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Heave Motion Effects on Kick and Lost Circulation Detection in Floating Drilling Rigs

Celso K. Morooka
State University of Campinas, Brazil

Manoel T. Doria
PETROBRAS, Brazil

ABSTRACT

A fast and precise identification of abnormalities in the wellbore when drilling is crucial for safety of the operation. Particularly, when drilling in deepwater from a floating drilling rig in waves, the early detection of fluid influx from the formation into the wellbore, denominated kick is very important to guarantee the safe of the crew, rig equipment and the well itself.

In offshore drilling from a floating rig, the mud flow rate which returns from the well is measured and fluctuations are observed on it. Commonly, this measurement is the main element to decide an interruption of the rig operation in order to maintain the safety of the operation from a kick. On the other hand, heave motion which is the main reason of those fluctuations can cause large instantaneous fluctuation on the mud flow rate measurements and, sometimes it causes undesirable interruptions in the operation with large delay in the drilling schedule.

In the past, many methods has been investigated and proposed in order to avoid the above mentioned problem. In the present work, a method to identify the mud flow rate fluctuations due to rig heave motion is presented. For this purpose, mud flow rate in the drilling system is quantified and heave motion effects is mathematically described.

In order to verify the present method, mud flow rate and heave motion has been measured in a floating drilling rig in a field operation on a drillsite Offshore Brazil. Simulations of mud flow rate following the present method has been performed and compared with the measured one. Results of simulations for situations of loss and gain of mud has addressed the present method as an useful tool to evaluate the safety of offshore drilling operations.

Key Words: Ship Motion in Waves, Offshore Drilling, Blow Out, Gas Kick, Simulations

NOMENCLATURE

$Q_I(t)$ -injected mud flow rate
$Q_M(t)$ - injected mud flow rate plus oscillatory part of returned mud flow rate due to heave motions
$Q_R(t)$ - returned mud flow rate
$Q_T(t)$ - large oscillatory part in the returned mud flow rate due to heave motions
$Q_V(t)$ - scattered large or small oscillatory part of returned mud flow rate caused by drilling system or maneuvers
S - transversal area of annular formed between riser internal diameter and outer drillstring diameter at the riser telescopic joint
t - time
V(t) - volume of the annular between riser and drillstring at the telescopic joint
z - heave motion response
ΔQ - delta flow (mud flow rate deviations from the injected mud flow rate)
δQ - gain or loss of drilling fluid from or into the formation

SI Metric Conversion Factors

ft	X 3.048 000 . 10^{-01}	= m
gpm	X 6.309 020 . 10^{-05}	= m^3/s