TSCFA 台灣超臨界流體協會
Taiwan Supercritical Fluid Association

電子報第 205 期

活動訊息

◆ ***論文徵稿***

即日起徵求**「能源與綠色製程」**、**「食品與生技醫藥」**、**「淨零碳排與精密製造」**等3大主題領域的研究論文，邀請各界踴躍投稿，及蒞臨與會交流。

https://www.tscfa.org.tw/ec99/rwd1480/news.asp?newsno=43

◆ ***19 TH ISSF, (European Meeting on Supercritical Fluids EMSF)***

日期：**26-29 MAY 2024**

地點：MARIBOR, SLOVENIA

CHAIR： ZELJKO KNEZ, SLOVENIA

Scientific Meetings – ISASF (supercriticalfluidsociety.net)

◆ ***第23屆超臨界流體技術應用與發展研討會暨113年度會員大會***

時間：2024年**10月18日(星期五)**

地點：高雄蓮潭國際會館R102會議室

◆ ***14 TH ISSF(International Symposium on Supercritical Fluids)***

日期：**JUNE 2025**

地點：BALI

CHAIR： JAEHOON KIM, SOUTH KOREA

Scientific Meetings – ISASF (supercriticalfluidsociety.net)

淨零永續

◆ iDB 產業節能減碳資訊網 INDUSTRIAL ENERGY SAVING AND CARBON REDUCTION INFORMATION WEB

https://ghg.tgpf.org.tw/

◆ 淨零永續學校

https://college.itri.org.tw/nzschool/

團體會員介紹

◆ 愛之味股份有限公司

教育訓練班

◆ (夜間班)高壓氣體特定設備操作人員安全衛生教育訓練班 05/21~06/02

技術文摘

- A versatile pressure-cell design for studying ultrafast molecular-dynamics in supercritical fluids using coherent multi-pulse x-ray scattering (一種多功能壓力單元設計，用於使用多脈衝 X 射線相干散射研究超臨界流體中的超快分子動力學)
- Advances and Prospects of Supercritical CO_2 for Shale Gas Extraction and Geological Sequestration in Gas Shale Reservoirs (超臨界 CO_2 頁岩氣開採及頁岩氣藏地質封存研究進度與展望)
- Balancing Surface Facilities & Well Design to Comply with Cap-Rock Integrity in CO_2 Storage Projects: Experience from UAE (平衡地面設施和井設計以符合 CO_2 封存專案的蓋岩完整性：阿聯酋的經驗)
- Effect of Pressure and Surface Wettability on Thermal Resistance across Solid–Liquid Interface in Supercritical Regime (超臨界狀態下壓力和表面潤濕性對固液界面熱阻的影響)
- Geothermal Exploitation via Recycling Supercritical CO_2 after Thermal Recovery in Deep Heavy Oil Reservoirs (深層重油油藏熱採後 回收超臨界 CO_2 於地熱開採)
- Quality Characteristics of Vegan Mayonnaise Produced Using Supercritical Carbon Dioxide-Processed Defatted Soybean Flour (使用超臨界二氧化碳加工脫脂大豆粉生產的純素蛋黃醬之品質特性)
- Temperature Perturbation with Depth and Induced Pressure in Vicinity of Wellbore During Supercritical $CO_2/CH_4/H_2$ Injection for Gas Storage Design and Evaluations (儲氣庫設計與評估超臨界 $CO_2/CH_4/H_2$ 注入過程中井筒附近深度與感應壓力的溫度擾動)

台灣超臨界流體協會
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TSCFA 台灣超臨界流體協會

第二十三屆
超臨界流體技術應用與發展研討會

論文徵稿

發表日期｜113年10月18日（五）

申請收件截止日期｜113年9月10日(二)

審核結果通知日期｜113年9月20日(五)

發表地點｜蓮潭國際會館R102會議室
(高雄市左營區崇德路801號)

