Gas Chromatography System Purchasing Guide
GMI Certified Knowledge

Gas Chromatography (GC), also referred to as vapor-phase chromatography or gas-liquid chromatography, is a commonly used analytical and preparative technique involving separation and analysis of compounds that can be vaporized without decomposition. Compared to other forms of chromatography, Gas Chromatography has components of the samples dissolved in a solvent and vaporized in order to separate and distribute the analytes between a stationary phase and a mobile phase. GC is also important in identifying particular compounds and improving purity of substances.

Covering and quantifying components of thousands of compounds in matrices related to pharmaceuticals, foods & beverages, forensic science, and environmental analysis to name a few, a basic GC system primarily operates with a carrier gas, a sample introduction port, GC column, GC detector, and a computer software/data management system. With scientists and researchers utilizing these systems to evaluate compositions of chemical products, toxicity of various elements such as water and air, and to measure substances, getting the appropriate equipment to meet application requirements is essential.

Selecting the most fitting unit for your needs can be quite an intimidating and overwhelming task given the assortment of models and types of GC systems available from various manufacturers. GMI understands this and has prepared a simple guide to save you valuable time and money as well as familiarize you with the key factors to consider when purchasing the right Gas Chromatograph System for your laboratory.

Determine Application Demands for Your Gas Chromatography System Purchase

Finding a suitable gas chromatography system for your facility highly depends on your application requirements. Narrow down the plethora of gas chromatography system options by answering these questions:

- **How many and what kind of tests and samples will you work with?**

  If you will be performing a variety of tests with different sample types, you should be looking for GC systems that allow simultaneous usage of more than one detector. Reduce downtime in between tests by choosing gas chromatographs that let you interchange or switch in-and-out different detectors in just minutes. Some units that showcase dual or multiple detector capabilities include the Agilent 6890 Plus Dual ECD.

- **What is your expected throughput?**

  If you are working with a number of sample loads and if you need quicker turnaround time, find GC systems that come with automation solutions. Fully-integrated systems covering sample preparation to sample analysis let researchers work on other lab processes with the freed-up time. For added efficiency, you can go for gas chromatographs featuring an informatics software to assist in analyzing and documenting your data like GMI's Explosives GC System, HVROC GC, and the Method 25 Methane-Nonmethane GC all equipped with the PeakSimple data system. You may also want to check out GC systems including Agilent 6890N, and HP 5890 Series that can be integrated to other vendor softwares like ChromPerfect and Clarity.

- **Are you dealing with identified samples or non-routine ones?**

  Working with unknown or non-routine samples would require a GC system backed with a non-destructive detector. This type of detector does not change samples chemically and allows for a secondary detector to be set-up, making way for further analysis. Some non-destructive detectors available in the market include UV detectors, thermal conductivity detectors, and electron capture detectors. On the other hand, if your application requires continuous transformation of the column effluent through burning or mixing with reagents, then it is best to score a GC system with a destructive detector such as a flame ionization detector, flame photometric detector, and mass spectrometry detector.

- **If you are dealing with Mass Spectrometry, do your results need to be in parts per million or parts per billion?**

- **Have you operated a GC system before and are you familiar with ChemStation?** For first-time GC system users, it is recommended to look for a lab equipment distributor that offers installation and training options like GMI. Doing so can help you get started on the right track, with the device and software package like the ChemStation properly configured for your specific application.

Sample Introduction System of Your Gas Chromatography System

A suitable-sized sample immediately introduced as a plug of vapor using the correct injection technique makes way for efficient GC outputs. You would want to avoid oversized samples or slow injection as these can cause peak broadening and poor resolution. Depending on your application, you can look for a GC system that supports:

- Direct Injection - injects sample that is then flash vaporized and passed directly to the column, can present difficulties when injecting small sample volumes
- Split Injection - with only a fraction of the injected sample passing the column and the rest going to waste
- Split-Splitless Injection - allows accurate and reproducible injection of varied amounts of the analyte, induces no change in sample composition, split injection is recommended when working with high analyte concentration samples (>0.1%) while splitless injection are preferred for trace analysis with low analyte concentration samples(<0.1%).

The choice of inlet type to use is reliant on your sample whether it is in liquid, gas, or solid form, or if there is a solvent matrix present that would need to be vaporized. If conditions are well-defined, dissolved samples can be directly introduced onto the column with a cold-on column injector. For solvent-matrix that has to be vaporized and to some extent removed, you can use a split/splitless-injector instead. Procure systems featuring gas switching valves like the SRI8610C for gaseous samples like air cylinders.

