



US005869435A

# United States Patent [19]

[11] Patent Number: **5,869,435**

Kelly et al.

[45] Date of Patent: **Feb. 9, 1999**

[54] **COMPOSITIONS FOR FRACTURING SUBTERRANEAN FORMATIONS**

5,476,775 12/1995 Fodge et al. .... 435/209

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[21] Appl. No.: **403,078**

[22] Filed: **Mar. 13, 1995**

### Related U.S. Application Data

[62] Division of Ser. No. 209,679, Mar. 10, 1994, Pat. No. 5,421,412.

[51] Int. Cl.<sup>6</sup> ..... **E21B 43/26**

[52] U.S. Cl. .... **507/211; 507/217; 507/922; 435/209**

[58] Field of Search ..... 507/211, 217, 507/922; 435/209

### [56] References Cited

#### U.S. PATENT DOCUMENTS

3,922,173	11/1975	Misak	106/194
4,250,044	2/1981	Hinkel	166/30 X
4,502,967	3/1985	Conway	166/308 X
4,996,153	2/1991	Cadmus et al.	435/209
5,067,566	11/1991	Dawson	166/308
5,201,370	4/1993	Tjon-Joe-Pin	166/300
5,226,479	7/1993	Gupta et al.	166/300
5,247,995	9/1993	Tjon-Joe-Pin et al.	166/312
5,297,625	3/1994	Premuzic et al.	166/246

### OTHER PUBLICATIONS

J. Gulbis and D. Schlumberger; *Fracturing Fluid Chemistry; Reservoir Stimulation* 2d edition; pp. 4-1 thru 4-14 (1989).  
 E. Luthi, et al; *Cloning, Sequence Analysis, and Expression in Escherichia coli of a Gene Coding for a  $\beta$ -Mannanase from the Extremely Thermophilic Bacterium "Caldocellum saccharolyticum"*, Applied and Environmental Microbiology, 57 No. 3; pp. 694-700 (1991).  
 M.D. Gibbs, et al; *The  $\beta$ -Mannanase from "Caldocellum saccharolyticum" Is Part of a Multidomain Enzyme*; Applied and Environment Microbiology, 58 No. 12; pp. 3864-3867 (1992).

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### [57] ABSTRACT

A method of fracturing a subterranean formation which surrounds a well bore comprises the steps of providing a fracturing fluid, and injecting the fracturing fluid into the well bore at a pressure sufficient to form fractures in the subterranean formation which surrounds the well bore. The pressure is then released from the fracturing fluid, after which the fluid may be removed from the well and the well placed into production. The fracturing fluid comprises an aqueous liquid, a polysaccharide soluble or dispersible in the aqueous liquid in an amount sufficient to increase the viscosity of the aqueous liquid, an enzyme breaker which degrades said polysaccharide at a temperature above 180° F. Fracturing fluid compositions and enzyme breaker systems useful for carrying out the invention are also disclosed.

**18 Claims, 3 Drawing Sheets**

