TECHNICAL SPF //

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ASK RICK & MASON What is the issue on SPF auto-ignition?

INDUSTRY VETERANS, RICK DUNCAN AND MASON KNOWLES, DISCUSS THIS HEATED TOPIC

Featured Technical SPF

During the past four to five years, the industry has experienced an increasing number of fires related to SPF application. The rate of growth of these incidents is significantly greater than the growth of the SPF market, so the uptick in these fire incidents is not simply due to more people spraying foam.

Rick Duncan (RD): Since I've been involved in the industry, I heard and read a few stories about these fires. Most often, these fires can occur in dumpsters and spray rigs, and in most cases are extinguished and not reported. These are the near misses. However, there have been a number of highly publicized incidents where the fires completely destroy spray foam rigs, as well as customer homes and buildings. Tragically, one such fire resulted in a fatality, killing a spray foam installer inside of an attic in 2008.

It is injuries, loss of life and property damage that make the news. These unfortunate events result in a lot of negative press for the SPF industry, raising contractor insurance premiums, and ultimately having SPF deselected by

homeowners, builders, designers and code officials. In most cases, these fires are caused by SPF installation, in others they may be incorrectly reported by under-informed journalists. The good news is that each and every one of these types of SPF fires is easily preventable.

Mason Knowles (MK): Since 2009, I have investigated more than 20 SPF auto-ignition fires (eight in the last two years) that resulted in significant property damage and in one case, the loss of life. In the 35 years before, I could only recall one SPF auto-ignition fire that resulted in significant structural damage of a building or house. While this is still a fairly rare occurrence, as reported by Rick, the negative publicity, de-selection of SPF applications and the tragedy of replacing a home or burying a loved one make it an extremely important issue.

WHAT IS THE HISTORY OF SPF REGARDING AUTO-IGNITION?

MK: Since the development of SPF in the early 60s it was well known among applicators and suppliers that large volume (greater than 12 inches) of SPF installed in thick lifts can cause the foam to develop sufficient exothermic heat to auto-ignite. From the mid 60s to the 2000s, most auto-ignition SPF cases involved applicators creating large buns of foam by testing spray patterns and troubleshooting equipment. This resulted occasionally in dumpster fires and sprayfoam rig fires. Applicators learned quickly to limit the thickness of the sprayfoam buns or to break them apart before disposing of them.

From 1995 to 2007, I participated on the Society of Plastics Combustibility Committee and later staffed the American Chemistry Committee on Fire Issues Relating to Plastics. These groups promulgated research related to combustibility characteristics of foam plastics, developed industry guidelines and investigated fires involving foam plastics on a world-wide basis. During that 18-year time frame we investigated less than one fire every two years. Most fires developed by using a cutting or welding torch on unprotected foam.

We investigated only one auto-ignition fire in a flexible foam manufacturing facility caused by an off-ratio large foam bun (4in x 4in x 40in).

WHAT IS THE SCIENCE BEHIND SPF AUTO-IGNITION?

are mixed. These chemical reactions generate heat, very similar to heat that develops when one mixes a two-part epoxy adhesive. This generation of heat is called an exothermic reaction. Since closed-cell SPF has a high R-value and high density, this exothermic heat is retained inside the foam for several minutes. When closed-cell foam is properly applied to manufacturers installation instructions, it is not unusual for temperatures inside the foam to reach 300°F or more at the center of the pass. Figure 1 shows an exothermic temperature measurement for a closed-cell foam using thermocouples at the substrate and in the center of the lift.

MK: In closed-cell sprayfoam, exothermic heat is retained within the cells for longer periods of time. During the rise process exothermic heat is created that helps develop the foam cells. When installed properly, rising foam will reach temperatures approximately 160°F to 200°F. But, if the foam is installed in thickness greater than the manufacturer's recommendations, temperatures within the rising foam can exceed 300°F. Under these circumstan ces the foam will discolor and begin to scorch. Inextreme circumstances the foam can auto-ignite.

