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Gas Seepage and Pressure Buildup at a North Sea Platform Location: Gas Origin, Transport Mechanisms, and Potential Hazards

T.I. Tjelta and G. Svanø, Statoil; J.M. Strout and C.F. Forsberg, NGI; S. Planke, VBPR; and H. Johansen, IFE

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Abstract

Gas migration into well annuli with resultant high pressures is a common problem in oil and gas production wells. On a North Sea major gas producer high pressure has been observed in the outermost annulus of several wells and anomalous pressures were observed below the gravity platform base. Gas may migrate along the well-path and into the well annulus to create pressure problems and was further suspected to continue to the surface.

The source of such gas is often linked to shallow gas pockets or small reservoirs and the mechanism whereby the gas migrates into the annulus and creates excess pressure problems has often been associated with poor cementing or micro-cracking in the cement. The pressure and associated gas volumes are routinely dealt with by bleeding off the gas and/or water, but this action does not necessarily solve the problem.

A detailed study was initiated to investigate if the gas migration was a hazard to well integrity and foundation stability. Work to identify the source of the gas and mechanisms involved on this North Sea platform has provided a new insight into the understanding of gas migration in sediments and overburden. A gas source exists even if no gas pockets are present, and the migration into annuli is independent of the presence and quality of cement. The gas migration as a potential hazard for the platform foundation and a possible link with a natural gas flux in the seabed and the formation of pockmarks has been checked. The time scale for gas migration is important to judge the hazard. A model is presented in which water insoluble H_2 gas plays an important role.

This paper gives a brief overview of the problems associated with gas migration, pressure build up in the wells and the foundation, and its relation to the formation of pockmarks in the soft clayey seabed of the Norwegian Trench.

BACKGROUND AND DESCRIPTION OF PROBLEM

The Troll A Platform is a huge concrete gravity base structure located in the Norwegian trench at a water depth of 305m, see Figure 1. The platform was installed in 1995 and in the following two years 40 wells were installed, 39 gas production wells and 1 monitoring well. A typical well design is shown in Figure 2. The platform is the North Sea largest gas producer with an average yearly production in the order of 26 GSm^3 (923 billion cu.ft).

After a few years of production it was realized that pressure bleed-off activity from outer annuli was high, for some wells 10-20 bleed-offs every month. It is standard practice to set safe threshold values for pressure in well annuli and if this value is reached, pressures are reduced by bleeding off gas. The threshold for outer annulus was 6 bar, and this was raised to 15 bar after an evaluation of wellhead seals in 2001. This action reduced the problem of very high bleed-off activity to more normal conditions, typically once a month for an average well.

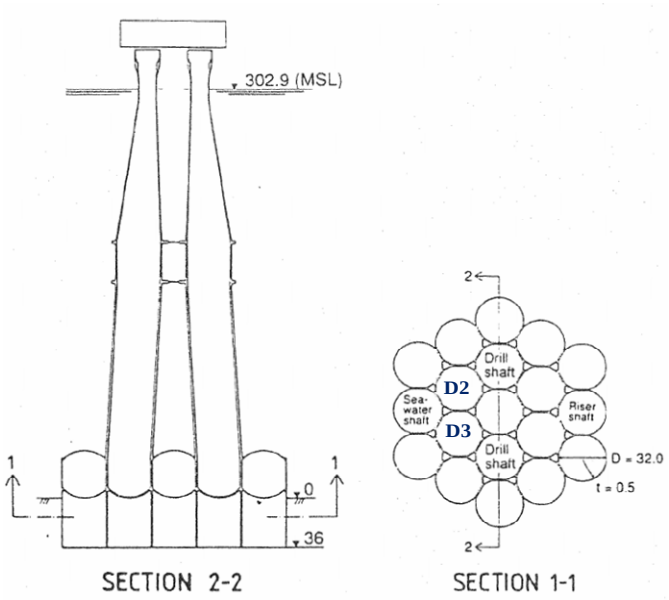

Figure 1. Gravity base structure at Troll A. The 19 skirt cells shown on Section 1-1, where the cells D2 and D3 are identified (Ref. /1/ Hansen et al., 1992).

High annulus pressure is frequently observed in oil and gas production wells both onshore and offshore. The pressures are