Technical Note 20552

Gas Chromatography Syringe Selection Guide

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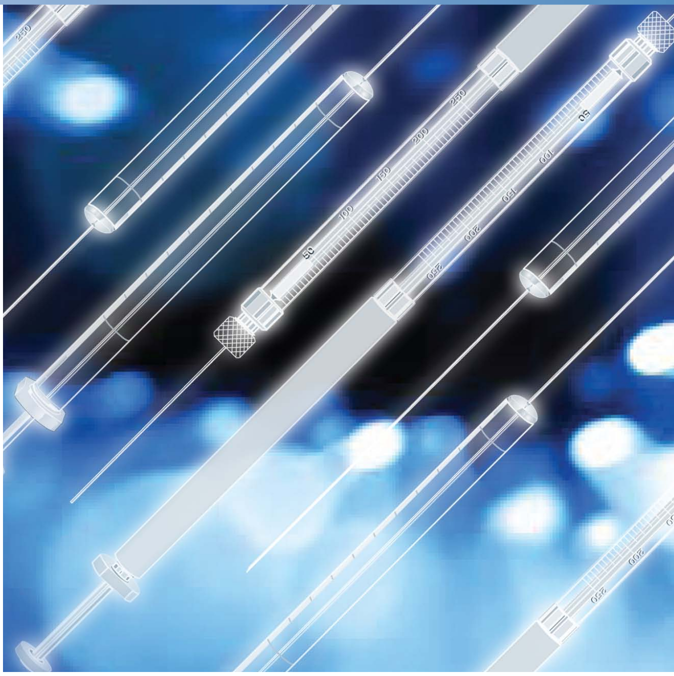


Key Words
Syringe selection

Abstract
Choosing the correct syringe from the wide selection available can be a difficult task, however with a little more information this process can be simplified.

Introduction
The syringe plays a pivotal role in the GC system as it takes the sample from the vial and introduces it into the inlet. There is a lot of scope for error when selecting the correct syringe due to a wide range of inlets from different manufacturers and also the wide range of autosampling devices.

Once the correct syringe for the inlet and the autosampler has been selected, there are further parameters, such as needle gauge and tip style, that can be crucial when selecting a syringe. In this guide we will simplify the syringe selection process, allowing users to confidently select the correct needle for their instrument

How to Select the Correct Syringe
Given in Table 1 are the details required to select the most appropriate syringe for an application, with an explanation of syringe components from tip to plunger in subsequent sections.

Parameter	Example	Relevance to selection
1. GC type	Thermo Scientific, Agilent	Correct needle length
2. Autosampler Type	Thermo Scientific, Agilent, Gerstal	Correct syringe plunger attachment
3. Sample type	Liquid, headspace	Needle tip style
4. Sample volume	1 µL, 1000 µL	Total syringe volume

Table 1: Parameters required to select the correct GC syringe

Once all of this information has been gathered, the most appropriate syringe can be determined by using the following sections:

Needle Length

Each injection port is designed differently and requires a specific length of syringe to be used. For reproducible sample transfer from liner to column, injection ports require the sample be injected at a specific depth inside the inlet liner. This makes it critical to have the correct needle length installed for your application.

For a list of which needle lengths are compatible with injection ports and autosamplers please refer to Table 2.

		Thermo Scientific TriPlus	Thermo Scientific AS1310 (for TRACE 1300/1310)	Thermo Scientific TriPlus RSH on TRACE GC	Thermo Scientific TriPlus RSH on TRACE 1300 GC	Thermo Scientific AS2000, AS3000	Agilent	CTC (Gerstel MPS)	Perkin Elmer Autosampler	Manual Injection	Shimadzu
Needle Length (mm)	42						x				x
	50	x	x			x				x	
	51							x		x	
	56							x			
	57			x	x						
	65										
	70								x	x	
	75									x	
	80	x				x					
	85			x							

Table 2: Needle length by Autosampler

Needle Tip Style

Selecting the correct needle tip allows the best performance to be achieved by your syringe. Thermo Scientific supply needles in the following tip styles:

- Cone (tapered tip) – these are the most versatile needle for autosampler use and resist coring of vial and inlet septa
- Bevel (sharp tip) – these are typically used for manual injections. The tip shape helps reduce septa coring
- Side hole (dome tip with side hole for sample exit) – usually used for headspace and large volume injections
- Blunt End or 90° (flat tip) – used for injectors that do not contain an inlet septa such as Merlin Microseal

To determine which needle tips are compatible with your instrument refer to Table 3.

