岩石力學機制對自然裂縫地層裂縫滲透率影響之研究*

Effects of Geomechanics on Fracture Permeability in Naturally Fractured Reservoirs*

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本研究目的是以解析法研究岩石力學機制對自然裂縫地層之裂縫滲透率及其壓力反應之影響。本研究以 Jabbari 理論為基礎，針對其壓力解析解中的彈性函數積分項進行函數特性分析並推導出近似式。然後推導出應力敏感性自然裂縫地層之暫態壓力近似解。本研究也推導出壓力反應之前、後期階段之視直線壓力解，以及研究前期階段結束時間、後期階段開始時間與裂縫特性參數之關係。利用所推導的壓力解，本研究建立了裂縫特性參數與彈性參數之分析程序，並利用案例分析來驗證所推導之方程式與參數分析程序。

本研究所獲得之主要結果為：(1) 在生產過程中，受到應力影響時，會相對的減少生產所需壓力差使得壓力反應前期階段與後期階段皆出現視直線效應，但兩條視直線不會平行。若使用傳統壓力分析方法針對後期階段之視直線進行滲透率推求，會產生過度高估的結果。(2) 本研究推導出應力敏感性自然裂縫地層之壓力近似解，並推導出壓力反應前期階段及後期階段之視直線壓力解，而改善 Jabbari 理論並有助於應力敏感性自然裂縫地層之井壓測試分析。(3) 利用所推導之前期階段與後期階段的視直線壓力解，使之與完整壓力解比對，並設定無因次壓力偏離值為 0.1 作為前期階段結束時間與後期階段開始時間的分析判斷準則，利用迴歸分析而得其與裂縫特性參數之關係。(4) 由案例研究之結果可知，利用本研究所建立之裂縫特性參數分析流程推求之地層參數結果與現場資料（在案例中為產生一組生產資料所使用之設定值）相當接近，而證實本研究模式之可用性，未來可應用於應力敏感性地層之壓力測試分析之用。

關鍵詞： 自然裂縫地層；應力敏感性；岩石力學

The purpose of this study is to investigate the effects of geomechanics on the fracture permeability and pressure response in stress-sensitive naturally fractured reservoirs using an analytical method. Major results and conclusions are summarized as follows:

(1)The pressure drop of the stress-sensitive reservoirs was smaller than that of the non- stress-sensitive (traditional) reservoirs. The pressure responses were not parallel straight lines at the early time and late time regions in the stress-sensitive reservoirs. The traditional well testing analysis may have overestimated the formation permeability. (2) The approximate pressure solution for the stress-sensitive reservoirs was derived. The apparent linear equations for the early time and late time regions were derived to improve the applications of the Jabbari's theory in the well testing analysis. (3)The equations for estimating the starting time and ending time of the transition regions were derived. The criteria used to analyze the starting time and ending time of the transition regions was the dimensionless pressure of 0.1. (4) The procedures established in this study for analyzing the fracture characteristic parameters and the elastic parameter of the stress-sensitive naturally fractured reservoirs were validated from the case study.

Key words: Naturally Fractured Reservoirs, Stress-sensitive, Geomechanics

* 一零一年十一月二日在本會一零一年年會宣讀之論文

Paper presented at 2012 CIMME Annual Convention, November 2nd, 2012, Kaohsiung

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