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Early Kick Detection by Using the Electrical Conductivity and Mud Density in Nahr Umr Oil Field

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Abstract

The kick is a prevalent problem related to drilling operations. Therefore, to reduce the likelihood of a blowout, it is essential to identify the kick as quickly as possible. Using a kick detection technique that depends mainly on monitoring surface parameters, there is a high likelihood of kick detection delay in addition to other problems. Techniques for down-hole monitoring may be capable of recognizing a kick in its early stages. The conductivity of the drilling fluid is between 80-200 µs/cm based on the conductivity range of the fluid being used during the operation and based on variations in the fluid's down-hole conductivity and flow rate, this study evaluates the occurrence of a kick. Moreover, there is provided a method to identify a kick without raising false alarms. In addition, the variables most sensitive to formation fluid. In order to monitor the downhole parameters, three different instruments are used: the density meter, the conductivity sensor, the Coriolis flow, and the pressure transmitter. The accurate interpretation of kick occurrence may be improved by monitoring parameters of down-hole data, which also greatly reduces the false alarms and gives a comprehensive view of down-hole situations. The kick-detection time may be minimized by using down-hole monitoring methods. Well NR-C was selected to study the problem of the kick in Nahr Umr field. The result shows that the electrical conductivity is reduced to 40 µs/cm when a kick occurs. On the other hand, it was concluded that Electrical conductivity is considered the best method for early kick detection, but it is active only with water-based mud.

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1. Introduction

Oil and gas well drilling is an expensive procedure because of the cost of the equipment and the labour; the cost of drilling could increase further because of the non-productive time (NPT) event. One of the main problems with oil field drilling operations is the kicking issue [1]. Drilling of all types of wells must be done in accordance with engineered and experienced plans in order to complete the drilling operation properly without running into issues that result in expensive NPT, which is a stage that is particularly undesirable while drilling or performing work over [2].

An influx of fluid into the wellbore is referred to as a “kick". When the formation pressure is greater than the hydrostatic pressure, an influx flows into the wellbore. Uncontrolled kicks can lead to blowouts, which can result in loss of operation, damage to the rig, loss of life, and environmental harm. Due to an inflow of gas, the kick is the most hazardous. This is due to the fact that gas can expand at lower pressures, such as near or on the surface [3]. Avoiding kick events can save thousands, perhaps millions, of dollars in lost productivity and potentially the plugging and abandonment of wells. Kick prevention aims to completely prevent or significantly minimize the kick on rigs [4].

By focusing on several kick indicators near the wellbore’s bottom, the technique of monitoring the bottom hole may decrease the time it takes to detect a kick [5]. The results of bottom-hole sensors may be used for detecting declining well conditions and estimating the likelihood of a blowout. However, there are significant difficulties with down-hole monitoring, such as the potential for too many false alarms. Several down-hole parameters could be monitored and analysed collectively to reduce the frequency of false alerts [6].

This will make it easier to understand what actually occurring down-hole is. Monitoring several kick indicators in the downhole may enhance interpretation quality and greatly lower the likelihood of false alerts [7].

Many studies have been done in order to find the appropriate methods to prevent the kick, Islam [8] points out that monitoring mass flow rate simultaneously yields the best accurate identification of kick and blowout possibility. He illustrates that managing blowout risk with real-time monitoring and a blowout risk model is a dependable and efficient method. This strategy can lead to a paradigm shift in drilling safety if it is successfully tested in the field. Huque et al. [9] presented kick warning signs and discussed many ways to detect the kick before it occurs. Finally, the research discussed some recent progress and challenges in kick detection on managed pressure drilling. Qushchi [10] discussed developing the well control project related to the design and analysis of the well control model taking into account the key parameters for simulating this phenomenon by the simulator, which was an important point of view to be taken into consideration for the training, and finally performing the sensitivity analysis for the well control and drilling parameters to check how they can affect well control and a comprehensive analysis of well control techniques has been done. Sule et al [11] showed the impacts of gas kicks on drilling parameters that are dynamic. These downhole dynamic drilling parameters such as weight on bit, the torque, bottom hole pressure, penetration rate, rotary speed, and bit axial displacement are measured and computed during experimental simulations. Besides, these parameters, three parameters on the surface include choke pressure, volume flow rates, and density must also monitor

The objectives of this study were selecting the best method to treat kick in order to minimize NPT, cost, and time of drilling operation and identifying the best method for early kick detection.

