Journal of applied science and engineering innovation Vol.1 No.6 2014
ISSN (Print): 2331-9062
ISSN (Online): 2331-9070

Study On Warning Monitoring System About Well Control Of The Oilfield

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Abstract. If Well blowout out of control occurred, in the process of drilling wells, which shall lead to the fire and often disastrous accident. Therefore, how to avoid the occurrence of serious accidents effectively, is an imminent problem. This paper puts forward for Daqing oil field design scheme of well control prevention early warning system. The system judges the abnormal situation through the establishment of mathematical model about the well control blowout warning, and then develops a set of well control preventing blowout warning system software.

Keywords: Well Control; Warning Control Technology; oilfield.

1.Introduction

In the sixties and seventies, accidents occurred frequently in the oil drilling industry, which caused great harm to people's life and national property. Therefore, at the beginning of 80's, well control technology began to be taken seriously[1]. An imminent problem is how to effectively avoid the serious accident to happen such as blowout. A series of investigations shows that a perfect set of well control monitoring early warning system, can deal with the accident timely and completely avoid such heavy casualties. Even though advanced information technology like network and bus have been applied to drilling monitor system available, most of the monitoring systems are still using industrial computer for data processing and monitoring function such as network communication. As a result, the hardware of the core of the control system is large, as well as the cost is high, what's more, compared with general PC system, its pertinence of hardware and software platform of drilling monitor system is not that strong, real-timely perform or stable[2]. The purpose of this item is to develop a set of early warning and accurate, easy to popularize to the well control of the early warning system. The system uses multiple parameters for comprehensive monitoring process, and issues a warning signal timelessly, accurately. At the same time，the design of the reception of wireless data, touching operations, more color display of the digital curve and sound and light alarm, makes the system visual display, more operationally. Finally the simulation of the well control the bop warning system through the test in laboratory for lost circulation and overflow, proofs that the system can alarm in time. At the same time, both data acquisition and signal receiving wirelessly are stable, reliable[3].

2. Well control blowout early warning monitoring system hardware design

Well control the bop early warning and monitoring system takes drilling fluid as the research object, through the means such as Liquid level meter, density meter and flow meter to monitor the drilling fluid, density and the changes in import and export flow and so on, to make early warning effectively. Warning system is connected to the driller's console to alarm timely, in other words, corresponding measures can be adopted timely after alarm signal send by monitoring system. After completion of the design, the system can realize voice alarm, threshold Settings and real-time storage. Well control the bop warning system is made up of data acquisition system, signal transmission system, data processing system and alarm system. Among them, the data acquisition system consists of electromagnetic flow sensor, ultrasonic liquid level sensor and density sensor, whose sensors are intrinsically safe or explosion-proof; Signal transmission system will transmit real-time data to monitoring host installed in the driller room through wireless transmission module; Data processing system includes a host monitoring, which will give real-time data analysis and processing from data acquisition system by internal processing unit, at the same time real-time display LCD for the results, as well as processing software system. Data processing system can be used for data storage and calling historical data, playback and print, and convenience of safety inspection on daily production, the analysis of the causes and responsibility division after an accident; Alarm system will take off sound and light alarm to the alarm results of the analysis of data processing system; The keyboard of the host monitoring can set parameter to the system and cancel the alarm information, and so on.

Well control the bop early warning monitoring system structure principle is shown in Fig.1.

