

HOW TO: Calculate Km and Vmax with Excel

Summary

This step by step article explains how to calculate Km and Vmax using Microsoft Excel.

Solver add-in is available as a part of optional component in Excel. With Solver, you can find an optimal value for a formula in one cell — called the target cell — on a worksheet. Solver works with a group of cells that are related, either directly or indirectly, to the formula in the target cell. Solver adjusts the values in the changing cells you specify — called the adjustable cells — to produce the result you specify from the target cell formula. Your target formula of course will be the Michaelis-Menten formula. You will use it to calculate the “calculated rates”. You will need the values of Km and Vmax which will be your adjustable cells and since we don’t know the values we will use random numbers. The target cell will be the sum of the square differences between experimental and calculated rates. When the target cell will be minimized it will minimize the difference between the experimental and the calculate rate and adjust the values of Km and Vmax thus fitting the calculated rates curve to your experimental data.

Requirement

- Excel 2000 or 2002
- Solver – to add the Solver to your Tools click on the Tools menu select Add-ins and then selecting Solver from the Add-ins window. The Solver becomes available in the Tools menu.
- Substrate concentration
- Experimental Rates or Velocities calculated for every substrate concentration used

Calculating velocity with preset Km and Vmax


Select cell A1 and type Km= and press enter. Type Vmax= and then select cell B1. The B1 will contain the value for Km as mentioned above we will use a random number so type 1 and press enter. Type 1 again and this will be your Vmax. If you fill your data similar to the next picture then you can follow the step by step instructions.

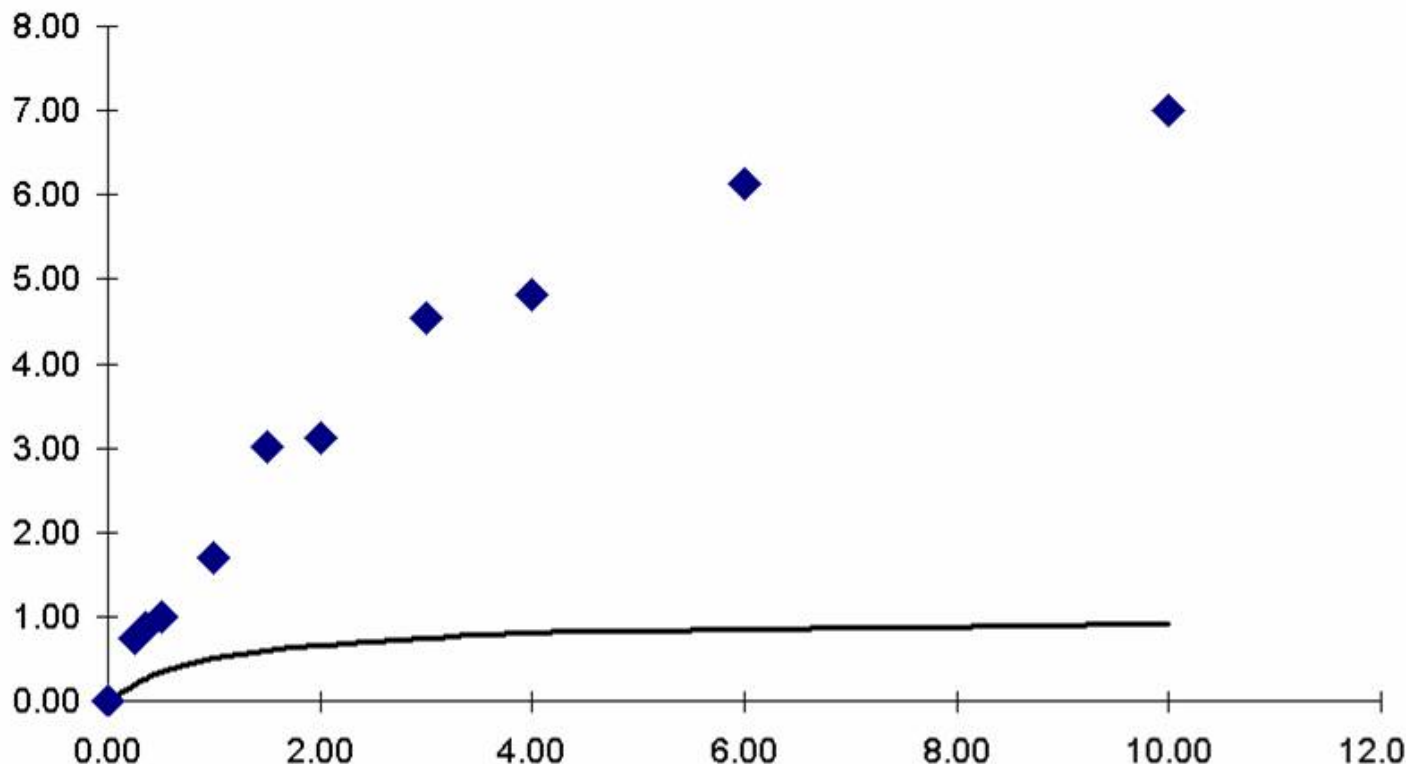
SUM ✖ ✔ fx =\$B\$2*A5/(\$B\$1+A5)				
	A	B	C	D
1	Km=	1		
2	Vmax=	1		
3				
4	Substrate concentration	Measured velocity	Calculated velocity	
5	0.00	0.00	=B\$2*A5/(\$B\$1+A5)	
6	0.25	0.7435		
7	0.35	0.8738		
8	0.50	0.9895		
9	1.00	1.7023		
10	1.50	3.0029		
11	2.00	3.1201		
12	3.00	4.5344		
13	4.00	4.8254		
14	6.00	6.1392		
15	10.00	7.0071		
16				
17				

