Varec Biogas
A Division of Westech Industrial Inc.
5362 Oceanus Dr. Ste. A, Huntington Beach, CA 92649
p: 714.220.9920 | f: 714.952.2701
www.varec-biogas.com

TECH NOTES

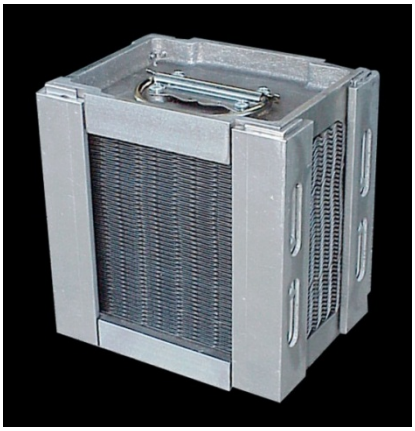
VB-TN-002, Rev. A **August 16** **R. HANSON**

5000/5010 Series Flame Arresters –

Your Only Choice for Biogas Applications

In biogas systems, flame arresters are typically installed on top of digester roofs or gas holders to prevent any potential for igniting the biogas accumulating in the digester. Flame Arresters are also installed where there is an open flame or possible sparking from compressors, flares, boilers or engine-generators. Additional protection of utilizing thermal shut-off valves and pressure (explosion) relief valves are typically specified along with the flame arrester.

The Varec 5000/5010 Series Flame Arrester is a square flame arrester (shown at right). The bank assembly includes corrugated rectangular sheets housed in an extensible frame (see photo below). When neatly stacked together, the sheets form tiny passages. These passages comprise the net free area that will dissipate the heat and quench the flame.



How does it work?

The type of gas and the type of flame determines the size of the passages.

Understanding flame characteristics

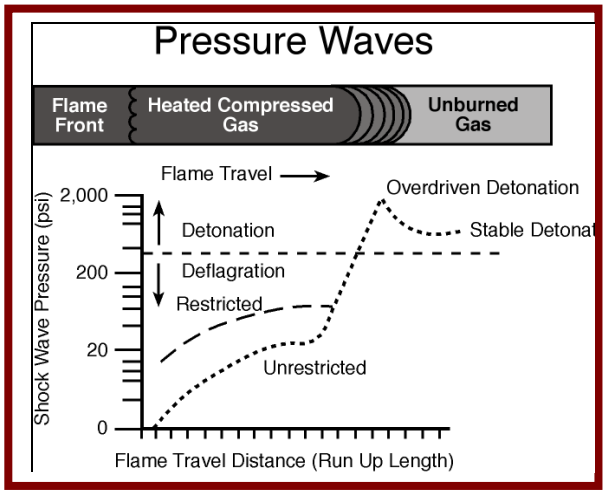
Upon ignition, a pressure shock wave occurs. The compressed gases travel ahead of the flame. The flame traveling through the pipe increases in velocity and pressure (see chart-next page).

Overdriven detonation occurs at the point where the flame ignites the compressed gases.

The flame arrester should be able to sustain a flame flashback (deflagration), and in some applications, the flame arrester must be able to stop the potential for detonation.

Gas Classification

Flame Arresters are also classified into four basic groups according to the reactivity of the gas/vapor and air mixture application. Classification for biogas being primarily composed of Methane is Group D in the United States, and Group 1 in Europe.



