Schebler
CHIMNEY SYSTEMS

WHITEPAPER

STAINLESS STEEL SPECIAL GAS VENTING SYSTEMS

WHY DO THEY OFTEN LEAK CONDENSATE?

To ensure their systems do not leak combustion products, boilers with forced draft burners require positive-pressure exhaust systems. These systems are classified as Category III (see the information on the right for what constitutes a Category III appliance).

Chimney breeching and stacks for boilers operating as Cat III use UL-listed positive pressure stainless steel double wall products—and have for decades. The use of stainless steel for these UL-listed products has long provided a long-lasting, trouble-free system that typically lasts the life of the boiler. They use various grades of stainless steel depending on the exhaust gas temperatures and type of fuel source, and their compliance with the UL standard is maintained with strict UL testing and continuous inspection of a manufacturer's processes. Pre-engineered products are recommended, as they are generally safer, more reliable and more cost-effective than field-fabricated ones.

Category I
An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

Category II
An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

Category III
An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

Category IV
An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

ALONG COME HIGH-EFFICIENCY CONDENSING BOILERS

High-efficiency boilers use force draft burners and should always operate with an exhaust gas temperature below the dew point. These exhaust systems, referred to by NFGC as Special Gas Vents, are considered Category II or Category IV depending on the pressure in the exhaust system. Without going into detail on the physics that allows these units to obtain the added efficiency, the result is the production of condensation inside both the boiler and the exhaust system. When operating at peak efficiency, high-efficiency boilers will produce gallons of acidic condensate per hour, typically at a pH level of 3-5.

A special gas venting product must be able to perform regardless of the acidity of the condensate, temperature requirements and pressure requirements as stated in the UL 1738 standard. While special gas venting systems are nothing new for anyone working with high-efficiency boilers, they aren't immune from problems—the most important of which is condensate leakage. Anyone who has dealt with a system experiencing leaks understands the damage and costs incurred along with the dreadful task of permanently correcting the problem.

There are three main contributors to a leaking special gas venting system that we need to look at closely.

1. **Product design**
2. **System design**
3. **Installation**

Let's explore each.

PRODUCT DESIGN

Special gas venting systems for Category IV appliances must be able to handle continuous static pressure, high-velocity exhaust flow, condensate (which is moving with the exhaust flow and draining back toward the boiler) and temperature cycling.

The design intention of Category IV boilers is to obtain a slight positive pressure at the exhaust outlet to ensure maximum efficiency. This means that any weak point in the system is subject to leaking, similar to inadequate plumbing. This differs from non-condensing boiler systems that often operate under negative pressure due to the high draft effect. With those systems, the boiler does not produce condensate.

For more information on the proper system design for Category IV boiler exhaust venting, watch the Schebler Chimney YouTube video. https://www.youtube.com/watch?v=Jevv8ASLwvQ.

Most product designs for special gas venting utilize an overlapping male/female joint connection to join the sections together. This joint design is like a B-Vent product connection, which doesn't operate under positive pressure or carry gallons of condensate. To utilize this joint design, the manufacturer typically incorporates a gasket that enables the system to meet the low-pressure requirement of the UL 1738 listing.

The problem with this setup is that with an overlapping male/female joint connection, the product becomes directional. This forces the exhaust to flow against the overlap due to the condensate that accumulates in the exhaust system, and the condensate must flow back toward the boiler exhaust outlet or back to a drain located in the system.

This exhaust gas, which also contains condensate, can cause issues because it flows directly against the gasket surface. Leakage of the gas and the condensate can easily occur if the product is out of alignment, slightly out of round or not supported correctly. This problem is especially common with a double wall system, in which the condensate is pushed into the inner airspace and will likely leak in a different location than the source. Since manufacturers of products with this joint design utilize very light gauge material, the product can easily be out of round or have support and alignment issues.