Rig destroyed by fire from overheated spray buns placed inside without

Voids caused by exceeding the recommended lift thickness. PHOTOS PROVIDED BY MASON KNOWLES

A sample of charred foam caused by excessive exothermic temperatures. PHOTOS PROVIDED BY MASON KNOWLES

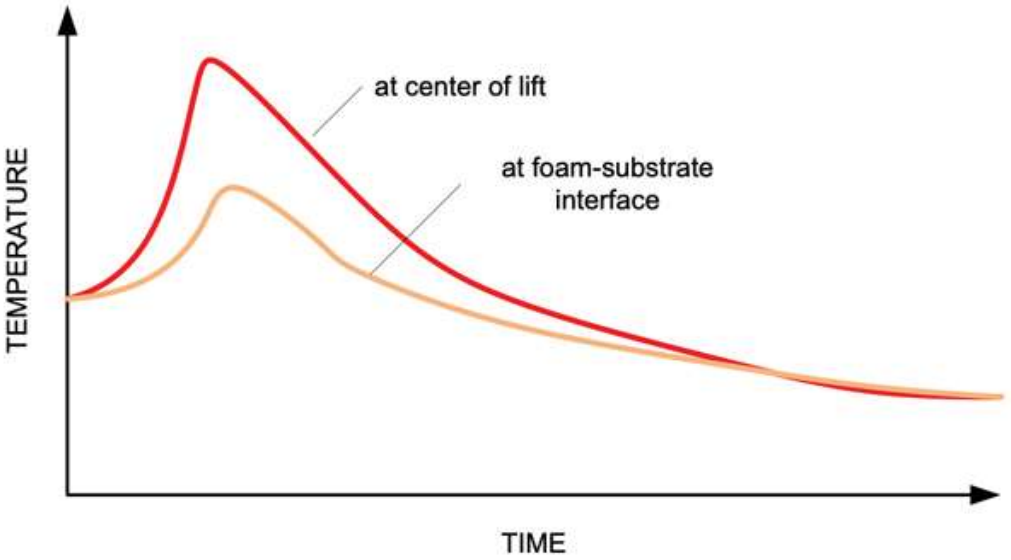

FIGURE 1 Lift temperatures versus time at the foamsubstrate and at the center of the lift.PHOTOS PROVIDED BY MASON KNOWLES

As reported by George Woods in The ICI Polyurethanes Book, “Auto-ignition results from the exothermic reaction of excess isocyanate in freshly made blocks of lower density (1.5 to 3.0 lb polyurethane foam), polyether-based foam, which have already reached a temperature of 165°C (330°F)”

WHAT FACTORS ON THE JOBSITE LEAD TO AUTO-IGNITINON?

RD:

- All MII and supplier training programs provide information on maximum pass thickness and installation methods for closed-cell SPF. However, some installers are either never properly trained or informed about closed-cell foam exotherms, maximum pass thickness or cooling times between passes.
- In other cases, the installer is in a rush to finish a job. This mistake is typically made in tight spaces like attics and crawlspaces, where proper pass thickness and cooling times can slow up an installation. Installers in

soffits, band-joists in crawlspaces. In these cases, the exothermic heat generated may not self-ignite the foam until many hours after the crew has left the jobsite. Several SPF fires have occurred this way, resulting in a complete loss of the building.

- Another cause of SPF fires is from scraps and test buns. Each day when the rig is fired up, it is common practice for the installer to spray a number of test buns prior to application of the SPF. During this time, the installer is checking foam quality against the equipment settings. In some cases, multiple passes of closed-cell foam are made to create these test buns, frequently without allowing each pass to properly cool. These test buns are then thrown into a nearby dumpster or back into the rig. These buns can become literally ticking time bombs, causing the foam to ignite the dumpster, or worse yet, start a fire in your rig.

