

Gas Sampling Probes

General Information

United Sensor Gas Sampling probes have been designed for accurate sampling of burner exhaust gases primarily used in efficiency studies of combustion and they have been endurance tested in routine test work.

An internal static tap is located in the inner flow passage of the probe near the sample inlet as shown in Fig. 1 so the static pressure of the sampled gas can be measured. In order to obtain a true sample, it has been found necessary to draw off the gas at the same velocity as is flowing in the duct. If the sample is accelerated or decelerated as it is drawn into the probe, it will not be a true average since, in the first case, a disproportionate share of low density components will be drawn in, and in the second case, too much of the high density components will be sampled.

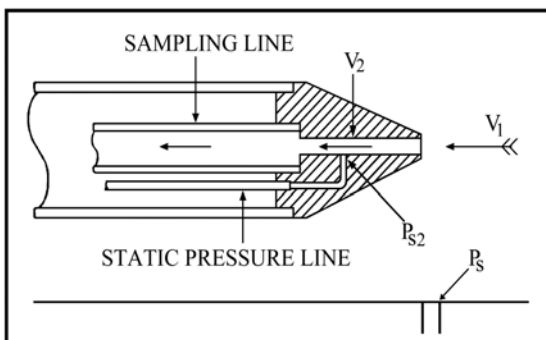


Fig. 1 - Measuring Static Pressure of Sampled Gas.

This would not be true in a perfectly homogeneous mixture of gases, but in the region most sampling is done the mixture is not homogeneous since the fuel particles are usually still burning or have just completed burning and the products of combustion are concentrated in "slugs" of gas interspersed by lighter, unburned air.

The gas velocity in the duct is proportional to:

$$V_1 = K \sqrt{\frac{P_{t1} - P_{s1}}{d_1}}$$

Where P_t , P_s , and d are total pressure, static pressure, and density, and K is a constant.

The gas velocity in the probe inlet is proportional to:

$$V_2 = K \sqrt{\frac{P_{t2} - P_{s2}}{d_2}}$$

P_{t1} will automatically equal P_{t2} since no work is done on the gas in drawing it into the probe so if P_{s1} is made equal to P_{s2} it can be seen that V_1 will equal V_2 . Since the static pressures are equal and there is no change in temperature, d_1 and d_2 will also be equal.

By measuring the static pressure P_{s1} with a static tap in the wall of the duct at the same cross section and P_{s2} with the internal static tap on the probe, the two can be equalized by adjusting the sampling suction.

In some cases, the resulting volume of gas flow through the sample probe is too high or too low for the gas sampling apparatus. The orifice inlet diameter is picked to be high enough to give a flow at the lowest duct velocity V_1 sufficient for analysis purposes and the excess gas sampled at higher duct velocities is by-passed around the analyzer by a bypass line and valve.



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United Sensor Sampling probes are made in three types:

Type A

Type A is uncooled, of welded construction, suitable for use up to 2000°F and is the smallest.

Type B

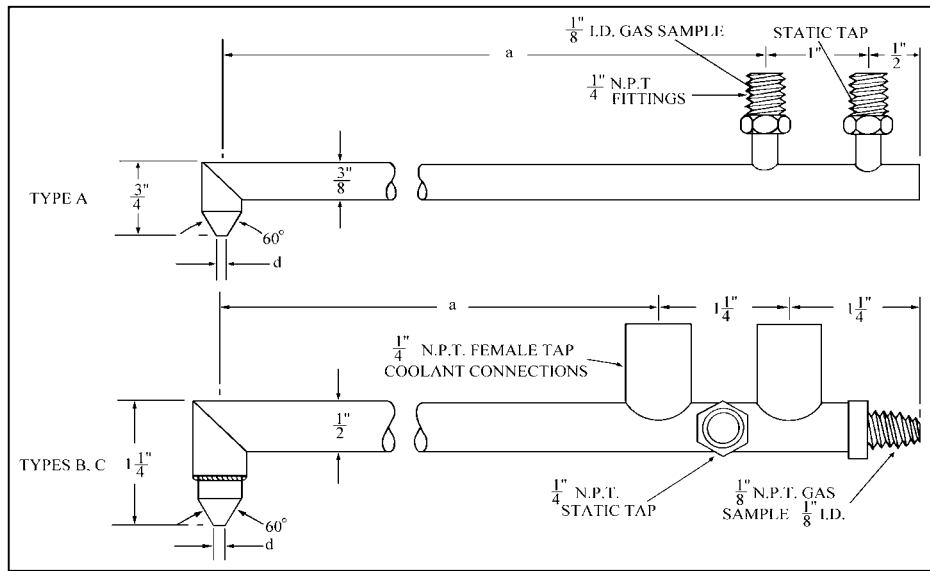
Type B can be used either as a heated or cooled probe. The cooling passages are especially designed for unrestricted flow of cooling or heating fluids. For some applications, it is important to keep the sampled gas above 500°F to the analyzer to prevent condensation of evaporated hydrocarbons. In this case, the probe is heated by blowing hot air through the cooling passages. This is more satisfactory than trying to heat it with an electric coil

because the variation of heat loss conditions from the surface of the probe makes it almost impossible to maintain an even temperature. For higher temperatures, the probe can be kept hot enough to prevent condensation but cool enough not to melt by blowing unheated shop air through the coolant passages. Above 3000°F, even with water cooling the stainless steel tip on the Type B probe it would burn out. Therefore, Type C is recommended.

Type C

Type C probes have a copper tip, which has a high enough conductivity to prevent burning out at the highest temperatures and velocities. Since the tip is easily damaged, it is not recommended for lower temperature applications.

Types A, B, & C



ORDERING INFORMATION

Example:

Class: G (Gas Sample) _____ G A - 24 - 050
 Type: A, B, C _____
 a: Overall Length - inches _____
 d: Inlet hole diameter - thousandths of inch _____
 maximum .125 for Types B, C
 maximum .093 for Type A

Standard Construction: Stainless Steel, welded and brazed for use without water-cooling (Type A) to 2000°F
 Water-cooled for use to 4000°F (Types B,C)

Standard Probes: GA-024-050, GB-24-050, GC-24-050

Special construction and other sizes to customer's designs. Special take-offs and mounting adapters to sketches or specifications.



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