To calculate the Calculated velocity select the C5 and type “=” then select the value of Vmax (cell B2), type *, select the corresponding substrate (cell A5), type /, open parenthesis, select the value of Km (B1), add the substrate concentration and close the parenthesis. To keep the position of the Km and Vmax values constant add the \$ sign before the column and the row number so instead of B2 you will have \$B\$2. Hit enter. Select the calculated cell and move the mouse pointer to the right bottom corner, when the pointer turns into a cross push the mouse left button and pull it down to calculate the rates for the rest of the substrate concentrations.

Plotting experimental and calculated data on one plot

To visualize the data you will plot both series on one plot

Select the data columns A to C and corresponding rows depending on how many substrate concentrations you have and hit the plot button on your toolbar , select chart type scattered and click next. Follow the rest of the chart wizard steps to finish the plot if you wish to rename the series you may do so. Once the plot is ready double click the data series that corresponds to calculated velocity (when you click on the data series the corresponding columns and rows are highlighted) and change the marker format to none and line format to custom. Your plot should look similar to the plot below.



Calculating difference

Calculate the difference between the measured and experimental velocities. You can use the excel formula POWER to calculate the square of the difference. Your screen will look similar to the following picture.

SUM X ✓ fx =POWER(B5-C5,2)					
	A	B	C	D	E
1	Km=	1			
2	Vmax=	1			
3					
4	Substrate concentration	Measured velocity	Calculated velocity	Square of difference	
5	0.00	0.00	0.0000	=POWER(B5-C5,2)	
6	0.25	0.7435	0.2000	POWER(number, power)	
7	0.35	0.8738	0.2593		
8	0.50	0.9895	0.3333		
9	1.00	1.7023	0.5000		
10	1.50	3.0029	0.6000		
11	2.00	3.1201	0.6667		
12	3.00	4.5344	0.7500		
13	4.00	4.8254	0.8000		
14	6.00	6.1392	0.8571		
15	10.00	7.0071	0.9091		
16					
17					

Since the Solver can minimize one value at a time you will calculate the sum of the square of differences.


Calculating Km and Vmax

Select the cell which contains the sum of the square differences and choose solver from the Tools menu.


Your screen will look similar to the following picture.

	A	B	C	D
1	Km=	1		
2	Vmax=	1		
3				
4	Substrate concentration	Measured velocity	Calculated velocity	Square of difference
5	0.00	0.00	0.0000	0
6	0.25	0.7435	0.2000	0.29539225
7	0.35	0.8738	0.2593	0.377660322
8	0.50	0.9895	0.3333	0.430554694
9	1.00	1.7023	0.5000	1.44552529
10	1.50	3.0029	0.6000	5.77392841
11	2.00	3.1201	0.6667	6.019335121
12	3.00	4.5344	0.7500	14.32168336
13	4.00	4.8254	0.8000	16.20384516
14	6.00	6.1392	0.8571	27.90012766
15	10.00	7.0071	0.9091	37.18571487
16				
17				
18			Sum of squares	109.9537671
19				
20				
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31				
32				
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34				
35				
36				

Solver Parameters

Set Target Cell: 

Equal To: ☐ Max ☒ Min ☐ Value of:

By Changing Cells: 

Subject to the Constraints:

As you can see the Target cell is set to the sum of the square difference and it will be minimized by changing the cells which contain the random values of Km and Vmax.

Select Solve, solver will pose after first approximation and you will need to click on continue button. When the last iteration is done you will note that the calculated curve is fit to your measured velocities and the Km and Vmax are changed.

To test the goodness of the fit as an additional exercise you can calculate the correlation coefficient or R-square.