2. Area of Study

Nahr Umr oilfield was conducted in this study to minimize kick problems. The significant consequences of this problem are an increase in well costs and (NPT). This field is about 25 km north-northwest of Basra city in southern Iraq. It is situated between Majnoon oil field and the eastern Zubair oil field [12], as shown in Figure 1.

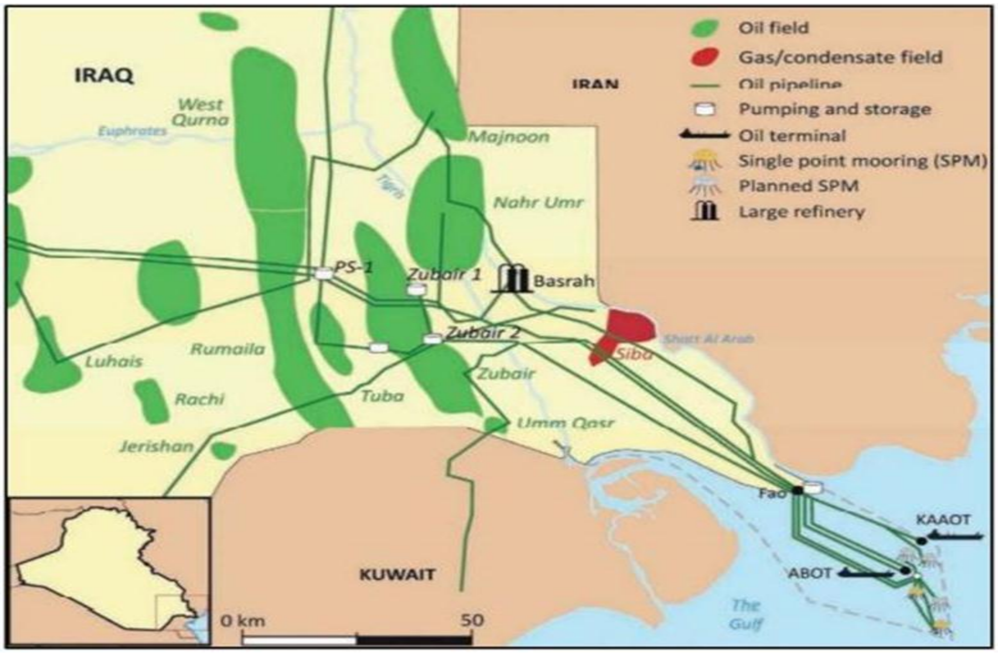

Figure 1: Nahr Umr oil field location [13].

3. Reasons for Kick

Any type of operation in the well may encounter the kick due to a number of variables. The well's permeability, porosity, differential pressure, and how long the well remains under balance are the factors that determine when the kick occurs and the hydrostatic pressure must be higher than the formation pressure to prevent the kick from occurring [8]:

The following are the causes of the kick in the well:

- When tripping, incorrectly filling the hole

The hydrostatic column of well fluid, as discussed in the basic well control approach, is crucial to preventing the kick. After pulling the drill string out of the hole, the well needs to be filled with mud to prevent a decrease in the hydrostatic column. The height of the fluid will decrease if the operators do not circulate sufficient mud volume into the well [6].

- Swabbing:

Before a trip-out operation, it is important to consider the swabbing phenomenon. Due to the poor clearness of the well bore and the drill string, the bottom hole can be reduced below formation pressure [14, 15].

- Inadequate mud weight:

The mud density should exceed the pressure of the formation. Fluid can enter the well if the formation pressure gradient is greater than the mud weight and pressure gradient [16, 17]. Because static bottom hole pressure (BHP) is always lower than dynamic bottom hole pressure (BHP) due to annular pressure loss, this is significant when the circulation stops. As a result, during circulation, there probably won't be a kick entrance into the well if the mud weight is insufficient, but once the pumps are stopped, it can flow [18].

- Loss of Circulation:

There are two possible causes for the loss of circulation in the wells. Mud may enter the formation as a result of an overbalanced situation if the hydrostatic column of fluid provides pressure larger than the formation pressure and the permeability is high [19, 20]. Typically, this issue can be avoided by creating mud so that it can form a mud cake on the borehole wall. The pressure generated by the mud may rise above the formation's fracture pressure and result in formation fracturing. If this occurs, drilling fluid will enter the formation [21].

