

# HOW TO DO STUFF: CHAPTER I

## WATER WELLS

### CHECKING GRAVEL PACKING

As sand is pumped out of the well, the gravel will fill in the cavity that is created and the gravel level will drop. This can result in exposing the well screen if gravel is not added periodically. The gravel is usually added to the well through a gravel packing pipe. This pipe is about usually 4" in diameter and is sunk beside the casing. The level of the gravel pack should be checked at least yearly. This can be accomplished using the following procedure:

- 1) Tie a small weight and a paper clip "fish hook" to the end of a string.
- 2) Drop the string down the packing pipe until it hits the top of the gravel and then mark it.
- 3) Pull the string out until the "fish hook" catches on the bottom of the gravel pipe and mark it again
- 4) Measure the distance between the marks and pull the string out (straightening the paper clip "hook").

Gravel should be cleaned by flushing with water and disinfected with a strong chlorine solution before it is added to the well. The gravel level should be rechecked as the new gravel is added. Gravel should never be allowed to stand in the packing pipe. The vibration that is created when the pump is running can compact the gravel and block the pipe.

### DISINFECTING WATER WELLS

The final step before putting a well in service is disinfection and testing for bacteriological quality. The completed well should be cleared as thoroughly as possible of drilling mud and debris prior to disinfection. (It is always easier to flush dirt out of the system than it is to burn it up with chlorine.) Disinfection is achieved by the addition of a strong solution of chlorine to the well. The chlorine dosage should be at least 50 mg/l, however, if higher dosages (100-200 mg/l) are added, less contact time will be required. The contents of the well should be agitated by surging and allowed to stand for several hours, preferably overnight. The contact time at a dosage of 50 mg/l should be 18 to 24 hours but at 200 mg/l only about 2 hours is needed. However, with longer contact times, the chlorine will move farther out into the surrounding aquifer.

The proper dosage can be determined from the tables from the tables on the following page, provided the number of feet of casing below the water line is known. First, multiply the number of feet by the gallons in each foot using the top table on page 2. After the total number of gallons to be treated is determined, the bottom table is used to figure the proper dosage.

The well should be flushed out to remove the remaining chlorine once disinfection is completed. The bacteriological (Bac-T) samples should then be taken from the well and submitted for testing. These samples must be taken daily until they are total coliform negative on two consecutive days.

### VOLUMES OF WELL CASINGS

<u>Diameter in inches</u>	<u>Gallons per Foot</u>
4"	0.7
5"	1.0
6"	1.5
7"	2.0
8"	2.6
9"	3.3
10"	4.1

#### Dosage per 100 Gallons of Water in the Casing

<u>Dosage</u>	<u>HTH - 70%</u>	<u>Bleach - 5.25%</u>	<u>Contact time</u>
100 mg/l	2 oz. or 4 Tablespoons	1 quart	12 hours
200 mg/l	4 oz. or 8 tablespoons	2 quarts	2 hours

**Example:** A well has a 6" casing and it is 200 feet from the water level to the bottom of the well screen. From the tables it is determined that a 6" well casing holds 1.5 gallons/foot. Multiplying 1.5 by 200 ft. of water, the total amount of water to be treated is 300 gallons.

$$1.5 \text{ gal/ft} \times 200 \text{ ft. of water} = 300 \text{ gallons}$$

For a dosage of 100ppm (mg/l) the table shows 2 ounces (4 tablespoons) of HTH per 100 gallons. Multiplying 2 ounces by 300/100 (or 3.0), it will require 6 ounces (12 tablespoons) of HTH to dose at 100 ppm.

## **ADJUSTING IMPELLER CLEARANCE (LATERAL SETTING)**

When the pump is operating, the proper clearance between the wear rings and the impeller should be between 1/32-1/4" (depending on the impeller design). Wear rings, as the name implies, are designed to eventually wear out. The clearance between the impeller will increase as wear occurs. Specific adjustments can be made to raise or lower the impellers and bring the clearance back within acceptable tolerances.

Line shaft stretch must also be taken into account. Even though the shaft is made of hardened steel, it will stretch under load. There are several factors that will determine how much the shaft will stretch. They are:

- **The weight of the shaft**
- **The weight of the impellers**
- **The downthrust exerted against the impellers**

The most common means of raising and lowering the shaft is by adjusting the top shaft nut or adjusting nut, located on the top of a hollow core motor. The rotor in a hollow core motor is hollow and the pump shaft can slide up and down through the motor core. The adjusting nut prevents the shaft from slipping down through the motor. Tightening and loosening the top shaft nut will then raise and lower the pump impellers. Smaller shallow wells may not have hollow core motors. If this is the case, the adjustment is made at a special motor coupling or by shimming the base of the motor.

