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

電子報第 192 期

會員動態

◆ **達諾生技正式取得原料 EPA90/EPA95 國際 IFOS 五星認證**

團體會員介紹

◆ 台灣端板鋼鐵企業股份有限公司

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 5/03~05/09

技術文摘

◆ A Critical Review on Heat Transfer of Supercritical Fluids 超臨界流體熱傳的批判性評論

◆ Advanced Heat Transfer Technologies: Fundamentals and Applications 先進熱傳技術：基礎與應用

◆ Catalyst-free synthesis of 5-hydroxymethylfurfural from fructose by extractive reaction in supercritical CO_2 – subcritical H_2O two-phase system 超臨界 CO_2 -亞臨界 H_2O 兩相體系中果糖無催化劑萃取合成 5-羥甲基糠醛

◆ Influence of Geometric Parameters for a 100 kW Inward Flow Radial Supercritical CO_2 Turbine 幾何參數對 100 kW 內流式徑向超臨界 CO_2 渦輪機 的影響

◆ Numerical simulation of flow and heat transfer performance during supercritical water injection in vertical wellbore: A parameter sensitivity analysis 豎井超臨界注水流動熱傳性能數值模擬：參數敏感性分析

◆ Solubility of probenecid in supercritical carbon dioxide and composite particles prepared using supercritical antisolvent process 丙磺舒在超臨界二氧化碳中的溶解度及超臨界反溶劑法製備的複合顆粒

台灣超臨界流體協會
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Raw Materials Summary Report

Raw Material Brand Name:	Dynes Biotechnology
Raw Material Summary: Dynes ★★★★★	★ The manufacturing facility is an approved and registered food/dietary supplement manufacturing facility with an appropriate certification = **YES** ★ The company and/or product has been registered in accordance with the regulatory authorities' requirements where the product is produced = **YES** ★ The analytical methods used have met the IFOS standard of testing = **YES** ★ Each lot of certified IFOS raw material has been individually inspected and reviewed for IFOS program compliance = **YES** ★ The product has met the IFOS Consumer Report 5-Star Rating Criteria = **YES**
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Company Phone:	+886-8-7622007
Certificate Expiry:	31/MAR/2024

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台 灣 端 板
鋼鐵企業股份有限公司
Taiwan End-Plate Co., Ltd.

公司概要/簡介

台灣端板鋼鐵企業股份有限公司創立於 1967 年 9 月，具有多年石油化工、發電廠、化纖廠、肥料廠、食品廠各型工廠壓力設備設計、製造及安裝豐富經驗。台灣端板在新北市三重區與高雄市永安區各擁有一座工廠，多年來承蒙各界支持與惠顧，使公司產品獲得國內外客戶的好評。

公司產品

- 端板 Head
- 球槽 Spherical Tank
- 壓力容器 Pressure Vessel
    1. 壓力槽 Pressure Vessel
    2. 塔槽 Tower
    3. 除氧器 Deaerator
    4. 過濾器 Filter
    5. 反應攪拌槽 Reactor & Agitator Tank
- 熱交換器 Heat Exchanger
- 儲槽 API Tank
    1. 冷凍儲槽
    2. API 儲槽
- 處理系統 Treatment System
- 燃燒塔 Flare
- 配管工程 Piping Work
- 其他(1) Other
- 其他(2) Other

認證/認書

- ASME
- ISO
- ML
- CNS

TSCFA 台灣超臨界流體協會
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(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：05/03~03/05 08:00~17:00；05/08~05/09 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	112 年 05/03~05/09	
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

2023/05/03 (三)	08:00 ~ 17:00
2023/05/04 (四)	08:00 ~ 17:00
2023/05/05 (五)	08:00 ~ 17:00
2023/05/08 (一)	08:00 ~ 17:00 (實習第 1 組)
2023/05/09 (二)	08:00 ~ 14:00 (實習第 1 組)

A Critical Review on Heat Transfer of Supercritical Fluids

超臨界流體熱傳的批判性評論

By **Qingyang Wang** [a, b], **Jinliang Xu** [a, b], **Chengrui Zhang** [a], **Bingtao Hao** [a] **& Lixin Cheng** [C]

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[c] Department of Engineering and Mathematics, Sheffield Hallam University, Sheffield, UK