For high throughput applications, you can get autosamplers that can work with up to 150 samples and instantaneously inject the same amount of samples every time. Enjoy a plug-and-play design, perform small-volume to large volume injection to multi-phase sampling with the Agilent 7683 Auto Sampler Injector G2613A. Introduce volatiles contained in liquid or solid samples into your GC systems with the Agilent 7683 and Agilent 7694 headspace autosamplers, all in-stock at GMI.

GC Column Options for your Gas Chromatography System

Picking out the proper GC column for your equipment is necessary as it is considered to be the heart of a GC system, making or breaking your analysis. The two general types used in gas chromatography are packed GC columns and capillary GC columns (open tubular columns).

Usually made of glass or metal tubing densely packed with a solid support material like diatomaceous earth, packed columns showcase a larger diameter for larger sample capacity. These have a limited range of length compared to open tubular ones, only offering about 50% of the efficiency capillary columns can provide. This type of GC column is ideal for less universal applications like fixed gas analysis.

Capillary columns are more commonly used, thinner, has smaller sample capacity and are more efficient. These can be further classified as:

- Wall-Coated Open Tubular (WCOT) Column - wall is coated with the liquid stationary phase, length is typically 5-100 meters
- Support-Coated Open Tubular (SCOT) Column - inner wall is lined with a thin layer of support material like diatomaceous earth that has absorbed the stationary phase, less efficient than WCOT
- Fused-Silica Wall-Coated (FSWC) Column - wall drawn from purified silica containing minimal metal oxides, much thinner than glass columns, and with a polyimide coating on the outside of its tubing

For the properties of each gas chromatography columns, you can refer to the table below:

Property	**Type of Column**			
	FSWC	**WCOT**	**SCOT**	**Packed**
Length	10 to 1000 m	10 to 1000 m	10 to 1000 m	1 to 6 m
Inner Diameter	0.1 to 0.3 mm	0.25 to 0.75 mm	0.5 mm	2 to 4 mm
Efficiency (plates/m)	2000 to 4000	1000 to 4000	600 to 1200	500 to 1000
Sample Size	10 to 75 ng	10 to 1000 ng	10 to 1000 ng	10 to 10^6 ng
Pressure	Low	Low	Low	High
Speed	Fast	Fast	Fast	Slow
Inertness	Best	Good	Fair	Poor

Detector Types for your Gas Chromatograph System

Gas chromatography detectors help identify and measure concentration of eluting components in the carrier gas stream. To get the best unit for your system and application, know how each detector type differs. These devices can be identified based on their selectivity as listed below:

- Selective detector - responds to a range of compounds sharing a common chemical or physical property
- Non-selective detector - responds to all compounds except for the carrier gas itself
- Specific detector - responds to a single specific compound

These devices can also be:

- Concentration dependent - signal is proportional to the concentration of the solute in the detector, does not usually destroy the sample, dilution using make-up gas will lower the detector's response
- Mass flow dependent - signal is dependent on the rate at which solute molecules enter the detector, sample is usually destroyed, response is not affected by flow rate changes of the make-up gas

Frequently used detectors in gas chromatography include:

- Flame Photometric Detector (FPD) - detects sulfur- or phosphorus-containing compounds, uses chemiluminescent reactions of such compounds in a hydrogen/air flame as a source of analytical information
- Electron Capture Detector (ECD) - measures degree of electron capture with a radioactive beta particle source, most sensitive detector for environmental samples, with a limited signal range
- Photoionization Detector (PID) - most efficient and inexpensive gas detector, capable of providing instantaneous readings and monitoring, detects volatile organic compounds in soil, sediment, air, and water, GC systems that can work with a PID detector include the 310 Soil Gas GC System, SRI 8610C Multi-Gas Analyzer System
- Mass Spectrometer (MS) - one of the most powerful gas detectors, scans masses continuously throughout the separation, tunable for any samples
- Flame Ionization Detector (FID) - most widely used detector in GC, require flammable gas, for organic analyses, solvent and material characterization, and environmental analyses to name a few
- Thermal Conductivity Detector (TCD) - non-destructive universal detector, can measure almost all molecules like inorganic, permanent gases as well as organic vapors, for general organic and analytical testing, atmospheric monitoring, and bulk measurements

  Looking for GC systems that you can customize with FID or TCD detectors? Check out the HP 5890 Series Single Detector II,HP 5890 Series II Dual Detector II, Dissolved Gas Analyzer GC, and Educational TCD GC System from GMI.