論文主題

- 能源與綠色製程
- 食品與生技醫藥
- 淨零碳排與精密製造

聯絡資訊：

台灣超臨界流體協會 吳家瑩小姐　專線：(07)355-5706　投稿信箱：tscfa@mail.mirdc.org.tw

協會網址：https://www.tscfa.org.tw/

主辦單位｜TSCFA 台灣超臨界流體協會

愛之味股份有限公司

企業簡介

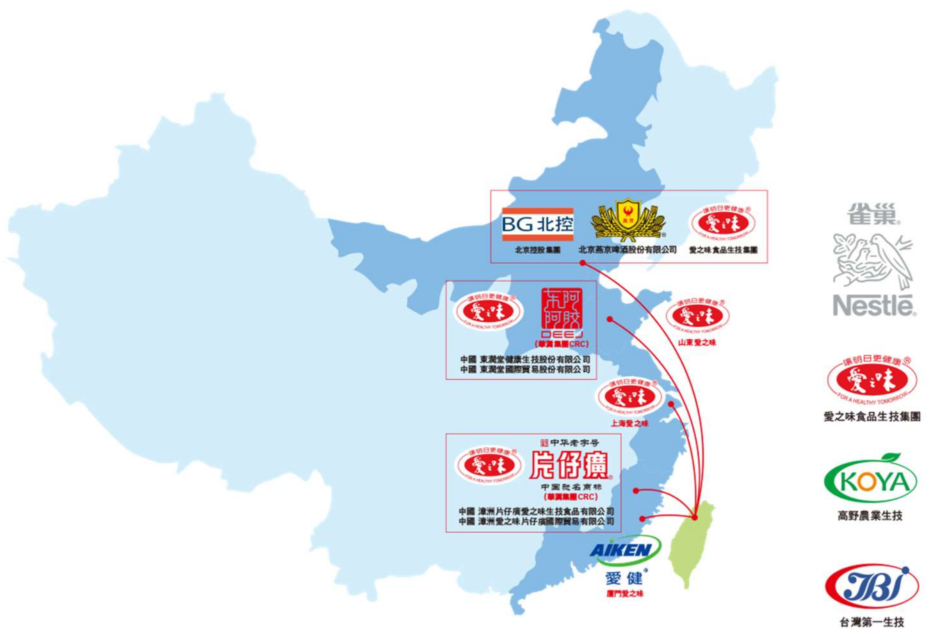
愛之味股份有限公司，創立於 1971 年，提供大眾高品質中華美食，創造領導潮流商品，到專注於抗氧化，預防文明病等預防醫學的研究與開發。生技中心、中央健康科學研究院是愛之味領先業界創造新產品的中心。

近年來愛之味公司著重發展生物科技，全力發展提昇人類生命科學的保健食品。

經營理念

愛之味食品生技集團(AGV)立足台灣近半世紀，一向秉持**「讓明日更健康 FOR A HEALTHY TOMORROW」**的產品宣言，並以極具前瞻性之「樂活環保、綠色健康」之經營理念引導食品潮流、創造消費趨勢。

愛之味食品生技集團(AGV)旗下中央健康科學研究所擁有國內外碩博士人才及世界級尖端檢驗設備，屢獲國內外政府、民間第三方公正單位頒發之專利、認證及獎項：如國家生技醫療品質獎(SNQ)、國家品質標章、健康食品認證、世界品質評鑑大會(Monds Selection Award)金牌獎、世界乳品協會最佳乳飲品獎及最佳新品獎(IDF，The Best New Comer, The Best Dairy Drink)、中國、美國、台灣及世界各國專利(功效、製程)、TFDA/TAF 國家級實驗室等多項認證。



多年來愛之味食品生技集團(AGV)在國內業績不但呈倍數成長，近年來更與中國北京控股集團、首都農業集團旗下全球 10 大啤酒品牌之一「燕京啤酒」在兩岸展開合作，亦與中華馳名商標、中華老字號、國家機密配方的「漳州片仔癀、東阿阿膠」（隸屬中國最大投資控股集團華潤公司）等成為大中華區戰略合作夥伴，積極在大陸市場推出聯合品牌產品，同時於許多省份銷售愛之味品牌的相關產品。

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無菌冷充填

「**愛之味**」為了確保消費大眾喝的品質，轉投資全國第一家榮獲國際 ISO22000、HACCP 等國際認證的**「台灣第一生化科技公司」**，是專業的 OEM、ODM 生產工廠，建構與國際接軌與世界同步的科學化、生技化、數位化優勢產銷平台，爲**「愛之味」**產品開發提供堅強厚實的後盾，目前擁有三大廠：保特瓶一廠、保特瓶二廠、健康食用油廠。

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官方網址：愛之味股份有限公司 – 好料多、營養多、愛心多 (agv.com.tw)

