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TECHNICAL INNOVATION OF FARM WELL PUMP

Shaokang Zhang (The Water Conservancy Bureau of JiNing District, ShanDong Province)
Yongliang Dang (The Water Conservancy Bureau of ShanDong Province, China)

ABSTRACT

As result of not selecting and using farm well pump properly, it's running regime is far away from high efficient zone and running efficiency of farm well pump is lower. The paper analyses unhealthy tendencies of technical state of diving-electric pump, deep well pump and centrifugal pump which are commonly used in our country. The paper also summarizes several technical innovation plans to raise effieincy : stage change plan, diameter change plan , speed change plan and synthetic tenchincal innovation. Each plan gives a detailed introduction of designings and contruction manners. through practical measuring, the synthetic efficency of innovated well pumps raise above 30percent. Economic benefit is evident.

INTRODUCTION

The development and the use of underground water resources and the development of agricultural irrigation of the north since 1960s play a great role in improving the farm production and against the natural disasters. But most well pumps are mismanaged for many years, they are heavily depressed and aged and technical innovation of farm well pump has become an urgent task . We've done a great deal in the aspect of well pump innovation of several pump types as follows

TECHNICAL INNOVATION OF DIVING-ELECTRIC PUMP

Diving-Electric pump is a kind of advanced water-lifting appliance developed in ourcountry in 1970s. It is widely used in ShanDong province since 1980 oweing to its flexible adeption. But the diving-electric pump's working efficiency is lower as a result of improper well pump type selecting , too high residual lift and appliancy zone. In a survey and test innovation , sixteen sets of diving pump have been innovated on the spot, including eleven sets fo r 250QFB10-50-40 type, three sets for 200NQ50-36 type and tow sets for 250JQ 80-100/4 type. they are diameter-changed and stage-changed respectively. At the same time, they are being kept in good repair and maintenance condition. As a result, the innovated pumps increased their synthetic effciency about

13.30percent on average. They save energy 32.10percent.The economic benefit is evident.

1.Stage-Change Innovation

Stage-change innovation can be taken into consideration first if the residual lift is too high for multistage diving pump installment. The detailed innovation method for stage-change follows:

(1) Total Head Formula

$$Ht=H1+H2+H3+\frac{V^2}{2g}$$

In the above formula ,H1 indicates the distance from water surface to the center of dischange pipe during the pump working ;H2, H3 indicate loss head along the way and partial loss head.

$$H2=A\cdot Q^2\cdot L$$

$$H3=\S\cdot\frac{V^2}{2g}$$

$\frac{V^2}{2g}$ indicates kinetic energy of the discharge mouth, generally it can be neglected.

(2) Determination of The Maximum Suction Head(Hm)

Hm should be carefully determined.Hm should be a little bit more than the maximum depth of precipitation for motor-pumped well water stage when normally pumped in a common year.Lava crevice water for commonly deep motor-pumped well:Hm=Ht · 8～10%.

(3)Innovate and Select Lift(Hs)

Hs=Ht+Hm

(4)Calculate the Innovated impeller stage(D)

D=Hs/Hu (D should be an integer)

2.Diameter-change innovation

(1)Determine Pump and Selectlift(ditto to the method of calculation)

(2)Calculate the Innovation Impeller's external diameter according to segment law.

$$\frac{H1}{H2}=\left(\frac{D1}{D2}\right)^2$$

$$\triangle d=D1-D2$$

In the formula, $\triangle d$ indicates amount of turning (unit:mm)

(3)Basic Knowledge For Amount of Turning and Range of Diameter Change

According to data : pump officiency will decline about one percent after impeller's each turning for ten percent ; and raising of appliance's syn-

thetic efficiency. After diameter-change innovation, pump's running regime is in high efficiency area; systemetic appliance matches well and synthetic efficiency will be raised . tests prove the following truth: diameter -change innovation for diving electric pump applies to the motor-pumped well with a lift less than unistage impeller's head or with appliance's present waste of lift more than five meters; △d should be properly decreased according to the increase of pump's specific revolutions. The maximum turning can not surpass twenty percent. Commonly △d value for diving pump with specific revolution should be controled under fifteen percent.

3. Construction On-The-Spot

(1)Test

Organize a team of an electrician, a driver , measurement and innovation personnel. They share the work or energy consumtion, lift, flow and record . Before test, first survey the general state of motor-pumped well, appliance and irrigation . Complete the record table for on-the-spot test. During pumping for test, a record should be made every ten minutes after water stage of motor - pumped well is steady. obtain three groups of data all together and average it to calculate appliance's synthetic efficiency. All the reliable data is necessary to determine the innovation plan.

