The principle components of a mass spectrometer are an inlet, ion source, mass analyzer, detector, and data analysis. The function of an inlet system is to introduce a small amount of sample into the ion source with minimal loss of vacuum. However, many mass spectrometers contain more than one inlet system to accommodate a variety of samples. These include batch inlets, direct probe inlets, and chromatographic and capillary electrophoretic inlet systems.

**Batch Inlets**

The batch inlet system is considered the most common and simplest inlet system. Normally, the inside of the system is lined with glass to elude losses of polar analytes by adsorption. This system externally volatizes the sample which leaks into an empty ionization region. Boiling points up to 500 degrees C of gaseous and liquid samples can be used on typical systems. The system’s vacuum contains a sample pressure of $10^{-4}$ to $10^{-5}$ Torr. Liquids are introduced using a microliter syringe into a reservoir; gases are enclosed in a metering area that is confined between two valves before being expanded into a reservoir container. Liquids that have boiling points lower than 500 degrees C cannot be used in the system because the reservoir and tubing need to be kept at high temperatures by ovens and heating tapes. This is to ensure that the liquid samples are transformed to the gaseous phase and then leaked through a metal or glass diaphragm containing pinholes to the ionization area.

**Direct Probe Inlets**

A direct probe inlet is for small quantities of sample, solids, and nonvolatile liquids. Solids and nonvolatile liquids are injected through a probe, or sample holder. The probe is inserted through a vacuum lock which is designed to limit the volume of air needed to pump from the system after the probe has been inserted into the ionization section. Unlike the batch inlet, the sample will need to be cooled and/or heated on the probe. The probe is placed extremely close (a few millimeters) to the ionization source, where the slit leads to the spectrometer, and the sample is held in place on the surface of a glass or aluminum capillary tube or a small cup. This position makes it possible for thermally unstable compounds to be analyzed before decomposition because of the low pressure in the ionization area which is in close proximity to the sample. Do to the probe, nonvolatile samples such as carbohydrates, steroids, and metal-organic species can be studied because the low pressures lead to increased concentrations of the nonvolatile samples. The principle sample requirement is attainment of an analyte partial pressure of at least $10^{-8}$ torr before the onset of decomposition.¹

**Chromatographic and Capillary Electrophoretic Inlets**

Chromatographic systems and Capillary Electrophoretic units are often coupled with mass spectrometers in order to allow separation and identification of the components in the sample. If these systems and units are linked with a mass spectrometer, then other specialized inlets, electrokinetic and pressure injection, are required. Electrokinetic and pressure injection controls the amount of volume injected by the duration of the injection, which typically range between 5 to 50 nL.
Electrokinetic Injection

The electrokinetic injection method involves one end of the capillary and electrode in a small cup removed from the buffer. Ionic migration and electroosmotic flow of the sample in the capillary are a result of a voltage applied for a recorded time. After this voltage is applied, the capillary end and electrode are placed back into the regular buffer solution for the remainder of the separation. The electrokinetic Injection technique injects larger quantities of the mobile ions versus the slower moving ions.

Pressure Injection

The pressure injection method is similar to the electrokinetic injection because the capillary end and electrode are removed from the buffer and placed into a small cup. However, instead of a voltage being applied, a pressure difference drives the sample into the capillary. A vacuum is applied at the detector end which produces the potential difference by pressurizing the sample or elevating the sample end. Pressure injection does not discriminate because of ion mobility, but it cannot be used in gel-filled capillaries.¹

References