

Split Peaks and High Back Pressure in HPLC Analyses - Troubleshooting

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Introduction

Split peaks combined with unusually high system back pressure are strong indicators of a mechanical disruption within the HPLC column. When the column's packed bed—responsible for ensuring uniform flow and consistent chromatographic performance—loses its structural integrity, both peak shape and pressure behavior change dramatically.

Recognizing these symptoms allows analysts to diagnose column failure quickly and avoid misattributing the issue to solvents, samples, or system hardware.

Flow Channeling Inside the Column

The most common cause of simultaneous split peaks and elevated pressure is flow channeling, a condition where the mobile phase no longer moves uniformly through the packed bed.

- **Disrupted packing uniformity:** Voids, cracks, or collapsed regions within the column redirect flow into narrow, uneven pathways.
 - **Uneven analyte transport:** Because some parts of the bed no longer contribute to separation, analytes elute as multiple unresolved fronts rather than unified peaks.
 - **Rapid onset or progressive degradation:** Channeling may occur suddenly due to mechanical shock, or gradually through cumulative stresses such as repeated pressure fluctuations. These flow disruptions are generally irreversible once the bed structure has been compromised.
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Relationship Between Channeling and High Back Pressure

A compromised packed bed not only alters flow paths but also increases resistance to solvent movement.

- **Compressed or collapsed regions:** Blocked pathways force solvent through tighter spaces, elevating pressure.
- **Particle shifting:** Even minor disturbances in particle arrangement can significantly impact system hydraulics.
- **System risk:** Persistent high pressure places additional stress on pumps, seals, and tubing, making early diagnosis critical.

In nearly every case, high pressure coupled with severe peak distortion points directly to internal column damage rather than instrument malfunction.

Why the Column Must Be Replaced

Once flow channeling occurs, no cleaning or flushing procedure can restore the original packing uniformity.

- Irreversible bed damage: Physical rearrangement of packing particles cannot be reversed by solvents or back-flushing.
 - Unpredictable performance: Even if pressure drops temporarily, separation quality will not return to specification.
 - Preventing additional failures: Continued use of a damaged column increases the risk of pump overloading, leaking seals, and poor analytical reproducibility.
- For these reasons, replacement is the only reliable and manufacturer-supported solution.

Conclusion

Split peaks accompanied by elevated back pressure are hallmark signs of flow channeling due to a disrupted packed bed. Because this structural damage cannot be repaired, the affected HPLC column must be replaced to restore reliable chromatographic performance.

Prompt identification prevents further system strain and minimizes downtime.



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