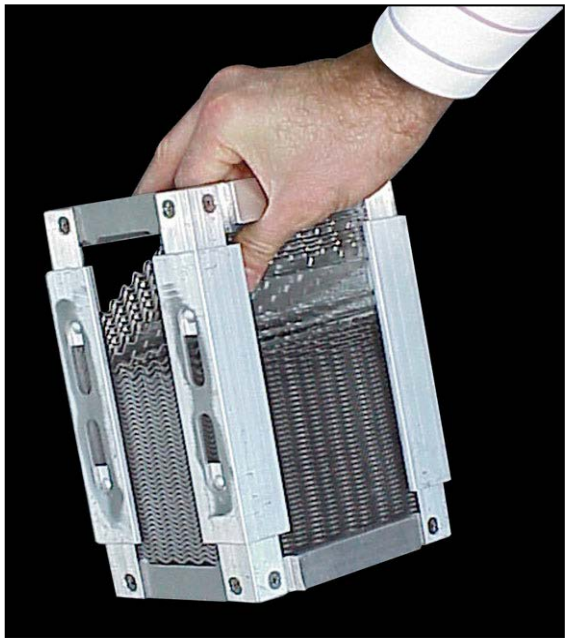
Gases are classified using the Maximum Safe Experimental Gap (MESG). The MESG is the maximum width of a gap, one inch (25mm) long in an enclosure through which a flame cell of a particular gas cannot pass through. The MESG value is smaller for more reactive gases. The tiny passages that are formed when the corrugated rectangular sheets are neatly stacked together on the flame arrester need to be smaller than the MESG of the gas. This will ensure that the flame cells are subjected to a smaller area and assist in reducing its velocity and temperature.

Arresters are tested and approved according to the classification of the test gas selected by the Flame Arrester Manufacturer. Flame Arresters tested to this gas can only be used for this type of gas or for less reactive gases.

It is therefore important to note that the flame arrester specified should be particularly designed to handle Group D – Methane Gas by accounting for the overall net free area. If a flame arrester is misapplied, it will potentially compromise the device's effectiveness and may not prevent flame passage nor flame re-ignition within the arrester.

How is it better?

The 5000/5010 Flame Arrester has become the standard for biogas application because its design takes into account the nature of wet and dirty biogas.



Net Free Area

A higher overall net free area creates the barrier for flame front propagation. The position of the rectangular sheets in the bank assembly allows condensate or sediment to properly drain when installed either in the vertical or horizontal position. Proper draining prevents condensate pooling and sediment build-up ensuring proper operation of the flame arrester.

Maintainability

Easy maintainability with the bank assembly prevents any need to remove the entire unit off line. The connecting pipe flanges remain undisturbed when the cover plate is removed. Hence, there is no stress applied to the connecting piping when maintaining the 5000/5010 flame arrester.

Shorter maintenance downtime can be achieved when cleaning the bank assembly. First, having a spare bank assembly handy for easy replacement while one is cleaned is important. Next, the unit requiring cleaning can be removed from service by simply unbolting the fasteners on the cover plate of the 5000/5010 Flame Arrester.

Cleaning is simplified as well. High spray wash water is not necessary for cleaning because the low copper extensible frame allows the sheets to be individually inspected for any sediment build-up. Simple soaking in solvents does the trick. You also eliminate the possibility of distorting the flame element when using a high-pressure spray wash system for cleaning. Any flame element distortion could represent a flame path. This is one of the main reasons why Varec no longer sells individual sheets because possible mishandling of the sheets could lead to a potential flame path. No margin of error is allowed!

A typical design common to flame arresters in the industry is shown on the left. Varec's version of the round configuration is the Model 5400 Series Flame Arrester. This is a product that Varec strictly provides to the oil and gas industry where the media is traditionally cleaner and less saturated.

Two pieces are shown on the photo (shown left). The left is the entire unit, and the right piece is the core assembly. The core assembly is made of spiral-wound crimped ribbon susceptible to clogging. This core assembly is what stops the flame from propagating downstream of the ignition source.