4. Methodology

When the system is underbalanced, Formation fluids can begin to flow into the wellbore; a change in the wellbore parameters (flow rate, mud density, and electrical conductivity) may offer accurate and timely information about the anomaly in the wellbore. Monitoring the early kick indicator as the flow rate, mud density and electrical conductivity in the down hole is the important aim of this study. This can provide important information to identify the influx at its earliest stage. The probability of a blowout can then be predicted using these down-hole factors by decreasing the mud density and electrical conductivity because of the gas kick. Electrical conductivity will decrease when formation fluids have been entered into the wellbore. So, to fully understand what is happening in the down-hole, the various characteristics are interpreted together. Additionally, each of these down-hole variables is examined separately to see how to describe the influx.

4.1 Parameters of Bottom Hole Monitoring

- Electrical conductivity: The fluid conductivity in the bottom hole changes when the formation fluid with a different conductivity reaches the wellbore. Therefore, conductivity variation can be an indication of an early kick.
- Flow rate: Drilling fluid tends to flow quickly if formation fluid enters the wellbore

To identify the kick in its earliest stages, changes in electrical conductivity and flow rate are monitored as illustrated in Figure 2. The electrical conductivity is used to detect the kick more accurately and quickly than other methods.

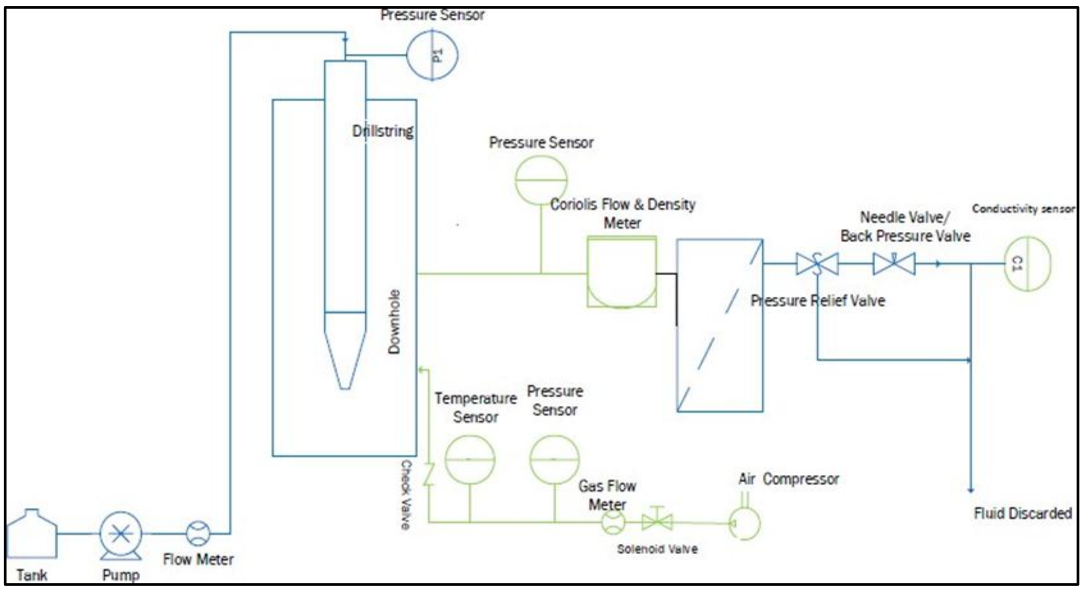

Figure 2: Diagram model to kick detection.

4.2 Equipment

The equipment used in the field and this work are listed in Table 1.

Table 1: List of tools and devices used in this work.

Equipment	Application
Relieve valve	Protect the equipment
Needle valve	Modify the pressure in down hole
Solenoid valve	Inject compressed air into well bore
Coriolis meter	Monitor mud density and flow rate
Conductivity sensor	Measure the electrical conductivity
Fluid discarded	Works as a burning line
Air compressor	Compress the air a formation of gas
Check valve	Permits air to move in one direction

5. Results and Discussion

5.1 The Scope of the Problem

While drilling the 12 1/4” hole at a depth of 2306 m in Mishrif formation with rate of penetration (ROP) (averaging 1.8 m/hr). The torque begins to increase and ROP decreases gradually. Then, the operator increases the RPM and checks the mud properties. When the torque remained in high value. They decided to pull out in order to change the bit. During pulling out mud losses occurred and at a depth of 1874 m during make connection the string got stuck. After releasing the stuck pipe and monitoring the down hole parameters kick detection noticed that the flow rate increased and electrical conductivity decreased to 40µs/cm because of the gas kick.

5.2 The Treatment of the Problem

After detecting the kick by the electrical conductivity method, the kick volume is larger gradually until becomes 3m3. The well was controlled by (Wait & Weight) killing method with normal circulation (sp. gr of mud was increased to 1.31 gm/cc). In the Wait and Weight method circulate non-homogenous fluid which includes the kill mud and the kick. So, Figure 3 is used to reduce initial circulation pressure to final circulation pressure each 100 stroke.