Four examples of fire damage from exothermic ignition from an excessive amount of foam applied in a single pass to fill and seal the soffit area. PHOTOS PROVIDED BY MASON KNOWLES

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WHY AFTER MORE THAN 40 YEARS ARE WE SEEING AN INCREASE IN SPF AUTO-IGNITION FIRES?

MK: There are a few factors to consider.

- First, we are spraying thicker amounts of closedcell foam than ever before. 20 years ago, the typical closed-cell application ranged from two to four inches with a maximum of five inches. Now, in order to meet building codes, six to nine inches of closed-cell foam are commonly specified.
- Another factor is that unvented attics call for sealing the soffits. The soffits can range in depth from one to three ft. If SPF is used to seal off the soffits without a backer board, excessive thickness of foam can easily be installed. In the seven cases of auto-ignition I have investigated, the soffits were filled with 12 inches and more of SPF.
- Many open-cell applicators have begun installing closedcell foam the last few years. Open-cell foam can be installed in very thick lifts without developing excessive exothermic heat. Consequently, the new applicators to closed-cell foam may not be aware of how excessive thickness of closed-cell foam can cause auto-ignition.
- Another factor that can cause excessive exothermic heat is the temperature of the foam liquid as it is mixed. The higher the liquid

temperatures, the greater the exothermic heat reaction within the foam

- The change in blowing agents that allow thicker lifts of SPF than before may actually cause applicators to disregard the potential for auto-ignition. In the last year, I investigated four auto-ignition fires where the applicator assumed auto-ignition was not possible with the new high lift formulations.

HOW LONG DOES IT TAKE FOR SPF TO AUTOIGNITE?

MK: SPF auto-ignition is a slow process. It typically takes from one to four hours for the exothermic heat to reach auto-ignition temperatures within the foam. However one fire I investigated took more than 12 hours to develop because the SPF was installed 10 foot thick. Many of the SPF foam fires do not start until the applicators are gone from the scene.

SO HOW DO WE PREVENT SPF AUTO-IGNITION FIRE?

RD: Proper training is the key to prevention of exothermic ignition of closed-cell SPF. All installers, not just the project manager or master installer, should take an equipment and materials course from a qualified supplier or distributor before unsupervised application of any SPF product. This training will cover the proper installation of SPF. Equipment and material training is mandatory for all SPFA-PCP assistant installers.

When spraying test buns, always allow them to properly cool before disposal or transporting them in a truck. Use a meat thermometer to check the internal temperatures of all test buns. It is a good idea to break test buns into smaller pieces (three to four inch chunks) using a saw, axe or hatchet to promote cooling before disposal or transport of any foam.

It is also good practice (and an OSHA requirement) to have fire extinguishers of the proper type readily accessible by installers in the spray zone. Just in case a self-ignition event occurs.

Routinely use a probe thermometer to periodically check temperatures at the center of each pass. Check temperatures in each pass before application of a second pass to assure proper cooling.

SITUATION 1 SOFFITS:

Rather than using the SPF to fill in the soffit, fasten a backer board of insulation, fiberboard or other similar material to the space before spraying the foam. (Note: Be sure the backer board is on the outside of the interior wall so that hot air cannot travel to the roof deck causing ice damming in winter.)

SITUATION 1 TIGHT SPACES

Many jobs involve spraying foam in a tight space where movement is limited. It is human nature to go over the recommended thickness and to spray too soon over freshly installed foam when spraying in a tight area. I train contractors to use two applicators in these situations. One applicator sprays a section, then hands off the spraygun to his partner who then sprays his area. Most often by the time the second applicator has finished, the first section is cool enough to spray again.

Self-ignition of SPF from high exothermic temperatures can be avoided. Here are a few recommendations:

- ***PROPER DISPOSAL:*** Carefully dispose of all test buns and be sure they are properly cooled before placing them in the rig or in a dumpster
- ***KNOW YOUR PRODUCT:*** Know the maximum pass thickness for the foam you are using and follow it. It should be readily available in the manufacturer's installation instructions.

to-reach areas. Wait for the foam to properly cool before applying a second pass.