# PERFORMANCE OF DIVERTERS UNDER MULTI-PHASE FLOW

839

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Objective: To enhance design criteria for blowout prevention systems used to handle shallow gas.

## Introduction

Safety of personnel, equipment and environment is a concern in offshore hydrocarbons explorations. Blowouts are among the most dangerous hazards in marine environments where abnormal formation pressures may be encountered at very shallow depths. Well control is especially difficult where a threatened blowout situation occurs prior to setting surface casing in the well. If the conventional blowout prevention equipment and procedures are applied, hydraulic fracturing is likely to occur in an exposed shallow formation due to the pressure build-up in the well. Moreover, if one or more fractures reach the surface, the resulting flow can destroy the foundations of a bottom supported structure.

Presently, the best available procedure for handling a threatened blowout from a shallow gas formation is to divert the gas flow away from the rig structure and drilling personnel. This requires the use of a diverter system large enough to prevent a pressure build-up within the well bore, minimizing exposure of the weakest formation to fracture. The essential elements of a diverter system include (1) a vent line for conducting the flow away from the structure, (2) means for closing the well annulus above the vent line during diverter operations, and (3) means for closing the vent line during normal drilling operations.

The sequence of events occurring when a shallow gas flow is encountered are illustrated in Figure 1. When the driller recognizes that the well has begun to flow, the diverter system is actuated (1b). This simultaneously causes the vent line to open and the annular diverter head to close. As drilling fluid is displaced from the well, the rate of gas flow into the well increases due to the loss in bottom-hole pressure (1c). After the well is unloaded of drilling fluid, a semi-steady state condition is reached (1d) in which formation gas, water, and sand are flowing through the vent line.

Although conceptually simple, the design, maintenance, and operation of an effective diverter system for the various types of drilling vessels is a difficult problem. Past experience has shown that when a situation calling for the use of a diverter arises, failure in the diverter system often occurs. Among other factors, failures generally result from higher pressures than expected. The trend to larger pipe sizes in modern diverter systems has reduced the risk of high pressures due to plugging.