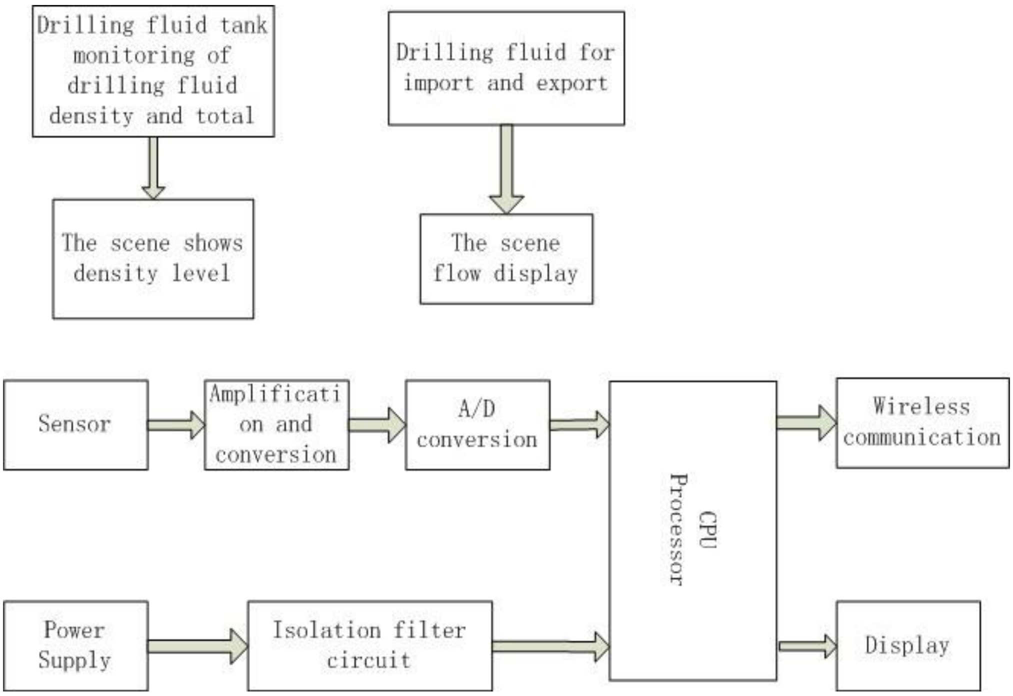

Fig.1 Well control the bop early warning monitoring system principle

3. Well control blowout early warning monitoring system software design

This system detects real-time import flow, the outlet flow, the change of the level of the drain, and calculates the difference of import and export flow based on the measurement data. We calculated the difference according to the historical data of the difference between import and export flow. Combining with the flow changes, we get the change tendency. And then combining the density variation of the drain and the volume change of the drilling in the tank, the conclusion was reached and early warning alarmed. In accordance with The functional requirements of the system, the program block diagram is shown in Fig.2.