TSCFA 台灣超臨界流體協會
Taiwan Supercritical Fluid Association

(夜間班)高壓氣體特定設備操作人員安全衛生教育訓練班

需要有操作證照的單位，歡迎向協會報名。

- ●上課日期：**(夜班)05/21~5/30 18:30~21:30；06/01~6/02 08:00~17:00(實習)**
- ●上課時數：高壓氣體特定設備操作人員安全衛生教育訓練課程時數 35 小時＋2 小時(測驗)。
- ●課程內容：高壓氣體概論 3HR、種類及構造 3HR、附屬裝置及附屬品 3HR、自動檢查與檢點維護 3HR、安全裝置及其使用 3HR、操作要領與異常處理 3HR、事故預防與處置 3HR、安全運轉實習 12HR、高壓氣體特定設備相關法規 2HR，共 35 小時。(另加學科測驗 1 小時及術科測驗約 1~2 小時)
- ●上課地點：高雄市楠梓區高楠公路 1001 號【金屬工業研究發展中心研發大樓 2 樓　產業人力發展組】
- ●參加對象：從事高壓氣體特定設備操作人員或主管人員。
- ●費　　用：**本班研習費新台幣 7,000 元整，本會會員享九折優惠**。
- ●名　　額：每班 30 名，額滿為止。
- ●結訓資格：期滿經測驗成績合格者，取得【高壓氣體特定設備操作人員安全衛生訓練】之證書。
- ●報名辦法：1.傳真報名：(07)355-7586台灣超臨界流體協會
  2.報名信箱：tscfa@mail.mirdc.org.tw
  3.研習費請電匯至 兆豐國際商銀 港都分行(代碼017)
  戶名：社團法人台灣超臨界流體協會 帳號：002-09-018479（註明參加班別及服務單位）或以劃線支票抬頭寫「台灣超臨界流體協會」連同報名表掛號郵寄台灣超臨界流體協會，本會於收款後立即開收據寄回。

※洽詢電話：(07)355-5706 吳小姐 繳交一吋相片一張及身份證正本

報　名　表

課 程 名 稱	高壓氣體特定設備操作人員安全衛生教育訓練			上課日期	113 年 05/21~06/02	
姓　　名	出生年月日	身份證字號	手機號碼	畢業校名		公司產品
服 務 單 位					電　　話	
服 務 地 址	□□□				傳　　真	
發 票 住 址	□□□				統 一 編 號	
負　責　人	人	訓練聯絡人 / 職稱		email：		
參 加 費 用	共　　元		參加性質	□公司指派	□自行參加	
繳 費 方 式	□郵政劃撥	□支票	□附送現金	報名日期	年　月　日	

※ 出生年月日、身份證字號、畢業校名、電話、地址須詳填，以利製作證書。

上課日期時間表

課程名稱：(日間班)高壓氣體特定設備操作人員安全衛生教育訓練班

2024/05/21 (二)	18:30 ~ 21:30
2024/05/22 (三)	18:30 ~ 21:30
2024/05/23 (四)	18:30 ~ 21:30
2024/05/24 (五)	18:30 ~ 21:30
2024/05/27 (一)	18:30 ~ 21:30
2024/05/28 (二)	18:30 ~ 21:30
2024/05/29 (三)	18:30 ~ 21:30
2024/05/30 (四)	18:30 ~ 21:30
2024/06/01 (六)	08:00 ~ 17:00 (實習第 1 組)
2024/06/02 (日)	08:00 ~ 14:00 (實習第 1 組)

A versatile pressure-cell design for studying ultrafast molecular-dynamics in supercritical fluids using coherent multi-pulse x-ray scattering

一種多功能壓力單元設計，用於使用多脈衝 X 射線相干散射研究超臨界流體中的超快分子動力學

By **Priyanka Muhunthan ; Haoyuan Li ; Guillaume Vignat ; Edna R. Toro ; Khaled Younes ; Yanwen Sun ; Dimosthenis Sokaras ; Thomas Weiss; Ivan Rajkovic ; Taito Osaka; Ichiro Inoue ;Sanghoon Song ; Takahiro Sato ; Diling Zhu ; John L. Fulton ; Matthias Ihme**

[1] Department of Mechanical Engineering, Stanford University, Stanford, California 94305, USA

