Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

Subject: Chemistry

Course Code: CHD-103

Course Title: Selected Instrumentation in Chemistry

Unit 2: Chromatographic Techniques

Module Name: Terms involved- Retention Time, Retention Volume and Relative Retention.

Name of the Presenter: Ms. Asmita S. Naik Gaonkar, Assist. Prof. in Chemistry (Organic), Government College of Arts, Science and Commerce; Quepem -Goa

Notes

In Gas Chromatography, rate of travel *(R_s)*is given as

$$R_s = \frac{u}{(1+K')} \qquad \text{----------Eq(1a)}$$

Where 'u' is the mobile phase linear velocity. *u is replaced by $\bar{u}$* in gas chromatography, which is the average linear velocity. This is due to the different linear velocity values of mobile phase(gas phase) at different positions along the column, occurring as a result of compressibility of gases. (Gary Christian, 2008)

$$R_s = \frac{\bar{u}}{(1+K')} \qquad \text{----------Eq(1b)}$$

$$K' = K\frac{V_s}{V_m}$$

Where K is the distribution coefficient, V_s is the volume of stationary phase and V_m is the volume of mobile phase.

Retention Time (t_R): Retention time for a component is defined as the time taken by the component to move over the entire length of the column and hence to come out of it. (K. Raghuraman *et al.*, 2008), (Sharma B.K., 1997)

Retention Time(t_R)= $\frac{\text{Length of the column}}{\text{velocity of the component}}$

$= \frac{L}{R_S}$

$= \frac{L}{\frac{\bar{u}}{1+K'}}$ -----from Eq (1b)

$= \frac{L(1+K')}{\bar{u}}$ ---------- Eq (2)

L, is the length of the column.

But, $t_M = \frac{L}{\bar{u}}$, i.e. the time taken by the mobile phase to move over the entire length of the *column.*

Therefore, we can write Eq (2) as follows:

$$t_R = t_M(1 + K') \quad \text{-----Eq (3)}$$

Factors Affecting retention time:

1. Velocity of mobile phase.
2. The distribution coefficient of the solute *between the two phases.*
3. The ratio of volumes of the two phases: stationary and mobile.
4. *The length of the column.*

Retention Volume (V_R): Retention volume for a component is defined as the total volume of mobile phase required to elute the component completely from the column. (K. Raghuraman *et al.*, 2008)

OR

The volume of mobile Phase necessary to convey a solute band from the point of injection, through the column, and to the detector (to the apex of solute peak) is defined as retention volume.(Willard *et al.*, 1986)

$$\text{Retention Volume} = [\text{Retention time}][\text{Flow rate of the mobile phase}]$$

$$V_R = t_R . F_c \quad \text{-----Eq(4)}$$

F_c= is the volumetric flow rate of mobile phase given in terms of volume of mobile phase per unit time.

From Eq(3) and (4), we have,

$$V_R = t_M (1 + K')F_c$$

$$V_R = t_M F_c(1 + K') \qquad \text{-----Eq (5)}$$

Since t_M is the retention time for the mobile phase and F_c is the flow rate of the mobile phase,

$$V_M = t_M F_c \text{----------Eq(6)}$$

From Eq(5) and (6), we have,

$$V_R = V_M (1 + K')$$

Factors Affecting retention time:

1.Velocity of mobile phase.

2.The distribution coefficient of the solute between the two phases.

3.The ratio of volumes of the two phases: stationary and mobile.

4.The length of the column.

Relative Retention(α): it is defined as the ratio of retention time or retention volume of the solute to the retention time or volume of the standard added after correction of retention time or retention volume of the mobile phase.

$$\alpha = \frac{t_R - t_M}{t_R^* - t_M}$$

OR

$$\alpha = \frac{V_R - V_M}{V_R^* - V_M}$$

t_R and V_R are retention time and retention volume for the component (solute).

t_R^* and V_R^* are are retention time and retention volume for the standard

Reference:

Chatwal, G. R. and Anand, S. K. (2017) *Instrumental Methods of Chemical Analysis*. 5th edn. Himalaya Publishing House.

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Sharma B.K. (1997) *Instrumental Methods of Chemical Analysis (Analytical Chemistry)*. 16th edn. Goel Publishing House.

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