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

電子報第 204 期

活動訊息

- ***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)
- ***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

- 興采實業股份有限公司

教育訓練班

- (日間班)高壓氣體特定設備操作人員安全衛生教育訓練班 04/22~04/26
- (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

- Aspects of Gas Storage: Confined Geometry Effects on the High-Pressure Adsorption Behavior of Supercritical Fluids (儲氣方面：受限幾何形狀對超臨界流體高壓吸附行為的影響)
- Characteristics of Purified Horse Oil by Supercritical Fluid Extraction with Different Deodorants Agents (不同除臭劑超臨界流體萃取純化馬油的特性)

- Comprehensive Single-Platform Lipidomic/Metabolomic Analysis Using Supercritical Fluid Chromatography–Mass Spectrometry (使用超臨界流體色譜-質譜法進行全面的單平台脂質組學/代謝組學分析)
- Near Well Supercritical CO_2 Injectivity Study in Depleted Clastic Gas Field in Offshore Malaysia (馬來西亞近海貧化碎屑氣田 近井超臨界 CO_2 注入研究)
- Numerical Simulation on Interaction Between the Supercritical CO_2 and Water-Rock in Tarim Basin (塔里木盆地之超臨界 CO_2 與水岩 交互作用的數值模擬)
- Supercritical Carbon Dioxide Shock Behavior Near the Critical Point (臨界點附近的超臨界二氧化碳衝擊行為)
- The Study of Supercritical Carbon Dioxide Trapping Behavior in Carbonate Reservoirs Through Pore-Scale Imaging Analysis (透過孔隙尺度成像分析碳酸鹽岩儲層中超臨界二氧化碳捕捉行為研究)

台灣超臨界流體協會
電話：(07)355-5706　E-mail：tscfa@mail.mirdc.org.tw

興采實業股份有限公司

關於興采(SINGTEX®)

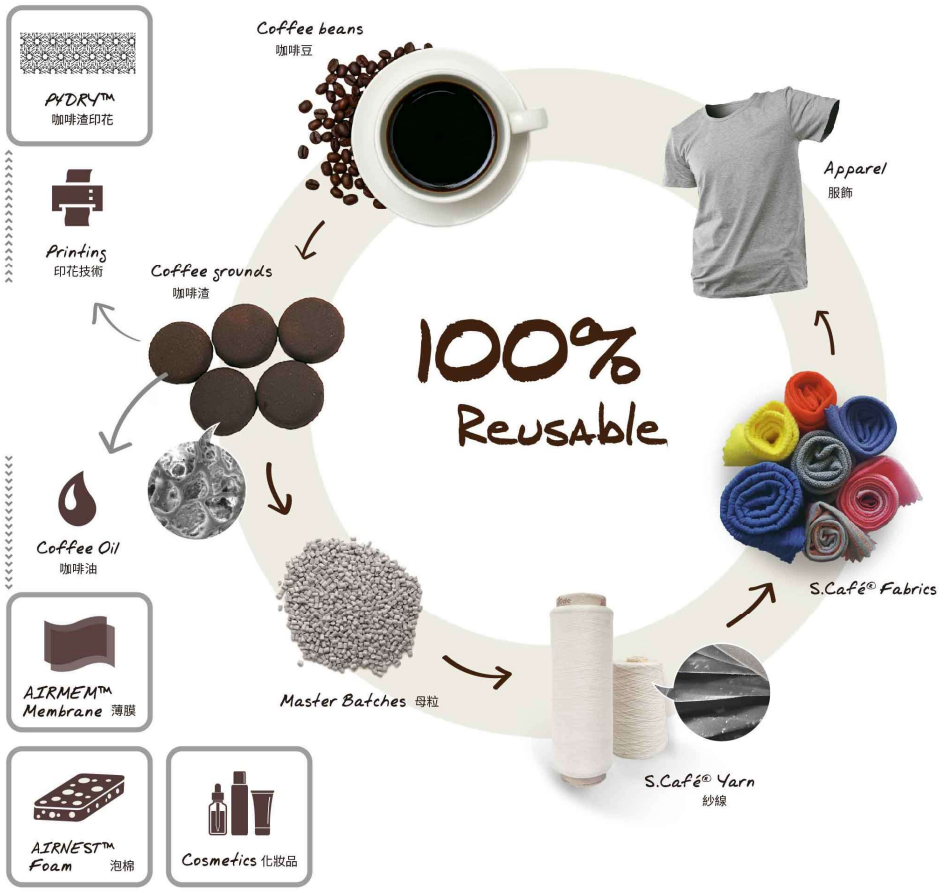
興采實業自西元 1989 年成立以來，從過去以機能性紡織品為發展主軸，直至近年，體認地球環境氣候急劇變遷對於人類生存環境之影響，秉持地球只有一個，須共同努力維護的理念，斥資數億元創立專業的前瞻研發中心及高精密環保染整研發中心，興采的產品不但連續多年獲得台灣精品獎肯定，更獲選為建國百年台灣百大品牌、卓越中堅企業、國家品質獎以及許多國際性獎項，並於 2014 年正式上櫃（股票代號 4433），未來也將會持續開發符合環保的良善產品，減少汙染及能源消耗，為再生資源多盡一份心力!

