

Stainless Steel Special Gas Venting Systems

Why do they often leak condensate?



Boilers utilizing forced draft burners require positive pressure exhaust systems, to ensure the system does not leak products of combustion. These systems are classified as Cat III due to positive pressure and exhaust gas temperatures above the dew point. Chimney, breeching and stacks, for boilers operating as Cat III have utilized UL listed positive pressure stainless steel double wall products for decades. These pre-engineered products have allowed engineers and contractors to provide safe, reliable, and cost-effective exhaust systems versus field fabricated systems of the past. Strict UL testing along with continuous inspection of a manufacturer's processes, ensures compliance of the UL standard. Various grades of stainless steel have been utilized based on the exhaust gas temperatures and/or type of fuel source. Utilization of stainless steel for these UL listed products provides a long-lasting trouble-free system that typically lasts the life of the boiler.

Along comes High Efficiency Condensing Boilers! High Efficiency Boilers also utilize force draft burners and should operate with an exhaust gas temperature below the dew point. The exhaust system, which are referred to by NFGC as Special Gas Vent, are considered Cat IV or Cat II depending on the pressure in the exhaust system. Without going into detail on the physics that allow these units to obtain the added efficiency, the result is the production of condensation inside the boiler AND inside the exhaust system. High Efficiency boilers, when operating at peak efficiency, will produce gallons of condensate per hour which is acidic; typically, a pH level of 3-5.

Special Gas Venting product must be able to handle the acidity of the condensate, temperature requirements, and pressure requirements per the UL 1738 standard. While Special Gas Venting Systems are nothing new for anyone who has been working with High Efficiency boilers there seems to be a lot of questions and problems that have transpired. It is important to address the most common problem with these systems, 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.

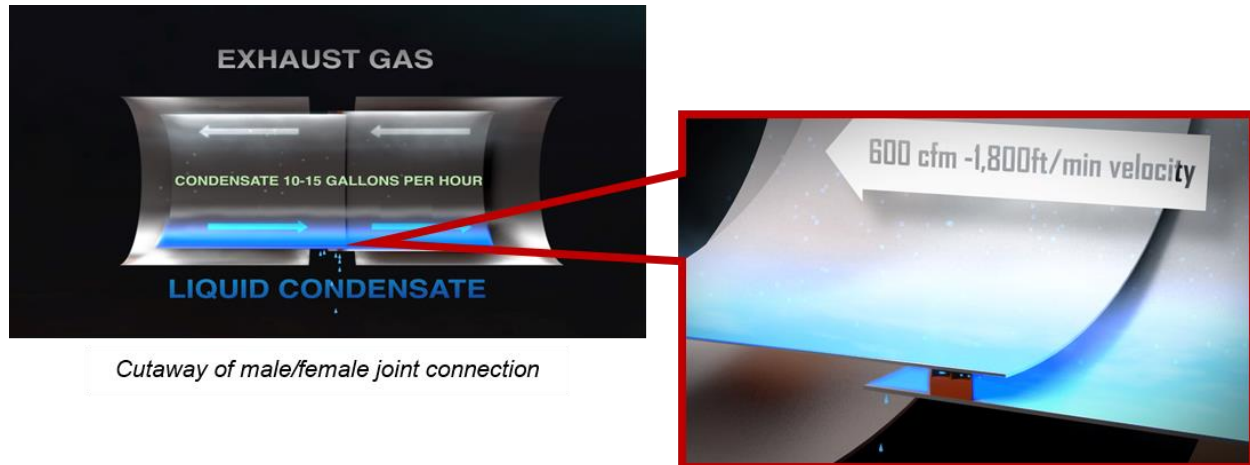
- 1) Product design
- 2) System design
- 3) Installation

Product Design – Special Gas Venting Systems for Cat IV appliances must be able to handle static pressure, high velocity exhaust flow, condensate which is moving with the exhaust flow and draining back toward boiler, and temperature cycling.

