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An Analysis of Gas Kick Removal From the Marine Riser

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ABSTRACT

This paper presents an analysis of the dynamic pressures imposed on the marine riser and diverter line during the gas removal from a riser-diverter system. The occurrence of formation gas in the riser may lead to a drilling accident known as "riser blowout" that can cause the collapse of the riser pipe in addition to the inherent risk of fire.

This analysis makes use of a numerical simulator, detailed in this study, that models the pressure and flow rate behavior in the riser-diverter system. The simulator is based on the numerical solution of a system of flow equations for a two-phase mixture moving upward in the riser-drill pipe annulus. The model accounts for the acceleration of the drilling fluid flowing ahead the two-phase mixture and the sonic flow at the diverter line exit.

In this paper, the approach of circulating a fluid through the lower portion of the marine riser to displace the gas up and inside the riser and diverter system is extensively investigated. Through a sensitivity analysis, the effects of pertinent parameters - especially the circulation rate - on the pressures generated inside the riser-diverter system during the gas removal process are discussed. Non-circulation situations are also studied.

References and figures at the end of paper

INTRODUCTION

The need for new hydrocarbon reserves has been motivating the oil industry to drill in very deep waters. In such circumstances, the use of floating rigs is required so that the blowout preventers are located at the seabed with a marine riser linking them to the vessel. A typical equipment configuration of the deepwater drilling is shown in Figure 1.

If a gas kick is taken in a deepwater drilling operation, the recommended action is to close the BOP rams immediately. This procedure is sustained by several field case accidents and by theoretical studies reported in the literature. In one of these studies[1], it was shown that if the gas is allowed to flow in an uncontrolled manner through the diverter line, the generated pressures can lead to equipment failure in two different moments. As illustrated in Figure 2, in the beginning of the riser unloading process, high pressures (420 psi) are encountered which may cause dangerous gas leak at the diverter. Later on, the riser internal pressure drops dramatically to 150 psi. This low internal pressure may cause collapse of the lowest joints of the marine riser.

Even following the appropriate practice of closing the BOP, some formation gas may enter the marine riser. This can happen due to delay in closing the BOP after kick detection or due to the gas trapped in the subsea stack and released to the riser, after a successful gas kick removal from the wellbore. In both cases, the gas rises and, as it expands, a large amount of drilling fluid