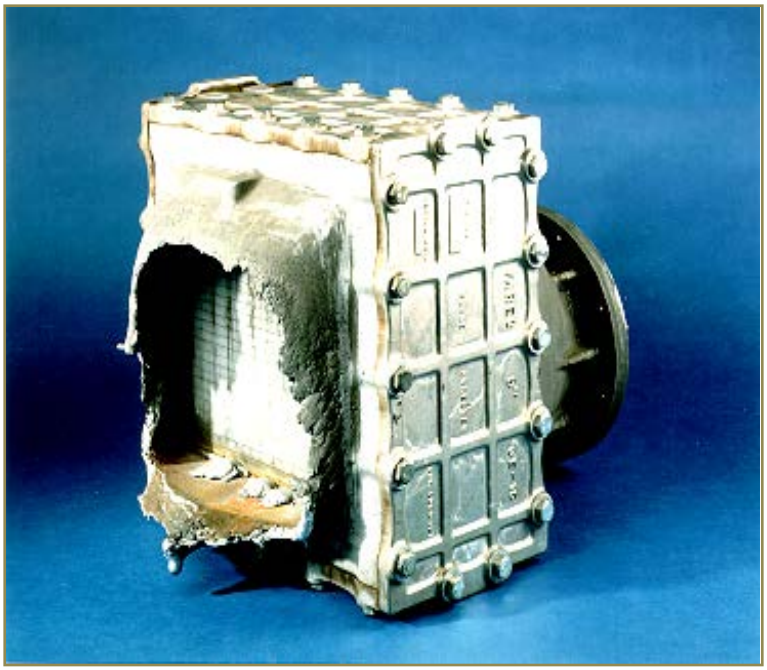
The round configuration or corrugated roll is also susceptible to condensate pooling because there is no place for the condensate to properly drain especially when installed in a horizontal position. When the flame arrester is poorly maintained and clogged, then the pressure loss through the unit is increased and can potentially affect the entire plant control system.

There are five distinct pieces in the round flame arrester and they are as follows: (a) The two end flange housings; (b) the two gaskets; and (c) the core assembly. In order to get to the core assembly, the two end housings must be pried apart with the use of a jackscrew to extend the housing. If a pressure and vacuum relief valve is sitting on top of this type of flame arrester, then the pressure and vacuum relief valve must be properly supported or may require taking the valve off line before removing the core assembly of the flame arrester. This is the same when the arrester is installed in-line, it is important to ensure that the pipe is well supported prior to removing the core assembly.

Since it is difficult to tell if the crimped ribbon design is clean and ready to be put back in service, most operators use a high-pressure spray wash system to clean the core assembly. It is equally difficult to tell if there is any distortion on the crimped ribbon after the core has been spray-washed.
Putting together the five pieces correctly may present a safety issue because if any of the five pieces are misaligned when re-assembled, then there is potential for gas leakage, or worst, ignition.

How is it important?

We have heard the common response from the industry that the potential for biogas igniting in a low pressure and velocity piping system is so minute, that the need for a sophisticated flame arrester is not a must. The photo on the next page is an actual case. Late 1996, a food-processing plant in Grand Forks, North Dakota installed a Varec Model 450 Flame Trap Assembly upstream of a waste gas burner. The food-processing plant treats its own wastewater estimated at ½ million gallons per day. The water is a by-product of the steam utilized to power most of their food-processing equipment. The plant uses an anaerobic lagoon that produces 300,000 scfd of biogas. Currently, all of the recovered biogas is run through the flare, and completely burned. At the food processing plant, the flame arrester was installed off a 90° tee from the flare: before the thermal bypass shut-off valve. The standard installation is the thermal shut-off valve should be installed immediately upstream of the potential flame source, and in this instance, the thermal shut-off valve should have been installed immediately upstream of the waste gas burner. According to the Operations & Maintenance (O&M) Manager of the wastewater treatment sector, he checked the Model 450 before he left for the day. Upon his return eight hours later, the flame already burned through one of the flanges of the flame arrester. A flashback from the burner occurred sometime that night. In the O&M Manager's estimation, the flame arrester may have actually sustained the flame for more than four hours (picture shown)! Despite the lapsed time, it is important to note that arrester held back the flame. Even the thermal bypass shut-off valve escaped unscathed.



Briefly put, the flame arrester did its job. An occurrence like this is something a plant hopes never happens. In the event that it does, you have to ensure that the flame arrester you install will do the job. Reliability is the key!