature was reading between 550°F and 600°F.

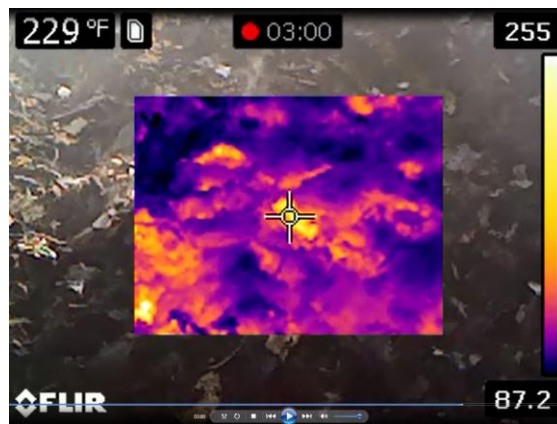
Momar's chemist was using a FLIR TIC, which and was displaying readings of 400°F - 500°F with hot spots as hot as 798°F, as shown in the image below.



9:33 AM Three minutes after the fire had been extinguished, the metal wall temperatures remained extremely high (495°F) as shown in the image below.



The surface of the fluff also retained high amounts of heat (229°F) as shown in the image below.



9:50 AM The substrate reignited and regained a surface temperature of >1,200°F within 3 minutes. As the fire hose line had already been primed with a 3% solution of Flame Freeze and water, it was used to re-extinguish the fire.

TEST #2 - FIRE EXTINGUISHED WITH A 3% SOLUTION OF FLAME FREEZE

9:48 AM Pile #2 was ignited using flares. Because the first fire didn't become as deep-seeded as everyone had hoped, the fire captain pushed the flares deeper into the second pile, approximately 5" into the substrate. Material began to rapidly burn and spread very quickly.

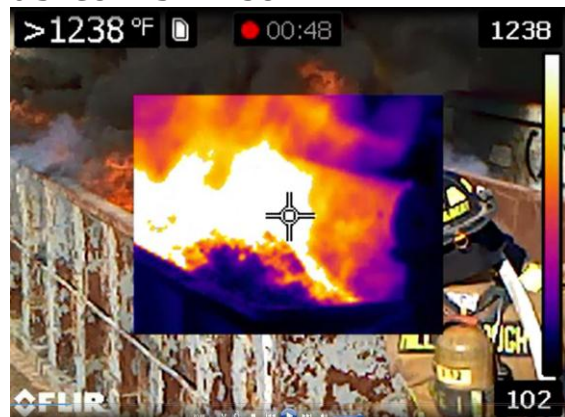
- 9:59 AM After 11 minutes, the substrate was fully engulfed, and the fire and black smoke were significantly greater than Test #1. The fire and smoke were further intensified by the higher winds. However, it was decided to allow the fire to burn a few minutes longer to get a true test of how well Flame Freeze could extinguish a deep-seeded fire.
- 10:01 AM After 13 minutes, it was decided that the fire needed be extinguished. The 3% Flame Freeze solution was sprayed onto the fire. The first noticeable reaction was a quick burst of white steam with the dark smoke quickly turning to light smoke.

It required 4 seconds to extinguish the flames, and water was applied for a total of 23 seconds before there were no traces of smoke. Less than 1.5 gallons of Flame Freeze was consumed during the 23 seconds that the 3% solution was applied, which equates to approximately 50 gallons of water total used to extinguish the fire. That's less than half the volume required in Test #1.

The Captain used his Bullard TIC to record the surface temperature of the fluff to be 130°F - 140°F, significantly cooler than when water only was used on the first fire during Test #1.

The following images document the first 60 seconds of the test and display the thermal imaging temperatures at several increments during the test.

