

Separation Efficiency vs. Resolution for Unequal Chromatographic Peaks

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1 Introduction

The resolution R_s as defined in the literature gives only an approximate estimate of the separation efficiency between two overlapping chromatographic peaks except for the special case where the two peaks are equal. In this case [1]

$$\eta_{1:1} = A (2R_s) \quad (1)$$

$\eta_{1:1}$ is the separation efficiency in the case of two equal peaks.

$A(t)$ is the area under the normal distribution curve which is tabulated in the literature

$$A(t) = \frac{1}{\sqrt{2\pi}} \int_t^{\infty} e^{-x^2/2} dx \quad (2)$$

Eq (1) is plotted also in Ref [1] where $\eta_{1:1}$ is plotted vs R_s on probability graph paper.

The separation efficiency η_m is defined as the impurity ratio when a cut is made such that this ratio is the same on both sides of the cut. The subscript m denotes the area ratio between peaks 2 and 1.

In Fig. 1 where the two peaks are equal, the cut \bar{v}_c^0 is drawn between the two peak maxima \bar{v}_1 and \bar{v}_2 . One can prove that in the case of two equal peaks \bar{v}_c^0 lies at the harmonic average between \bar{v}_1 and \bar{v}_2 , therefore

$$\bar{v}_c^0 = \frac{2\bar{v}_1\bar{v}_2}{\bar{v}_1 + \bar{v}_2} \quad (3)$$

In the case of two unequal peaks, however, there is no direct relation between η_m and R_s . An equation for η_m in terms of $\eta_{1:1}$ in the form

$$\eta_m = \gamma \eta_{1:1} \quad (4)$$

was introduced by *Glueckauf* [2] several years ago where $\gamma = 4m/(1+m)^2$.

The *Glueckauf* equation was reproduced in several textbooks but it has long since been shown to be incorrect by *Said* [3] and other authors [4,5].

According to *Glueckauf*, γ is a function of m only. Actually it is a function of m , R_{s1} , and β where

$$\beta = \frac{1+k_2}{1+k_1} \quad (5)$$

k_2 and k_1 are the capacity ratios of components 2 and 1 respectively.

The *Glueckauf* equation ceased to appear in text books but no alternative for η_m is to be found in the literature.

The purpose of this communication is to deduce the correct relation between η_m and $\eta_{1:1}$, by first collecting data in the form of table and plots and then deducing an empirical formula which fits the data as close as possible.

2 Mathematical Procedure

Figure 1 shows two equal and overlapping chromatographic peaks 1 and 2. Each peak is of unit area and hence the cut \bar{v}_c^0 divides the base between \bar{v}_1 and \bar{v}_2 into two segments Z_1^0 and Z_2^0 .

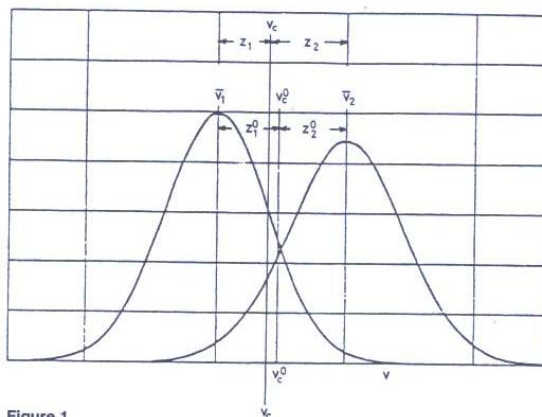


Figure 1
Two overlapping Gaussian peaks with the cut at equal fractional impurity.

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