圖說：陳國欽董事長從蔡英文總統手中接下『國家品質獎-經營技術典範獎』肯定。

暖心的 S.Cafe®

全球第二大飲品是咖啡，我們喝的每一杯咖啡，僅淬取咖啡豆最精華的部分，而這部分僅佔一顆豆子的 0.2%，剩下 99.8%的咖啡渣都遭丟棄。興采秉持著地球上沒有絕對的廢棄物，從廢棄物中挖掘商機，致力於找回 99.8%的咖啡，SINGTEX® 於 2008 年成功研發出世界首創的-S.Café®環保科技咖啡紗，因善用咖啡渣本身的孔洞特性，具有「異味控制」、「速乾」及「紫外線防護」的優異性能。更重要的是，一般被當作廢棄物處理的咖啡渣，經由「超臨界特殊萃取技術」、奈米研磨、多孔性及吸溼性材料改質等專利技術運用，成為全新素材加入紗線中，不論是技術或概念，都是對環境保護實際落實的一大步。而 S.Café®咖啡紗 100%可回收的永續價值

更是徹底的落實了循環經濟。興采成功研發世界首創咖啡紗，除了成功取得多國專利外，該技術自此獲得了世界前三項發明大獎的認可。(美國匹茲堡 INPEX 金獎和優異獎；紐倫堡 iENA 金獎；日內瓦國際發明展覽會金獎和特別獎)。



圖說：S.Café®環保科技咖啡紗

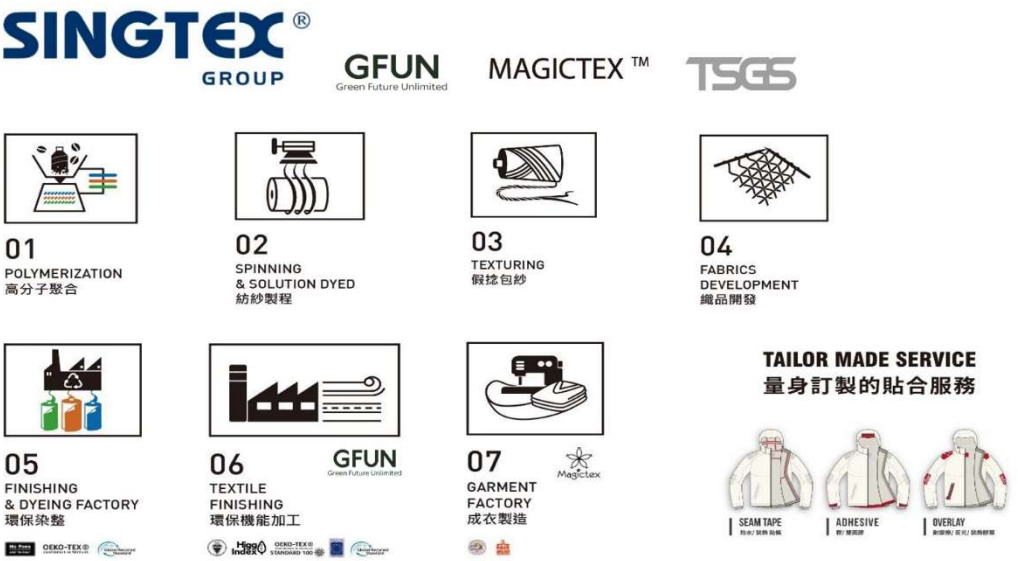
高精密環保染整與研發中心

除針對產品環保性開發之外，更積極於 2007 年投入 2.5 億元資金，建構高精密環保染整研發中心，於設廠之初，即導入環保工程建設，從能源的選擇到染料選擇皆符合環保設計之要求。更於 2008 年通過全球環保標準最嚴苛之瑞士藍色環保標章認證機構-bluesign®驗證。