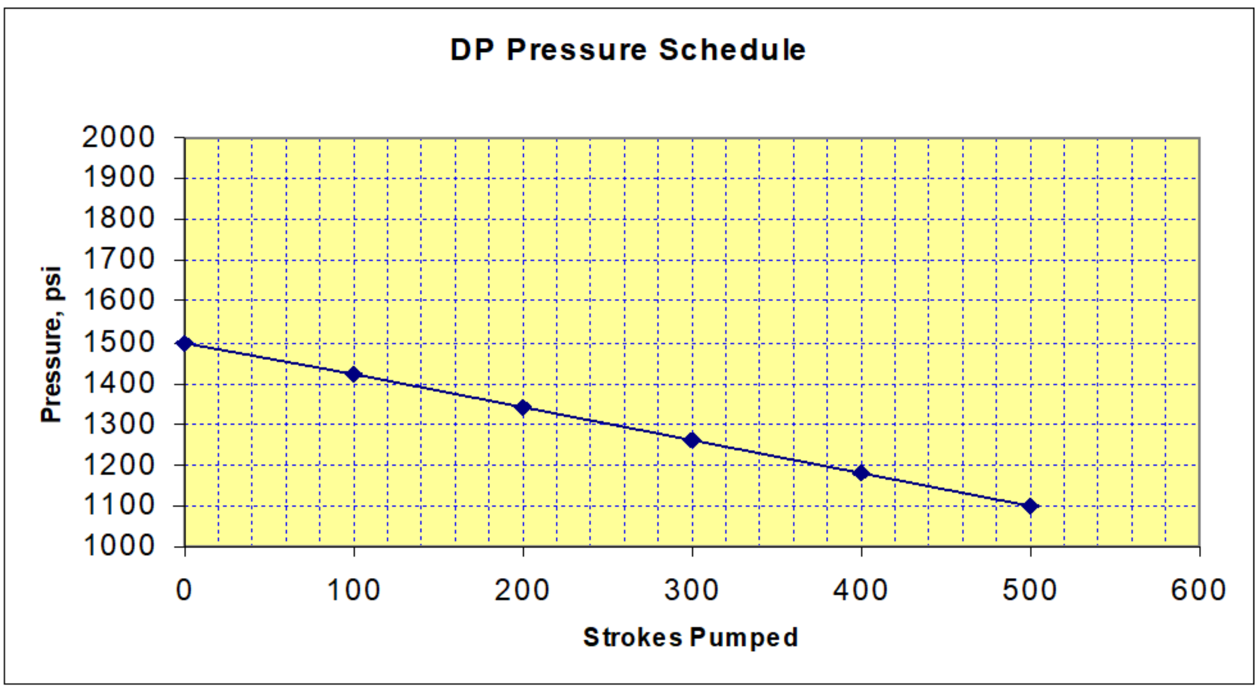

Figure 3: The drill pipe pressure schedule.

A kick is recognized by decreasing electrical conductivity as illustrated in Figure 4. By monitoring the bottom hole parameters of kick detection noticed that electrical conductivity decreased to (40µs/cm) during (20 sec.) because of the gas kick and the conductivity of the drilling fluid is between 80-200 µs/cm based on the conductivity range of the fluid being used during the operation.