(2)Determine Innovation Plan

After the test and calculation for some data; compare appliance's total head with rated, then determine maintenance, stage-change and diameter-change innovation plans according to pump's residual head (ditto to the method of calculation).

a. appliance head (Ha)+lost head(Hl)+Hm=selective head(Hs)

If rated head (Hr)minus selective head (Hs) equals difference head (Hd) i.e. Hr-Hs=Hd, and Hd is less than five meters, then repair and maintenance is enough.

b. If difference head is more than one meter, stage-change innovation can be determined for two unistage impeller's heads.

c. If difference head is more than five meters or less than unistage impeller's head, diamer-change innovation can be determine for two unistage impeller's heads. once the plan is determined, inform and arganize personnel to lift pump.

(3)Repair, Innovate and Assemble On-The-Spot or in A Specific place.

(4)Turning of impeller

For diameter-change pump, after the impeller is dismantled , the original one can be used for turning if there is no excessive attrtion, otherwise change it.

Attached chart for Innovation Diving pump unit (table 1)

TECHNICAL INNOVATION OF DEEP WELL PUMP

Most deep well pumps in our country are JD type. As a resolt of unit's impeller improper head selection and no maintenance in time, deep well pumps have low efficiency and are easily damaged. After technical innovation for three types of deep well pump on-the-spot, the unit's efficiency is raised 11.05 percent on average. Energy saving is 28.65 percent. The innovation effect is evident. The detailed innovation method follows:

1. Stage-Change Innovation

Stage change innovation should be first considered if Hm is too large for pump installment after test.

Innovation method:

Calculation of total head:

$$Ht=Hd+Ha+\frac{V^2}{2g} \quad (1)$$

Generally $\frac{V^2}{2g}$ can be neglected, $Hd=Hs+Hp$ (2)

Depth of precipitation head (Hp) is difference beteen the maximum, static and maximum dynamic water stage during single well discharge. (water lever of motor pumped well should be considered in common precipitation, affluent precipitation and low precipitation year.)

Data for depth of precipitation head should be obtained by pumping test after well development.

Lost head along the way $Ha=A \cdot Q^2 \cdot L$ (3)

Partial lost head $Hp=\S \cdot \frac{V^2}{2g}$ (4)

Generally for lava clearance water, $Hm=Ht \cdot 8\sim10\%$ (5)

(carefully determine it after practical test)

$Hs=Ht+Hm$ (6)

$D=Hs/Hu$ (only integer remained) (7)

After pump's impeller is reduced, change for pump shaft of same stage. Generally the efficiency can be raised four to five percent for dismantling middle part than only dismantling impeller.

2. Partial Type Change Innovation

When water resource for motor-pumped well is better and affluent head is more, partial type-change Innovation can be taten by means of using diversion body with more flow.

Innovation method follows:

According to innovated pump's selective head and tested water stage' range for depth of precipitation before innovation , and reference to checked and accepted colomn chart after well boring find out the thickness and layers of water-bearing strata and estimate water stage's maximum range of change for innovation single well's designed discharge , so as to determine innovated selective head (commonly pre-remain one stage impeller head). We ever changed JD36 type into JD56 type, because these two types apply to the same well's diameter, and their revolution speed , diameter of driving shaft, external diameter of pump body and quality of material are no difference . After pump's partial type change , the flow increased, as a result, difference between dynamic and static water stage becomes larger , the head and power for pump shaft were raised and the pump matched the orginal electric motor more reasonably. Therefore , the innovation unit's efficiency correspondingly got raised , commonly the improved unit's synthetic efficiency can be increased above eighteen percent . (Refer to innovated Jd type deep well pump chart). In addition, high speed JD type deep well pump, Which is installed in bend well, is frequently damaged with its synthelic efficiency of twenty-five percent or so. If well's diameter is allowable, it is suggested to change 6 JD36 type and 6JD56 type high speed deep well pumps into 10JQ50 type , 6609/5 type, QFBand NQ type diving pump units (only take advantage of head pipe of deep well pump). Thus the unit's efficiency can be raised to about forty-five percent.

3. Reasonably Adjust Axial Clearance

After installment of deep well pump , axial clearmance between shell and impeller must be reasonably adjustted according to pump's depth under the well Axial clearances for JD type pumps are mostly adjusted by means of lifting nuts. After adjustment, fix them with position screws and put them into operation. Presently this method is commonly neglected and the careless installment causes decline of working efficiency. According to analysis by test: improper adjustment of axial clearance affects synthetic efficiency to above ten percent.

