Methods Discussing to Improve The Efficiency of Pumping Unit Well System

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Abstract. In this paper, combined with the actual oilfield production, based on the well system efficiency of the pumping unit of yushulin oil field is generally low, according to the composition of the system efficiency, its main influencing factors are analyzed.From strengthening daily management work, strengthening the technical management and optimization of swabbing parameters, etc., Improve the system system efficiency of the pumping unit in yushulin oil field are proposed.

1.Preface

System efficiency is the important indicator of oilfield production, not only reflects the energy consumption of the pumping unit well condition and economic benefit, also reflects the comprehensive oilfield technical equipment and management level.Elm forest oilfield belongs to low permeability oil fields in the peripheral part of daqing, pumping unit well system efficiency is only 5.31%, and the average is 24.84%, it is 11.54% in the peripheral oil fields.Low system efficiency has become a problem to be solved of energy conservation and consumption reduction.If you can find the main factors influencing the efficiency of pumping well system, formulate reasonable improving measures, the system efficiency is increased by 2%, then the power saving can be up to 957.2 x 10^4 kw. H..

2.The composition of System efficiency

$$\eta = \frac{P_e}{P_s} \times 100\% \qquad P_e = \frac{\alpha \cdot Q \cdot H \cdot \rho \cdot g}{86400} \qquad (1)$$

Pumping unit systems are composed of motor, pumping unit, sucker rod, subsurface pump, downhole string and wellhead equipment. System efficiency is the ratio of the effective power to lift underground liquid into the ground and of the input power of the motor under a certain lift.

$$\eta = \frac{P_e}{P_s} \times 100\% \qquad P_e = \frac{\alpha \cdot Q \cdot H \cdot \rho \cdot g}{86400} \qquad (1)$$

By the formula (1), improve the system efficiency of pumping Wells can improve the effective power or consider both to reduce the input power.

Type: Q - well theory produced fluid volume of the well, m^3 / d. ρ- liquid density, t/m^3;

G - the acceleration of gravity, g = 9.8 m/s^2.H - effective lift, m; α- pump efficiency, %.

Under given swabbing parameters, effective power was mainly affected by effective lift and pump efficiency.Along with the increasing effective lift, effective power is rising, system efficiency is increasing corresponding.According to the characteristics of the pumping unit and the law of conservation of energy, the input power is equal to the sum of effective power and the loss of power.

Power loss can be divided into two parts, the ground loss and downhole loss.Ground loss can be subdivided into motor loss, belt loss, loss reducer and so on;Downhole power loss can be subdivided into loss of sucker rod, subsurface pump etc.

3.The way to enhance the efficiency of the system

3.1 Strengthen daily management, reduce the ground loss of power

Daily management, including pumping unit balance rate, the donkey head and mouth of the well in the case, the adjustment on the packing, etc.Now will be the same pumping unit in different balance rate list of the measured energy consumption and system efficiency.

Tab1 The actual system efficiency under different balance

well name	debuggingtimes	degree of balance (%)	measured power (kW)	The power of the polished rod (kW)	Effective power (kW)	The efficiency of the system (%)
A	1	81	4.81	1.85	0.22	4.67
A	2	95	4.75	2.02	0.29	6.11
A	3	100	4.93	2.16	0.34	6.82

From table 1, balance rate has a certain influence on the pumping unit system efficiency.For with a well balanced rate between 85% ~ 100% than less than 85% higher than that of 1% ~ 3%.

3.2 Strengthening technical management, and improve the effective power

System efficiency formula: $\eta = \frac{P_e}{P_e+\Delta P} \times 100\%$ (2)

In the operation of the pumping unit system, lost power is certain, when the effective power is too low, will cause the system efficiency is low.

3.2.1 By improving the pump efficiency to enhance the effective power

Pump efficiency $\eta_e = \frac{S_P}{S} \cdot \beta \cdot \frac{1}{B} \times 100\%$ (3)

Type: S_P - piston stroke effectively, m;S - polished rod stroke, m; β- pump with degrees, %;B - liquid volume factor.

$$\beta = \frac{1 - K_s F_{go}}{1 + F_{go}} \times 100\% \quad (4)$$

Type: F_{go} - gas oil ratio;K_S, clearance ratio.

$$K_s = \frac{V_s}{V_p} \quad (5)$$

clearance ratio

Type: VS - clearance volume; VP - stroke piston up volume.

