Cavity Stress-Relief Method for Recovering Methane from Coal Seams

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ABSTRACT

Stimulating gas flow from coal seams is vital to the economical production of methane. The most commonly used stimulation method is hydrofracturing, the purpose of which is to increase permeability of the coal matrix, creating a long channel with high permeability. This method does not always deliver the expected results. Consequently, in 1979 the author developed a new coalbed stimulation method based on recognition of the fact that approximately 90% of the methane distributed in a coal seam is in adsorbed form and only 10% is in free stage. To increase gas production, not only permeability of the coal matrix but also the rate of desorption must be increased. The cavity stress-relief method that was developed takes advantage of the effects of depth-dependent triaxial compression, under which the coal is subjected, to increase coal seam permeability and significantly increase the rate of diffusion.

INTRODUCTION

Methods of extracting methane from coal can be classified into two categories, based on whether they are carried out within a mine or independent of a mine. In the first method, as a procedure to increase mine safety, methane is drained from coal that is being mined or that will be mined in the near future.

The second method, virgin coal demethanation (VCD), is most often used to extract gas from coal that will be mined within five or more years or from coal that may never be mined. The VCD method was developed in North America fifteen years ago, mostly in response to the energy shortages of the 1970s. At that time methane in coal was recognized as a significant resource that could supplement conventional oil and gas.

The VCD system combines three technologies—coal, oil and gas, and hydrogeology. In this method a borehole is drilled from the surface to intercept one or more coal seams. The contact between the coal and the borehole is kept as large as possible. The borehole usually is drilled about 30 ft (10 m) below the lowermost coal. A pump is installed there to remove the water. Pumping the water reduces the hydrostatic pressure on the coal, allowing methane to desorb and move toward and up the wellbore under a pressure gradient.

Because most coals have low permeability and usually occur in place in large blocks, wells generally have low productivity unless the coal is stimulated. In early work of the U.S. Bureau of Mines, which initiated the program in demethanation, the need arose to improve well production. Hydraulic fracturing was attempted because it was a convenient, available technique. This technique, introduced in the early 1950s, was designed to enhance the productivity of oil and gas wells by creating a large, conductive fracture in the reservoir. Since its introduction, development of the technique has been directed toward enhancing this effect and improving control on fracture size, length, and direction.

The production rate of oil and gas wells is limited only by permeability. That is, if infinite permeability could be induced in the reservoir containing the hydrocarbons, all the production could be obtained almost instantaneously. This is not true of production from coal demethanation wells.

Using the hydrofrac method in coal solved what was believed to be the cause of low gas production—that is, low permeability of the coal. The desired effect was obtained when the well was hydraulically fractured, thus “proving” the validity of the theory. It is my intent to show that the effect of hydraulic fracturing is not what is commonly thought to occur, and that once the actual mechanism responsible for improved gas production via an induced fracture is understood, a better stimulation technique will be developed.

EXPERIENCE WITH HYDRAULIC FRACTURES

Since 1977 I have carried out more than eighteen hydraulic fracturing operations of variable size, depth of application, injection fluid, and presence or absence of propping agents to optimize their application to virgin coal demethanation. When the results of these treatments were analyzed, it was found that the effects of the fractures were generally greater than could be ascribed solely to an increase in permeability,