# Simplifying Column Selection

## WHICH COLUMN DO I NEED?

Successful separations depend on choosing the right column, but with so many options available how do you know which is best? Understanding the basic elements of the resolution equation and how they relate to column characteristics is the key to getting the best separation in the shortest possible time!

$$R = \frac{1}{4}\sqrt{N} \times \left(\frac{k}{k+1}\right) \times (\alpha - 1)$$

| A measure of **Efficiency**. This term is affected by: | A measure of **Retention**. This term is affected by: | A measure of **Peak Separation**. This term is affected by: |
|---|---|---|
| • Length<br>• Inner diameter<br>• Carrier gas type and linear velocity | • Inner diameter<br>• Film thickness<br>• Temperature | • Stationary phase composition<br>• Temperature |

N = L/H = Effective theoretical plate number
L = Column length
H = HETP = Height equivalent to a theoretical plate

k = Retention factor
α = Separation factor
Baseline resolution (R = 1.5) is the goal.

For an in-depth discussion on how to choose the right column and improve your chromatographic results, as well as helpful troubleshooting information, visit **www.restek.com**

- Download our *Guide to GC Column Selection and Optimizing Separations* (lit. cat.# GNBR1724- UNV)
- Request our *GC Troubleshooting Tips poster* (GNWC1723-UNV)

## STATIONARY PHASE

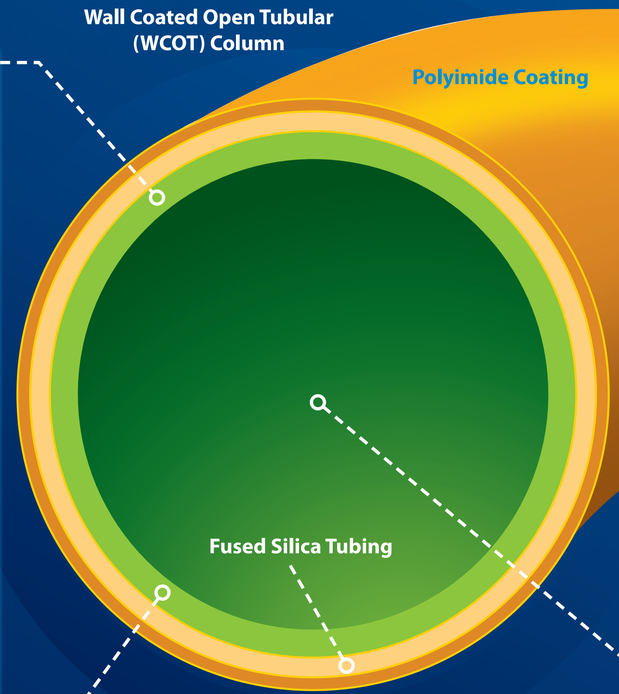
Choosing the right stationary phase is the first step toward optimizing your separation. Resolution is most influenced by separation factor, which is affected by polarity and selectivity. When making your choice, consider:

- Target analyte and stationary phase interactions—resolution generally increases as solubility, molecular interactions, and retention increase.
- Expected maximum temperatures.
- Method requirements.

**Nonpolar → Polar**

- **100% Dimethyl** — Rxi®-1ms; Rxi®-1HT; Rtx®-1
- **Proprietary (Silarylene)** — Rxi®-5Sil MS; **5% Diphenyl**: Rxi®-5ms; Rxi®-5HT; Rtx®-5
- **Proprietary** — Rxi®-XLB
- **Proprietary** — Rtx®-440
- **20% Diphenyl** — Rtx®-20
- **Proprietary (Silarylene)** — Rxi®-624Sil MS; **6% Cyano**: Rtx®-624; Rtx®-1301
- **50% Phenyl** — Rtx®-50
- **Proprietary (Silarylene)** — Rxi®-35Sil MS; **35% Diphenyl**: Rtx®-35
- **Trifluoropropyl** — Rtx®-200; Rtx®-200MS
- **65% Diphenyl** — Rtx®-65
- **Proprietary (Silarylene)** — Rxi®-17Sil MS; **50% Diphenyl**: Rxi®-17
- **14% Cyano** — Rtx®-1701
- **Polyethylene Glycol** — Rtx®-Wax; Stabilwax®
- **90% + Bis-Cyano** — Rtx®-2330
- **50% Cyano** — Rtx®-225

In general, maximum operating temperature decreases as polarity increases.
Note that silarylene columns typically differ in selectivity and have higher temperature limits than their conventional counterparts.




## LENGTH

**Short Length → Long Length**

| 5 m–15 m | 20 m–30 m | 50 m–150 m |
|---|---|---|
| **Characteristics**<br>• Good efficiency<br>• Short analysis times | **Characteristics**<br>• Better efficiency<br>• Moderate analysis times | **Characteristics**<br>• Best efficiency<br>• Longer analysis times |
| **Applications**<br>Samples with few compounds | **Applications**<br>More complex samples | **Applications**<br>Very complex samples |

**Longer Columns Can Increase Resolution...**
Doubling the column length only increases resolution by approximately 41% because the column length is under the square root function in the efficiency term of the resolution equation.

**But, Longer Columns Increase Cost and Analysis Time**
On longer columns, analysis time is increased by as much as a factor of two. Longer columns are also more expensive.

## FILM THICKNESS

Stationary phase film thickness (µm) directly affects retention, resolution, and elution temperature for each sample component. When changing either film thickness or the temperature program, you must reconfirm peak identifications as elution order changes can occur.

**Thin Film → Thick Film**

| 0.10 µm–0.50 µm | 1.0 µm–10.0 µm |
|---|---|
| **Characteristics**<br>• Shorter retention times<br>• Lower bleed<br>• Higher maximum temperatures<br>• Lower sample loading capacity<br>• High resolution for high molecular weight compounds | **Characteristics**<br>• Longer retention times<br>• Higher bleed<br>• Lower maximum temperatures<br>• Higher sample loading capacity<br>• High resolution for volatiles and low molecular weight compounds |
| **Applications**<br>Medium and high molecular weight compounds | **Applications**<br>• Volatile, low molecular weight compounds<br>• High concentration samples (e.g., purity testing) |

As film thickness increases, retention, sample loading capacity, and column bleed increase; whereas, maximum temperature decreases.

## INNER DIAMETER

**Small ID → Large ID**

| 0.15 mm–0.18 mm | 0.25 mm–0.32 mm | 0.53 mm |
|---|---|---|
| **Characteristics**<br>• Highest efficiency<br>• Shorter analysis time<br>• Lower sample loading capacity | **Characteristics**<br>• High efficiency<br>• Good performance for analysis time and sample loading capacity | **Characteristics**<br>• Good efficiency<br>• Longer analysis time<br>• Higher sample loading capacity<br>• May require higher flow rates than MS detectors can tolerate |
| **Applications**<br>• Highly complex samples<br>• Fast GC<br>• GC-MS<br>• Split injection | **Applications**<br>• Complex samples<br>• Wide concentration range<br>• Split , splitless, direct, headspace, and on-column injection | **Applications**<br>• Packed column replacement<br>• Purity analysis<br>• Split, splitless, direct, headspace, and on-column injection |

As inner diameter increases, efficiency decreases, sample loading capacity increases, optimal flow rate increases, and analysis time increases.

RESTEK

Visit **www.restek.com** for our complete line of general-purpose and application-specific GC columns.

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