For specific Wells on the same block, through the optimization of swabbing parameters, increase effective piston stroke and to improve pump efficiency;Of liquid and pump with degrees and swabbing pump in the gas oil ratio of the pump clearance than about: one is the KS is smaller, the greater the beta.To make small, KS should make less VS or increases the piston stroke in order to improve the VP.Therefore, we should try to reduce the impingement distance, xiao yu gap reduction ratio;Second, the smaller the gas-oil ratio, the bigger the value.In order to reduce the gas oil ratio, can increase the submergence of the pump in order to improve the pump inlet pressure, also can use gas anchor, to prevent and reduce the gas into the pump.

3.2.2 Enhance the effective power by improving the effective head

Enhance the effective power by improving the effective head

Effective lift is decided by liquid level depth, tubing pressure, casing pressure and fluid density.

$$H = H_0 + \frac{(P_O - P_C) \times 1000}{\rho \cdot g} \quad (6)$$

Type: Ho - dynamic liquid level depth,m;Po - tubing pressure ,MPa;Pc - casing pressure ,MPa.

Obtained from the type: if you want to improve the effective head, must improve the dynamic liquid level depth and tubing pressure, reduce casing pressure.Research shows that, the higher the effective head is not better, when the pump setting depth must be with the increase of effective head, cause the submergence depth decreases, and pump efficiency is reduced, the production fluid amount is reduced, which affects system efficiency.

3.3 To optimize swabbing parameters, improve the efficiency of system

For example, well A, under the analysis of swabbing parameters effect the efficiency of the system.

Tab2 The original data table OF WELL A

No.	A	Oil pumping unit model	CYJY10-3-53HB
stroke(m)	3	speed(mm)	4.5
Pump diameter(mm)	32	Rod string(mm×m)	φ25×275+φ22×430.05+φ19×827.04
PFL(m)	1453.6	Sinking degree(m)	0
Reservoir depth(m)	1840		

Tab3 The system efficiency under different S/n of Well A

stroke (m)	Stroke speed (mm)	The system efficiency value (%)
2.5	4.5	4.94
3.0	4.5	6.82
3.0	3.0	8.76

(1)Other data unchanged, when S/n is not at the same time

When the speed is constant, the system efficiency is increased with the increase of stroke;When the stroke is constant, the system efficiency increases with speed reduced.With the increase of stroke length and speed down, reduce energy consumption.By table 4 shows: with the 3.0 m stroke, 3.0 (r/min) at times, the system efficiency of stroke than 3.0 m, 4.5 (r/min), 4.5 times and 2.5 m stroke (r/min) speed can be increased by 2% and 2% respectively.

(2) Other data unchanged, pole combination is not at the same time.

Table 4 System efficiency Well B under different combination of rod string table

rod string assemblage (mm×m)	The system efficiency value			
	Rod string weight(kN)	surface efficiency(%)	Downhole efficiency(%)	The efficiency of the system(%)
φ25×400+φ22×1132	48.2	45.37	14.66	6.65
φ25×275+φ22×600+φ19×657	42.2	44.66	15.07	6.73
φ25×275+φ22×430+φ19×827	41.00	43.81	15.57	6.82

Table 5 B well system efficiency under different pump diameter

Pump diameter (mm)	The system efficiency value (%)		
	surface efficiency (%)	Downhole efficiency (%)	The efficiency of the system (%)
32	43.81	15.57	6.82
38	37.26	14.38	5.35
44	35.23	12.67	4.46

The heavier the rod string of large energy consumption, polished rod power increases, downhole efficiency;When the stroke, speed and pump diameter unchanged, only change the rod string combination, has little influence on the system's efficiency.

(3) Other data unchanged, pump diameter is not at the same time

As the pump diameter, the system efficiency is lower, the required input power increases, resulting in the motor rated power increase.If the reservoir for the liquid is sufficient, increases with the pump diameter, downhole power and underground efficiency will increase.

You can see from the above analysis, swabbing parameters had a great influence on system efficiency, through the optimization of swabbing parameters, can reduce energy consumption and improve the efficiency of the system greatly.

4. Conclusion

1.By strengthening daily management, Adjust the balance of pumping unit rates、The donkey head and mouth of the well in the case and the tightness wellhead sealing packing and drive belt,system efficiency can be increased by 1% ~ 3%.

2.It is another effective way to improve the efficiency of the system by improving the pump efficiency and effective delivery lift and other technical measures to improve the effective power.

3.By seeking optimum parameters, system efficiency can be increased by 2% ~ 5%.

4.Strengthen monitoring efforts on system efficiency on mechanical production Wells, understanding of the situation of energy consumption on mechanical production Wells timely and accurately, take targeted measures, is the premise to improve the efficiency of the system.

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