General Applications

How to Choose a GC Inlet Liner: Simplify Selection Based on Injection Type

By Scott Adams

Choose the best liner for:

- Split injection
- Splitless injection
- Direct injection
- Gas injection
- PTV injection

In gas chromatography (GC), the inlet is the first part of the instrument with which your sample can interact. The inlet's main purpose is to transfer the sample onto the GC column for analysis. Samples can vary in a number of ways; for example, they may be liquid or gas, and they may contain high concentrations or just trace amounts of your compounds of interest. Choosing the correct GC inlet liner is critical in assuring that the desired amount of sample is transferred onto the column in an efficient manner, without negatively impacting the target compounds.

Many inlet liners are available for use in gas chromatography, and they differ in geometric configuration/design, volume, base material (borosilicate, quartz, or metal), deactivation, and the presence or absence of some sort of packing. Different styles of liners are used for different types of samples (liquid or gaseous) and different types of injections (split, splitless, on-column, or direct). Fortunately for the user, determining how to choose a GC inlet liner can be greatly simplified by basing the decision on the type of injection that will be used.

Split Injections

A split injection is used when the compounds of interest in your sample are of relatively high concentration or when low limits of detection are not necessary to achieve. As the name implies, the injection is split so that a manageable amount of your sample is transferred onto the GC column. Split injections are accomplished by high flow rates through the inlet, with some flow (and sample) going to the GC column and some flow (and sample) going out the split vent. The ratio, total inlet flow compared to the column flow, is referred to as the split ratio. Injecting less sample matrix into the column is desirable, when possible, as this will usually greatly increase column lifetime.

Since there is a high flow rate through the inlet, the time that the sample actually spends within the inlet is minimal. In order to efficiently and reproducibly get a representative amount of sample onto the analytical column, the inlet must vaporize the sample and mix it quickly. Two liners are suggested for use in a split injection, based on their ability to enhance vaporization and mixing of the sample. The first is the Sky® Precision® split liner with wool (Figure 1). This liner contains deactivated glass wool that is placed consistently in the same location within every liner and held there by dimples on the inside of the liner. The wool enhances vaporization and mixing of the sample by increasing surface area, and it also wipes the syringe needle during injection to increase repeatability. With Sky® inlet liners the wool is deactivated *in situ*, making for a very inert liner, which will work well for the majority of split injection applications.

Figure 1: Sky® Precision® liner with wool for Agilent® GCs.

If your sample interacts negatively (e.g., compound degradation or adsorption) with wool, then a Sky® Cyclo liner (Figure 2) is recommended for split injections. This liner does not contain wool. Instead, the bottom third of the liner contains a corkscrew of glass, which increases the interior surface area, assists with sample vaporization, and creates a vortex that mixes the sample. As with the Sky® Precision® liner, the Sky® Cyclo liner is also Sky® deactivated, making for a very inert sample introduction and mixing chamber.

Figure 2: Sky® Cyclo liner for Agilent® GCs.

Splitless Injections

A splitless injection is used when the compounds of interest in your sample are present at lower levels. With this technique, the split vent is closed at the start of the injection and all of the flow passing through the inlet is directed through the column for a programmed period of time, sometimes known as purge valve time. The split vent is then opened to flush out any remaining vaporized solvent. In a proper splitless injection, 99% of your compounds of interest will have been transferred onto the GC column.

As with a split injection, two liners are recommended for use in a splitless injection. The first is the Sky® single taper liner with wool (Figure 3). The single taper at the bottom of the liner limits the interaction of the analytes of interest with the metal inlet seal and helps direct or focus the sample to the head of the column. The wool catches the injected sample and provides a place from which it can vaporize, while also trapping nonvolatile "dirt" that can contaminate the expensive GC column. With Sky® liners, the wool is deactivated *in situ*, creating a very inert liner, which is often needed when the compounds of interest are found at trace levels within the sample. This liner is a good starting place for the majority of splitless injections.

Figure 3: Sky® single taper with wool for Agilent® GCs.