SINGTEX®不斷以創新研發的方式增加產品的差異性，透過智慧財產權與專利權的取得，維持品牌優勢，積極與專家學者合作研發新技術，創造產品差異化；同時透過產學合作、建教合作等方式，整合研發資源，持續與大專院校保持密切聯繫，積極爭取政府科專計畫，取得關鍵技術及原料，與世界接軌。

興采也提供垂直整合服務，紗、織、染、整在同一廠區，從研發、原料生產、

紗線、布料、後加工處理，到成衣設計開發與自有品牌發展，讓品牌商能從紗線段即客製化特殊需求，滿足客戶追求產品差異化。



圖說：SINGTEX Group 提供垂直整合服務

始終如一的綠色理念

興采實業一直以成為世界性的環保機能性紡織品公司為目標，在永續發展的前提下，創造出更好、更環保的產品。減少汙染及能源消耗，為再生資源多盡一份心力，讓地球能永續生存，同時放大台灣的創新能量，引領世界綠色時尚新潮流! P4DRY™咖啡渣印花、AIRMEM™咖啡薄膜、AIRNEST™環保泡棉等生質材料，給予各方面高機能調節，滿足身體在不同環境氣候下達到舒適輕鬆的要求；Solution Dye 免水染環保織物，更解決了客戶染整段的問題與對環保織物的需求；而 STORMFLEECE™平織刷毛技術，可以取代傳統的針織刷毛，僅須一層面料就能兼顧防風、防水與保暖，更能減緩微塑膠纖維排入海洋，已獲得台灣發明專利(No.I630296)以及歐洲專利(EP 3354778B1)。目前美國百年戶外品牌 L.L.Bean 已推出 STORMFLEECE Pro 外套，全球知名環保戶外品牌 patagonia 也推出系列外套；於 2022 年推出 STORMEGA 3D 空氣層保暖織物，取得台灣新型專利(M634064)，更獲選 ISPO TEXTRENDs 2023/24FW 最高殊榮 Best Product! 興采未來將推出更多創新環保機能面料，讓國際品牌驚艷台灣的面料工藝，維持產業競爭力。

溫暖人心、感念上天、愛護地球

興采多年來在企業社會責任上的付出更是不曾停歇。不僅於外部的社會貢獻，興采透過認養稻田、讓員工共同參與有機耕作、響應地球日關燈節能行動、與五股

濕地保育活動、淨山、淨灘活動等，將企業內部的行動實際貢獻在環境永續上。除此之外，興采多年持續與連鎖咖啡店合作，取得咖啡紗的製作原物料—咖啡渣，更不定期舉辦咖啡渣環保回收講座來傳遞品牌理念，也讓員工參與咖啡渣打包過程，完整貫徹興采品牌堅持的環保理念。興采的企業願景透過一步一腳印的能量累積，由台灣延伸越南再橫跨到非洲去，用大愛理念來改變更多人的生活，確實做到愛地球與溫暖人類的品牌文化。興采品牌的使命：「在有限的地球資源條件下做到現有資源的活化再利用，以達到生態環境的永續願景」，也將為人類生活帶來正向希望理念，使興采已經成為名符其實溫暖人心、令人感動，並且擁有「天地人」理念的環保品牌。