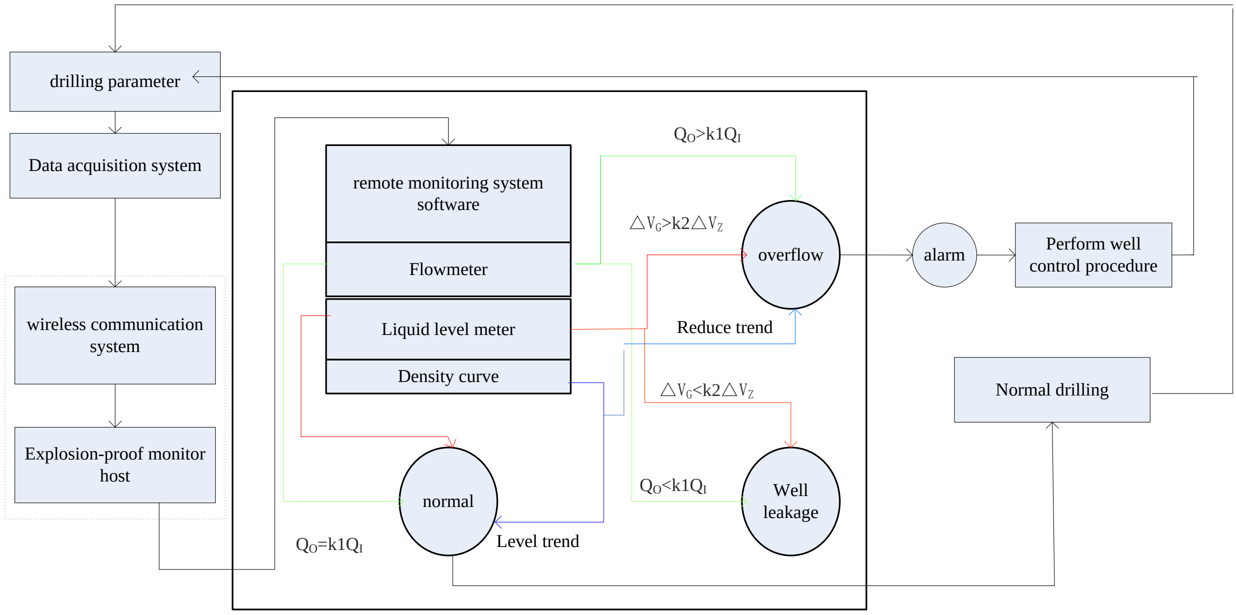

Fig.2 warning system program block diagram

In the figure:

Q_i – inlet flow

Q_o – outlet flow

P– drilling fluid density

ΔV_{pot} – drilling jar drilling fluid volume variation

ΔV_{drill} – drill volume variation

k1, k2 – correction coefficient

Data processing system is the core of the early-warning system. It is essential for determining the downhole condition, reducing the mistake and the occurrence of false negatives on the basis of the actual situation to establish scientific and reasonable mathematical model[4].

A mathematical model is established in this paper as follows:

In the time domain T on uniform time series t_1、 t_2 … t_n , in the process of drilling, corresponding import and export flow at each time point difference is:

$$\Delta Q_i = Q_{\mathrm{in},i} - Q_{\mathrm{out},i} \qquad i = 1,\ 2,.\ n \tag{1}$$

If we define t_i as the starting point, the sum of 100 points of continuous flow on the time series is Q_i :

$$Q_i = \sum_{i}^{i+99} \left(\Delta Q_i + \cdots + \Delta Q_{i+99} \right) \tag{2}$$

When it is normal drilling and circulating drilling fluid, the system takes the data from the meter as the main criterion basis[5] :

1. If the drilling of the time period taken t_i as the starting point is the normal:

$\dfrac{Q_i}{Q_{i-1}} = 1$,Judging system for the normal state;

2. If the time period taken t_i as the starting point:

If $\dfrac{Q_i}{Q_{i-1}} > 1$, the judging system for lost circulation;

3. If the time period taken t_i as the starting point:

If $\dfrac{Q_i}{Q_{i-1}} < 1$, the system for overflow .

The main part of the system human-computer interaction interface terminal includes real-time data acquisition, display and processing, as well as a color set, port settings and parameters settings and so on.

The display of results of data acquisition and processing is completed by the main interface of the software, which is only allowed to watch not to change. However the data processing as well as the additional part is completed by each module respectively, user need to login in the system to operate or modify.

Main interface consists of flow, flow display, curve display, status display, number of well, temperature display, depth of well and other parameters of eight parts, in addition to processing bar and status bar (Fig.3).