## **DETERMINING SHAFT STRETCH (ELONGATION)**

The shaft stretch can be determined if information on the number and type of impellers, size and length of the shaft, and discharge head on the pump are available. This information should be available on the engineering drawings that were supplied by the design engineer or contractor as part of the well log. When this information is available, the following procedure can be used to calculate the stretch:

- 1) Determine the weight of the shaft by multiplying the weight per foot (Table 1) and multiplying by the length of the shaft.
- 2) Determine the weight of the impellers by multiplying the weight of each impeller (Table 2) by the number of stages on the pump.
- 3) Determine the down thrust by multiplying the thrust, in pounds per foot of head (Table 2), by the discharge head on the pump.

NOTE: If the designed discharge head for the pump is not available, it can be calculated by taking the discharge pressure from the well head (in feet of head) and adding it to the length of shaft (i.e. 150 feet of head and 300 feet of shaft equals 450 feet of discharge head on the pump.)

- 4) Determine the total weight on the shaft (shaft weight + impeller weight + down thrust).

5) Use this number to determine the shaft stretch, in inches per 100 feet of shaft, from Table 3. Then multiply that number by the length of shaft divided by 100 (i.e., 350 feet of shaft will equal a factor of 3.5).

6) Add the stretch to the recommended impeller clearance from Table 4. This number represents the total distance the impellers must be raised off the pump bowls in order to have the correct clearance when the shaft stretches.

Tables 1-4 are supplied by and printed with permission of Peerless Pumps. Check with your pump dealer for this information on other brands of pumps. Although the numbers may change, the procedure described above can still be used.

**TABLE 1**  
COLUMN SHAFT  
WEIGHT

Shaft Diam.	Weight lbs/ft
3/4	1.50
1	2.67
1-3/16	3.77
1-1/2	6.01
1-11/16	7.60
1-15/16	10.02
2-3/16	12.78
2-7/16	15.86
2-11/16	19.29
2-15/16	23.04
3-3/16	27.13
3-7/16	31.56

**TABLE 2**  
HYDRAULIC THRUST AND WEIGHT DATA

Size	Thrust lbs/ft	Wt. lbs	Size	Thrust lbs/ft	Wt. lbs
4LO	1.6	1.5	10MA	5.5	12
4LE	1.0	1.5	10HH	9.5	35
6LB	1.5	3.5	10HXB	5.8	15
6MA	2.8	3	11MB	6.2	58
6HXB	2.2	3	12LB	6.0	14
7LB	2.4	5	12LD	7.8	22
7HXB	3.4	6	12MB	7.5	21
8LB	2.6	7	12HXB	8.5	17
8MA	5.6	7	12HXX	11.0	27
8HXB	3.62	7	14LD	10.4	38
9LA	3.9	11	14MC	10.0	33
10LB	4.1	25	14HXB	12.4	32
14HH	20.0	44			
15LC	6.4	46			
15MA	15.0	56			
16MC	12.7	50			
16HXB	20.3	35			
16HH	30.3	75			
18MA	22.5	54			
18HXB	24.4	72			
18HH	35.0	151			