The Impact of Stainless Steel Costs

A special gas venting product must be able to handle the acidity of the condensate, temperature requirements and pressure requirements as stated in the UL 1738 standard. To handle the acidity, specific grades of stainless steel are required to obtain the listing (AL 29-4C was originally the only material UL accepted for the listing although recently 316L has been accepted and approved by UL. This change and its implications will be addressed in a separate white paper). The high price of these specific grades of stainless steel has driven many manufacturers to design products utilizing very thin gauge (28 gauge or even lighter) material to reduce cost.

Due to the high risk of leaks with light gauge male/female joint connections, some manufacturers produce products that utilize the same basic pressure stack joint connection as non-condensing boilers. The proven flange-to-flange connection allows these products to reach much higher pressure ratings, eliminate exhaust and condensate flow directly against the joint seal and provide a much more robust product. Systems of this design will have a much lower percentage of condensate leakage.

SYSTEM DESIGN

Proper system design is critical to ensure proper boiler operation and eliminate condensation leakage. A properly operating high-efficiency boiler will produce gallons of condensate per hour (for example, a 3M BTU boiler can produce up to 20 gallons per hour[1]).

For the system to perform adequately, a large amount of condensate must be drained from the exhaust system. The following issues will occur if it is not removed.

- Reduction of the vent ID which will restrict exhaust flow
- Additional weight added to the system, which may stress joints and system supports
- An increase in acidity as exhaust continues to push into condensate pools, which may cause corrosion of the inner liner

Special gas venting systems' horizontal runs must be pitched properly to allow the condensate to drain back into the boiler. These runs should also include drains in the system, ideally every ¼" feet (per the NFPA 54/National Fuel Gas Code). Designing the system with the proper amount of pitch is critical to ensure adequate drainage and a leak-free system.

System condensate drains are vital to ensure the adequate removal of condensate throughout the entire horizontal breeching and stack. Most codes and standards, however, do not specify the use of drains in special gas venting systems. As a result, they are often excluded from designs to reduce costs and eliminate the need to pipe the condensate to an approved neutralizer. Unfortunately, failure to include drains can potentially flood the system with condensate, which will then likely develop leaks. Adding these drains later, in addition to repairing or replacing the damaged parts after leaks have occurred, will result in costs that far surpass the initial investment needed to install the drains in the first place.

1. Aerco BMK_VENT- COMBUSTION-AIR_9-14-18).

PROPER INSTALLATION

It's important to ensure the proper installation of a chimney breeching or stack system. UL-listed pre-engineered products are designed to handle high temperatures and harmful combustion byproducts. These systems depend on the installing contractors' comprehension of the system design documents and the UL installation instructions provided by the manufacturer. Failure to follow these instructions can hurt product performance and greatly increase the risk of condensate and exhaust gas leaks. Anyone who has been in a mechanical space with a leaking system understands the damage not only accumulated to the venting system but also to anything the condensate comes into contact with.

A special gas vent manufacturer should provide a detailed drawing showing the parts' locations and details of the supports, hangers, drain sections and roof penetration components. This provides a simple road map for anyone installing the product. If the specific system design is not followed during installation, there is a high probability the system will experience leaks.

Systems that utilize field-applied sealant require special attention to detail. Each manufacturer has specific sealant recommendations to meet the UL listing and product requirements. These recommendations cover surface inspection, prep/cleaning, sealant application procedure and cure time. All the steps of this document's process must be followed to ensure a leak-free installation.

Unfortunately, following that process is not always simple, especially when construction site conditions might hinder the ability to apply the sealant properly. Adequate sealant cure time might also pose problems. The sealant is part of the UL listing and has been tested to hold up to temperatures and the acidity of the condensate. However, when the sealant is exposed to condensate without completely curing, it will not be able to perform as tested and listed. Leaking due to uncured sealant may not show up during the initial operation or even after the first few months of operation. However, later inspection of the system is likely to show sealant failure.

SUMMARY

While the UL 1738 listing ensures a special gas venting product meets the requirements for venting high-efficiency appliances, selecting the most robust product, obtaining a complete system design layout and strict adherence to installation instructions are key. Cutting corners on any of those items can impact your ability to ensure a leak-free special gas venting system.

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