



UNIVERSAL SILENCER

noise control and air filtration solutions

LOW OUTER SKIN TEMPERATURE TURBINE EXHAUST SYSTEM DESIGN

Universal Silencer's internally lined turbine exhaust systems provide a low skin temperature exhaust system while reducing size and weight. Internal insulation protected by a stainless steel liner provides a thermal barrier to the hot exhaust gas. Thermal conduction between the inner liner and the outer skin are prevented with the use of Universal Silencer's proprietary clip design.

INTERNAL LINER DESIGN

A. **Thermal Isolation:**

Thermal isolation of the outer stainless steel shell liner is obtained through the use of bridges in the liner support structure. These thermal bridges not only minimize heat transfer to the shell but also maximize the life cycle of the exhaust system. Our liner design protects the shell structural welds from thermal stresses due to differential thermal expansion. Universal Silencer's low skin temperature liner design does not incorporate studs or other devices which allow through metal contact from the hot liner to the outer shell of the exhaust system.

Each thermal bridge assembly is welded to the outer shell and bolted to the channel-based liner support frame at a 24-inch spacing. High dynamic loads require a closer spacing. Low thermal conductivity material separates the bridge assembly from the liner support frame, allowing the necessary differential thermal growth between the liner and shell while maintaining a solid mechanical connection between the two.

B. **Outer Surface Temperature:**

Universal Silencer's unique liner design ability to provide the lowest possible skin temperature for given design criteria has been verified under both laboratory and field conditions. Universal Silencer typically designs a smaller size and weight silencer when a specified skin temperature is demanded.

For example, if a skin temperature of 140° F is specified, Universal Silencer's clip design may result in 8" of thermal material in the walls. Our competitors would probably have 10" to 12" of thermal material in the walls to meet same specification and would probably have many local hot spots at the stud locations assuming the industry standard attaching methodology is used. **Figure 1** is a graphical display of actual thermal test results (please note no wind was blowing across the test panel).

**Low Outer Skin Temperature
Turbine Exhaust System Design
Figure 1 - Wall Temperature Distribution**

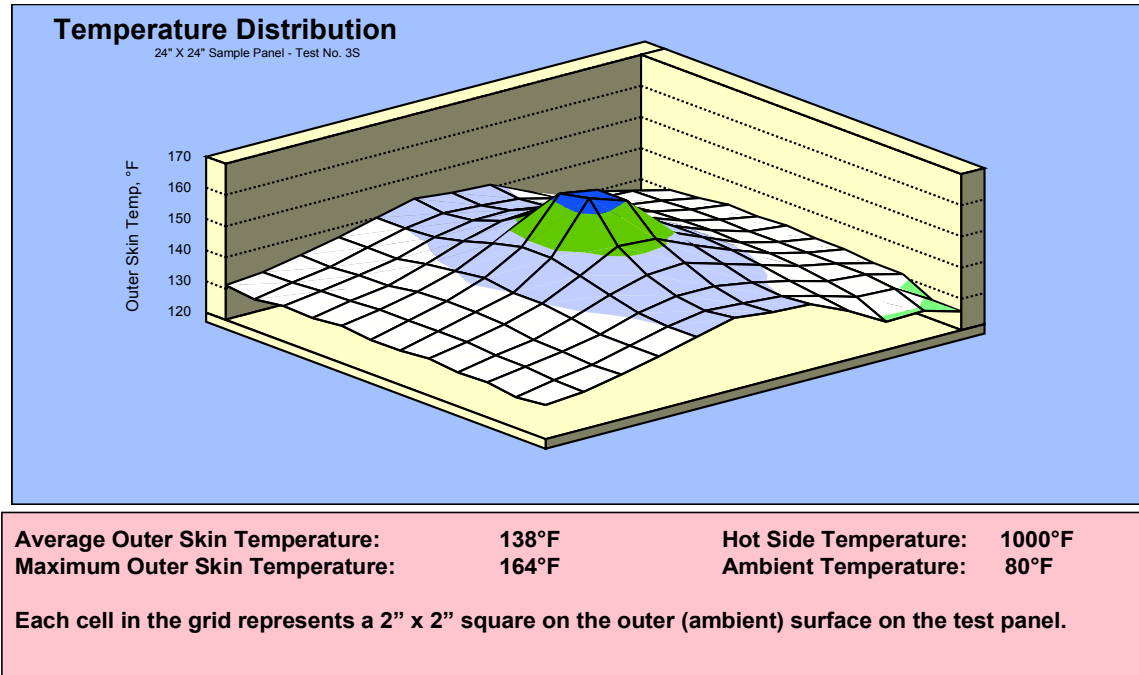


Figure 1

The additional thermal material typically supplied by our competitors typically means a larger diameter stack, more weight, more structural support and more money.

C. Thermal Growth of Internal Liner:

This design accommodates differential thermal growth by allowing adjacent liner modules to move independently without the use of bolting in the flow stream.

Each liner module is designed to grow thermally through the connection of the channel-based liner frame to the shell by way of multiple thermal isolation bridges. The liner cover grows at the same rate as the liner framing since it is of the same stainless steel material and is essentially at the same temperature. The liner cover is therefore welded to the framing rather than being mechanically fastened.

The area between adjacent liner modules is spanned by factory installed intermediate liner covers with the same thermal insulation material packed underneath. The intermediate covers are held in place by closely spaced, heavy-gauge joggle clips that allow the covers to move independent of the liner modules.

- D. Liner Insulation:** Typically 8 lb/ft³ ceramic insulation with a low thermal conductivity is compressed to the final thickness needed to meet the specified skin temperature. Insulation pins are used to minimize the effect of material settling when the insulation area exceeds a 24" x 48"

area.

EXHAUST SILENCER BAFFLE DESIGN

A. Baffle Construction:

The exhaust acoustic baffles are an all-welded construction typically built from 409 stainless steel sheet and 409 stainless steel perforated sheet steel. The material selection, both in type and thickness, may vary depending upon the application. For example, the exhaust gas temperature downstream from a heat recovery steam generator is typically 200 to 300° F. Carbon steel framing and carbon steel perforated sheet would be more economical although heavier gauges may be selected to provide a higher degree of corrosion allowance.

All flat parallel baffles have a semi-circular “nose” to minimize the pressure loss across the baffles. In some cases, the exit end of the flat baffle will be shaped into a tapered tail to further reduce the pressure loss. Some cylindrical exhaust system designs require annular acoustic rings or a central internal cylinder packed with insulation as opposed to the flat parallel baffle design.

Baffle insulation will vary depending upon the application. For exhaust temperatures below 1000° F and reasonably non-turbulent gas flow, 4 to 6 lb/ft³ mineral wool or 2.5 to 4 lb/ft³ fiberglass insulation are used. Higher gas temperatures require ceramic insulation of the same density. In either case, pack migration is reduced by the installation of two layers of 40 strand per square inch stainless steel wire mesh between the acoustic material and the perforated sheet exposed to the airflow.

B. Baffle Support:

The silencer baffles are supported between opposing liner sheets, i.e., there is no through contact to the outer shell. The liner framing is enhanced at these contact locations to provide the proper support of the baffles. Steel guides between baffles maintain the necessary parallel flow paths for acoustic and aerodynamic purposes. The baffles are captured into proper position but are free to grow within the silencer/stack housing during thermal cycles. This allows relatively easy replacement or upgrading of the baffles at a later date and allows the baffles to grow thermally without being fixed to the internal liner.