EXCESSIVE SHRINKAGE OF CELLULAR PLASTIC FOAM INSULATION

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There has been quite a few articles in various publications pointing out problem of shrinkage of cellular plastic foam insulation. This is a real concern of the design and construction community, especially if the cellular plastic insulation will be used to provide the plane of airtightness. If there is excessive shrinkage in the product, this will result in the joints opening up and the plane of airtightness compromised.

With spray polyurethane foam, there **can be** shrinkage; however, there does not have to be. The shrinkage can be severe to the point of twisting wood framing members or denting metal. Normally, the foam will give way within itself and crack open – this is referred to as thermal cracking. To fully understand this statement, you need to understand both the material and also how the material is tested.

Whether the material will shrink (or expand) after being installed, starts with the chemist for the material. The chemist blends together many chemicals to produce a resin which, when combined with isocyanate, produces a material with very specific performance and specific physical properties. That chemist can make the material do almost anything (the key word is "almost"). This means that there can be a "bad" material, either by improper chemistry or something happening during the blending process.

When you look at the specification sheet for a spray polyurethane foam material, you will normally see results for dimensional stability testing. Typically, the specification sheet will list 3 atmospheres:

1. Cold (-20°C)
2. Hot (80°C)
3. Hot/humid (70°C and 97% relative humidity)

This will cover most of the conditions, whether you are installing the material in cold climates, desert climates, and hot and humid climates. Typically, in cold climates, you are concerned about shrinkage and in hot and humid climates you are concerned about expansion. In any case, you will want to know how the material performs in all environments. This will tell you a lot about the material.

Do not modify the material on site by adding chemicals to the resin. What is blended and what you get is what you have to deal with. The first step is to determine if the material meets a specific material specification standard. The material specification standard that has been around the longest for an air barrier application is the **CAN/ULC S705.1** Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density, Material – Specification. If the material you are considering to use does not meet a standard, then it is your responsibility to determine what you need and how the material will work in a specific application, under certain conditions. As a consumer, builder, or designer, making these decisions is beyond the normal decision making process.

The dimensional stability test method used for cellular plastic is **ASTM D2126** Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging. When conducting this test, specimens are placed in a climate controlled environmental chamber for a period of 14 days. Some people use shorter time period, but the foam can sometime expand and then contract before settling in. It is important to be "aged" long enough to give you a proper understanding of what the foam material properties are. In these environmental chambers, the following is expected:

- Maximum shrinkage is 2%
- Expansion can be 5% for the cold
- Expansion can be 8% for the hot
- Expansion can be 14% for the hot and humid

Although the hot and humid gives the largest numbers, you want to do all 3 temperatures to that you know how the material performs in different environments. **In almost all cases, you are more concerned about shrinkage than you are about expansion.**

The complaints that you hear about cellular plastics are about shrinkage and not about expansion. Medium density closed cell spray polyurethane foam should only shrink a maximum of 2% (not a whole lot.) However, there is more to the story and that is in the way that the material is being tested. In **S705.1**, the specimens are cut and are not attached to any substrate. That means that the specimen has nothing to hang onto. Spray polyurethane foam likes to hang on to something and will stick to almost anything out there as a normal substrate. The maximum of 2% shrinkage that you may see in a free standing specimen will **not** be the same when the spray foam is installed on a substrate.

Now that you have picked a material that meets a national standard and has been properly tested for dimensional stability, you still need to complete your due diligence. Spray polyurethane foam is a site

manufactured material. You do not get the final physical properties advertised, until it is installed. The absolute best material on the market can still be installed wrong. If there is a problem with the installation, it is normally in **how** the material was installed. Installing material with the pressure set too high or the temperature set too high (or too low in both cases) will result in the material not meeting the intended physical properties. Installing the material in too thick of a pass will cause the exothermal reaction within the foam to overheat the chemicals; resulting in the dimensional stability being very low. In cold climates, this improperly installed spray foam can crack when the temperature drops – sometimes months later. This cracking effects the thermal performance of the spray foam insulation but, more importantly, this is a major breach in the plane of airtightness.

Spray foam that is used in an air barrier application needs to perform better than spray foam used as a thermal insulation application. **The spray foam cannot crack.** Also keep in mind that spray foam used in an air barrier application must also handle the loads imposed by the wind, the stack effect, and the mechanical effect. Thermal insulation does not have to deal with any of these loads. If you are installing an air barrier system in a building that is 120 meters high, on costal locations the wind load alone can be almost 5600 Pa. Not an application that you can afford to have the material crack.

You need to make informed decisions when choosing an air barrier. There are many excellent air barrier materials on the market including excellent spray polyurethane foam materials. Choose one that you know that will work on your project and perform as you need it to – sealing all the air leakage in the building. You need the spray foam to be installed properly as an air barrier application. These requirements go well beyond what is required to install spray polyurethane foam. You need to deal with all the penetrations, terminations and changes in plane of the substrate. The **SPFA-PCP** provides you will the knowledge, skills, and abilities to properly install spray polyurethane foam. The **Air Barrier Association of America (ABAA)** provides training and certification to extend the knowledge, skills, and abilities to installing spray polyurethane foam in an air barrier application.

As more and more states adopt requirements for air barriers in buildings, the spray foam industry will need to understand the differences in installing spray polyurethane foam in an air barrier application.