9.2.3.9 Distribution Constants

The distribution constant is the concentration of a component in or on the stationary phase divided by the concentration of the component in the mobile phase in equilibrium conditions. Since in chromatography a component may be present in more than one form (e.g., associated and dissociated forms), the analytical condition used here refers to the total amount present without regard to the existence of various forms. These terms are also called the *Distribution Coefficients*. However, the present term conforms more closely to the general usage in science.

The concentration in the mobile phase is always calculated per unit volume of the phase. Depending on the way the concentration in the stationary phase is expressed various forms of the distribution constants may exist.

Distribution Constant (K_c)

In the general case, the concentration in the stationary phase is expressed *per unit volume of the phase*.

This term is mainly applicable to partition chromatography with a liquid stationary phase but can also be used with a solid stationary phase:

$$K_c = \frac{W_{i(S)} / V_S}{W_{i(M)} / V_M}$$

where $W_{i(S)}$ and $W_{i(M)}$ are the amounts of component i in the stationary and mobile phases, while V_S and V_M are the volumes of the stationary and mobile phases, respectively.
The term *Distribution Constant* and the symbol K_c are recommended in preference to the term *Partition Coefficient* which has been in use in partition chromatography with a liquid stationary phase.

The value of K_c is related to the retention volume (V_R) of a sample component and the volumes of the stationary (V_S) and mobile phases (V_M) in the column:

$$V_R = V_M + K_c\, V\mathrm{S}$$

In gas chromatography both V_R and V_M have to be corrected for gas compressibility: therefore V_R^o (see *Corrected Retention Volume (Time)*) is to be used for V_R, and $V_G = V_M^o$ (see *Interparticle Volume of the Column*) is to be used for V_M.

$$V_R^o = V_G + K_c V_S$$

Distribution Constant (K_g)

In the case of a solid stationary phase, the distribution constant may be expressed *per mass (weight) of the dry solid phase*:

$$K_g = \frac{W_{i(S)} / W_S}{W_{i(M)} / V_M}$$

where $W_{i\,(S)}$ and $W_{i\,(M)}$ are the amounts (masses) of the component i in the stationary and mobile phases, respectively, W_S is the mass (weight) of the dry stationary phase, and V_M is the volume of the mobile phase in the column.

Distribution Constant (K_s)

In the case of adsorption chromatography with a well characterized adsorbent of known surface area, the concentration in the stationary phase may be expressed *per unit surface area*:

$$K_s = \frac{W_{i(S)} / A_S}{W_{i(M)} / V_M}$$

where $W_{i\,(S)}$ and $W_{i\,(M)}$ are the amounts (masses) of the component i in the stationary and mobile phases, respectively, A_S is the surface area of the stationary phase, and V_M is the volume of the mobile phase in the column.

Note: The symbols of the distribution constants are generalised.