

Glass Inlet Liners for Gas Chromatography



Choosing the Right Glass Inlet Liners for the Gas Chromatograph Injector Systems

you have a broad choice of different injectors and liners which allow you to adjust several variables in order to optimize the injection. This provides a lot of flexibility, but as a consequence can introduce some complexity for the users. Reference these guidelines on how to choose the right liner depending on your sample and matrix. The main types of liners and internal geometry are simply explained, providing some useful tips for all chromatography users.

Making a good injection is an important step for any chromatographic technique, but even more crucial in Gas Chromatography (GC). The injector and liner is an essential component of the gas chromatograph (Figure 1). Today

Improved Capillary GC has become an essential tool in analytical chemistry, despite its poor quantitative reputation in the past.

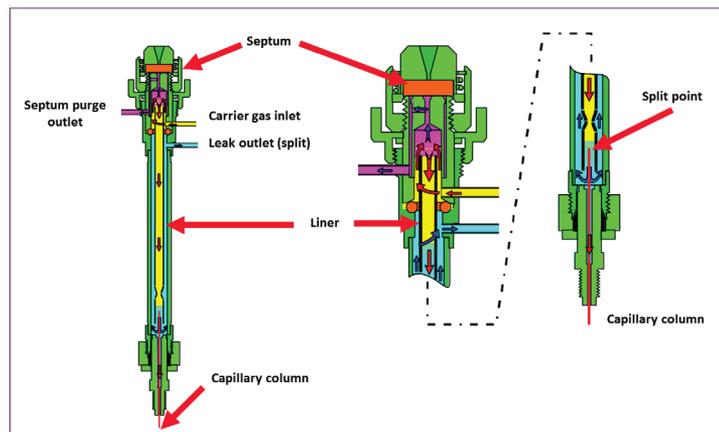


Figure 1. Diagram of the split/splitless injector, liner shown in light blue. The carrier gas enters to the top between the inner wall of the metal body and the outer wall of the liner.

The liner has multiples roles:

- Facilitates cleaning and replacement
- Reduces adsorption of the polar and active solutes on the liner wall, which is more or less inactive
- Ensures compatibility with the chosen injection mode
- Optimizes the flow in the injector
- Ensures that peaks are as narrow as possible, resulting in maximum resolution and sensitivity depending on the chosen injection mode

Chromatograph manufacturers offer split/splitless injectors so that both injection modes are possible in the same electrically-heated metal body. Often, it is thought that the only difference between the two techniques is that the split vent is open in split mode and closed in splitless mode. In reality, there are several differences, beginning with the choice of liner (Figure 2).

| | SPLIT | SPLITLESS |
|---|---|---|
| Liner's diameter | Large, average (glass wool, special geometry) | Average, narrow (straight geometry) |
| Needle of the syringe Depth of penetration* | Short (eventually with spacer) | Long |
| Injection's speed* | Fast | < 0.5 µl/sec |
| Sample's dilution* | No dilution or medium | Always strong |
| Initial oven's temperature | Higher than the boiling point | 20 to 30°C lower than solvent's boiling point |
| Thermal program | No constraint | Always programmed  |
| Injected volume * | Not important (0,2 to 5 µl) | > 0,5 µl (preferably from 1 to 2 µl) |

*Some parameters can be adjusted on the autosampler.

Figure 2. Main differences between split and splitless modes, using the same injector body.