[2] SLAC National Accelerator Laboratory, Menlo Park, California 94025,USA

Abstract

Supercritical fluids (SCFs) can be found in a variety of environmental and industrial processes. They exhibit an anomalous thermodynamic behavior, which originates from their fluctuating heterogeneous micro-structure. Characterizing the dynamics of these fluids at high temperature and high pressure with nanometer spatial and picosecond temporal resolution has been very challenging. The advent of hard x-ray free electron lasers has enabled the development of novel multi-pulse ultrafast x-ray scattering techniques, such as x-ray photon correlation spectroscopy (XPCS) and x-ray pump x-ray probe (XPXP). These techniques offer new opportunities for resolving the ultrafast microscopic behavior in SCFs at unprecedented spatiotemporal resolution, unraveling the dynamics of their micro-structure. However, harnessing these capabilities requires a bespoke high-pressure and high-temperature sample system that is optimized to maximize signal intensity and address instrument-specific challenges, such as drift in beamline components, x-ray scattering background, and multi-x-ray-beam overlap. We present a pressure cell compatible with a wide range of SCFs with built-in optical access for XPCS and XPXP and discuss critical aspects of the pressure cell design, with a particular focus on the design optimization for XPCS.

資料來源：https://doi.org/10.1063/5.0158497

Advances and Prospects of Supercritical CO_2 for Shale Gas Extraction and Geological Sequestration in Gas Shale Reservoirs

超臨界 CO_2 頁岩氣開採及頁岩氣藏地質封存研究進度與展望

By **Weijun Shen*, Tianran Ma, Luo Zuo, Xu Yang, and Jianchao Cai***

National Key Laboratory of Petroleum Resources and Engineering, China University of Petroleum, Beijing 102249, China

Abstract

The advancements in hydraulic fracturing and horizontal drilling techniques have substantially facilitated the large-scale extraction of natural gas from shale gas reservoirs. However, the use of fracking water poses several potential drawbacks including the contamination of groundwater, surface water, and soil, as well as risks to air quality. Due to the unique physical properties of supercritical CO_2, shale gas exploitation using this method has been considered a promising technology that can not only improve gas recovery but can also enable CO_2 geological storage. This paper clarifies the gas adsorption mechanism in shale formations, including the factors influencing the adsorption of CH_4, the differences between CH_4 and CO_2 adsorption, and various adsorption models. We show that shale inherently exhibits a preference for CO_2 adsorption over CH_4. Then, the supercritical CO_2 fracturing mechanism, including the shale fracking pressure and the factors influencing CO_2 fracturing, is analyzed. The mechanisms of CO_2 extraction in shale gas and the key factors influencing CO_2 geological storage are discussed. The main challenges and future prospects regarding the use of supercritical CO_2 for shale gas recovery and geological sequestration in gas shale reservoirs are finally summarized. A more detailed understanding is required to evaluate the efficiency of shale gas recovery and CO_2 geological sequestration in shale formations using supercritical CO_2. This work provides a basis and serves as a reference for future research investigating the mechanisms of shale gas exploitation using supercritical CO_2, as well as the limitations and advantages of CO_2 geological sequestration in unconventional shale gas reservoirs.

資料來源：https://doi.org/10.1021/acs.energyfuels.3c03843

Balancing Surface Facilities & Well Design to Comply with Cap-Rock Integrity in CO_2 Storage Projects: Experience from UAE

平衡地面設施和井設計以符合 CO_2 封存專案的蓋岩完整性：阿聯酋的經驗

By **Siqing Xu; Aurifullah Vantala; Imtiaz Ali; Mohamed Baslaib; Aaesha Al Keebali; Satya Perumalla; Ayman Samy; Luciana Concilio; Hemant Singh; Carlos Mascagnini; Shekhar Pandya; Hiren Kasekar**

Abu Dhabi National Oil Company

Abstract

CO_2 injection is different than oil and gas injection, where CO_2 phase changes are very likely to occur inside tubing at various operating conditions, especially in depleted gas reservoirs during early stages where reservoir pressure is low, and CO_2 can change from supercritical to gas phases at various depths inside tubing when flow approaches perforation intervals. This is a dynamic and transient behavior, and modelling wellbore pressure and temperature during the life of the well (early, mid and late) is essential and can provide better understanding of the potential risks that are associated with CO_2 injection and the appropriate actions and mitigation plans. Severe cooling due to phase changes and Joule Thomson effects inside tubing, as well as cycling of cooling and heating conditions, can negatively impact well and reservoir integrity including cap rock.

This paper presents a case history of a CCUS project in the Middle East where wellbore pressure and temperature modelling showed a significant impact on surface facility design, and a geomechanical model was constructed to investigate cap rock integrity as well as the safe operating envelope for CO_2 injection. The workflow included modelling of seven time-steps to represent CO_2 injectivity performance and pressure/temperature profiles inside tubing from start to the end of the project. In addition, sensitivity analysis was considered for CO_2 impurities at each time step. The results feed the geomechanical study to ensure reservoir and caprock integrity during injection as well as surface facility design and mitigation plans.

