

# Pump ED 101


## Affinity Calculators - Impeller Trim, RPM, Hertz & Pulley Size

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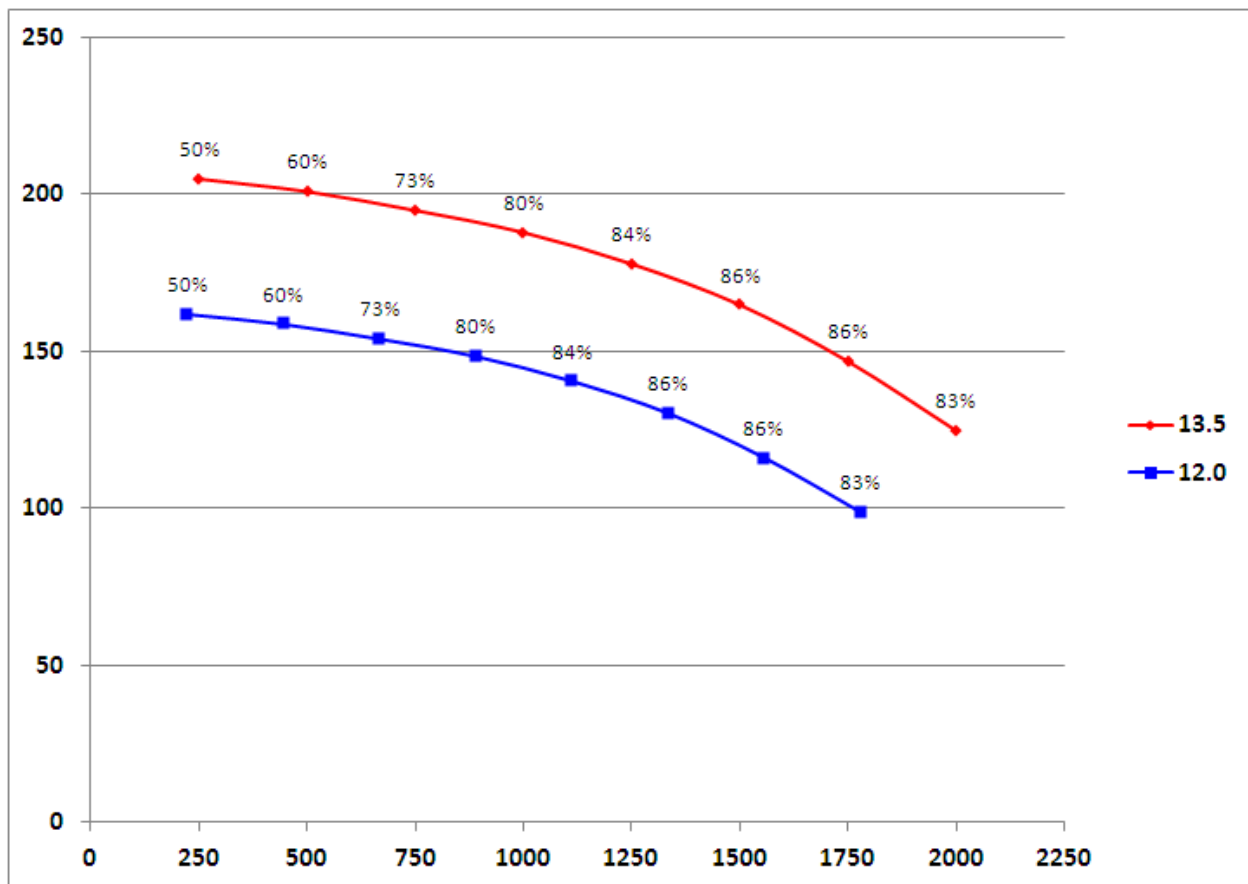
The affinity laws tell us quite a bit about pump performance when impeller diameter or rotational speed changes. The common denominator is peripheral speed, which is the velocity of a point on the periphery of the impeller. That velocity is directly proportional to a change in diameter or rotational speed. Flow is directly proportional to a change in peripheral speed while head (in feet) changes as the square and brake horsepower (BHP) changes as the cube. The affinity laws provide accurate performance information for changes in rotational speed and can exceed 95% accuracy for most impeller trims that are 10% or smaller.

The affinity law calculators calculate the head, flow and BHP of a centrifugal pump, based upon changes in impeller diameter, RPM, frequency and pulley size. Figure 1 is a screen shot of the data entry tab for the Impeller Trim Calculator. The

	A	B	C	D	E	F	G	H	I	J	
1	<b>IMPELLER TRIM CALCULATOR</b>										
2											
3											
4		1) Enter the pump test curve impeller diameter in cell B15									
5		2) Enter the reduced or increased impeller diameter in cell B22									
6		3) Enter up to eight flow values in cells C15 - J15									
7		If there are fewer than eight points enter the last flow multiple times									
8		4) Enter the corresponding heads in cells C17 - J17									
9		If there are fewer than eight points enter the last head multiple times									
10		5) Enter the hydraulic efficiencies (%) for each flow point in cells C18 - J18									
11		6) Calculated flows, heads & BHP will appear in the blue cells									
12		7) Click on the tabs to view the curves									
13											
14			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	
15		13.5	250	500	750	1000	1250	1500	1750	2000	
16			H1	H2	H3	H4	H5	H6	H7	H8	
17			205	201	195	188	178	165	147	125	
18		Pump Eff	50	60	73	80	84	86	86	83	
19		BHP	26	42	51	59	67	73	76	76	
20											
21			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	
22		12.0	222	444	667	889	1111	1333	1556	1778	
23			H1	H2	H3	H4	H5	H6	H7	H8	
24			162	159	154	149	141	130	116	99	
25		BHP	18	30	36	42	47	51	53	53	

required data include the full and trimmed impeller diameters, the head and flow values for up to eight points on the test curve and the pump efficiency at each flow point. These data are entered into the yellow cells and the calculated results are displayed in the blue cells. The calculator uses the affinity laws to calculate the new head and flow values for the trimmed impeller. Flow, head and efficiency are used for the BHP calculations.

Although not shown in Figure 1, three additional tabs plot the performance curves for each trim and a comparison of the two. Figure 2 shows the comparison plot for the two different impeller trims used in Figure 1.



The RPM, Hertz and Pulley calculators have the same format and require similar information. The RPM calculator compares the pump test curve RPM to one selected by the user. Similarly, the Hertz calculator compares the test curve frequency to one selected by the user. It also allows plotting of 60 Hz curves based on 50 Hz test data. The Pulley calculator computes the pump speed based upon motor speed and the two pulley diameters and then compares the performance. All plot the various head / capacity curves like the one shown in Figure 2. Since the calculators use the affinity laws and ratio analysis for

computation of head and flow, any units of measure may be used for flow, head and diameter (impeller & pulley). However, the BHP calculations require flow in GPM and head in feet.

The calculators can be very useful when predicting corrections that may be necessary due to system changes. They are especially useful when working with older pumps that may not be available in a manufacturer's electronic catalog. All four are available for download from the "Pump Evaluation, Selection & Testing Tools" page at PumpEd101.com.

*Joe Evans is responsible for customer and employee education at PumpTech Inc, a pump & packaged systems manufacturer & distributor with branches throughout the Pacific Northwest. He can be reached via his website [www.PumpEd101.com](http://www.PumpEd101.com). If there are topics that you would like to see discussed in future columns, drop him an email.*