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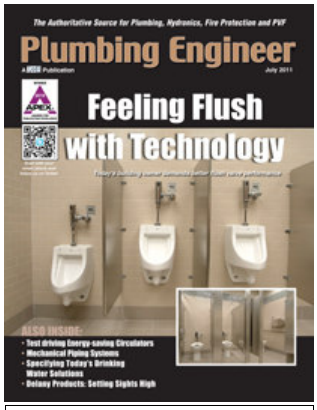

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Is PVC an acceptable vent material for flue gases?

By Ron George,CPD,
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I recently inspected the mechanical systems in student housing at a Midwest university. The school had hundreds of apartments in numerous buildings with high efficiency water heaters that were installed more than 10 years ago. There were reported problems of not having enough hot water.

My inspection revealed a high efficiency water heater with purple/brownish PVC pipes and yellowish PVC flue pipe fittings. The flue pipes were obviously deformed from heat, and they were sagging. A maintenance man for the university said that some really bad pipes had come apart at the fittings and melted. This set off the carbon monoxide alarm and prompted a maintenance call. The water heater had scaled up due to minerals in the water supply; this caused the flue gas temperatures to rise, which created the noted problems.

The pipe was Schedule 40 PVC pipe. Although the water heater installation manual we obtained recommended using PVC pipe as a flue material, PVC pipe manufacturers do not recommend this. I called the manufacturer of the PVC pipe in this case and asked the representative a few questions about using PVC pipe as a combustion flue for fuel gases. He was quite familiar with this issue and emailed me a link to the company's technical manual, which discussed all of the physical and temperature limitations of the piping.

He said that the company has had numerous complaints about PVC pipes used for venting flue gases, and that they always point out that they do not recommend this usage and that there is no listing for it in their manual. He has asked every major manufacturer of boilers and water heaters for data to support the recommendations in their literature for the use of PVC pipe for combustion flue materials but has not received any replies.

This is concerning to me. Just because a manufacturer recommends using PVC does not mean that it is acceptable or safe. Just because PVC works in new installations does not mean that a condition cannot occur in which scale builds up over a short time in hard water areas and causes high flue gas temperatures. Most boiler and water heater manufacturers list other ways of venting with stainless steel, but they seem to always recommend the cheapest way in their literature, in an attempt to make the boiler seem more affordable to consumers.

The piping manufacturer's PVC pipe technical manual has the following information:

Using Plastics for Combustion Gas Venting

The piping manufacturer recommends that inquiries about the suitability of plastic piping systems for venting combustion gases should be directed to the manufacturer of the water or space heating equipment being installed.

As stated in the International Code Council's International Fuel Gas Code 503.4.1.1:
Plastic pipe and fittings used to vent appliances shall be installed in accordance with the appliance manufacturer's installation instructions.

Furthermore, several of the ASTM standards applicable to PVC plastic pipe and fittings that this company manufactures their pipe to include the following note: This standard specification for PVC pipe does not include requirements for pipe and fittings intended to be used to vent combustion gases.

There is no standard referenced in any of the codes in the United States for a plastic flue vent for combustion flue gas piping, although many water heater and boiler manufacturers recommend this. There is a Canadian standard, ULC S636, but that standard has several flaws in that it allows flue gas temperatures that exceed the temperature limits of the pipe material manufacturers.

The maximum temperatures listed in the ABS, PVC and CPVC pipe manufacturers' technical literature are shown in the following table. Any temperatures above the rated temperature will allow the pipe to melt, sag and, possibly, collapse or pull apart. There are serious consequences with carbon monoxide asphyxiation and fire that cannot be ignored.

Generally, for a new condensing water heater or boiler, the stack temperature will be about 20 degrees higher than the water temperature. The design and efficiency of the unit, along with several other factors, including water quality, will affect the stack temperature. If a water heater is set to store water at 140 F to minimize Legionella bacteria growth, the flue gas temperature will be about 160 F when the heater is new.
As scale builds up and the heater efficiency falls off, the flue gas temperatures can easily increase to over 350 degrees F. Even if someone had their water heater set at 120 F, with scaling, the flue gas temperatures can rise well above 300 F. Boiler thermostats or burner controls are generally limited to 200 F, commercial water heater thermostats or burner controls to 180 F and residential water heater burner controls to 160 F, and all can overshoot by several degrees. As scale builds up on the heating surfaces, the scale insulates the flue gases from the hot water in the system, causing the flue gas temperatures to increase.

Some boiler and water heater manufacturers offer stack or flue gas temperature gauges as a way to see whether the unit is scaling up and losing efficiency, which is helpful for monitoring the flue condition. A temperature sensor or probe with a high-limit control could be inserted into the flue at the

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flue connection to the boiler or water heater.

This control would shut off the burner if the flue gas temperature exceeds the temperature rating of the flue pipe.

A standard will be needed for plastic flue pipes that should include a temperature gauge and a high limit probe. Then PVC, CPVC and polypropylene flue gas piping can be safely used on high efficiency boilers and water heaters. This would be an answer to the dilemma of cost versus safety.