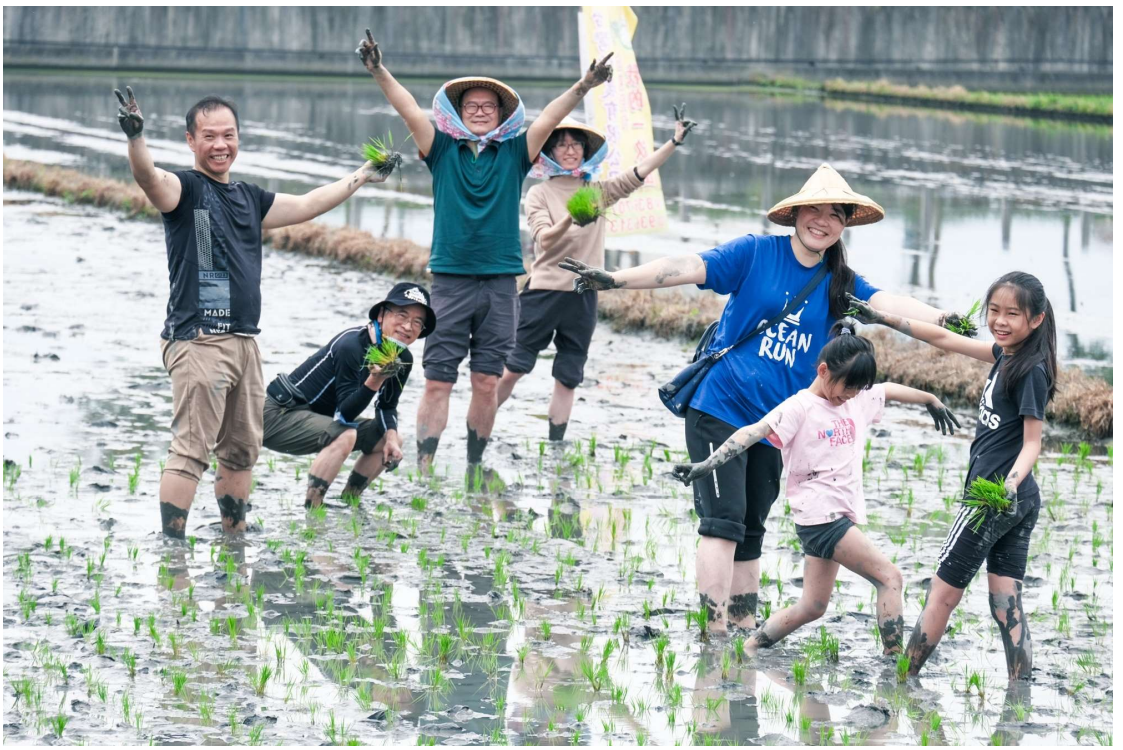


圖: 2024 年為興采認養宜蘭福田的第 14 年

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

(日間班)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：**113/04/22~04/26 08:00~17:00；04/25~04/26 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 04/22~04/26	
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

2024/04/22 (一)	08:00 ~ 17:00
2024/04/23 (二)	08:00 ~ 17:00
2024/04/24 (三)	08:00 ~ 17:00
2024/04/25 (四)	08:00 ~ 17:00 (實習第 1 組)
2024/04/26 (五)	08:00 ~ 14:00 (實習第 1 組)

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)

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※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)

Aspects of Gas Storage: Confined Geometry Effects on the High-Pressure Adsorption Behavior of Supercritical Fluids

儲氣方面：受限幾何形狀對超臨界流體高壓吸附行為的影響

- By **Simon Eder, Patrick Guggenberger, Tatiana Priamushko, Freddy Kleitz, and Matthias Thommes***

Institute of Separation Science and Technology, Friedrich-Alexander-Universität Erlangen-Nürnberg, Egerlandstr. 3, Erlangen 91058, Germany

Abstract

During the last decades, major progress was made concerning the understanding of subcritical low-pressure adsorption of fluids like nitrogen and argon at their boiling temperatures in nanoporous materials. It was possible to understand how structural properties affect the shape of the adsorption isotherms. However, within the context of gas storage applications, supercritical high-pressure gas adsorption is important. A key feature here is that the experimentally determined surface excess adsorption isotherm may exhibit a characteristic maximum at a certain pressure. For a given temperature and adsorptive/adsorbent system, the surface excess maximum (and the corresponding adsorbed amount) is related to the storage capacity of the adsorbent. However, there is still a lack of understanding of how key textural properties such as surface area and pore size affect details of the shape of supercritical high-pressure adsorption isotherms. To address these open questions, we have performed a systematic experimental study assessing the effect of pore size/structure on the supercritical adsorption isotherms of pure fluids such as C2H4, CO2, and SF6 over a wider range of temperatures and pressures on a series of model materials exhibiting well-defined pore sizes, i.e., ordered micro- and mesoporous materials (e.g., NaY zeolite, KIT-6 silica, and MCM-48 silica). A fundamental result of our experiments is a unique fluid-independent correlation between the pressure of the surface excess maximum pmax (at a given temperature) and the pore size (by taking into account the kinetic diameter of the fluid and the underlying effective attractive fluid-wall interaction). Summarizing, our results suggest important structure–property relationships, allowing one to determine, for given thermodynamic conditions, important information related to the optimal operating conditions for supercritical adsorption applications. The insights may also serve as a basis for optimizing and tailoring the properties of nanoporous adsorbent materials for gas storage applications.