		Merlin Microseal injector	Thermo Scientific TRACE SSL	Thermo Scientific TRACE PTV	Thermo Scientific TRACE 1300/1310 SSL/ PTV	Agilent 6890 SSL	Perkin Elmer	Shimadzu	Manual Injection
Gauge	22/22s								x
	23	x	x	x	x	x	x	x	
	25								x
	26		x	x		x	x	x	
	23-26					x		x	
Tip style	Cone	x	x	x	x	x	x	x	
	Bevel		x	x	x	x			x
	Side hole		x	x	x	x			
	Blunt	x							x

Table 3: Needle gauge and tip style by instrument type

Needle Gauge

Needle gauge is a measure of the “thickness” of the needle. The higher the number the thinner the syringe (e.g. a 26 gauge needle is narrower than a 23 gauge).

The suffix “s”, e.g. 23s refers to a needle with a narrower internal diameter (and volume) than is standard for that gauge.

Selecting the correct gauge of needle is critical for on-column injections. This is because the syringe must fit inside a capillary column (typically 0.53 mm I.D.). If a large (e.g. 23 gauge) syringe is used, the column will break and the sample will not be injected onto the column.

Different injection ports are designed to accept specific needle gauges. For a list of which gauge is suitable for which inlet refer to the Table 2. In general, select the smallest gauge (i.e. thickest) needle that is compatible, as thicker needles are more robust, helping to increase needle lifetimes.

Needle Attachment

Syringes are available in both fixed and removable needle designs, both of which have their merits.

Fixed Needle Syringes

Advantage

- Lower purchase price compared to removable needle designs

Disadvantage(s)

- Cannot be repaired, considered a disposable item
- Contain adhesives to attach the needle that may be damaged by solvents. Refer to maintenance section for details

Removable Needle Syringes

Advantage(s)

- Needle can be replaced when damaged, potentially giving longer lifetimes
- Overall lower cost over the lifetime of the syringe
- More versatile as can use the same syringe for multiple applications by changing the needle for another of different tip style, length or gauge

Disadvantage

- Higher purchase price

Syringe Volume

A wide range of syringe volumes are available. In general using a sample volume lower than 10 % of the maximum syringe volume will reduce the precision of the injection. For liquid sampling, volumes are typically between 0.5 – 3 µL so the most common syringe volumes are 5 and 10 µL. For headspace sampling the typical volumes are 1 – 3 mL, so larger volume syringes are required.

Large syringe volumes are available (>500 µL) these enable large volume injection (LVI), headspace and on-line sample preparation to be performed.

Plunger Design

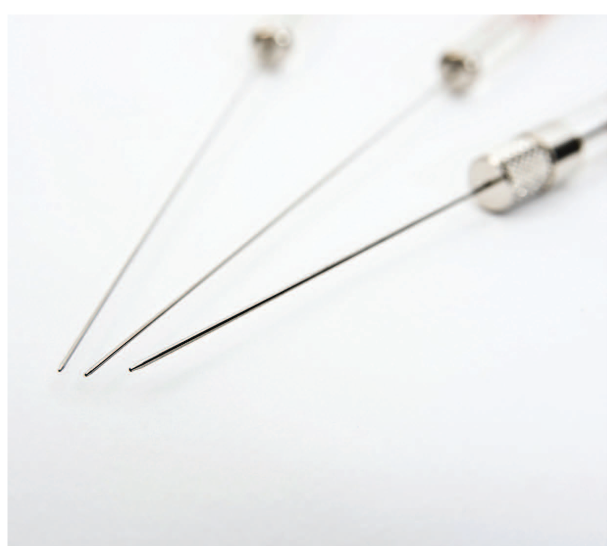
Most plungers are made from stainless steel with an option of a PTFE tip on the end. If no PTFE tip is present then the syringe is not classified as gas tight and should only be used for liquid sampling (i.e. not for headspace). If a PTFE tip is present the syringe is suitable for gas and liquid sampling.

Gas tight syringes resist plunger freezing (or sticking) due to the inherent low friction properties of PTFE. This may help extend the lifetime of the syringe, especially if dirty samples are being analyzed that are prone to clogging syringes.

If no information in the product literature is given about the plunger and the syringe is not stated as gas tight then the plunger can be assumed to be stainless steel.

