# Experimental Determination of $K_i$ Using the Dixon Plot

In the derivation below, V is used to represent $V_{max}$ and K is used to represent $K_m$.

The expression that describes the relationship of v to [S], [I] and various constants is given below:

$v = V[S]/(K(1 + [I]/Ki) + [S](1+ [I]/Ki'))$; the reciprocal of this relationship can be written as

$1/v = (K + [S])/V[S] + [I](K/Ki + [S]/Ki')/V[S]$, which means that at any fixed value of [S], 1/v is linearly related to the value of [I]. (A plot of 1/v vs. [I] is called a Dixon plot.)

If such a relationship is empirically studied at two different values of the fixed substrate concentration ($[S]_1$ and $[S]_2$), the two straight lines intersect when $1/v_1 = 1/v_2$. Using the above relationship for 1/v, it can be shown that under these conditions

$$K + [S]_1/(V + [S]_1) + [I](K/Ki + [S]_1 /Ki')/ (V + [S]_1) = K + [S]_2/(V + [S]_2) + [I](K/Ki + [S]_2 /Ki')/ (V + [S]_2)$$

Canceling the constant terms that appear on both sides of the equation leaves

$K/V[S]_1 + [I](K/Ki)/V[S]_1 = K/V[S]_2 + [I](K/Ki)/V[S]_2$, or
$K/V[S]_1 + [I](K/Ki)/V[S]_1 - K/V[S]_2 - [I](K/Ki)/V[S]_2 = 0$, which can be factored according to
$K/V(1/[S]_1 + 1/[S]_2) + (K[I]/VKi)(1/[S]_1 + 1/[S]_2) = 0$ or $K/V(1/[S]_1 + 1/[S]_2)(1 + [I]/Ki) = 0$.
Since by definition neither of the first two terms in the above relationship can have a value of zero, it must be true that at the point of intersection of the lines in a Dixon plot representing two different fixed values of [S], $(1 + [I]/Ki) = 0$. This means that at the point of intersection, $[I] = -Ki$; thus a vertical line from the point of intersection to the [I] axis provides an empirically determined value for Ki.