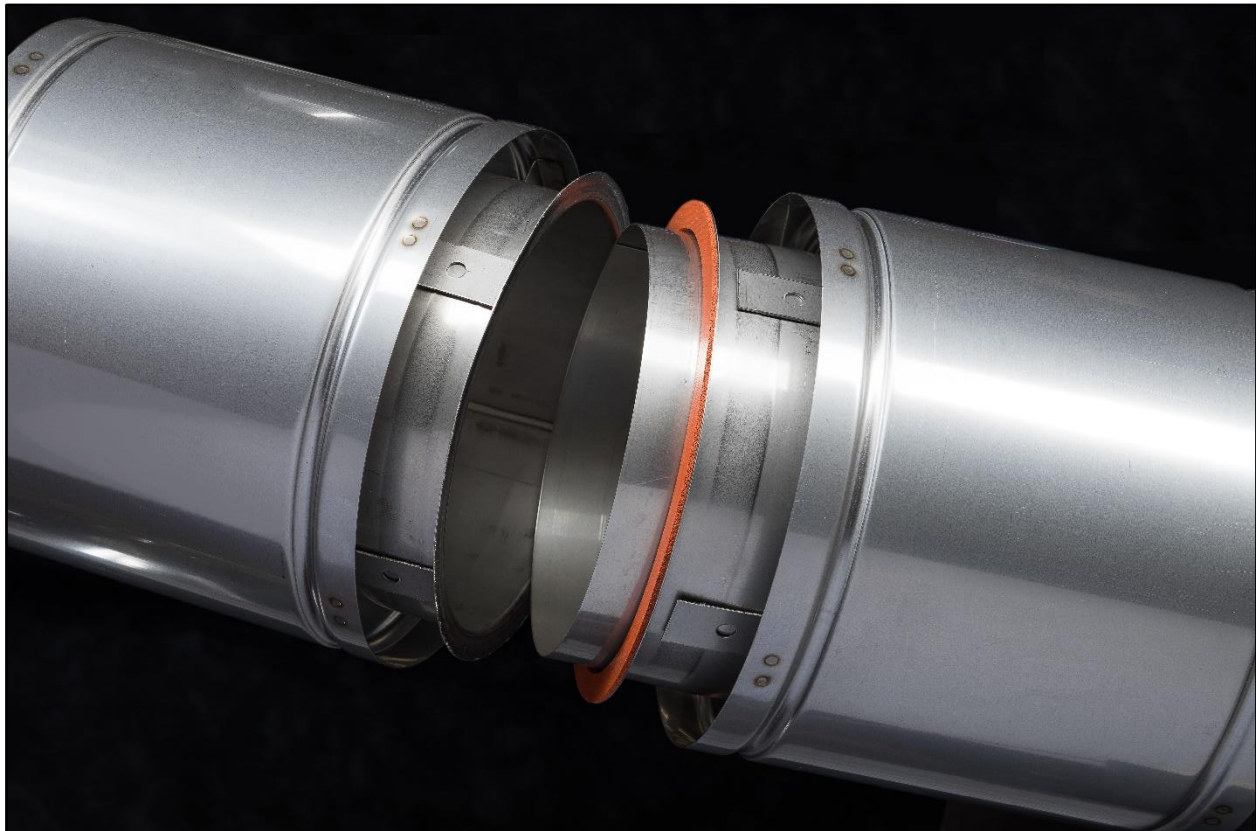
The design intention of Cat IV boilers is to obtain a slight positive pressure at the exhaust outlet to ensure maximum efficiency, see Schebler Chimney Systems' YouTube (<https://www.youtube.com/watch?v=Jevv8ASLwvQ>). Since the exhaust system is under a slight positive pressure, any weak point in the system would be subject to leaking, almost like plumbing. This is different from non-condensing boiler systems which often end up operating under negative pressure, due to the high draft effect, and the boiler not producing condensate.