Without a standard for proper use of these safety devices in combination with plastic flue gas piping or without the use of stainless steel flues, plastic flue materials can melt as flue gas temperatures rise. Not only is energy lost when this happens but flues can become blocked or disconnected, which can be a carbon monoxide or a fire danger.

A family of four died in Aspen, Colorado, in 2008, of carbon monoxide poisoning from the failure of PVC plastic flue pipes on a condensing snow melting boiler system in a rental property. The plastic pipe manufacturer was not at fault, because they had published limitations on the use of their piping, and they had not recommended PVC piping for that application. The boiler manufacturer that recommended using PVC pipe as flue material was a target of the liability claim by surviving family members.

I have heard arguments by many contractors that do not believe PVC flue venting for combustion gases is a problem, but I have seen melted and discolored piping in many of my investigations, so I know it is a problem. I also see the proliferation of recommendations from high efficiency, condensing boiler and water heater equipment manufacturers for the use of combustible and unlisted PVC piping products as corrosion resistant combustion flue venting.

This approach seems to be a way to lessen the initial cost of installing a high efficiency boiler or water heater. High efficiency equipment will cost significantly more than less efficient models, so there seems to be a movement by manufacturers to promote these unlisted and, therefore, non-code-approved materials over code approved and listed stainless steel flues, which are corrosion resistant.

Some people argue that the mechanical code allows you to follow the manufacturer's recommendations. The 2009 International Mechanical Code (IMC) has the following language:

801.20 Plastic Vent Joints. Plastic pipe and fittings used to vent appliances shall be installed in accordance with the appliance manufacturer's installation instructions.

Section 802 Vents

802.1 General. All vent systems shall be listed and labeled.

There is no listing for plastic piping for flue gas venting applications.

The 2009 IMC also has the following language:

Section 304 Installation

304.2 Conflicts. Where conflicts between this code and the conditions of listing or the manufacturer's installation instructions occur, the provisions of this code shall apply.

Exception: Where a code provision is less restrictive than the conditions of the listing of the equipment or appliance or the manufacturer's installation instructions, the conditions of the listing and the manufacturer's installation instructions shall apply.

There is a conflict between sections 801.20 and 802.1. The water heater manufacturer's installation instructions conflict with the requirement in section 802.1 that requires all vent systems to be listed and labeled for the application. PVC pipe is not listed and labeled as a combustion flue pipe material, as noted in the piping manufacturer's notes above, yet manufacturers of the water heaters and boilers seem to be avoiding the issue, and they continue to recommend the use of PVC flue venting in their installation instructions.

Section 304.2 addresses conflicts. The code restriction requiring all flue materials to be listed and labeled for their intended purpose is more stringent language, so the more restrictive code requirement requiring listed and labeled flue pipe materials would apply. There is additional language in the International Fuel Gas Code.

I have not seen any testing data or an independent test report from a boiler or water heater manufacturer that shows that PVC piping has been tested and approved for the conditions it will likely see in a water heating or boiler installation. Any testing should include the extreme conditions when scaling occurs and flue gas temps rise, near the end of the equipment's service life.

The Canadian standard, ULC S636, covers the design, construction and performance of gas venting systems intended for negative or positive pressure venting of gas-fired appliances producing flue gases having temperatures under the following:

1. Class I venting systems are suitable for gas-fired appliances producing flue gas temperatures of more than 135 C (275 F) but not more than 245 C (473 F);

2. Class II venting systems are suitable for gas-fired appliances producing flue gas temperatures of 135 C (275 F) or less;

3. Class II venting systems are further classified into four temperature ratings as follows:
(A) Up to and including 65 C (149 F)

This temperature limit was intended to allow the use of PVC pipe for use as a flue gas material. The temperature limit for PVC pipe is 140 F, and the allowable temperature in the ULC S636 standard exceeds the temperature limits set by PVC pipe manufacturers.

(B) Up to and including 90 C (190 F)

This temperature limit was intended to allow the use of CPVC pipe for use as a flue gas material. The temperature in the pipe manufacturer technical data is 180 F. The ULC S636 standard allows the material to exceed the limit for CPVC piping by 10 degrees Fahrenheit.

(C) Up to and including 110 C (230 F)

This temperature limit was intended to allow the use of Polypropylene (PP) pipe for use as a flue gas

material. There is currently one manufacturer listed to this standard, but the potential for the flue gases to exceed the 230 F is still there. A high-limit switch to shut off the boiler or water heater would be advisable.

(D) Up to and including 135 C (275 F)

I am not aware of any plastic pipe manufacturers that meet this sub-section of the standard. The potential for the flue gas temperatures to exceed the 230 F is still there. A high-limit switch to shut off the boiler or water heater would be advisable.

It will be interesting to see which way the industry goes on this issue. There are forces pulling each way, and I believe that a significant change will be coming within the next few years. I hope the industry can develop a standard to allow low cost, high temperature plastic materials. I believe that we will see a few code changes on this topic in the next round of code hearings. The 2012 Code is nearing completion and should be available in 2011. The 2015 code cycle will begin in the not too distant future.

Ron George is president of Plumb-Tech Design & Consulting Services. He has served as Chairman of the International Residential Plumbing & Mechanical Code Committee. To contact Ron, write him at rgdc@rongeorgedesign.com.

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