If your compounds of interest degrade or adsorb on wool, a Sky® single taper liner without wool is recommended (Figure 4). As mentioned before, the single taper at the bottom of the liner limits the interaction of your compounds of interest with the metal inlet seal and helps direct sample flow onto the analytical column. Sky® deactivation ensures a highly inert liner for analyzing compounds at trace levels.

Figure 4: Sky® single taper without wool for Agilent® GCs.

Direct Injections

A direct injection is typically used when the compounds of interest in your sample are at trace levels and no contact between the sample and the wool or the inlet bottom seal can be tolerated due to the potential for compound loss through degradation or adsorption. With a direct injection, the sample is injected into a hot inlet allowing the entire sample to be vaporized into the GC column, which is sealed directly to the inlet liner.

A Sky® Uniliner® inlet liner is designed with an internal "press-fit" connection at the bottom of the liner, which seals the GC column to the liner so there is no contact between the sample and the metal seal on the bottom of the inlet. Sky® Uniliner® inlet liners are made in two configurations. One has a small hole drilled near the top of the liner (Figure 5), while the other variation has a hole drilled near the bottom but above the liner/column seal (Figure 6). If your analytes of interest are semivolatile compounds, or if they could be affected by a tailing solvent peak, use the Sky® Uniliner® inlet liner with the hole drilled near the bottom. For aqueous injections or when your compounds of interest elute away from the solvent peak, choose the configuration with the hole drilled near the top.

Figure 5: Sky® Uniliner® with hole near top for Agilent® GCs.

Figure 6: Sky® Uniliner® with hole near bottom for Agilent® GCs.

Gas Injections

Injecting a gaseous sample is fundamentally different than injecting a liquid sample. With a liquid sample, the inlet needs to vaporize the sample so that it can be introduced onto the analytical column. For a gas sample, the inlet only needs to move the sample efficiently onto the analytical column.

The best inlet liner for gaseous samples has a small inner diameter (ID) to transfer the gaseous sample to the analytical column in the tightest sample band possible. A Sky® straight liner with a 1.0 mm ID is recommended for the injection of gaseous samples (Figure 7).

Figure 7: Sky® straight liner (1 mm) for Agilent® GCs.

Programmable Temperature Vaporization (PTV) Injections

The principle of a PTV inlet is that a sample is injected into a cold inlet. The inlet is then programmed to increase in temperature, often vaporizing the solvent to vent and then increasing in temperature to vaporize the compounds of interest and introduce them onto the analytical column.

There are a number of different manufacturers that offer PTV inlets and liners for these inlets will vary depending upon the geometry of the inlet. Certain features that almost all PTV liners have include a small inner diameter and baffles or dimples on the inner surface of the liner. These baffles/dimples increase the inner surface area of the liner, providing more space for the sample to adhere

as well as enhancing the heat transfer from the inlet to the sample as the temperature of the inlet is increasing. When choosing a PTV liner look for your specific inlet manufacturer, then select a liner with Sky® deactivation and a small inner diameter that contains at least one baffle or dimple.

Summary

There is a wide variety of liners available, so how do you determine which one you should use? In most cases, the question of how to choose a GC inlet liner can be simplified based on the injection technique you employ. With split or splitless, there are two types of liners to choose from: one with wool and one without. Choose an inlet liner with wool if your compounds of interest are not highly sensitive. Sky® inlet liners with *in situ* glass wool deactivation will allow you to use wool with confidence. In most cases, using a Sky® single taper liner with wool for splitless injection or a Sky® Precision® liner with wool for split injection will produce excellent results. In the rare cases where your analytes are extremely sensitive, choose the liner without wool. For direct injections, the placement of the drilled hole is the only decision you need to make. For most applications using direct injection, the hole drilled at the top of the liner will work. For gaseous samples, a Sky® inlet liner with a narrow inner diameter is recommended to ensure a tight sample band. Finally, for PTV injections, a narrow inner diameter liner would also be used, but be sure to choose one that contains baffles or dimples and that is compatible with your inlet. Restek's Sky® inlet liners are available in all the configurations recommended here for each injection type.

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