

台灣變質岩地區地熱井閃發點判釋研究-以 C-2 號井為例

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摘要

台灣中油公司肩負政府的綠能政策，在台灣宜蘭縣大同鄉變質岩帶不同地熱區鑽鑿數口地熱井，期望能開發高溫地熱流體作為發電的熱源。由於產能測試過程發現管內有碳酸鹽結垢現象，因此為了解台灣變質岩區碳酸鹽類結垢成因，並進一步規劃適當解決方案，必須對地熱流體閃發點進行深入判釋。

本研究整理碳酸鹽結垢的機制，富含二氧化碳的地熱流體，在地熱流體減壓上升過程中，會發生二氧化碳汽化以及地熱流體沸騰兩個現象，均會發生二氧化碳逸出導致碳酸鹽結垢。本研究利用四種判釋閃發點之研究方法，為溫度-壓力對深度曲線法、壓力梯度曲線法、溫度-壓力-轉子-飽和蒸汽壓疊圖法、以及使用地化模擬軟體 Wellsim 等四種方式，以分辨台灣變質岩區地熱井地熱流體之沸騰點造成快速結垢點之對應深度，並討論閃發點之定義，應如何對照此兩種現象。以變質岩地熱區新鑽鑿的 C-2 井作為分析案例，利用井下壓力-溫度-轉子量測工具(PTS tool)於產能測試的噴流試驗進行井底量測，獲得溫度、壓力、轉速等數據進行分析。結果顯示 C-2 井若在節流嘴 4 吋之噴流情況下，地熱流體沸騰點位置約在 100-150 公尺深，溫度約為 152°C，壓力約為 6.1 bar，二氧化碳汽化深度約在 400-430 公尺深，其溫度約為 160°C，壓力約為 25.26 bar；另外亦進行節流嘴 3 吋、2.5 吋及 2 吋噴流時之分析。不同尺寸地熱流體沸騰點及二氧化碳汽化點溫度壓力條件均類似，而對應深度則隨噴流嘴尺寸縮小而逐漸接近地表。最後利用地化資料和模擬軟體 wellsim 進行閃發點模擬對比。應用本研究結果可做為未來地熱電廠建置時，解決碳酸鹽類結垢提出對策所需的重要參考數據。

關鍵字： 地熱、閃發點、碳酸鹽結垢

Study on flash point of geothermal wells in Metamorphic Rock Areas in Taiwan- Taking Well C-2 as an example

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Abstract

CPC(Taiwan) drilled several geothermal wells in the metamorphic rock of Datong Township, Yilan County. Hoping to develop high-temperature geothermal fluid for geothermal power. Carbonate scaling was found in the pipe during the productivity test. Therefore, it is necessary to research on flash point to understand the cause of carbonate scaling in metamorphic rock area and to further plan appropriate solutions.

This study sorts out the mechanism of carbonate scaling. In geothermal fluids rich in CO₂, during the decompression and rise of the geothermal fluid, two phenomena will occur: CO₂ degassing and boiling. Both will cause CO₂ to escape and lead to carbonate scaling. This study uses four research methods to determine the flash point, which are the temperature-pressure versus depth curve method, the pressure gradient curve method, the pressure-temperature-rotor (PTS) saturated steam pressure overlay method, and the simulation method. To distinguish the depth of scaling point caused by the boiling point, and by the decompression degassing of CO₂. Then discuss the definition of the flash point, which should compare these two phenomena. Taking the C-2 well as an analysis case, the PTS tool was used to perform bottom-hole measurements in the discharge test to obtain the temperature, pressure, spinner speed.

The results show that if the C-2 well with a 4-inch choke product, the boiling point is about 100-150 m deep, the temperature is about 152°C, the pressure is about 6.1 bar, and the CO₂ degassing depth is about 400-430 m deep, with about 160°C and about 25.26 bar. In addition, the analysis of the 3, 2.5, 2-inches chokes were also carried out. The PT conditions of the boiling point and carbon dioxide degassing point of geothermal fluids of different sizes are similar, while the corresponding depth gradually approaches the surface as the size of the chokes. Finally, geochemical data and the simulation software Wellsim were used to conduct flash point simulation comparisons. The results can be used as important reference to solve carbonate scaling problems.

Keywords: Geothermal, Flash point, Carbonate scaling.