Chapter 66
Lost Circulation

Nediljka Gaurina-Medjimurec
University of Zagreb, Croatia

Borivoje Pasic
University of Zagreb, Croatia

ABSTRACT

Lost circulation is defined as the uncontrolled flow of mud into a thief zone and presents one of the major risks associated with drilling. The complete prevention of lost circulation is impossible, but limiting circulation loss is possible if certain precautions are taken. Failure to minimize lost circulation can greatly increase the cost of drilling, as well as the risk of well loss. The risk of drilling a well in areas known to contain potential zones of lost circulation such as fractured, cavernous, or high permeability formations is a key factor in making a decision to approve or cancel a drilling project. The successful management of lost circulation should include identification of potential loss zones, optimization of drilling hydraulics, and remedial measures when lost circulation occures.

INTRODUCTION

Lost circulation or lost returns are the partial or total loss of mud to subsurface formations. It occurs when the openings in the formation allow the mud flow into the formation, resulting in losses ranging from 0.16 m^3/hr (1 bbl/hr) to a complete loss of returns. When circulation is lost, the drilling fluid costs rise considerably, along with expenses associated with rig and equipment delays. The industry spends millions of dollars a year to combat lost circulation and the detrimental effect it propagates. Potential problems associated with lost circulation during drilling include: loss of mud, lost time, poor cement job, reduced safety, stuck pipe, additional casing string, failure to reach target depth, blowout and kill operations, downhole blowouts, environmental incident, and the abandonment of expensive wells. Lost circulation during cementing could result in reduced annular coverage, casing corrosion, poor zonal isolation and also reduced safety. In addition, during completion/workover operation, existing loss zone can cause the loss of completion fluid, lost rig time, formation damage and lost reserves of oil and gas. In partial lost circulation, mud continues to flow to the surface with some loss to the formation. Total lost circulation occurs when all the mud flows into a formation with no return to surface. If drilling continues during total lost

DOI: 10.4018/978-1-4666-8473-7.ch066

circulation, it is referred to as blind drilling. This is not a common practice in the field unless the formations above the thief zone are mechanically stable, without production and the fluid is clear water. Blind drilling also may continue if it is economically feasible and safe.

The complete prevention of lost circulation is impossible because some formations, such as inherently fractured, vugular, cavernous, unconsolidated (high-permeability zones) or depleted low-pressure formations (usually sands), are not avoidable if the target zone is to be reached (Al Ubaidan et al., 2000; Algu et al., 2007; Bell et al. 1987; Davidson et al., 2000; Ferras et al., 2002). The problem of lost circulation was magnified considerably when operators began drilling deeper and/or depleted formations (Sanders et al., 2003; Suyan et al., 2009). The high hydraulic pressure forces mud to invade the depleted formation. If this situation exists, plans should be formulated to prevent lost circulation or stuck pipe from occurring in the depleted zone. Moreover, lost circulation has even been blamed for minimized production in that losses have resulted in failure to secure production tests and samples, while the plugging of production zones have led to decreased productivity. Special bridging agents and sealing materials should be used to form a good seal and filter cake on the depleted zone. The petroleum industry has invested a significant effort into understanding the mechanisms behind lost circulation, developing new tools to help locate the thief zone, and implementing new steps to minimize or eliminate this problem because prevention is more effective than remediation (Whitfill et al., 2007).

Whitfill (2003) recommends a fully engineered approach that incorporates a number of planning tools, including: borehole stability analysis, hydraulics modeling to estimate Equivalent Circulating Density (ECD), drilling fluid and Lost Circulation Materials (LCM) selection to help minimize effects on ECD.

Conventional lost circulation materials including pills, squeezes, pretreatments, and drilling procedures employing equivalent circulating density management often reach their limit in effectiveness and become unsuccessful in the deeper hole conditions where some formations are depleted, structurally weak, or naturally fractured and faulted (Wang et al., 2005). With continued drilling of deep water wells, High Pressure High Temperature (HPHT) wells, infill wells, etc., the mud-weight window is not only becoming much narrower, but also more uncertain. To address these issues, new lost circulation solutions and concepts such as borehole strengthening or Wellbore-Pressure Containment (WPC) have been developed. Proposed mechanisms behind various means proposed and used to enhance wellbore-pressure containment include sealing incipient fractures at the wellbore wall; propping open multiple short fractures at the wellbore wall, thus increasing compressive stresses around wellbore; and sealing fractures with various materials using hesitation-squeeze technology (Wang et al., 2005; Salehi & Nygaard, 2012).

Where unsustainable losses occcur and conventional circulation is no longer possible the Pressurized Mud Cap Closed Hole Circulation Drilling (CHCD) technique may be used to allow the continuation of drilling in circulation loss zones by controling the annulus pressure and injecting a sacrificial fluid into the thief formation. Masi et al. (2010) discuss the operational details of conducting CHCD as well as the risk-management approach, which involves the identification, evaluation, and mapping of all risks involved in each scenario (qualitative risk assessment). A probabilistic model is, therefore, developed to combine all the risks identified and to address their consequences within operational time.

LOST CIRCULATION ZONES AND CAUSES

Potential zones of lost circulation include highly-permeable formations, highly-porous formations,

Related Content