Super-Elastic plungers are made from a more flexible material than standard plungers and may give longer lifetimes, especially when performing manual injections, than stainless steel plungers. This is because the plungers are less prone to permanent bending.

Plunger in Needle syringes are designed for extremely low volumes (< 1µL) and means that the needle contains part of the sample volume



Plunger Attachment Type

The correct plunger attachment must be selected to allow the syringe to interface with the autosampler. If the wrong attachment is selected the syringe cannot be used.

Syringe Maintenance

Routine Syringe Maintenance and Good Care Practices

Syringe lifetimes can be significantly improved by adhering to the maintenance procedures and good practice guidelines given below:

- Wash syringes daily with a solvent the intended samples are soluble in such as methanol, dichloromethane or acetonitrile. Completely fill and expel the syringe 5 to 10 times with the chosen solvent, removing any solid debris accumulating in the barrel or needle. Remove the plunger and wipe with a lint free cloth wetted with solvent. Finally rinse with acetone and allow to air dry.
- After using a syringe always rinse with 3 to 5 syringe volumes of solvent to remove any material that may block the syringe.
- Avoid operating the plunger when the syringe is dry - liquid in the barrel acts as a lubricant reducing syringe wear.
- Never fully submerge the syringe in solvent, as adhesives are used to assemble the syringe and submerging in solvent may cause damage to these.
- On non gas tight syringes the syringe barrel and plunger are manufactured together so they match each other perfectly. This means that plungers are not replaceable as the accuracy of the syringe will be compromised. If the wrong plunger is inserted the syringe calibration is no longer valid and must be repeated.
- The plungers on gas tight syringes are replaceable as the PTFE tip on the plunger creates a gas tight seal.
- It is not common to autoclave syringes used for GC analysis, however if autoclaving is required it is preferable to use a removable needle syringe as adhesives present in fixed needle designs can be damaged by autoclaving. In general syringes should be autoclaved at a maximum temperature of 100 °C. Also, note that autoclaving syringes will reduce their lifetime due to stressing of the adhesives used to assemble other parts of the syringe. If autoclaving multiple syringes simultaneously ensure the correct plunger is reinstalled in the correct barrel.
- Rough edges present on the tip of the needle can cause tearing of the GC inlet septa leading to septa siloxane contamination peaks in the chromatogram. Rough edges may be removed by smoothing with a fine sandpaper.

Unblocking Syringes

All syringes block occasionally, however if regular blockages are encountered it is likely that there is a problem with the syringe maintenance program, needle suitability or sample preparation procedures. It is recommended to optimize these procedures, as blocked syringes can be costly both in terms of broken syringes and lost instrument time.

When blockages do occur the procedures below enables the majority of blockages to be removed:

1. When a syringe has been blocked by the precipitation of compounds due to drying of salts and buffers, the easiest way to unblock the syringe is to soak the needle (do not submerge the entire syringe) in an appropriate solvent in which the blockage is soluble (often distilled water), for no longer than 5 minutes.

   This may dissolve the precipitate and unblock the syringe. Draw 5 to 10 syringe volumes through the syringe to completely remove any remaining material.
2. If the syringe is blocked by solid particles or vial/inlet septa a different approach is required. Remove the plunger and fill the barrel of the blocked syringe with another syringe. Re-insert the plunger and gently expel the syringe. This should dislodge the blockage. Never force the plunger as this can cause the barrel to crack or the plunger to bend.

3. If step 2 does not remove the blockage try inserting the needle wire supplied with the syringe into the needle. This may help move the blockage allowing step 2 to be repeated successfully.

4. When a particularly stubborn blockage is encountered it may be necessary to stand the syringe in a beaker of solvent, so that only the needle and needle attachment are submerged, and sonicate for a maximum of 10 minutes to try and remove the blockage. Repeat step 2 to remove the blockage.

5. As a last resort it may be necessary to gently heat the needle causing it to expand slightly enabling the blockage to be removed. Extreme care must be exercised when using this approach as the syringe may be damaged irreversibly. It is advisable to check the syringe calibration after performing this procedure to ensure syringe accuracy has not been affected.

Conclusion

When selecting a syringe, important factors to consider are:

- Needle length
- Syringe plunger attachment
- Needle tip style
- Total syringe volume

Selecting the correct product will ensure the optimum performance will be achieved from your syringe.

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