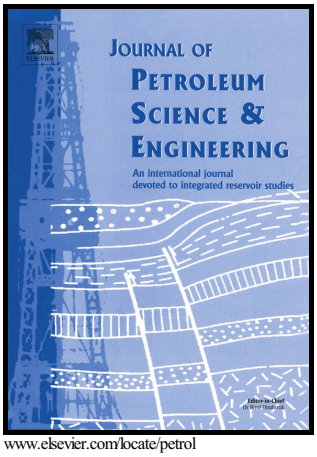

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FLUID FLOW AND HEAT TRANSFER MODELING IN THE EVENT OF LOST CIRCULATION AND ITS APPLICATION IN LOCATING LOSS ZONES

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ABSTRACT

Lost circulation is one of the most persistent and costly drilling problems that drilling engineers have been struggling with for decades. The pinpointing of the zones of loss allows the treatments to be applied directly to the points of loss rather than to the entire open hole. This paper presents an approach to predict the location of single loss zone in a vertical well by interpreting the transient mud circulating temperature profiles altered by mud loss. The fluid flow and heat transfer numerical model in estimating the transient mud circulating temperature profiles during a lost circulation event was developed. The temperature profile in both the flow conduits (drillpipe and annulus) were modeled using mass and energy balances. The flow rate of drilling mud decreases in the annulus above the loss zone as part of the fluids lost into the fractures, which in turn alters the heat transmission status between the drillpipe, annulus, and near-wellbore formation. The wellbore is divided into two sections, which accounts for single loss zone. Case studies were performed and numerical solution results were presented and analyzed. According to the results, alterations induced by mud loss include: 1) Declines in both annular mud temperature and drillpipe mud temperature over time, and 2) Discontinuity in the first order derivative of annular mud temperature with respect to depth at the location of loss. By matching the simulated results with the distributed temperature measurements at different time stamps, the depth of the loss zone can be identified.

Keywords
Lost Circulation; Drilling; Heat Transfer; Drilling Fluids; Downhole measurement

1. INTRODUCTION

Lost circulation is one of the most persistent and costly drilling problems that drilling engineers have been struggling with for decades. It happens when a very porous, cavernous or highly fractured zones intercept the current well path, and the drilling mud lost into that zone under overbalance pressure between the wellbore and formation [1].

Lost circulation not only costs large volumes of valuable drilling fluids, it also causes large amounts of nonproductive time as when circulation occurs the drilling crew cannot continue to perform most of the functions.

Severe lost circulation problems [2] that do not respond well to conventional treatments might be curable by spotting a LCM (lost circulation materials) pill and holding it under gentle squeeze pressure for a predetermined period. At downhole temperature, the LCM pill expands rapidly to fill and bridge fractures, allowing drilling and cementing operations to resume quickly. At shallow depth, the location of the losses into natural permeable zones need not be known exactly. However, at greater depth (more than 5,000 ft) or when severe losses are occurring, the exact location of the thief zones must be determined before efficiently spot the pills to the right locations. Besides, the overbalance pressure varies with depth, therefore, the squeeze pressure can also be optimized by knowing the depth of the fracture.

In the case when severe loss is present, setting the cement plug is one effective way of sealing the loss zone completely and followed by drilling back through the plug or sidetracking the well. Subsequently, without the knowledge of the loss zone location, there is no way as to decide which depth to set the cement plug and whether it is reasonable to set a cement plug to begin with.