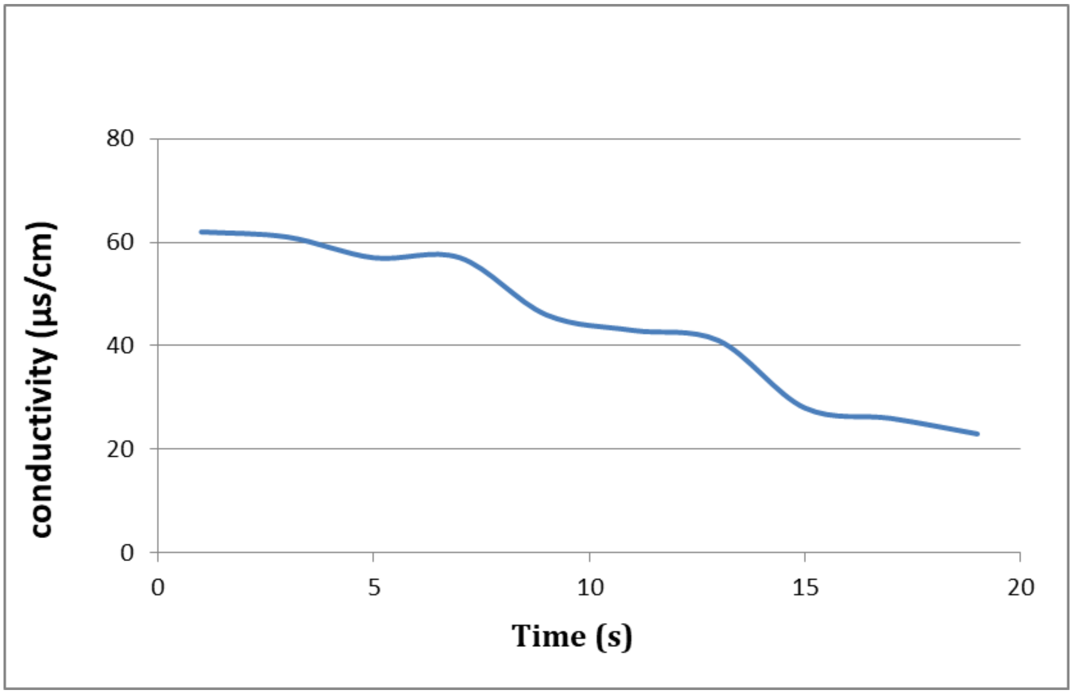

Figure 4: Behavior of conductivity when influx occurs.

Figure 5 shows that the mud density decreased to (1.155 gm/cc) because of the gas kick that led to this reduction. The gas kick occurred and its volume was larger gradually until became 3m3. The well was controlled by the volumetric method (sp.gr of mud was increased to 1.31 gm/cc).

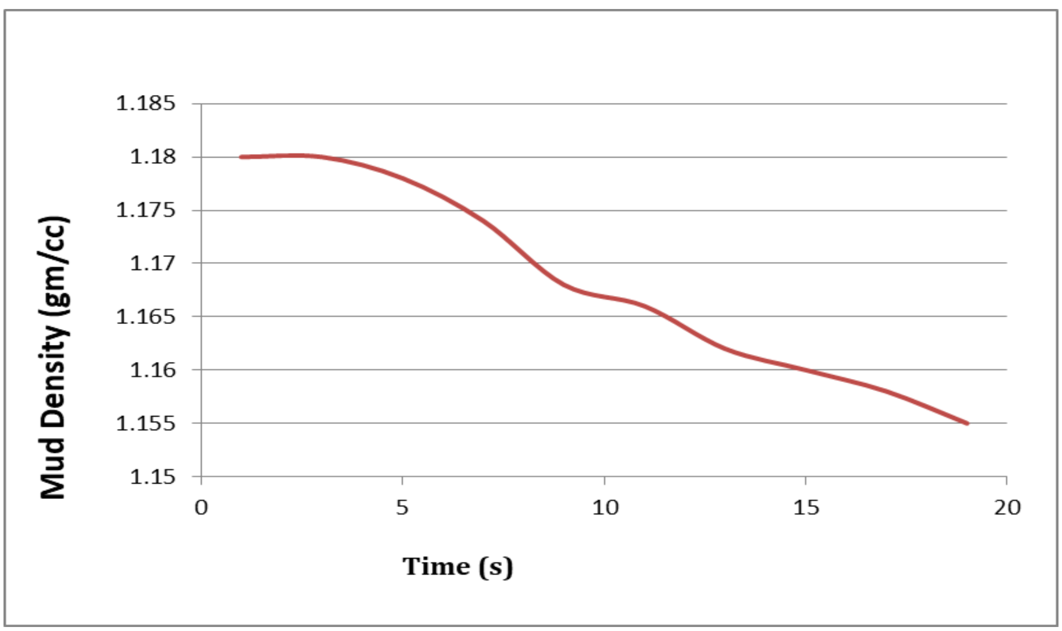

Figure 5: Behavior of mud density when influx occurs.

6. Conclusions

To reduce the likelihood of a blowout occurring, it is important to identify the kick from the formation as soon as possible. When using the detection system of a kick that is completely based on surface parameters monitoring, there is a high likelihood of kick detection delays. If down-hole monitoring is taken out in addition to surface monitoring, there may be a high possibility of blowout prevention. Monitoring of down-hole provides the ability to enhance the kick detection system with an accuracy that is challenging to perform using surface detecting techniques. Determining down-hole conditions quickly and accurately can assist bottom-hole monitoring for preventing catastrophic situations. Finally, electrical conductivity is considered the best method for early kick detection, but it is active only with water-based mud.

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