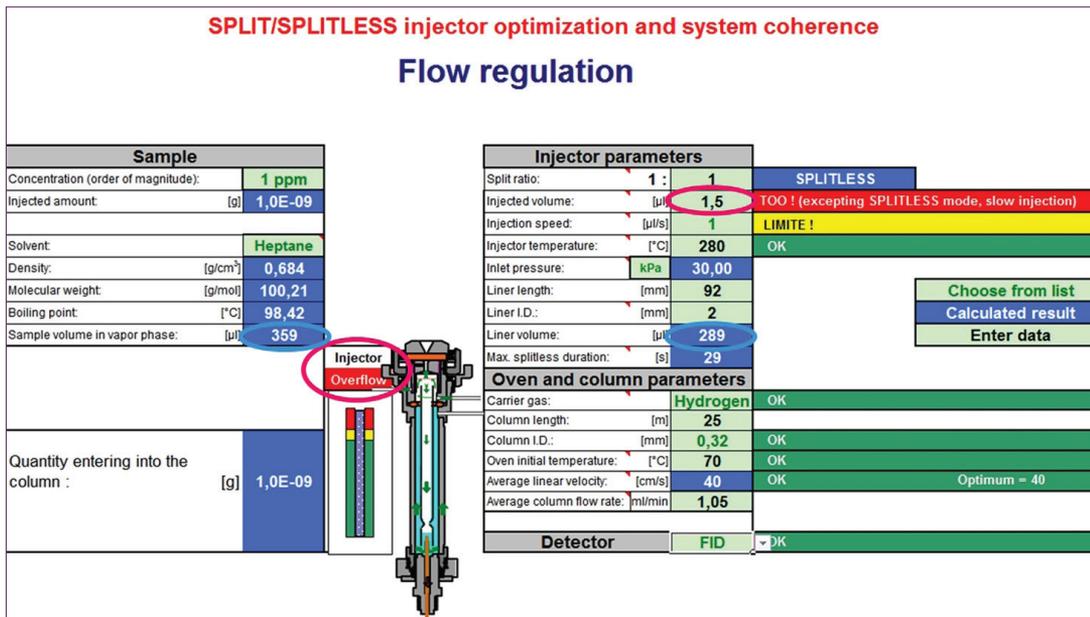


Figure 3. The red indicate injector overload, the blue circles compare the volume of the sample in the vapor phase with the liner's internal volume.

Selecting the right liner depends on the following parameters:

1. Length and outer diameter, determined by the chromatograph model.
2. Inner diameter depending on the injection mode. Remember the following guideline: in splitless mode diameter between 1 mm and 3 mm, in split mode diameter between 3 mm and 5 mm. These dimensions determine the maximum injectable volume. Failure to comply with this rule can lead to backflash and

recondensation of the sample on cold parts of the system, resulting in negative consequences such as repeatability and linearity problems, and also appearance of phantom peaks. Backflashing is an insidious phenomenon; by the time you realize it's happening, it's already too late. The GC optimization software (available on request and free of charge from PerkinElmer) provides a lot of useful information, including warning of injector overload (Figure 3).

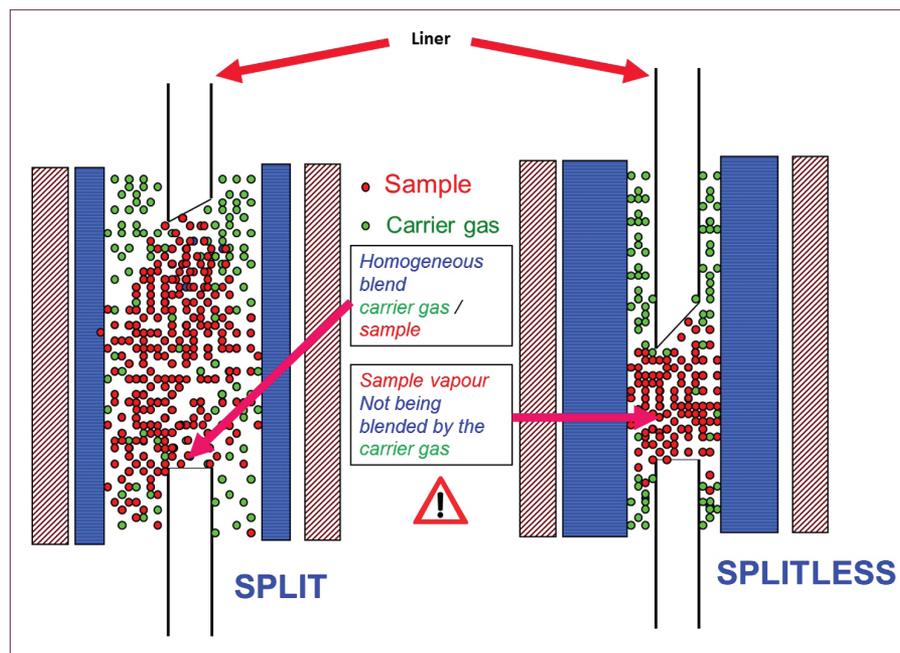


Figure 4. Comparison of split and splitless modes.