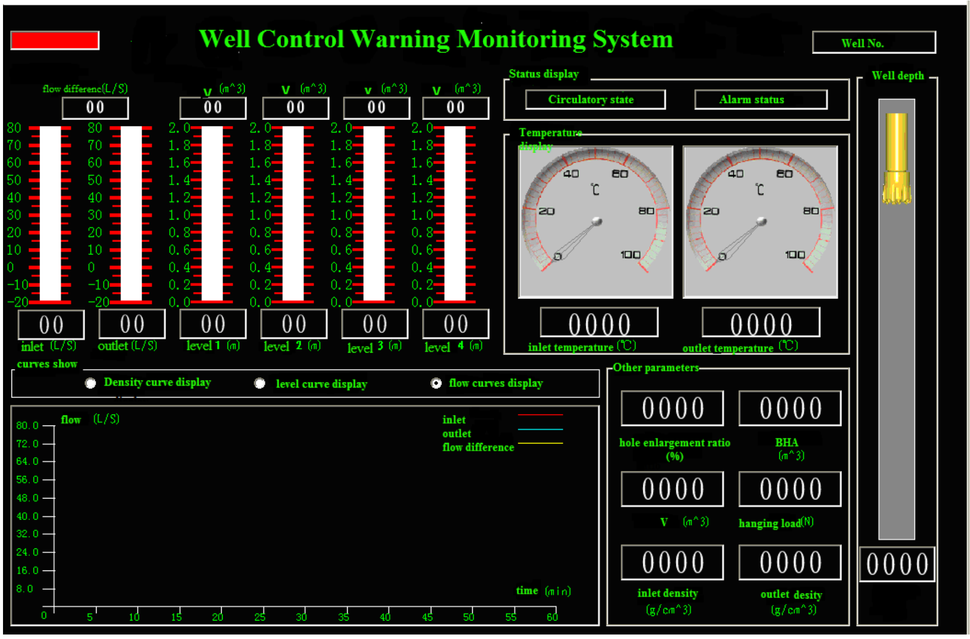

Fig.3 warning system main interface diagram

4. Field test

1. The simulation of well leakage test (no system error)

When the pump was opened till normal running, the reading of the import and export flow meter and the record of the status of the curve, are basically identical on September 19, 2008, 9:42 points for 10 seconds. When the drain valve is opened for lost circulation simulation in running 160 seconds, drain valve flow around 1L. System Alarm in open the valve after 25 seconds. Data showed that inlet flow rate is 25.67 L/s, outlet flow for 24.64 L/s, flow difference of 1.03 L/s. The system reports well leakage warning, and well leakage quantity is 26.5L. Close the drain valve to end the lost circulation system simulation experiment without system error. The test results are

Journal of applied science and engineering innovation Vol.1 No.6 2014
ISSN (Print): 2331-9062
ISSN (Online): 2331-9070

shown in Fig.4.

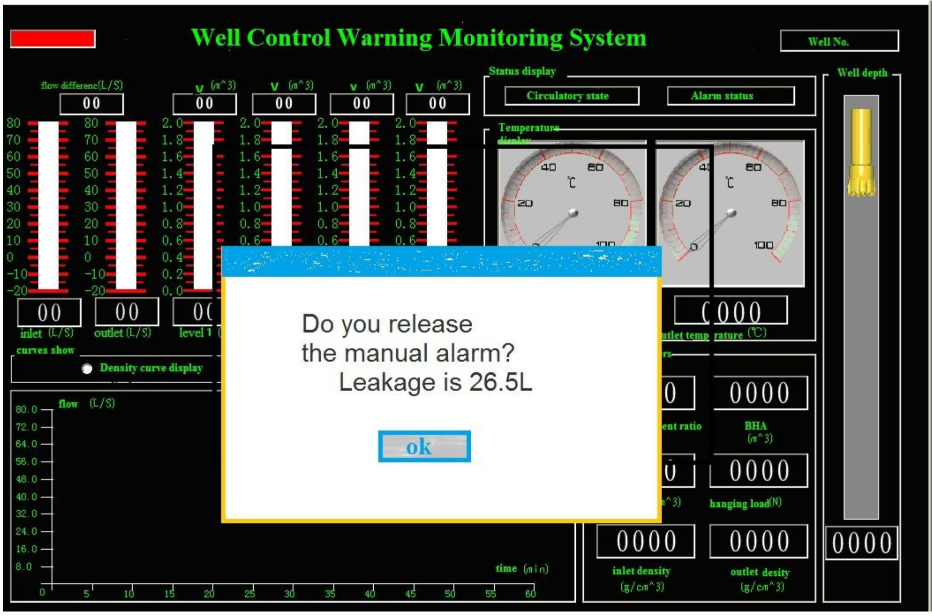

Fig.4 The ground simulation well leakage test

2. The overflow simulation test

When the pump was opened till normal running, the reading of the import and export flow meter and the record of the status of the curve, are basically identical Open the water valve for system overflow alarm simulation in running 80 seconds, the drain valve is about 1.5 L/s. The system alarm in 27 seconds later[6-10]. Data showed that inlet flow rate is 25.57 L/s, outlet flow is 27.04 L/s, flow difference is 1.47L/s. The system reports overflow warning, and flow capacity is 44.2L. Close the drain valve. The test results are shown in Fig.5.