0 SECONDS 1238°F

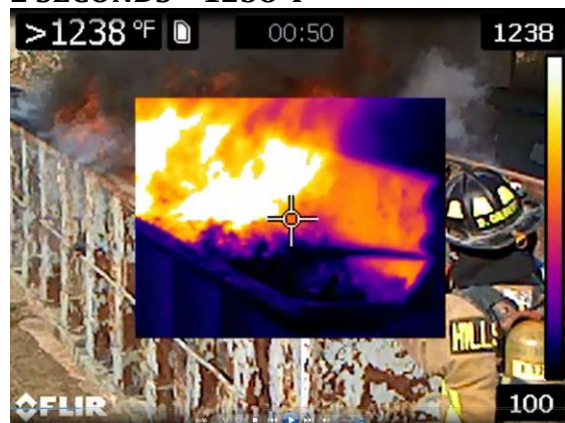


FLAMES

BLACK SMOKE



2 SECONDS 1238°F



FLAMES

BLACK SMOKE



4 SECONDS 191°F



NO FLAMES

STEAM AND GRAY SMOKE



6 SECONDS 191°F

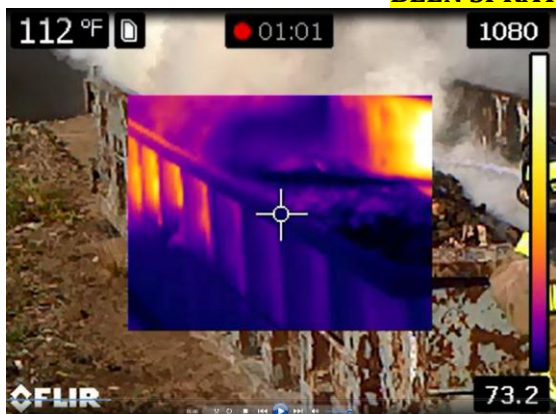


NO FLAMES STEAM AND NO SMOKE



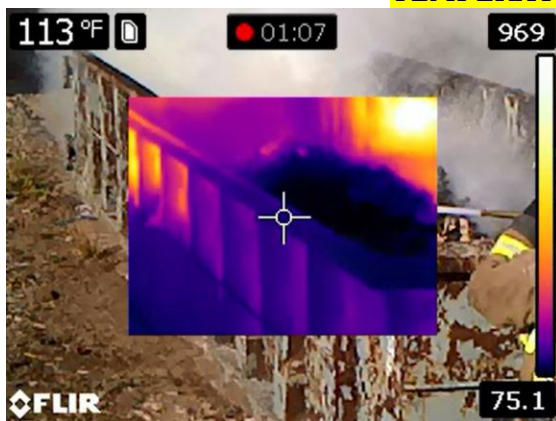
13 SECONDS 112°F

NOTICE THE WALL TEMPERATURES (112°F) WHERE FLAME FREEZE HAS BEEN SPRAYED COMPARED TO UNSPRAYED WALLS



19 SECONDS 113°F

NOTICE THE DARK BLACK AREA, WHICH REPRESENTS TEMPERATURES LOWER THAN 75.1F



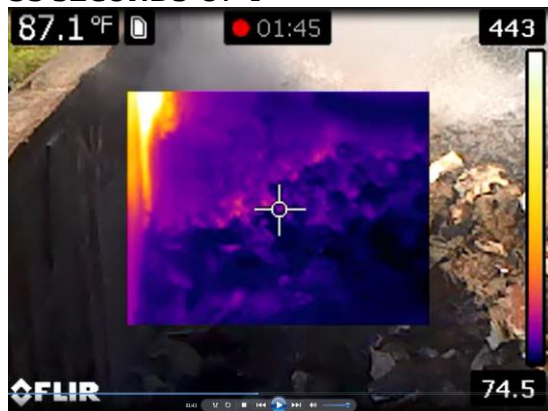
23 SECONDS 104°F



LIGHT STEAM

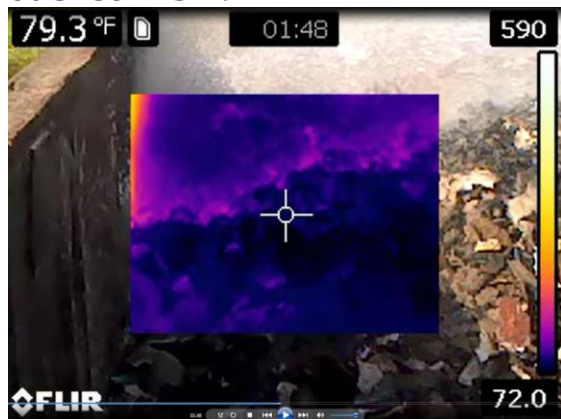


55 SECONDS 87°F



VERY LITTLE STEAM

60 SECONDS 79°F



VERY LITTLE STEAM

- 10:14 AM We waited to see if any reignition was going to occur and none did. It was discussed that in a typical fire event such as this, as material is extinguished, loader equipment would be utilized to remove extinguished material so that it could be spread out and soaked to prevent reignition.
- 10:35 AM It was directed to fully soak down both boxes as all parties had seen a satisfactory demonstration. For safety purposes, both boxes were sprayed and rakes were used to move around deeper pile portions. This continued for 10 – 15 minutes although spraying did not continue the entire time.

The 3% solution of Flame Freeze was used on both bins to ensure that all hot spots had been extinguished. Though a foam nozzle was not used during this trial, the product still produced copious amounts of foam when the water pressure was high.



CONCLUSIONS BASED ON RECORDABLE AND MEASURABLE METRICS:

Time required to extinguish the fire

Data:

Test #1 - Water-only: 15 seconds

Test #2 - 3% Solution of Flame Freeze: 4 seconds

Flame Freeze reduced the amount of time required to extinguish the flames by 73%.

Volume of solution required to extinguish the fire

Data:

Test #1 - Water-only: >100 gals (52 seconds)

Test #2 - 3% Solution of Flame Freeze: <50 gals (23 seconds)

Flame Freeze reduced the amount of water required to extinguish the flames by greater than 55%.

Temperature reduction of substrate and nearby metal surfaces