**TABLE 3**  
SHAFT STRETCH: INCHES PER 100 FEET OF SHAFT

HYDRAULIC THRUST	SHAFT DIAMETER													
	3/4	1	1-3/16	1-1/2	1-11/16	1-15/16	2-3/16	2-7/16	2-11/16	2-15/16	3-3/16	3-7/16	3-11/16	3-15/16
500	.047	.026	.018	.012	.009	.007								
600	.056	.032	.022	.014	.011	.008	.006							
800	.075	.042	.030	.019	.015	.011	.009							
1000	.094	.053	.037	.024	.019	.014	.011	.009						
1200	.112	.063	.045	.028	.022	.017	.013	.011						
1400	.131	.074	.052	.033	.026	.020	.015	.012	.010					
1600	.150	.084	.060	.038	.030	.022	.018	.014	.012					
1800	.169	.095	.067	.042	.033	.025	.020	.016	.013	.011				
2000	.187	.105	.075	.047	.037	.028	.022	.018	.015	.012				
2400	.225	.127	.090	.056	.044	.034	.026	.021	.018	.015	.012			
2800	.262	.148	.105	.066	.052	.039	.030	.025	.020	.017	.015			
3200		.169	.119	.075	.059	.045	.035	.028	.023	.020	.017	.014		
3600		.190	.135	.085	.067	.051	.040	.032	.026	.022	.019	.016		
4000		.211	.150	.094	.074	.056	.044	.036	.029	.025	.021	.018	.016	
4400		.240	.164	.103	.081	.062	.048	.039	.032	.027	.024	.020	.017	
4800		.253	.179	.113	.089	.067	.053	.043	.035	.029	.025	.021	.019	.016
5200		.274	.194	.122	.096	.073	.057	.046	.038	.032	.027	.023	.020	.016
5600			.209	.131	.107	.079	.062	.050	.041	.034	.029	.025	.022	.019
6000			.224	.141	.111	.084	.066	.053	.044	.037	.031	.027	.023	.020
6500			.243	.153	.120	.091	.071	.058	.047	.040	.034	.029	.025	.022
7000			.260	.164	.129	.098	.077	.062	.051	.043	.036	.031	.027	.024
7500				.176	.139	.105	.082	.067	.055	.046	.039	.033	.029	.026
8000				.188	.148	.112	.088	.071	.058	.049	.042	.036	.031	.027
9000				.211	.167	.126	.098	.080	.066	.055	.047	.040	.035	.031
10,000				.234	.185	.140	.110	.089	.073	.061	.052	.045	.039	.034
12,000				.222	.168	.122	.132	.106	.088	.073	.062	.054	.047	.041
14,000				.259	.196	.151	.124	.102	.086	.073	.062	.055	.048	.041
16,000				.296	.224	.176	.142	.117	.098	.083	.071	.062	.054	.048
18,000					.252	.198	.160	.131	.110	.093	.080	.070	.061	.054
20,000					.280	.220	.176	.146	.122	.104	.089	.078	.068	.061
22,000							.242	.195	.160	.134	.114	.098	.086	.074
24,000							.264	.213	.175	.147	.124	.107	.094	.082
26,000							.286	.230	.190	.159	.135	.116	.102	.088
28,000								.248	.204	.171	.145	.125	.109	.095
30,000								.266	.219	.183	.156	.134	.117	.104
32,000								.283	.233	.196	.166	.143	.125	.109
34,000									.248	.208	.176	.152	.133	.116
36,000									.262	.220	.187	.160	.140	.122
38,000									.277	.232	.197	.170	.148	.129
40,000									.292	.245	.207	.178	.156	.136

$$e = \frac{L \times 12 \times H.T.}{E \times G.S.A.}$$

e = Elongation (in inches)

L = Shaft Length (feet)

E = Modulus of Elasticity (29,000,000)

H.T. = Hydraulic Thrust (pounds)

G.S.A. = Gross Shaft Area (sq. inches)

TABLE 4  
MOST EFFICIENT IMPELLER CLEARANCE (INCHES)

<u>PUMP</u> <u>SIZE</u>	<u>IMP.</u> <u>#</u>	<u>CLEAR-</u> <u>ANCE</u>	<u>PUMP</u> <u>SIZE</u>	<u>IMP.</u> <u>#</u>	<u>CLEAR-</u> <u>ANCE</u>	<u>PUMP</u> <u>SIZE</u>	<u>IMP.</u> <u>#</u>	<u>CLEAR-</u> <u>ANCE</u>
6LB	2616324	1/32	9LA	ALL	1/8	12MB	2624331	1/32
	2618292	1/8	10LB	ALL	1/8		2623936	1/16
	2616318	1/8	10MA	T84363	1/8		2624332	3/16
6MA	V850B	1/32		2624288	1/16	12HXB	2608379	1/8
6HXB	2607800	1/4	10HXB	ALL	3/16		OTHERS	1/16
7LB	ALL	1/8	10HH	ALL	1/16	12HXX	ALL	1/8
7HXB	ALL	1/8	11MB	ALL	1/16	14LD	ALL	1/16
8LB	2616464	1/4	12LB	2623849	1/32	14MC	ALL	1/16
	2616465	1/8		2616025	1/8	14HXB	ALL	1/8
8MA	T84229	3/16		2616011	1/16	14HH	ALL	1/16
	T84234	1/8	12LD	ALL	1/16	15LC	ALL	1/8
8HXB	ALL	1/16				15MA	ALL	1/8

### EXAMPLE OF A LATERAL SETTING CALCULATION

The following example will illustrate how to determine shaft stretch:

The well pump is set at 300 feet. The shaft diameter is 1 inch. There are 7 stages of Model 8MA impellers. The discharge pressure at ground level is 120 feet of head.