The results showed that high purity CO_2 can yield significantly higher injection rates compared to a low purity scenario. During early stages of injection, low bottomhole injection temperature was observed. Injection under low temperature may jeopardize reservoir and caprock integrity. Potential solutions to mitigate such issues are to consider heating CO_2 at surface at early stage or to use smaller tubing size which may impact the injection capacity. Early stage during injection is the most critical period

and may impact completion design and reservoir/cap-rock integrity. Hydrate risk assessment was conducted and showed that surface conditions are close to the hydrate risk zone. The operational philosophy has been modified to consider a surface heating unit to be used during the early stage of injection until reservoir pressure builds up. This paper presents the importance of detailed wellbore pressure and temperature modelling during CO_2 injection and how this can impact the integrity of the project as well as the operational philosophy. Workflow and risk assessment are also presented.

Keywords: wellbore design, gas injection method, petroleum play type, structural geology, reservoir simulation, completion installation and operations, inflow performance, directional drilling, hydraulic fracturing, well performance

資料來源：https://doi.org/10.2523/IPTC-23651-MS

Effect of Pressure and Surface Wettability on Thermal Resistance across Solid–Liquid Interface in Supercritical Regime

超臨界狀態下壓力和表面潤濕性對固液界面熱阻的影響

By **Ming Dong, Jinliang Xu*, Yan Wang, and Guanglin Liu**

Beijing Key Laboratory of Multiphase Flow and Heat Transfer for Low Grade Energy Utilization, North China Electric Power University, Beijing 102206, China

Abstract

Micro- and nanoscale effects such as temperature jumps have a significant impact on heat transfer processes at the fluid–solid interface. Pressure is an important parameter for describing subcritical and supercritical fluids (SFs). However, with the wide application of the SFs heat transfer process in shale and deep geothermal systems, the effect of pressure on thermal resistance at the supercritical fluid–solid interface is unknown. In this study, the heat conduction process at the supercritical water–graphene interface is performed by molecular dynamics simulations. The effect of pressure on the interfacial thermal resistance under different surface wettabilities is investigated. The results show that the interfacial thermal resistance decreases with increasing pressure under all surface wettability. The effect of pressure becomes weaker as the surface wettability or pressure increases. The interfacial thermal resistance is determined by the peak density and structure factor of the first fluid layer and linearly related to the inverse of the product of the peak density and structure factor. The vibrational coupling of in-plane and out-of-plane phonon density of states is characterized by the structure factor and peak density, which represent the horizontal ordering mechanism and vertical layering mechanism of interfacial heat transfer, respectively. Moreover, the vertical layering mechanism is the main determinant of the interfacial thermal resistance. The mechanism of interfacial thermal resistance proposed in this study is verified for application to a wide range of wettability and supercritical water–copper interfaces. The lower interfacial thermal resistance of the supercritical water–copper interface results from the enhanced ordering of interfacial fluid represented by the horizontal mechanism. This study deepens the understanding of the mechanism of interfacial thermal resistance and is helpful for supercritical heat transfer at the micro- and nanoscale.

資料來源：https://doi.org/10.1021/acs.jpcc.3c07909

Geothermal Exploitation via Recycling Supercritical CO_2 after Thermal Recovery in Deep Heavy Oil Reservoirs

深層重油油藏熱採後 回收超臨界 CO_2 於地熱開採

By **Yu Li; Chao Peng; Waleed Ali Khan; Huiqing Liu; Qing Wang; Xiaohu Dong; Wai Lam Loh**

State Key of petroleum Resources and Prospecting, China University of Petroleum, Beijing, China

School of Petroleum Engineering, China University of Petroleum, Beijing, China

Abstract

After thermal flooding, the natural elastic energy of deep heavy oil reservoir tends to deplete. Yet, this reservoir retains plenty of remaining heat and oil. Supercritical CO_2 ($SCCO_2$) emerges as an optimal heat-carrying fluid and enhances heavy oil extraction due to its high mobility and unique thermal properties.

In this work, a comprehensive model of geothermal exploitation for depleted deep heavy oil reservoir via $SCCO_2$ injection was established, in which the process of heavy oil extraction, asphaltene precipitation on permeability were incorporated. Core displacements and computed tomography (CT) were employed to obtain the variational values of asphaltene precipitation caused by $SCCO_2$ on permeability. A reservoir simulation software (STARS), using the above various parameters such as diffusion coefficient of CO_2, permeability parameter and heat transfer properties, simulates the process of $SCCO_2$ injection for geothermal exploitation and remaining heavy oil development.

