Bottom Hole Annular Pressure: A Theoretical Problem With Real Effects

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Abstract:

A problem has always existed in deep and fast drilling situations such as coal overburden drilling, or when drilling with a tight annulus, such as 9 7/8" bits and 8 5/8" pipe. This problem is the difficulty experienced by blasthole bit and blasthole drill rig manufacturers to attain large jumps in bit and drill rig productivity through bit and rig design, when drilling in these specific situations. In other drilling situations, these large jumps in productivity have been easily attained.

High rates of penetration (ROP), deep holes, and (in combination with or separately from) a tight annulus may give rise to theoretically high annular pressures at and near the drill bit. This results from an increase in the fluid density (air-cuttings mix) due to the cuttings load, and the increased pressure required to move this "fluid" of suspended cuttings away from the bit and up the hole.

The potential for an "overbalanced" drilling system, one where the external hole circulating pressure may theoretically exceed the internal bit air pressure, may help explain the high incidence of bit bearing failure, bit plugging, bit shirttail erosion, and increased torque levels generally seen in deep, fast drilling, or when drilling with a tight annulus. Over the years, these situations have continually resisted attempts at productivity improvement by both rig and bit manufacturers. The phenomena of bottom hole annular pressure provides one possible explanation for this resistance.

A method for calculating these theoretical pressures will be presented, along with examples of theoretical calculations of hole pressures and annular bailing velocity, and actual observations of drill rig air pressures. Explanations of how this can contribute to certain bit failures will be given. Suggestions will be presented for possible solutions to the problem that should result in better bit life and rate of penetration.