- 1) To determine the weight of the shaft, find 1" from Table 1 and read the weight per foot next to it. In this case it is 2.67 pounds/foot. Now multiply 300 feet of shaft by 2.67 lbs/ft:

$$300 \text{ ft} \times 2.67 \text{ lbs/ft} = 801 \text{ lbs}$$

- 2) To determine the weight of the impellers, find the 8MA impeller size from Table 2. The number to the right is the down thrust and the number in the next column the weight of the impeller, which is 7 pounds in this case. Multiply 7 stages by 7 pounds/stage:

$$7 \text{ stages} \times 7 \text{ lbs/stage} = 49 \text{ lbs}$$

- 3) To determine the thrust on the impellers, find the 8MA impeller on Table 2 and read the thrust factor in the center column. There is 5.6 pounds of thrust created by every foot of head above the impellers. Since the ground level discharge pressure is 120 feet of head, it must be added to the 300-foot setting of the pump to get the total head on the impellers:

$$120 \text{ feet} + 300 \text{ feet} = 420 \text{ feet total}$$

Multiply 420 feet of head by 5.6 pounds of thrust/foot:

$$420 \text{ ft} \times 5.6 \text{ lbs/ft} = 2352 \text{ lbs of thrust}$$

- 4) Add the weight of the shaft and impellers from Steps 1 and 2 and the down thrust from Step 3 to get the total downward force on the shaft:

$$801 \text{ lbs} + 49 \text{ lbs} + 2352 \text{ lbs} = 3202 \text{ lbs of downward force}$$

- 5) Calculate the stretch in the shaft by finding 3200 (rounded off) on the left side of Table 3 and read the stretch factor from the 1" column. There is .169" of stretch in every 100 feet of 1" shaft at 3200 pounds of force. Multiply 3.0 (300 feet/100) by .169 to determine the total stretch in the shaft:

$$3.0 \times 0.169" = 0.507" \text{ Total Stretch}$$

- 6) Add the proper impeller clearance for the 8MA impeller (#T84234), which is 1/8" or 0.125", to the total stretch to determine the total distance the impellers have to be raised:

$$0.507" + 0.125" = 0.632" \text{ Total Adjustment}$$

NOTE: Ideally, these calculations are carried out to 0.001 of an inch. While it is possible to measure these distances with a micrometer; in this case, 0.507" could be rounded off to 1/2" without causing any serious problems. Then 1/2", or 4/8", plus 1/8" would equal an adjustment of 5/8".

NOTE: These calculations are appropriate for wells with under 500 feet of shaft. For longer shafts, particularly oil-lubricated shafts consult your pump manufacturer for additional information.

### **ADJUSTING THE IMPELLER CLEARANCE**

The following procedure can be used to adjust impeller clearance on a vertical turbine centrifugal pump:

- 1) Make sure the pump is locked and tagged out.
- 2) Remove the cover from the top of the motor and remove the locking screws or lock nut on the adjusting nut (thrust nut.)
- 3) Hold the shaft with a strap wrench (NOT a pipe wrench) and loosen the adjusting nut until it spins freely. The impellers are now resting on the pump bowls and the shaft cannot be turned by hand. Tighten the nut back down until it is snug.

**IMPORTANT: If the well/pump has a non-cartridge mechanical seal, the gland plate should be loosened or removed to prevent potential damage to the seals when the shaft is raised and lowered.**

- 4) Measure the shaft sticking out of the top of the adjusting nut and add the total adjustment distance to it.

- 5) Tighten the adjusting nut until the shaft has been raised the proper distance.
- 6) Replace the locking screws or nut, the top cover, and mechanical seal gland plate, if applicable.
- 7) Remove equipment locks and tags.
- 8) Start the well and check motor amps for acceptable readings.

## **MAINTENANCE INSPECTIONS**

A maintenance schedule should be established and followed as a means of preventive maintenance and identifying problem areas in the well system. A typical inspection schedule is listed below:

### **DAILY INSPECTIONS**

- 1) Check for excessive noise, vibration, or high temperatures while the pump is operating.
- 2) Check oil in motor and drip oil storage.
  - If packing/lineshaft bearings are water lubricated, check water feed lines.
- 3) Check flow readings or totals from the meter.
- 4) Check the discharge pressure.
- 5) Check for leaks around packing and all fittings.
- 6) Check for unsanitary conditions around well.

### **MONTHLY INSPECTIONS**

- 1) Check the motor amps.
- 2) Check the oil dripper rates on oil lubricated line shafts.
- 3) If well can be shut off for 24 hours, measure the water level to check recovery rate.

### **SEMI-ANNUAL INSPECTIONS**

- 1) Check the static level after the well has been out of service for several days.
- 2) Check pumping and drawdown levels during the period of heaviest pumping rate.
- 3) Check the gravel pack level.

Log all inspection data for future reference. When this information is plotted on a chart of the well field it can aid in planning the production schedule of the different wells and help in planning for the addition of new wells.