資料來源：https://doi.org/10.1021/acs.langmuir.3c02841

Characteristics of Purified Horse Oil by Supercritical Fluid Extraction with Different Deodorants Agents

不同除臭劑超臨界流體萃取純化馬油的特性

By **Anneke Anneke[1], Hye-Jin Kim[2], Dongwook Kim[1], Dong-Jin Shin[3], Kyoung-tag Do[4], Chang-Beom Yang[4], Sung-Won Jeon[4], Jong Hyun Jung[5,*], Aera Jang[1,*]**

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Abstract

This study investigated the impact of activated carbon (AC), palm activated carbon (PAC), and zeolites (Zeo) on horse oil (HO) extracted from horse neck fat using supercritical fluid (SCF) ex-traction. The yield and lipid oxidation of SCF-extracted HO were not significantly affected by the three deodorants. However, deodorant-treated HO exhibited significantly elevated levels of α-linolenic acid (ALA, C18:3n3) and eicosenoic acid (C20:1n9) compared to untreated HO ($p<0.05$), while other fatty acids remained consistent. Zeo-purified HO demonstrated significantly lower levels of volatile organic compounds (VOCs) than other treatments ($p<0.05$). Remarkably, Zeo decreased the concentration of pentane, 2,3-dimethyl (gasoline odor), by over 90%, effectively eliminating sec-butylamine (ammonia and fishy odor) in purified HO ($p<0.05$). Additionally, Zeo reduced fruity citrus odor compounds nonanal, octanal, and D-limonene in HO in contrast to untreated HO ($p<0.05$). This study suggests that integrating Zeo in SCF extraction enhances HO purification by effectively eliminating undesirable VOCs, presenting a valuable approach for producing high-quality HO production for the cosmetic and functional food industries.

Keywords: Horse oil; supercritical fluid extraction; purification; deodorants; zeolites

資料來源：https://doi.org/10.5851/kosfa.2024.e19

Comprehensive Single-Platform Lipidomic/Metabolomic Analysis Using Supercritical Fluid Chromatography–Mass Spectrometry

使用超臨界流體色譜-質譜法進行全面的單平台脂質組學/代謝組學分析

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Abstract

Supercritical fluid chromatography (SFC) is a rapidly expanding technique in the analysis of nonpolar to moderately polar substances and, more recently, also in the analysis of compounds with higher polarity. Herein, we demonstrate a proof of concept for the application of a commercial SFC instrument with electrospray ionization–mass spectrometry (MS) detection as a platform for the comprehensive analysis of metabolites with the full range of polarities, from nonpolar lipids up to highly polar metabolites. The developed single-platform SFC–MS lipidomic/metabolomic method is based on two consecutive injections of lipid and polar metabolite extracts from biphase methyl tert-butyl ether extraction using a diol column and two different gradient programs of methanol–water–ammonium formate modifier. Detailed development of the method focused mainly on the pressure limits of the system, the long-term repeatability of results, and the chromatographic performance, including optimization of the flow rate program, modifier composition and gradient, and injection solvent selection. The developed method enabled fast and comprehensive analysis of lipids and polar metabolites from plasma within a 24 min cycle with two injections using a simple analytical platform based on a single instrument, column, and mobile phase. Finally, the results from SFC–MS analysis of polar metabolites were compared with widely established liquid chromatography MS analysis in metabolomics. The comparison showed different separation selectivity of metabolites using both methods and overall lower sensitivity of the SFC–MS due to the higher flow rate and worse chromatographic performance.