Abstract

Supercritical fluids have been widely used in a variety of applications, in which heat transfer under supercritical pressure is of great importance. This paper presents a critical review on supercritical heat transfer, including a summary on the past work focusing on in-tube heat transfer and the pseudo-boiling concept, the understanding of the mechanisms of supercritical heat transfer, and suggestions for future work. For supercritical fluids heated in tubes, the typical characteristics, the effects of various parameters, the buoyancy and flow acceleration effects, and the heat transfer deterioration phenomenon are all discussed, and the heat transfer correlations and numerical methodologies are summarized. For supercritical fluids cooled in tubes, the experimental observations and explanations, the proposed heat transfer correlations, and the numerical results are summarized and discussed. More importantly, this review provides a comprehensive review of the supercritical pseudo-boiling concept, including the experimentally observed pseudo-boiling phenomenon, the theoretical studies for supercritical fluids to reveal their heterogenous two-phase features, and the progress in the application of the pseudo-boiling concept on supercritical heat transfer. Finally, suggestions for future research are provided to further advance the understanding and enable accurate prediction of supercritical heat transfer.

資料來源：https://doi.org/10.1080/01457632.2022.2164684

Advanced Heat Transfer Technologies: Fundamentals and Applications

先進熱傳技術：基礎與應用

By Lixin Cheng[a,b], Ke Wang[c], Guodong Xia[a] & Afshin J. Ghajar[d]

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[b] Department of Engineering and Maths, Sheffield Hallam University, Sheffield, UK

[c] Beijing Key Laboratory of Process Fluid Filtration and Separation, China University of Petroleum-Beijing, Beijing, China

[d] School of Mechanical and Aerospace Engineering, Oklahoma State University, Stillwater, Oklahoma, USA

Abstract

Advanced heat transfer technologies are the key to tackling the big challenges of energy shortage, global warming, environmental issues, clean energy, energy storage and sustainable development for human beings. Development and application of advanced heat transfer theory and knowledge are crucial in developing innovative technologies to improve the energy utilization efficiency, harness renewable energy and reduce environmental pollutions and carbon footprint.

Advanced heat transfer is the fundamental to a wide range of engineering subjects such as energy, power, energy saving and storage, renewable energy, combined heating, cooling and power generation, nuclear energy, hydrogen production and utilization, automotive, mechanical engineering, aerospace engineering, materials engineering, chemical engineering, environmental engineering and others, and interdisciplinary subjects such as net zero carbon technologies, micro- and nano-fluidics, high heat flux cooling technologies, advanced thermal energy and power cycles. Innovative heat transfer technologies require the breakthrough of advanced heat transfer knowledge and theories. Furthermore, the complexity of issues and challenges relating to energy shortage and environmental issues requires an interdisciplinary nature across many engineering disciplines. Therefore, it is urgently needed to develop advanced heat transfer knowledge, new theory, and innovative technologies through interdisciplinary research.

With the rapid development of various relevant interdisciplinary subjects and emerging subjects and technologies, research of advanced heat transfer is growing very fast nowadays than ever before. Just to name several examples here, due to the rapid development in fabrication techniques, the miniaturization of devices and

components is ever-increasing in many engineering applications. Studies and applications of micro- and nano-heat transfer technologies involved in traditional industries and highly specialized fields such as micro-fabricated fluidic systems, microelectronics, micro heat transfer and high heat flux cooling have been becoming particularly important since the late 20th century. Heat transfer enhancement technologies are the key to developing sustainable energy technologies and reduction of emissions and pollutants. All attempts to achieving high efficiency, low emissions and low costs in various thermal processes and thermodynamic cycles include advanced heat transfer theory and knowledge, heat transfer equipment and enhancement of heat transfer to a large extent. Sustainable energy development can be achieved by reducing final energy consumption, improving overall conversion efficiency, and making use of renewable energy sources through applying advanced heat transfer enhancement and heat exchanger technologies. Using CO_2 as a working fluid becomes important in thermal energy and power generation becomes an important research topic and engineering practice in recent years. Research on CO_2 evaporation heat transfer, supercritical CO_2 heat transfer for cooling and heating processes, thermal and power generation and high-performance heat transfer elements is extensively conducted.