3. Internal geometry. Initially, the guideline is as follows: in splitless mode use an empty liner with straight geometry, the gas flow should be laminar; in split mode use a fairly complex geometry to promote turbulent flow (Figure 4). In fact, to achieve satisfactory injection repeatability, you need to ensure that a homogenous blend is formed between the sample molecules (in the vapor phase) and the carrier gas. A fairly complex internal geometry encourages blending. In practice, chromatographers quickly found that putting glass wool inside the liner worked well. By doing so the larger warm surface area reduces discrimination between the light and heavy solutes. Conversely, the technique can be risky in the case of active, polar and thermally labile samples. For this reason, always use deactivated, silanized glass or quartz wool.

PerkinElmer offers a wide selection of GC glass inlet liners. To help you find the right liner for your application, see below the description and geometry of PerkinElmer liners adapted to the various characteristics of the sample and/or injection mode.

- **Empty straight liner, Figure 5: A, B, C, D and E**

The empty straight liners work fairly well with apolar or averagely polar, volatile and averagely volatile solutes (less than C15).

Repeatability is mediocre, especially in the case of products with higher molar mass. The liner is easy to clean.

- **Gooseneck liner, Figure 5: F, G and H**

Particularly suitable for the "direct" injection mode where you need to engage the column in the gooseneck (at the bottom) to create a seal.

In the case of an active sample (polar solutes) it is best to use a quartz liner. The liner is easy to clean.

- **Gooseneck liner with a hole in the side, Figure 5: J and K**

Particularly suitable for the splitless injection mode. In purge position the carrier gas passes through the hole in the side. Opt for J (hole at the top of the liner) when the solute peaks are very different from the solvent peak, and also when injecting aqueous solutions. Version K with hole at the bottom is preferable when the solutes are similar to that of the solvent. Liner is easy to clean.

- **Straight liner with glass wool or quartz or glass frit, Figure 5: L, M and R**

The glass wool creates turbulence inside the liner, assisting the formation of a homogenous blend of solutes and carrier gas. In addition, the solutes come into contact with a much larger warm surface, and therefore evaporate much more quickly, which decreases heavy solute discrimination. The glass wool also acts as a trap if the samples are dirty. Potential hazard: during use the fibres break, the glass wool becomes increasingly active and slows down the peaks. Change the wool often and always use deactivated (silanized) glass wool or quartz. Some authors suggest performing silanization in situ. Deactivated liners are particularly effective with very active solutes, for example chlorinated pesticides. The liner is somewhat complicated to clean.

- **Focus liner with glass wool, Figure 5: N and O**

The position of the glass wool is fixed, the needle penetrates the middle of the packing, the glass wool wipes the needle when it is withdrawn. It offers better repeatability and even lower discrimination. The throat at the column end ("tapered" or "drilled", see O) prevents active solutes from coming into contact with the metal base. Unlike "gooseneck" geometry, the "tapered" or "drilled" type does not want leaktight contact between the column and the liner. This throat proves particularly useful in splitless mode, as it avoids inaccessible "pockets". The liner is difficult to clean.

- **Cyclo gooseneck liner with glass wool, Figure 5: H**

Specially adapted to heavier and polar solutes. Note, the throat at the septum end reduces contact between the constituents, the septum and metal surfaces. The liner is difficult, if not impossible, to clean.

- **Gooseneck liner at the bottom, throat at the top, hole in the side, Figure 5: P and Q**

For traces and active constituents. The liner is difficult, if not impossible, to clean.

- **Liners for the PSS* injector, Figure 5: E, R, S and T**

In "cold" mode the choice of a liner with packing (R) is essential.