Data:

Surface of Substrate

Test #1 - Water-only: 229°F (2 mins after spraying)

Test #2 - 3% Solution of Flame Freeze: 79°F (60 secs after spraying)

Flame Freeze reduced the surface temperature of the substrate by more than 150°F more than the water-only application, and in half the time.

Data:

Metal walls of container

Test #1 - Water-only: 495°F (2 mins after spraying)

Test #2 - 3% Solution of Flame Freeze: 112°F (13 secs after spraying)

Flame Freeze reduced the surface temperature of the metal surfaces by more than 380°F more than the water-only application, and in 1/10th the amount of time.

Smoke opacity and steam opacity during and after extinguishing

Data:

Test #1 - Water-only: 17 seconds

Test #2 - 3% Solution of Flame Freeze: 4 seconds

Flame Freeze eliminated the plume of thick black smoke in 1/4th the amount of time, improving the fire fighters ability to see and reducing the chances of smoke inhalation. Because less water was used, the volume and duration of steam emitted during Test #2 was also greatly reduced.

Likelihood of substrate to reignite after being extinguished

Data:

Test #1 - Water-only: Reignited in 20 minutes

Test #2 - 3% Solution of Flame Freeze: No reignition

Flame Freeze prevents reignition of extinguished substrates

FEEDBACK AND COMMENTS FROM DEMONSTRATION

Captain

“Surface temperatures after the Flame Freeze application were clearly much cooler than with water alone”

Firefighter

“Using the Flame Freeze knocked the smoke down rapidly so I could easily see where I needed to spray.”

Firefighter

“After spraying the hot container walls with the Flame Freeze, you don’t see the wavy heat lines that are typical of spraying hot metal surfaces.”

Chief

“I can see an advantage to using a product like Flame Freeze on deep-seated pile fires.”

Safety Engineer of Facility

“I was surprised and somewhat scared about how quickly the fire took off and spread through the ASR fluff.”

West Gary, Chemist, Momar, Incorporated

“Overall the test was a success. Flame Freeze performed as expected. Had a foam nozzle been available, I feel strongly that Flame Freeze would have performed even better.”