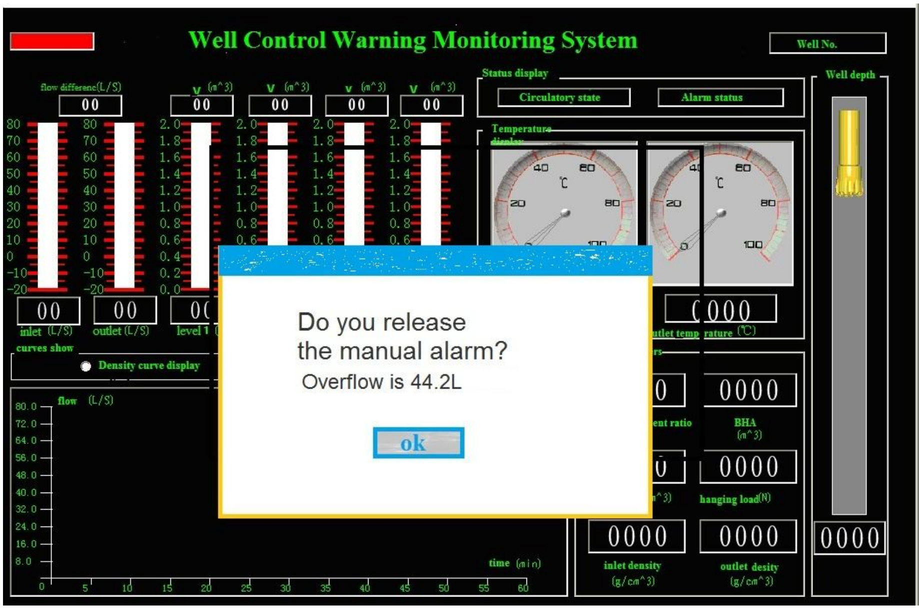

Fig.5 ground simulation flooding experiment 1

After the alarm was removed, open the water valve again and control valve opening to keep the different flow around 1L. System alarm after opening the valve for 29seconds. Data showed that inlet flow rate is 25.39L/s, outlet flow is 26.43L/s, flow difference is1.04L/s. The system reports overflow warning, and flow capacity is 31.0L. Close the drain valve. The test results are shown in

Fig.6.

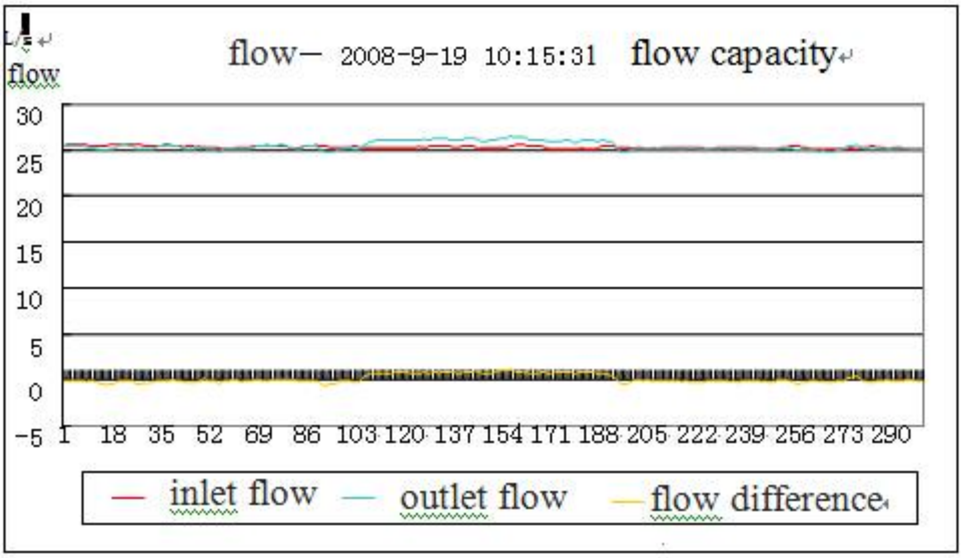

Fig.6 ground simulation flooding experiment 2

Through the field test, the instruments of Well control the bop warning system in processing are stable and accurate; In the case of electromagnetic interference, in the process of monitoring instrument and control system for wireless data exchange, Transmission is stable and accurate. Under this test condition, the distance for wireless transmission is 180 m, which meets the desired requirements; In the process of field test, well control the bop warning system can real-time record collected data, and can according to the data of the drilling fluid collected for data analysis and judgment[11-14].

