GC Basics – Constant Pressure, Constant Flow, & Constant Confusion

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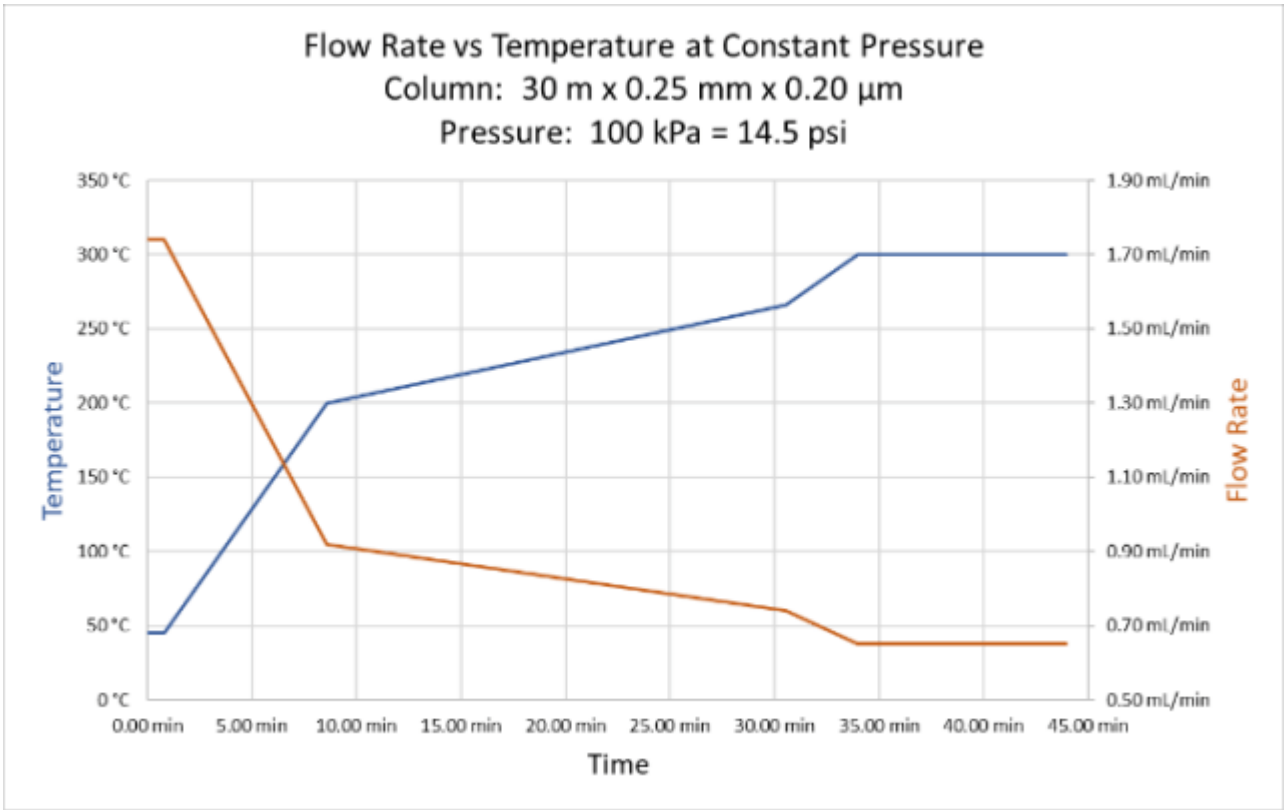
Gas chromatography methods often state that the carrier gas is delivered to the column under the conditions of either constant pressure or constant flow, but a method may need to be optimized for better performance or to accommodate the limitations of the GC instrument. This article will give you an overview of GC basics that you will need to know for your next analysis.

“Constant pressure” will maintain a consistent pressure of carrier gas onto the beginning of the column, while “constant flow” maintains a constant flow-rate of carrier gas through the column. Both applications of carrier gas present advantages and disadvantages that are distinct from one another, and I would like to help make some sense of the two.

The carrier gas will become more viscous within the GC column as temperature increases during a method. Specifically, the gas within the column will want to expand as temperature increases. The gas near the beginning of the column will want to expand back towards the column entry when heated, while the random kinetic movement of gas near the center of the column will lead to a standstill as each molecule travels more energetically to collide with one another and the interior walls of the column. The increase of viscosity is exacerbated with a narrower internal diameter of the column. We will discuss the gas near the exit of the column at a later time when comparing linear velocity and constant flow.



