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High Performance Carbon Dioxide Recycling for Supercritical Fluid Chromatography

John Whelan, Zigiang Wang, Harbaksh Sidhu
SFC Division, Waters Corp.
139 Lukens Drive, New Castle, DE 19720, USA

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Supercritical Fluid Chromatography (SFC) has shown its advantages in terms of high efficiency, high throughput, reduction of organic solvent usage and lower overall cost, especially at preparative purification scale.

While the overall process of SFC does not generate any net new carbon dioxide to the atmosphere, the origin of CO_2 used in SFC normally comes as by-products from some types of industrial processes, such as fermentation or petroleum refinery; from environmental perspective it will be desired feature if the massive volume of CO_2 at the end of the chromatographic process, especially at the elevated flow scale of industrial preparative purifications, can be recycled and reused in the same process, thus to prevent it vented directly into atmospheres, improve the utilization efficiency and further lower the overall solvent cost.

In the past efforts have been shown to implement such recycling functionality on various systems. However, the performances for such designs had not been consistent over the years, and the recycling efficiency (RE) has not reached satisfactory level that the majority of gaseous carbon dioxide was still eluding the system and vented to atmosphere without recycling.

In this study we demonstrated a novel design that optimized the control of the eluding gaseous carbon dioxide at the process end. On a SFC350 system, it captures the majority of CO_2 to recycling module, separate, re-pressurize and re-conditioning CO2 in the single device and recycles it to the same purification SFC process. The RE has consistently shown over 83% to 85% in most cases, including gradient programming. This means the SFC350 system runs only 15% to 17% CO_2 of original level for the same process. This represents six to seven times reductions on CO2 usage. At the same time, the chromatography performance of the process has shown the least amount of deviation(<2%RSD) compared to original single batch process, this ensured the straightforward scale-up that significantly decreases the complications for method validation process.