Shaft length of deep well pump varies with change of temperature and axial force. It is not an absolute value in different applied conditions. Therefore an optimum axial clearance, which can both guarantee no bumping and friction between shell and impeller and make pump have less return flow and the highest efficiency , must be properly controlled. Generally rated shaft length for 6JD36 type pump is six to ten millimeters and pump shaft's extension is 130 millimeters. It is found in test: most pumps' axial clearnces have

not been adjusted to optimum position and pumps have not got high efficiency running regime. We draw a great deal of enlightenment at this point. Here we attach (table 2) on innovated JD type deep well pump chart

TECHNICAL INNOVATION OF CENTRIFUGAL PUMP

Change of pump's revolution speed will cause change of pump's performance Proportioned law among pump's parameters is as follows:

$$\frac{Q1}{Q2}=\frac{n1}{n2}\ ;\quad \frac{H1}{H2}=\left(\frac{n1}{n2}\right)^2\ ;\quad \frac{N1}{N2}=\left(\frac{n1}{n2}\right)^3$$

In the above formula, Q1 and Q2 indicate rated and changed flow respectively (m^3/hr); n1 and n2 indicate rated and changed revolution speed (r/min); H1 and H2 indicate rated and changed total head(m); N1 and N2 indicate rated and changed power (kw)

Proportional law only applies to similar regime. Different regime can not use proportional law formula.

As most centrifugal pumps for shallow motor-pumped well are indirectly belt-transmitted, unit's total head is deviated from its rated head .In addition, diesel-driven pump consumes more energy and has low efficiency since its revolution speed can not be adjusted to economic one . Detailed innovation method is to adjust pump's speed according to proportional law , pump's perfor mance curve and reference to unit's head and test result . Main innovation measures are to change belt-pulley and keep correct maintenance and repair.

SYNTHETIC TECHNICAL INNOVATION

After pump's stage-change, diameter-change and speed-change , every part of systematic unit should be analyzed to find problems. The single item technical innovation to further raise every part's efficiency . In innovation, mai n measures taten are as follows:

(1).Grind Impeller's Trough and Flow Duct

As a result of limited cast craft for impeller, impeller's trough, middle part of diversion and inlet and outlet area, there exist problems of convex, rough surface and clogging after installment. In order to lessen hydraulic loss within pump, emery cloth and steel file can be used to grind until smoothness

(2).Dismantle Middle Part(For Diving Pump and Deep Well Pump)

After stage-change, pump shaft with same stage of innovated impeller's stage number can be change for, and the middle part inlet for multi-stage pump can be dismantled to lesson the hydraulic loss within pump. If pump shaft is not

changed for, a steel pipe with the same length of the dismantled part can be processed to connect with lift pipe so as to decrease hydraulic loss. Commonly the efficiency can be raised about one percent.

(3). Adjust Clearance Between Pump Shaft and Shaft Sleave(for diving pump)

After rubber bearing within pump is changed for , it is disposed to being jummed ouning to its irregularities. Wooden file can be used to file outer cicle of rubber bearing until its flexible turning , by this means, pump's mechanical friction loss can be lessoned . The efficiency generally can be raised about one percent.

(4). Dismantle Check Valve for Diving Pump and Bottom Value for Centrifugal Pump

Check valve for diving pump is a kind or protective part, which prevents from motor's reversing while water stops and from sudden surging force of high lift water return. Pratice proves this; after check valve for diving pump can still run safely with its efficiency's raising about four to fine percent.

(5). Change The Situation of "Big Horse For Small Wagon"

After deep well pump's stage change , shaft's power declines and electricity load decreases, therefore the efficiency of electric motor itself decreases. On motor's working perpormance curve, the highest efficiency point of motor is at seventy to eighty-five percent of its rated load . In order to match properly , lessen inefficient power and raise motor's efficiency, motors must be reasonably chosen. The efficiency can be raised five percent or so for changing the situation of "big horse for small wagon".

(6). All pump's inlets have screens which prevent aqueous suspersion from entering the pump, If pump is installed ten meters beneath static leavel, suspension will not enter the pump. So screens can be dismantled to decrease partial loss. In addition , innovated lift pipe should be properly widened. NInety degrees elbow also should be innovated.