The delivery of carrier gas through the column must assure of the “forward” direction of gas as it travels through the column. A “constant pressure” method will experience a decrease in the forward movement of gas through the column as the combating viscosity increases, while a “constant flow” method will adjust the pressure to maintain a consistent flow-rate through the column as temperature increases during a method. A method developer using “constant pressure” must assure that the flow-rate is optimal at the moment during which a critical pair of analytes must be resolved.

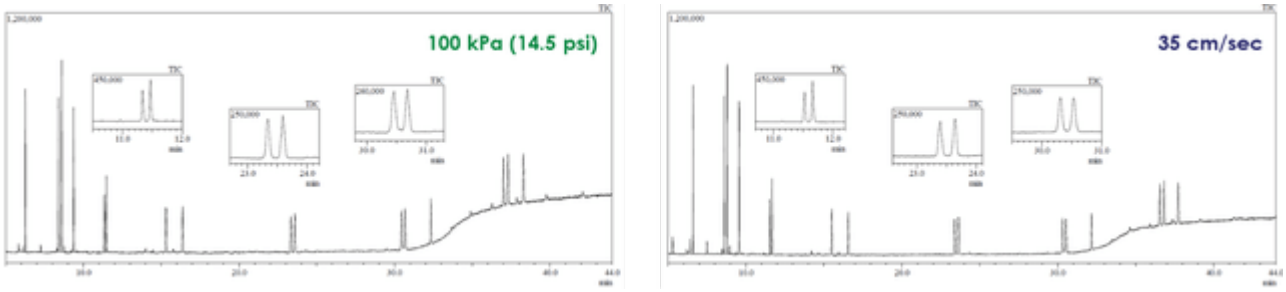
The advantage of “constant pressure” is the relative simplicity of the sensory instrumentation within the injection port, while a “constant flow” method requires complex

instrumentation to properly augment the on-column pressure as temperature increases and to attenuate the pressure of temperature decreases. Make sure that your "constant pressure" can maintain forward flow at the end of a temperature ramp, while also being mindful of the high pressures that will be generated near the end of a ramp when using "constant flow."

Column:	Zebron ZB-PAH-SeleCT
Dimensions:	30 meter x 0.25 mm x 0.20 µm
Injection:	Split 10:1 @ 300 °C, 1 µL
Carrier Gas:	Helium (flow specified in chromatogram)
Oven:	Initial 45 °C, hold for 0.8 min ramp to 200 °C @ 20 °C/min ramp to 266 °C @ 3 °C/min ramp to 300 °C @ 10 °C/min, hold 10 min
Detector:	MS @ 300 °C (transfer line and ion source)
Sample:	EPA 610 (5 – 10 ppm) in Toluene

The relationship between temperature and flow-rate in the above table corresponds to the following method, which I composed during the early stages of some recent method development for the analysis of EPA 610 PAH compounds. I evaluated the method parameters using 100 kPa (14.5 psi) of "constant pressure" and a *calculated* "constant flow" of 1.03 mL/min (linear velocity of 35 cm/sec). The flow-rate is within a suitable range for a 0.25 mm ID column at the moment when two critical pairs elute at 23.5 min and 30.5 min in both chromatograms, and was later optimized. The earlier analytes elute faster during the

“constant pressure” method as a result of the very fast flow-rate early on when compared with the same analytes in the “constant flow method. Conversely, the later analytes elute slower during the “constant pressure” method when compared with the “constant flow” method. The resolution among earlier and later analytes is robust to accommodate different flow-rates, while the flow-rate of gas through the column was optimal at the moments of elution for the critical pairs.



You might need to adapt a GC method whose delivery of carrier gas is not an option on your GC instrument. Be mindful of the necessary flow-rate for optimal column performance during the elution of any critical pairs. Maintain a balance between the desire for a simple delivery of carrier gas (constant pressure) and the optimal flow-rates needed for a specific set of column dimensions and the targeted analytes. If resolution is a challenge for most of your analytes throughout the duration of a method, then consider using either constant flow or a constant linear velocity. We will discuss the nuances of constant flow and linear velocity at a later time.

If you have any questions regarding GC basics or any other chromatographic inquiries, you can chat with Zach or any of Phenomenex's technical specialists nearly 24/7 through our free online chat service, Chat Now.

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