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Exotherm
A Hot Topic

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Tom's SPFA efforts include Chairman of the Consultants Committee, member of the Building Envelope Committee, Advocacy Committee, Training Committee and Geotech Committee.

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SPRAY POLYURETHANE FOAM ALLIANCE

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Today's Presentation

Learning Objectives

Define Exotherm in the context of spray foam

Identify things that influence our exothermic reaction

Cautions around heat development

Minimizing impact of reaction heat generation

What is Exotherm

We use the term “Exothermic Reaction” to describe the reaction between A and B side. There is no meaning for the term “Exotherm” but we use it.

What is an Exothermic Reaction

An exothermic reaction is one which releases energy to its surroundings. In our case in the form of heat. $A_{side} + B_{side} = HEAT$

It's the initial heat of reaction when we combine A and B, which boils the blowing agent and initiates the catalysts to make foam.

There is a "heat of reaction" called "Enthalpy" which can be calculated by looking at the specific chemistry of the A and B sides.

PUR is an Exothermic Reaction

Enthalpy is or can be calculated for each formulation by the chemist by taking the enthalpy of each reaction and adding them up.

Two primary reactions	Isocyanate with Polyol	Forms the polymer
	Isocyanate with Water	Produces CO_2 gas
Maybe a little of this	Isocyanate to Isocyanate	Forms the polymer
Isocyanate to Polyol	Depends on the # of reactive sites and amount in resin	
Isocyanate to Water	Depends on the amount in resin	

Spray Foam Exotherm

Total Heat of Reaction for spray foam depends on a lot of things.

The Heat from the Isocyanate reactions and the cooling effect due to the evaporation of the blowing agent which takes heat away.

So…… Total Heat depends on the amount and type of polyol, amount of water ***and*** amount of blowing agent.

(A_{side} + B_{side} Polyol) + (A_{side} + B_{side} Water) – (B_{side} Blowing Agent) = Total HEAT

Spray Foam Exotherm

(A_{side} + B_{side} Polyol) + (A_{side} + B_{side} Water) – (B_{side} Blowing Agent) = Total HEAT

It's VERY formulation specific

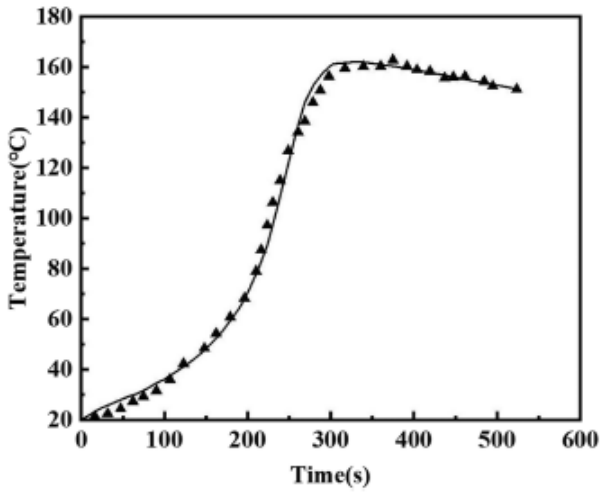
polyols and the amount can vary
amount of water can vary
amount of blowing agent can vary

Calculated

345°F

Measured

320°F



Concerns of Exotherm

Thermal Decomposition	Odor / Poor Quality Foam / Fire
CPVC piping	Leaks / Blow-out
Plastic Pipe Adhesive	Leaks
Wiring	Sheathing Degradation / Short Circuit

Thermal Degradation

Important things to remember…….

Initial thermal decomposition of typical 2.0 # SPF is around 380°F.

We are making insulation which holds the heat in so the center of the foam can't cool as quickly. **More foam = more insulation**

Piping

Important things to remember…….

Softening point temperature of PVC (older piping) is around 200ºF

Softening point temperature of cPVC (newer piping) is around 240ºF

Piping

Important things to remember…….

Solvent welding cPVC piping requires a primer and solvent application. The pipes or fittings are fused (on the molecular level) into a continuous piece – not "glued."

Piping

Important things to remember…….

Gluing PVC piping may require a primer and glue application. The pipes or fittings are bonded with another material acting as a connection between the two pieces.

Glued joints for non-pressurized pipes, solvent weld for pressurized pipes.

Piping

Important things to remember…….

Pressure check and confirm leak-free before applying SPF.

Drain pressure from system.

Protect joints. (Chemical contact and thermal degradation)

Install SPF around joints/pipe in thin passes/lifts.

Support back-side of pipe to reduce movement.

Wiring

Important things to remember…….

Softening point temperature of vinyl (old wiring) used in wiring is around 140ºF

Softening point temperature of PVC (newer wiring) is around 200ºF

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Wiring

Important things to remember…….

Wiring maximum allowable operating temperature 194°F

4 A minimum of 140-mm-thick foam was sprayed in a wood frame cavity made of OSB sheathing and 38-mm × 140-mm wood studs. Two electrical wires (12 AWG and 14 AWG) were installed in the cavity at different depths before the foam application. The maximum recorded temperatures near the wires were 159°C and 140°C. 318°F / 284°F

ELECTRICAL WIRING

- Huntsman Building Solutions Classic Plus™ has been evaluated with energized 14/3 and 12/2 residential wiring (max. 122°F/50°C).
- It is chemically compatible with typical electrical wiring coverings.
- For any insulation of older knob and tube wiring, please reference local electrical code.

Wiring

Important things to remember……. About electrical wiring

The temperature at the core of the foam pass shortly after installation exceeds the softening point of the materials but dissipates over a short period of time. If there is current running through the wires at the time of SPF installation (higher temps), this could be an issue.

There is no evidence of chemical degradation of the sheathing caused by typical SPF chemicals or the finished foam.

Cooling and Surface Temperature

Application Recommendations

Minimize 1st pass thickness

Allow first pass to cool before subsequent passes

Install foam behind wiring first to support wire while encapsulating

What influences Max Temp.

Chemical Formulation	(Polyol / Water / BA)	Big
Reactive speed of the foam	(Winter foam in Summer)	Slightly
Pass Geometry	(Thickness and Number)	Big
Environmental Conditions	(Relative Humidity / Temp)	Slight/Big
Configuration of Application	(Ability to dissipate heat)	Big

SPFA Study Results

Peak Exothermic Temperature			Lift Configurations ↔				
Spray Technique ↓			A	B	C	D	D'
	Picture-frame	Spray direction	1” x 6	2” x 3	3” x 2	5” x 1	2" x 3
1	Yes	Side-side	278	298	308	349	
2	No	Side-side	279	299	317	328	
3	Yes	Vertical	284	286	305	315	
4	No	Vertical	285	302	301	320	
5	Yes	Rising Foam		304	321		261
6	No	Rising Foam		300	311		229
		Avg Peak	282	298	311	328	245

Application technique influences Peak Exothermic Temperature.

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Reducing the Impacts of Exotherm

Know your Foam

Trust but Verify information

Don’t push the limits of the system

Thickness or Number

Watch confined spaces

Understand the impact your application technique is having on the foam. “Be curious not judgmental”

Summary

Spray Foam is created through an exothermic reaction (heat producing) between the Aside and Bside.

Many factors influence the amount of heat developed and the impact it will have on the quality of foam.

The heat developed will impact other construction materials. Use caution when installing thick sections around wiring and piping.

Understand the impact of spray technique on the exothermic reaction.