Pump ED 101

Testing Centrifugal Pumps In The Field

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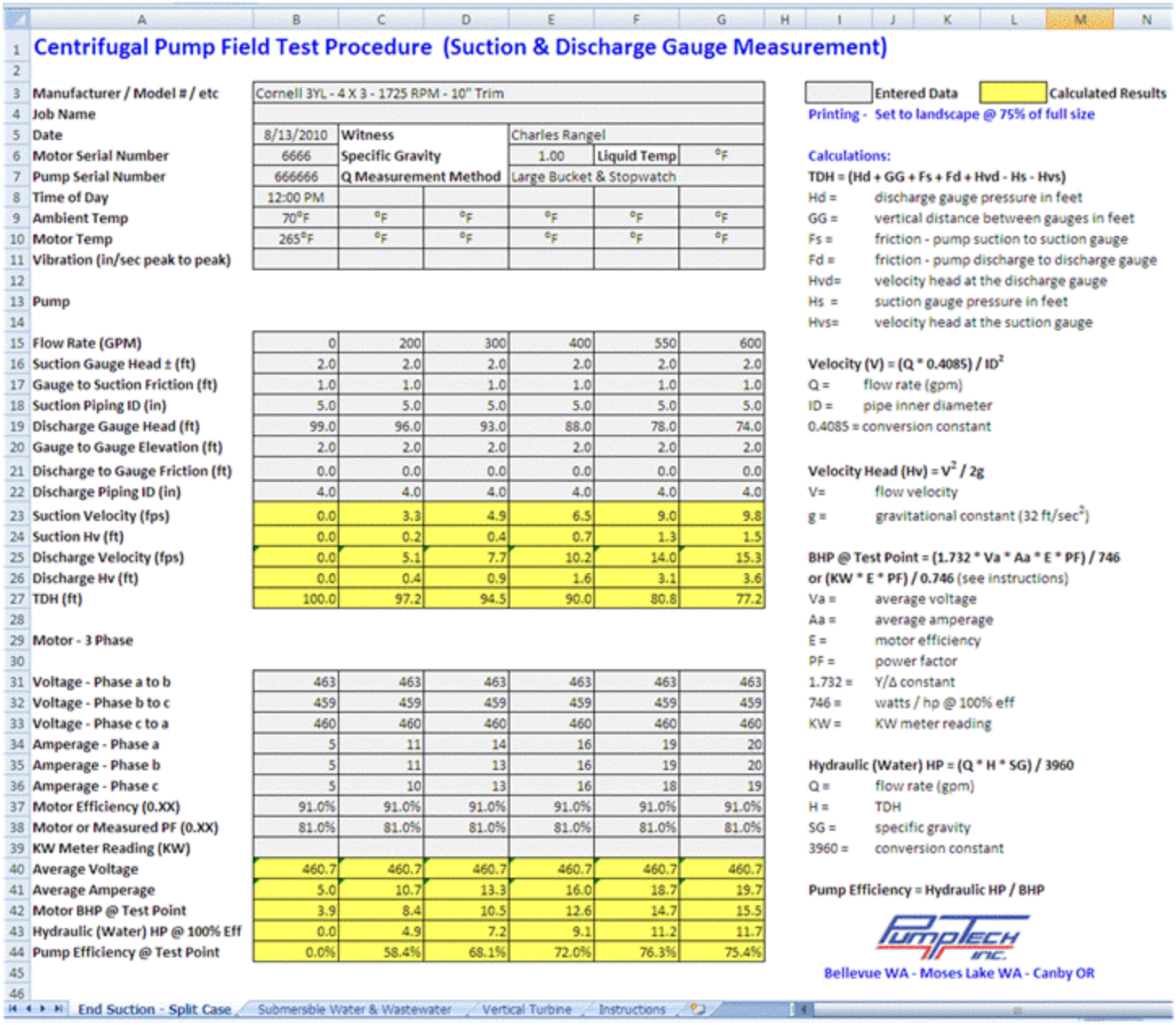
The performance curves generated by many pump manufacturers are based on results that are obtained in their test facility under tightly controlled conditions. The testing techniques we use in the field can vary substantially and may or may not provide accurate results.

Last year, one of my associates asked me to develop a single field test procedure that could be used company-wide for water pumping applications. After a little research, I found that we were using several different procedures and, although similar, the measured results could differ depending upon the system conditions. Over a period of several months, I put together a number of versions and received feedback from our field personnel. I also received some excellent feedback from Lee Ruiz, one of our faithful P&S readers and commenter's. The final result is an Excel spreadsheet, Field Test Calculator (FTC) that standardizes the testing of three of our most common water pumping configurations. It is used for both startup and post installation testing. To date, it has met or exceeded the testing requirements of our major pump manufacturers and the specifying engineering community. We still use some special procedures for the testing of pumps in the chemical, petroleum and food processing industries. There is nothing earth shattering about its design or content. Its purpose is to make sure that we use consistent methodology when testing pumps. The purpose of this article is to make it available to our readers as a tool or a template for developing your own version. It is available for download from the "Pump Sizing, Selection & Testing Tools" page at PumpEd101.com.