Most product design for Special Gas Venting utilize an overlapping male/female joint connection to join sections together. This joint design is like a B-Vent product connection which does not operate under positive pressure or carry gallons of condensate. To utilize this joint design, the manufacturers' incorporated a gasket enabling it to pass the low-pressure requirement of the UL 1738 listing. The issue with an overlapping male/female joint connection is the product becomes directional, which forces the exhaust to flow against the overlap due to the condensate that accumulates in the exhaust system. The condensate must flow back towards the boiler exhaust outlet or back to a drain located in the system. The velocity of the exhaust gas can cause issues because it flows directly against the gasket surface. This is troublesome because the exhaust gas contains condensate. In addition, exhaust gas and condensate leakage can also occur if the product is out of alignment, slightly out of round, or not supported correctly. If this is a double wall system, the condensate is pushed into the inner airspace and will most likely end up showing as a leak in a different location than the source. Product being out of round or having support and alignment issues can occur without difficulty since manufacturers of products with this joint design utilize very light gauge material.

Special Gas Venting product must be able to handle the acidity of the condensate, temperature requirements, and pressure requirements per the UL 1738 standard. In order 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 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, a few manufacturers' produce products that utilize the same basic pressure stack joint connection as non-condensing boilers. The proven flange to flange connection allows them to obtain much higher-pressure ratings, eliminate exhaust & 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 not only ensuring proper boiler operation, but to eliminate condensation leakage. As mentioned earlier, a properly operating high efficiency boiler will produce gallons of condensate per hour. An example of this is a 3M BTU boiler can produce up to 20 gallons per hour. *[source Aerco BMK_VENT-COMBUSTION-AIR_9-14-18]*

The large amount of condensate must be properly drained from the system. Several issues will occur if condensate is not removed properly from the exhaust system.

- Reduction of the vent ID which restricts exhaust flow
- Additional weight added to the system – stressing joints and system supports
- An increase in acidity as exhaust continues to push into condensate pools – possibly enough to cause corrosion of the inner liner.

Special gas venting systems horizontal runs must be pitched properly to allow the condensate to drain back to the boiler and should also include drains located in the system. This is noted in NFPA 54/National Fuel Gas Code as ¼” per foot to ensure the system drains properly. Designing the system with the proper amount of pitch is critical to ensure proper drainage and a leak free system.

System condensate drains are vital for adequate removal of condensate throughout the entire horizontal breeching and stack. Codes and/or standards do not specify the use of drains in Special Gas Venting Systems. Often these are not included to keep system cost down and to eliminate the need to pipe the condensate to an approved neutralizer. While this may save on initial cost, it could potentially flood the system with condensate which will most likely develop leaks. Adding drains and repair or replacement of damaged parts after leaks occur will far exceed the initial cost savings.

Proper Installation - Installation of any chimney breeching or stack system is extremely important. UL listed products are pre-engineered to properly handle the high temperatures and harmful byproducts of combustion to ensure the safety of building occupants. The performance of these products 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 greatly increases the risk of a system experiencing 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 that not only shows the part locations, but also details of supports, hangers, drain sections and roof penetration components. This provides a simple road map for anyone installing the product which will truly eliminate the risk of condensation leaks. As noted earlier, system design is extremely important. 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 a specific sealant utilized to obtain the UL listing and instructions for proper application. This includes surface inspection, prep/cleaning method, sealant application procedure and cure time. All steps of this document's process must be followed to ensure a leak free installation. This can be very difficult based on construction site conditions and access to properly apply sealant. Another concern is the ability to have adequate sealant cure time. Since the sealant is part of the UL listing it has been tested to hold up to temperatures and the acidity of the condensate. Uncured sealant that is exposed to condensate without completely curing 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. Inspection of a system that experiences this condition will clearly show sealant failure giving the impression that the sealant is faulty or not correct for this application.

Conclusion: 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 components to ensuring a leak free Special Gas Venting System.