Chapter 8
Risk and Remediation of Irreducible Casing Pressure at Petroleum Wells

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ABSTRACT

Oil well cement problems such as small cracks or channels may result in gas migration and lead to irreducible pressure at the casing head. Irreducible casing pressure also termed, Sustained Casing Pressure (SCP) is hazardous for a safe operation and the affected wells cannot be terminated without remedial operations. It is believed that even very small leaks might lead to continuous emissions of gas to the atmosphere. In the chapter, the author describes physical mechanisms of irreducible casing pressure and qualifies the associated risk by showing statistical data from the Gulf of Mexico and discussing the regulatory approach. This chapter also introduces a new approach to evaluate risk of casing pressure by computing a probable rate of atmospheric emissions from wells with failed casing heads resulting from excessive pressure. Also presented is a new method for assessing potential for self-plugging of such wells flowing wet gas as the gas migration channels could be plugged off by the condensate.

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ANNULAR AND SUSTAINED CASING PRESSURES

Petroleum wells are usually constructed such that their casing–casing annuli do not experience abnormal pressures. The exception occurs in gas lifted wells where gas is injected into the production tubing–casing annulus. Annuli differ from other well components in that they are usually not the result of purposeful design. Rather, they are a consequence of the design of tubulars and the well construction process. Therefore, the ability of an annulus to withstand loads that occur on its components is (or should be) evaluated at the end of the design process.

The right figure in Figure 1 shows different kinds of annuli in a well bore (JIP, 2001). The primary annulus (Type I, or A) is formed by the production tubing and casing. It is bounded on the top and bottom by the wellbore seal assembly and completion hardware (including packers and seals) respectively. In addition, there may be an annular safety valve, gas lift valves and related equipment depending on the nature of the well.

The secondary (outer) annuli (B, C, etc.) can be of two kinds- Types II and III. The Type II annulus is formed by two adjacent casing strings. It is bounded at the top by the wellhead seal assembly and at the bottom by the cement. The cement top in this instance is above the shoe of the outer string of the annulus. The type III annulus is essentially similar, except that its bottom is open to the formation. The cement top lies below the shoe of the outer casing string, either by design or accident.

By definition (as well as design) an annulus is a sealed volume, and there should be no flow paths that cause migration of fluids into (from) the annulus from (into) its surroundings. In

Figure 1. Simplified well schematic and types of annuli in a wellbore (Detail "A")