$SCCO_2$ with remarkable diffusivity and fluidity facilitates heavy oil extraction and obtain heat energy in a wider area. Consequently, the average oil recovery evidently rises from 18.5% to 30.8%. Nevertheless, the stability of heavy oil's micellar structure is compromised by $SCCO_2$, resulting in the aggregation and adsorption of asphaltenes onto the rock surface to promote the formation of membrane oil and reduce the effective flow area. The difference in gas-phase permeability between the core without steam flooding and the core subjected to steam flooding after $SCCO_2$ flooding averages 7.2%. In the case of high remaining oil saturation in the depleted deep heavy oil reservoir, the backflow of $SCCO_2$ propelled by gravity and capillary force leads to the extraction of numerous light components, leaving behind asphaltene precipitation. This process reduces the consumption of $SCCO_2$ in the lower-temperature region. Subsequently, the swift entry of $SCCO_2$ into regions with low oil saturation, facilitating efficient utilization of steam waste heat and formation heat.

$SCCO_2$ exhibits the potential to enhance oil recovery in low-temperature regions and improve the heat mining rate in high-temperature regions in deep heavy oil reservoirs. The mathematical and experimental simulations offer unique and reliable insights for the advancement of depleted deep heavy oil reservoirs.

Keywords: fluid dynamics, geology, steam-assisted gravity drainage, petroleum play type, chemical flooding methods, scco 2, extraction, university, unconventional play, geologist

資料來源：https://doi.org/10.2523/IPTC-24483-MS

Quality Characteristics of Vegan Mayonnaise Produced Using Supercritical Carbon Dioxide-Processed Defatted Soybean Flour

使用超臨界二氧化碳加工脫脂大豆粉生產的純素蛋黃醬之品質特性

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Abstract

Emulsifiers like egg yolk (EY) are necessary for the formation of mayonnaise, which is an oil-in-water type colloid. This study aimed to assess the potential of defatted soybean powder treated with supercritical carbon dioxide (DSF-SC) in enhancing the quality of plant-based may-onnaise as plant-based alternatives gain popularity. This study involved producing DSF-SC and comparing its quality attributes to those of mayonnaise made with varying amounts of control soy flour (CSF), DSF-SC, and EY. It was found that mayonnaise made with DSF-SC, with increased emulsifier quantity, showed better emulsion stability, viscosity, and smaller, more uniform particle size compared with CSF mayonnaise. Additionally, DSF-SC mayonnaise was overall rated higher in sensory evaluation. The addition of approximately 2% DSF-SC positively influenced the emul-sion and sensory properties of the vegan mayonnaise, making DSF-SC a promising plant-based alternative emulsifier for replacing animal ingredients.

Keywords: Mayonnaise, Soybean, Emulsifier, Supercritical carbon dioxide, Vegan

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Temperature Perturbation with Depth and Induced Pressure in Vicinity of Wellbore During Supercritical $CO_2/CH_4/H_2$ Injection for Gas Storage Design and Evaluations

儲氣庫設計與評估超臨界 $CO_2/CH_4/H_2$ 注入過程中井筒附近深度與感應壓力的溫度擾動

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Abstract

CO2/H2/CH4 are injected into subsurface for sequestration and storage purposes. The properties of gases are sensitive to the pressure and temperature, particularly when the supercritical condition is surpassed. Both density and viscosity change are critically dominating the pressure profile and stress induced in vicinity of a wellbore, These induced stresses and pressure must be calculated accurately for safety, injectivity and storage efficiency design. To calculate fluid pressure and induced stresses under different THM environments, a fully coupled THM model with mutiphase fluid may be used. Analytical solution is highly desirable as an efficient engineering tool, but difficult to be achieved. Thus numerical methods are normally utilized. To avoid resorting the complex numerical methods in this study, an coupled THM borehole solution is developed by considering thermal gradient, but the temperature change for a given depth is neglected. Pressure and density profiles in vicinity of a wellbore are studied and implications to field wellbore integrity subject to different injecting flux with perturbated temperature.

Keywords: drillstem/well testing, geologist, geology, reservoir surveillance, drillstem testing, enhanced recovery, mathematics of computing, equation of state, production monitoring, wellbore

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