資料來源：https://doi.org/10.1021/acs.analchem.3c04771

Near Well Supercritical CO_2 Injectivity Study in Depleted Clastic Gas Field in Offshore Malaysia

馬來西亞近海貧化碎屑氣田 近井超臨界 CO_2 注入研究

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Abstract

PETRONAS is committed to reduce the bulk carbon dioxide (CO_2) emission to the atmosphere by re-injecting the produced CO_2 from high CO_2 gas field to nearby identified storage site. One of the most important components to develop the storage site would be the understanding on the CO_2 injectivity potential. Limited study is identified for near well CO_2 injectivity research especially in determining the critical velocity rate to identify the injectivity potential during supercritical CO_2 injection ($scCO_2$). In this paper, the injection potential for Field D, which is in Offshore Malaysia has been studies for the storage prospect maturation purposes. Two representative sandstone samples with two distinctive permeability (~80 mD and ~300 mD) from the targeted injected zone in Field D were selected for the analysis. The initially brine saturated core sample was injected with $scCO_2$ at fixed flowrate to establish the core at irreducible brine saturation. $ScCO_2$ was then injected at slightly higher flowrate until the stable differential pressure is achieved. For each subsequent increases in flow rate, base rate of $scCO_2$ is implied in the intervals to observe if there is any formation damage occurred in laminar flow regime. Relative Injectivity Coefficient (RIC) was also calculated using the returned rate differential pressure information. Furthermore, pre- and post-injection core characterization, using routine core analysis (RCA) and X-Ray CT-scan were conducted to examine any petrophysical alteration that might take place during the experiment. The critical velocity rate is then analyzed according to the differential pressure data which later upscaled to well-scale resolution. Based on the differential pressure trend from the two injectivity experiments, there is no clear evidence of formation damage even after the core has been subjected to high $scCO_2$ lab flowrate (~110 cc/min). Only minor dissolution and fines flush-out was occurred. This observation is confirmed by pre- and post-$scCO_2$ injectivity analyses comparison where the petrophysical changes is very minimal. Based on the evidence from differential pressure and pre- and post-sample characteristics, it can be concluded that the critical flow rates were higher than the maximum achievable laboratory flow rates. This denotes that there is no

injectivity issues that is expected to occur up to upscaled well flowrate of 18.5 MMscf/day during the CO_2 injection in storage target zone in Field D.

Keywords: sedimentary rock, clastic rock, geologist, fluid dynamics, geology, rock type, enhanced recovery, core analysis, climate change, permeability

資料來源：https://doi.org/10.4043/35000-MS

Numerical Simulation on Interaction Between the Supercritical CO_2 and Water-Rock in Tarim Basin

塔里木盆地之超臨界 CO_2 與水岩 交互作用的數值模擬

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Abstract

Climate change is related to human survival and long-term development. In the context of global carbon neutrality, carbon dioxide capture, utilization, and storage play a key role in carbon emission reduction. Supercritical CO_2 appears weakly acidic when dissolved in water. After contact with the reservoir, the carbonate rock in formation will react with the CO_2 aqueous solution, which will lead to the process of original mineral dissolution and secondary mineral precipitation, and affect the seepage process. The numerical simulation method is used to study the CO_2-water-rock reaction time and storage capacity in structural and stratigraphic trapping, residual trapping, solubility trapping, and mineral trapping. Solubility trapping utilizes CO_2 to dissolve in the aqueous phase at a certain pressure/temperature to achieve the purpose of storage. It largely depends on pressure, temperature, and surface area in contact with water bodies. Residual trapping uses the effect of the relative permeability curve from displacement to suction to trap the non-wetting phase. The mineral trapping of Anorthite, Calcite, and Kaolinite after CO_2 injection under the initial condition of PH=7 was simulated. Comparison of water-rock reactions under four different storage methods. The results show that, during the simulation process, anorthite gradually dissolved, kaolinite gradually precipitated, and calcite initially dissolved and then precipitated. In the early stage of CO_2 injection and reaction, more than 90% of CO_2 is stored by structural and stratigraphic trapping and residual trapping, and there is a small amount of solubility trapping. The contribution rate of mineral trapping is about 0. With time, the amount of CO_2 stored by solubility trapping and mineral trapping gradually increases, the concentration of CO_2 dissolved in formation water and the concentration of Ca^{2+} and Mg^{2+} increase significantly, the dissolution rate of formation rock increases, and the mineral trapping rate of CO_2 also increases. It will take decades or even hundreds of years to realize the permanent

storage of CO_2. This provides theoretical support for long-term and safe storage of CO_2 in reservoirs and prediction of storage methods and has certain guiding significance.