  Want a system that can accommodate a variety of detectors such as Nitrogen-phosphorus (NPD), Pulsed Flame Photometric (PFPD), Sulfur chemiluminescence (SCD) and a lot more? Look into the Agilent 6890 Series also available at GMI.

Check out this table for the selectivity, detectability and dynamic range of each detector type:

Detector	Type	Support gases	Selectivity	Detectability	Dynamic range
Flame ionization (FID)	Mass flow	Hydrogen and air	Most organic cpds.	100 pg	10^7
Thermal conductivity (TCD)	Concentration	Reference	Universal	1 ng	10^7
Photo-ionization (PID)	Concentration	Make-up	Aliphatics, aromatics, ketones, esters, aldehydes, amines, heterocyclics, organosulphurs, some organometallics	2 pg	10^7
Nitrogen-phosphorus	Mass flow	Hydrogen and air	Nitrogen, phosphorus	10 pg	10^6
Electron capture (ECD)	Concentration	Make-up	Halides, nitrates, nitriles, peroxides, anhydrides, organometallics	50 fg	10^5
Flame photometric (FPD)	Mass flow	Hydrogen and air possibly oxygen	Sulphur, phosphorus, tin, boron, arsenic, germanium, selenium, chromium	100 pg	10^3

Ideally, you should pick out detection systems that offer adequate sensitivity for your application, good stability and reproducibility, a wide range of temperature range, short response time independent of the flow rate, low-noise, reliable and easy-to-operate.

Carrier Gas Selection for Your Chromatography System

Related and dependent to the type of detectors chosen and used is the carrier gas. The gas must be ensured dry, free of oxygen, chemically inert and has a molecular sieve for the removal of water and other impurities. Commonly used carrier gases include nitrogen, argon, carbon dioxide as well as helium which is safer than hydrogen, has a wider range of flow rates and is compatible with a variety of detectors.

Think of Lab Space where the Gas Chromatography System will be Situated

The convenience of location and accessibility of your equipment are dependent on the available space in your laboratory. If you have a large, open area and require full flexibility, you can look for modular GC systems such as the HP Agilent 7890A that can be customized and expanded depending on your particular needs. For modestly spaced workrooms, you can pick out powerful and tiny footprint gas chromatographs like the Agilent 6850 Series, CDS 7000, and the Model 310 Gas Chromatograph.

Review Budget Allocations for your Gas Chromatography Systems

When acquiring gas chromatographs, keep in mind other expenses that may come with your purchase. Aside from the GC system itself, you should also consider the costs of supplies such as the reagents to use as well as any column replacement in the future. Don't be surprised with GC systems having a wide price range as values of these will vary based on the capabilities, configurations, and data management features that you and your applications will require. If you have enough resources at hand, you can opt for new gas chromatography systems for your analytical chemistry applications.

For those with limited resources, don't fret as there are still a lot of alternatives you can go for. A popular option nowadays for labs with a tight budget is purchasing used or fully recertified to factory specifications gas chromatography systems. Compared to most Original Equipment Manufacturers (OEMs) that take a long time in supplying new lab instruments, a used equipment distributor like GMI provides easily available and economically priced gas chromatography systems for any urgent unit replacement needs, backups, or to meet market demands. You can also go for a lease-to-own option. Choosing quality, certified pre-owned lab equipment from trusted and industry-leading distributors such as GMI can help you save up to 70% of your budget.

The perfect gas chromatography system will be the one that best serves your application and laboratory needs. Familiarizing yourself with the key components listed above can help in procuring the right unit for your lab bench, saving you not only budget but also work time and consumables in the long run. If you are having trouble choosing the appropriate instrument for your specific applications, you can always rely on effective solutions and advice from industry experts like GMI. We carry a large portfolio of new and used gas chromatography systems that can be configured based on your requirements. We also house factory trained technicians for installation and training services.

For over 20 years, GMI has been supplying leading-edge products and exceptional services to the scientific market and cost conscious laboratories. With an ISO 9001:2008 under our wings, we assure any instrument purchased from us has undergone thorough refurbishing, recalibration, recertification and testing processes. Aside from these, we also offer a number of service agreement, warrant, rental, and lease-to-own options for our gas chromatography system products.

For any assistance needed on potential new or used gas chromatography system purchase, feel free to reach us at **1-888-702-1775** or email us at sales@gmi-inc.com.