FTC is designed for three basic pumping configurations - - end suction and split case pumps, submersible well and wastewater pumps and lineshaft turbines. The first uses both suction and discharge gauge measurement, while the latter two use discharge gauge measurement only. Figure 1 is a screen shot of the End Suction – Split Case tab. The other tabs are similar in design but require different input based on the system design. The gray



Centrifugal Pump Field Test Procedure (Suction & Discharge Gauge Measurement)

Manufacturer / Model # / etc	Cornell 3YL - 4 X 3 - 1725 RPM - 10" Trim						
Job Name							
Date	8/13/2010	Witness		Charles Rangel			
Motor Serial Number	6666	Specific Gravity		1.00	Liquid Temp	°F	
Pump Serial Number	666666	Q Measurement Method		Large Bucket & Stopwatch			
Time of Day	12:00 PM						
Ambient Temp	70°F	°F	°F	°F	°F	°F	
Motor Temp	265°F	°F	°F	°F	°F	°F	
Vibration (in/sec peak to peak)							
Pump							
Flow Rate (GPM)	0	200	300	400	550	600	
Suction Gauge Head ± (ft)	2.0	2.0	2.0	2.0	2.0	2.0	
Gauge to Suction Friction (ft)	1.0	1.0	1.0	1.0	1.0	1.0	
Suction Piping ID (in)	5.0	5.0	5.0	5.0	5.0	5.0	
Discharge Gauge Head (ft)	99.0	96.0	93.0	88.0	78.0	74.0	
Gauge to Gauge Elevation (ft)	2.0	2.0	2.0	2.0	2.0	2.0	
Discharge to Gauge Friction (ft)	0.0	0.0	0.0	0.0	0.0	0.0	
Discharge Piping ID (in)	4.0	4.0	4.0	4.0	4.0	4.0	
Suction Velocity (fps)	0.0	3.3	4.9	6.5	9.0	9.8	
Suction Hv (ft)	0.0	0.2	0.4	0.7	1.3	1.5	
Discharge Velocity (fps)	0.0	5.1	7.7	10.2	14.0	15.3	
Discharge Hv (ft)	0.0	0.4	0.9	1.6	3.1	3.6	
TDH (ft)	100.0	97.2	94.5	90.0	80.8	77.2	
Motor - 3 Phase							
Voltage - Phase a to b	463	463	463	463	463	463	
Voltage - Phase b to c	459	459	459	459	459	459	
Voltage - Phase c to a	460	460	460	460	460	460	
Amperage - Phase a	5	11	14	16	19	20	
Amperage - Phase b	5	11	13	16	19	20	
Amperage - Phase c	5	10	13	16	18	19	
Motor Efficiency (0.XX)	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	
Motor or Measured PF (0.XX)	81.0%	81.0%	81.0%	81.0%	81.0%	81.0%	
KW Meter Reading (KW)							
Average Voltage	460.7	460.7	460.7	460.7	460.7	460.7	
Average Amperage	5.0	10.7	13.3	16.0	18.7	19.7	
Motor BHP @ Test Point	3.9	8.4	10.5	12.6	14.7	15.5	
Hydraulic (Water) HP @ 100% Eff	0.0	4.9	7.2	9.1	11.2	11.7	
Pump Efficiency @ Test Point	0.0%	58.4%	68.1%	72.0%	76.3%	75.4%	

Entered Data Calculated Results

Printing - Set to landscape @ 75% of full size

Calculations:

TDH = (Hd + GG + Fs + Fd + Hvd - Hs - Hvs)

Hd = discharge gauge pressure in feet
GG = vertical distance between gauges in feet
Fs = friction - pump suction to suction gauge
Fd = friction - pump discharge to discharge gauge
Hvd= velocity head at the discharge gauge
Hs = suction gauge pressure in feet
Hvs= velocity head at the suction gauge

Velocity (V) = (Q * 0.4085) / ID^2

Q = flow rate (gpm)
ID = pipe inner diameter
0.4085 = conversion constant

Velocity Head (Hv) = V^2 / 2g

V= flow velocity
g = gravitational constant (32 ft/sec^2)

BHP @ Test Point = (1.732 * Va * Aa * E * PF) / 746
or (KW * E * PF) / 0.746 (see instructions)

Va = average voltage
Aa = average amperage
E = motor efficiency
PF = power factor
1.732 = Y/Δ constant
746 = watts / hp @ 100% eff
KW = KW meter reading

Hydraulic (Water) HP = (Q * H * SG) / 3960

Q = flow rate (gpm)
H = TDH
SG = specific gravity
3960 = conversion constant

Pump Efficiency = Hydraulic HP / BHP

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End Suction - Split Case | Submersible Water & Wastewater | Vertical Turbine | Instructions

cells are for data entry and the yellow ones are calculated results. With the exception of Specific Gravity, the data entered into the upper block is for reference only and is not used in the calculations. The equations to the right show how each of the results was calculated and all of the variables are defined below the equation. Each of the tabs allow for testing of multiple points or one or two points multiple times. Testing of multiple points will automatically plot the performance curve on page 3 of the sheet. Page 2 is for comments, additional information and witness signatures.

The Instructions tab includes instructions for each test procedure and explains some of the data that may or may not be required. For example, you will note that suction piping friction is included in the calculation for TDH. Normally the suction gauge reading will take friction into account. But if the gauge is located some distance from the pump's suction, the friction that arises from the gauge location to the suction must be included. There are also instructions for modifying the equation used to compute BHP if your measurement device is a kW meter. The default computation for BHP is average voltage and current.

If you have any feedback on changes or additions please drop me an email.

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