Keywords: geologist, sedimentary rock, fluid dynamics, carbonate rock, reservoir simulation, social responsibility, enhanced recovery, climate change, subsurface storage, modeling & simulation

資料來源：https://doi.org/10.4043/34864-MS

Supercritical Carbon Dioxide Shock Behavior Near the Critical Point

臨界點附近的超臨界二氧化碳衝擊行為

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Abstract

This paper aims to provide an understanding of sCO_2 inviscid adiabatic normal shock behavior near the critical point and to develop an explicit tool for faster prediction of the shock relations that can aid the supercritical turbomachinery design process. An iterative algorithm was developed to compute shockwave behaviors for nonideal fluids. Three important shock behavior parameters were investigated: postshock Mach number, shock strength, and polytropic efficiency. A comparative study was carried out between air (ideal gas assumption), ideal gas CO_2 (ideal gas assumption), and nonideal fluid CO_2 (Span–Wagner equation of state). The distinct differences show the inadequacy of the perfect gas shock relations when predicting sCO_2 shock behavior near the critical point. The results of nonideal fluid calculations show a general trend of stronger shock strengths and higher polytropic efficiencies toward lower preshock entropy conditions. This is also distinctive near the critical point due to the reduced speed of sound. Finally, explicit expressions for these parameters were retrieved using symbolic regression. The fitted models have significant improvements compared to the prediction from perfect gas shock relations with a 5–20% point reduction in relative errors. This study also shows the potential for machine learning to be applied in nonideal fluid effects modeling and the methodology developed in this paper can be easily introduced to other working fluids in their ranges of interest.

資料來源：https://doi.org/10.1115/1.4063384

The Study of Supercritical Carbon Dioxide Trapping Behavior in Carbonate Reservoirs Through Pore-Scale Imaging Analysis

透過孔隙尺度成像分析碳酸鹽岩儲層中超臨界二氧化碳捕捉行為研究

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Abstract

Severe climate change has urged the energy industry to revolutionalise the conventional technologies at pace to curb greenhouse gasses emission for more sustainable future. Carbon Dioxide (CO_2) storage at subsurface geological formation remains as the most effective technique to store massive quantity of CO_2 safely and permanently. Nonetheless, the flow and trapping behaviours of CO_2 at supercritical condition within geological formation are very complex, particularly for the carbonate rocks attributed to the wide spectrum of rock fabrics, pore geometries and structures. This study aims to investigate the pore interconnectivity and residual CO_2 trapping during the drainage and imbibition processes within porous media through digital rock technology. Native cores from three carbonate fields with different rock characteristics were plugged to obtain representative samples for the pore-scale coreflooding experiments. Brine and supercritical CO_2 were injected into core plugs at temperature up to 120 °C and pressure up to 3000 psi. X-ray images of the saturated core plugs were obtained through micro computed tomography (Micro-CT) facilities after injection of 10 pore volume (PV) of CO_2 and 5 PV of brine. Porosity, pore interconnectivity, fluid occupancy, saturation profiles and CO_2 ganglia size distribution were measured and studied through the pore-scale imaging analysis. The results indicate that the saturation of CO_2 after drainage and imbibition are strongly dependent on the local rock heterogeneity, specifically the presence and distribution of micropores within the rocks. All samples evidently show that micropores play critical role in pore interconnectivity. CO_2 ganglia in one sample was observed to be well connected initially but fragmented into smaller sizes after brine imbibition and, lastly, there was no CO_2 percolation within the pore network if the flow rate was too low. This paper presents a detailed study in investigating the flow and trapping behaviour of CO_2 at supercritical state, providing new insights to the important factors which influence the CO_2 trapping. Deeper understanding of the flow and trapping mechanisms is essential to formulate an effective CO_2 storage development plan, ensuring minimum injectivity and containment risk throughout the storage period.

Keywords: geologist, fluid dynamics, geology, social responsibility, complex reservoir, co 2, chemical flooding methods, reservoir characterization, micropore, cross-section

資料來源：https://doi.org/10.4043/34941-MS