- **Liners for the "on column" injector, Figure 5: T**

With this injection mode the role of the liner is reduced to simply guiding the column. The column is engaged in the gooseneck located at the top, the septum end. It can only be used with the PSS* injector.

| Table 1 Reference | Description | ID mm | OD mm | Length mm | Part No. | |
|-------------------|---|-------|-------|-----------|----------|--|
| A | Straight glass liner, empty | 4 | 6.2 | 92.1 | N6101052 | |
| B | Straight quartz liner, empty | 4 | 6.2 | 92.1 | N6121001 | |
| C | Straight liner, ID = 1 mm | 1 | 6.2 | 92.1 | N6502006 | |
| D | Straight liner, ID = 2 mm | 2 | 6.2 | 92.1 | N6121002 | |
| E | Straight deactivated quartz liner | 2 | 4 | 86.2 | N6121004 | |
| F | Glass liner, gooseneck | 4 | 6.2 | 92.1 | N6101375 | |
| G | Quartz liner, gooseneck | 4 | 6.2 | 92.1 | N6121003 | |
| H | Cyclo liner, gooseneck | 4 | 6.2 | 92.1 | N6502017 | |
| J | Quartz liner, gooseneck, hole in the side at the top | 4 | 6.2 | 92.1 | N6121022 | |
| K | Quartz liner, gooseneck, hole in the side at the bottom | 4 | 6.2 | 92.1 | N6502013 | |
| L | Deactivated silica wool liner, gooseneck | 4 | 6.2 | 92.1 | N6502016 | |
| M | Straight liner with glass wool | 4 | 6.2 | 92.1 | N6502009 | |
| N | Deactivated surface with deactivated glass wool "focus" liner | 4 | 6.2 | 92.1 | N9306233 | |
| O | Deactivated surface with deactivated glass wool "focus" liner | 4 | 6.2 | 92.1 | N9306235 | |
| P | Glass liner, gooseneck, hole in the side at the top | 4 | 6.2 | 92.1 | N6502014 | |
| Q | Glass liner, gooseneck, hole in the side at the bottom | 4 | 6.2 | 92.1 | N6502015 | |
| R | Straight liner with deactivated glass wool | 2 | 4 | 86.2 | N6502001 | |
| S | Straight quartz liner | 1 | 4 | 86.2 | N6121006 | |
| T | Glass liner for "on-column" injection, PSS* mode | 2.4 | 4 | 86.2 | N6101539 | |

Figure 5. Different liner geometries. The septum is always on the left-hand side.

Table 1. Liner selection based on the injection mode and sample characteristics.

| | Full column injector | Direct capillary injector | Split | Split and "Fast GC" | Splitless | PSS* | PSS* "on-column" (POC) | SPME** |
|--|----------------------|---------------------------|------------|---------------------|------------------|---------|------------------------|--------|
| General use | A, M | F, G | A, B, M, N | C, D | C, D, J, K, N, O | E, R | T | C |
| Gas or headspace | A, B, M | C, D, F, G | D | C, D | O, P, Q | E | — | C |
| Liquid and 0.53 mm column in "filled mode" | — | F, G | A, B, M, N | — | — | E, R | T | — |
| Volatile or averagely volatile constituents (<C15) | A, L | D, F, G | A, B, M | C, D | D, J, L, N, O, Q | E | T | C |
| Presence of heavier constituents | H, L, M | H, L | L, M, N | L, M | K, N, O, P | R | T | C |
| Concentrated sample | A, B, C, D | — | A, B, D | A, B, M | — | E, R, S | — | C |
| Trace analysis | A, L | F | — | — | D, O, P, Q | S | T | C |
| Large injected volume (>2 µl) | A, L, M | F | A, B, M | — | J, O, P, Q | R | — | — |
| Small injected volume (<0.5 µl) | C, D | C, D | C, D | C, D | C, D | S | T | C |
| Dirty sample | L, M | H, L | H, M, O | L, N | J, O | R | — | C |
| Active or polar constituents | B, L | F, G, L | B, L, O | B, L | N, P, Q | R, S | T | C |

* PSS: Programmed Temperature split/splitless

** SPME: Solid Phase Micro Extraction

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