However a lot of experiments and field data are needed to do accurate warning from field test in the process of quantitative data. According to the analysis of the current data collected, accurate information about early warning can be obtained in the existing database. So it is the role of the premise system to establish and organize the database, and to enrich the content of the database.

Acknowledgements

This work is financially supported by Youth Science Foundation of Northeast Petroleum Unive rsity (2013NQ105) and the Natural Science Foundation of Heilongjiang Province(E201260).

References

[1] Huang Xing, Researeh of Drilling Engineering Monitoring System Basedon Embedded Platformand WSN, Master's degree thesis, hubei university of technology, (2010)13-18.

[2] Xu, Jian-Jun ; Liu, Chao; Zhou, Quan. Study on steam turbine fault diagnosis of fish-swarm optimized probabilistic neural network algorithm[C].Lecture Notes in Electrical Engineering, v 86 LNEE, n VOL. 1, p 65-72, 2011

[3] YAN Li-mei， CUI Jia， XU Jian-jun*，Power system state estimation of quadrature Kalman filter based on PMU/SCADA measurements. Electric Machines and Control. Vol.18 No.6, June 2014: 78-84. (In Chinese)

[4] Li FuQ, Yuan GuoH, Lv PengF, et.al. In the process of drilling engineering abnormal analysis and judgment. Journal of daqing petroleum geology and development, 24 supplement(2013) 87-91.

[5] Liu Rui, Guo Xue, On-line fault detection and diagnosis of drilling process.Journal of drilling technology, (2004)14 -19.

[6] Nai-bo Zhang，Jian-jun Xu*，Chen-guang Xue．Core-shell structured mesoporous silica nanoparticles equipped with pyrene-based chemosensor: Synthesis, characterization, and sensing activity towards Hg（II）[J]． Journal of Luminescence， 2011，131（9）: p:2021-2025

[7] Xu Jian-jun, Xu Yan-chao,Yan Li-mei*, et al. Research on the method of optimal PMU placement[J]. International Journal of Online Engineering, v 9, S7, p 24-29, 2013

[8]Liu Zhengliang, Xu Jianjun*, Li Hongyu. A kind of energy saving controller based on Y/Δ change-over[J]. Sensors and Transducers, v 161, n 12, p 331-336, 2013

[9]Wang, Baoe; Xu, Jianjun;Yan, Limei*. Brittleness simulation of electric power systems based on chart theory[J]. Energy Education Science and Technology Part A: Energy Science and Research, v 31, n 3, p 1769-1778, 2013

[10]Xu, Jianjun;Liu, Shengnan;Xu, Bin;et al. Numerical modeling for chaotic characteristics of oil pipeline pressure time series[J]. International Journal of Applied Mathematics and Statistics, v 47, n 17, p 131-139, 2013

[11]Jun, X.J. Zi, Y.Y. Numerical modeling for enhancement of oil recovery via direct current[J]. International Journal of Applied Mathematics and Statistics, v 43, n 13, p 318-326, 2013

[12]Xu, Jian-Jun; Sha, Li-Ni; Zhang, Yan; et al. A new algorithm for minimum spanning tree[J]. Power System Protection and Control, v 39, n 14, p 107-112, July 2011 (In Chinese)

[13] Junxiong Liu, Limei Yan*, Yubo Duan, et.al. The research on brittleness source identification of electric machine system[J]. Energy Education Science and Technology Part A: Energy Science and Research. 2013 Volume (issues) 31(4): 1911-1918

[14] Junxiong Liu, Limei Yan*, Shiyang Yang, et.al. A class of new self-tuning predictor with variable structure for power system[J]. Energy Education Science and Technology Part A: Energy Science and Research. 2013 Volume (issues) 31(4): 1901-1910