

TECHNICAL UPDATE - TU-4003

SUBJECT: Temperature Drop in Uninsulated Stainless Steel Tubing

There have been a number of inquiries lately regarding how much the temperature of sample gasses drop in uninsulated lines feeding stack gas analyzers from high temperature stacks.

This temperature drop is a function of many factors, including: tubing material, gas type, gas flow rate, ambient temperature and wind, and installation geometry. The combination of factors makes it difficult to determine the exact temperature drop in a specific line without testing under actual operating conditions.

To investigate this problem, Unitherm set up a laboratory test. The purpose of the test was to gauge the order of magnitude of any temperature drop. Though it will not give exact figures for a specific application, the test can give the engineer an idea of the distances that may be required to allow a gas to cool sufficiently to allow it to be handled by a standard stack gas bundle.

The test set-up was simple. A section of 3/8" O.D. x .035" wall welded type 316 stainless steel tube was set horizontally in the lab. A vacuum pump with a flowmeter was used to draw an air sample at a specific flow rate. Thermocouples were installed in the tube to measure gas temperature at specific points along the tube. Heated air was drawn into the tube and the temperature recorded for different flow rates. The results are shown below.

Flow Rate	gas temp 6" (150 mm) from inlet	gas temp 12" (305 mm) from inlet	gas temp 18" (450 mm) from inlet
9.4 Liters/min	970°F (521°C)	310°F (155°C)	190°F (88°C)
4.7 Liters/min	700°F (371°C)	220°F (104°C)	150°F (65°C)
no flow	240°F (115°C)	150°F (65°C)	100°F (38°C)

The flow medium was room air at approximately 1900°F (1038°C). Ambient conditions were: temperature 85°F (29°C), relative humidity 55%, no wind. There were no structures within 5 feet of the test specimen to provide reflective heat transfer or shielding.

The temperature drop was dramatic, as shown in the table. At 9.4 Liters/min the air temperature dropped almost 1000°F (550°C) in the first 6 inches (150 mm) of tubing.

The effect of gas flow rate is shown clearly. The temperature drop at no flow was almost double that at the high flow rate.

In all cases, the gas temperature at 12 inches (305 mm) from the inlet was low enough for introduction into standard 400°F (204°C) rated gas analyzer bundles with PFA tubing.

Again, this test shows the relative values for one specific construction only. Applications requiring cool down lines must be evaluated on a case-by-case basis. Contact Unitherm engineering for further information on individual applications.