(7). Change High Speed Deep Well Diversion into Diving Pump Unit

High speed (2900rev/min) JD type deep well is installed in the elbow well hole . It has very low efficiency and is most easily damaged. If well hole is allowable , the original lift pipe can be used to convert into diving pump unit. The synthetic efficiency generally can be raised five to seven percent.

(8). Pumps Reasonably Pulled Down

If installment height for centrifugal pump (plus loss) surpasses allowable suction vacum hight, the pump should be pulled down. This measure is very effective and it should be used widdly.

(9). Get Rid of High Jet Pump Lessen Ineffective Head

(10). Innovate and Adjust Low Pressure Electricity Supply Line

a. voltage loss for a well and can not surpass ten percent of rated voltage i.e. 342 volts. If it is too low, the line diameter should be widened and line swivels be lessened. If possible, try to place transformer in the load center of pmotor-pumped well.

b. If cable for diving pump is too long, too five or electricity, it should be properly shortened , selected and wound. Electricity leakage at the cable swivels can affect synthetic efficiency above five percent. Problems should be dealt with in time. Besides, land leveling and canal's permeability-resistence are effective measures for energy-saving. Energy and water saving combined with technical innovation can only make motor-pumped well irrigation raised to a new level.

Table 1 Attached Chart for Innovated Divung Pump Unit

№	unit's matched state	provided power (kw)	rated head (m)	unit's head (m)	specific revolution	before and after innovation								
						flow (m/h)		energy consumption per thousand ton meter (Kwh)				unit's synthetic efficiency (%)		
						before innovation	after innovation	before innovation	after innovation	reduction	energy saving (%)	before innovation	after innovation	increase
	250QFB													
1	10-50-40	10	40	30.46	131	41.72	50.71	9.97	6.76	3.21	32.20	27.28	40.24	12.96
2	"	"	"	31.00	"	44.60	59.88	9.13	5.91	3.22	35.27	29.79	46.02	16.23
3	"	"	"	27.86	"	58.14	59.88	7.61	5.03	2.58	33.91	35.79	54.07	18.28
4	200NQ													
	50-36	10	36	26.52	141	63.44	44.60	7.97	6.48	1.49	18.70	34.12	40.54	7.42
5	"	"	"	29.52	"	27.87	33.75	11.00	7.71	3.29	29.94	24.72	35.32	10.60
6	"	"	"	18.68	131	60.76	56.44	10.27	7.77	2.50	24.34	26.48	35.01	8.53
7	250QFB													
	10-50-40	"	40	45.45	"	16.38	41.02	26.21	6.66	19.55	74.59	10.38	40.84	30.46
8	"	"	"	22.75	"	62.54	71.90	7.87	5.87	2.00	25.41	34.56	46.34	11.78
9	"	"	"	30.18	"	56.44	59.88	7.93	6.00	1.93	24.34	34.30	45.33	11.03
10	250JQ													
	80-100/4	37	100	26.44	140	109.77	96.47	14.43	8.81	5.62	38.95	18.85	30.87	12.02
11	250QFB													
	10-50-40	10	40	23.67	131	71.90	68.06	7.86	6.09	1.77	22.52	34.61	44.66	10.05
12	"	"	"	21.93	"	71.90	65.27	9.27	6.26	2.65	28.57	29.34	41.09	11.75
13	250JQ													
	80-100/4	37	100	27.75	140	85.26	97.64	13.87	7.95	5.92	42.68	19.60	34.59	14.99
14	250QFB													
	10-50-40	"	40	22.23	131	71.90	69.97	8.33	6.11	2.22	26.65	32.65	44.52	11.87
average						59.54	62.88	10.53	6.62	3.91	32.10	28.59	41.90	13.30

Table 2 Innovated JD Type Deep Well Pump Chart

item	ordinal		1	2	3	average
unit's matched stade	pump type		8JD80×12	6JD36×9	6JD56×10	
	provided power (kw)		30	22	22	
	rated head(m)		48	85	80	71
	unit's head(m)		26.61	28.27	29.34	28.07
	specific revolution		280	200	280	
	impeller's diameter(mm)		160	114	115	
	pump's revolution speed (r/min)		1460	2900	2900	
	pump's efficiency(%)		70	67	68	
before and after innovation	flow (m/hr)	before	88.54	33.75	59.88	60.72
		after	84.19	41.02	57.29	60.83
	energy consumption per thousand ton meter (kwh)	before	7.65	11.78	10.42	9.95
		after	6.45	7.38	7.00	6.94
	unit's synthetic efficiency (%)	before	35.56	23.07	26.10	28.24
		after	42.14	36.86	38.88	39.29