In order to reflect the recent research progress in the fundamentals and applications of advanced heat transfer and technologies, we have edited this special issue on this important research field. The special issue is aimed at providing the state-of-the-art research on advanced heat transfer and the relevant cutting-edge and interdisciplinary subjects. The thirteen papers in this special issue cover a variety of topics: (1) Recent progress on high temperature and high pressure heat exchangers for supercritical CO_2 power generation and conversion systems; (2) A critical review on heat transfer of supercritical fluids; (3) Numerical investigation on two-phase water density wave oscillations in a pipe under various heating conditions; (4) Numerical study of heat transfer in a two-dimensional rarefied hydrogen gas moved jet impingement using direct simulation Monte Carlo-finite difference coupled method; (5) Numerical study on heat transfer and performance of seasonal borehole thermal energy storage; (6) Drag reduction and Leidenfrost effect on submerged ratcheted cylinder; (7) Thermal and mechanical properties of plain woven ceramic matrix composites by the imaged-based mesoscopic model; (8) Heat transfer enhancement of partially serrated twisted finned tube bank; (9) Experimental study on the transient behaviors of mechanically

pumped two-phase loop with a phase change energy storage device for short time and large heat power dissipation of spacecraft; (10) Compact thermal modeling of magnetic components using an admittance matrix approach; (11) Numerical study on heat transfer and flow characteristics of supercritical CO_2 in printed circuit heat exchangers with zigzag channels; (12) Flow boiling heat transfer of R141b in sintered porous tubes; (13) Similarity analysis of droplet evaporation trajectory in high-temperature gas flow.

It is our great pleasure to present the recent frontier and progress of research in advanced heat transfer to the community. We would like to express our great thanks to all authors who have contributed to the special issue and all reviewers who helped to review the papers for the special issue. It is our greatest wish that readers can benefit from the state-of-the-art research in various topics of advanced heat transfer in the special issue.

資料來源： https://doi.org/10.1080/01457632.2022.2164676

Catalyst-free synthesis of 5-hydroxymethylfurfural from fructose by extractive reaction in supercritical CO_2 – subcritical H_2O two-phase system

超臨界 CO_2 -亞臨界 H_2O 兩相體系中果糖無催化劑萃取合成 5-羥甲基糠醛

By **Vincent Oriez [a b], Hélène Labauze [c], Bouchra Benjelloun-Mlayah [c], Thomas Deleau [b], Yuya Hiraga [d], Masaru Watanabe [d], Jean-Stéphane Condoret [a], Séverine Camy [a d]**

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Abstract

An extractive reaction configuration using supercritical carbon dioxide ($scCO_2$) as the extracting solvent was tested for the production of 5-hydroxymethyl furfural (HMF) from a 5 wt% fructose aqueous feed. In this configuration, extraction of HMF by $scCO_2$ prevents HMF degradation in the aqueous phase. Because of water co-extraction by $scCO_2$, the volume of the reactional mixture was maintained by continuous injection of water. Reaction was operated in a 90 mL high pressure reactor, where an HMF maximum yield of 62.4% was achieved at 160 °C and 25 MPa, with a CO_2 flow rate of 20 $g.min^{-1}$ for 420 min. This is the first time that HMF is reportedly produced with such a yield by a catalyst-and organic solvent-free process. Besides, the separation efficiency reached 97.3% and the relative purity of HMF in the extract was 95.8 wt%. Therefore, this configuration avoids post reactional purification which is needed in conventional batch processes or in extractive reaction processes using organic solvents. Based on kinetic and thermodynamic studies, modeling of the extractive reaction process was developed to perform a sensitivity analysis for CO_2 flow rate and extraction efficiency, upon the HMF yield. As an example, it was shown that for 800 min reaction duration, a CO_2 flow rate of 100 $g.min^{-1}$ or an extraction efficiency increase by a 10-fold factor could theoretically led to HMF yields of 73.0% and 73.7%, respectively.

Keywords: Fructose dehydration, 5-hydroxymethylfurfural synthesis, supercritical CO_2, subcritical water, extractive reaction, empirical modeling

資料來源： https://doi.org/10.1016/j.supflu.2023.105904

Influence of Geometric Parameters for a 100 kW Inward Flow Radial Supercritical CO_2 Turbine

幾何參數對 100 kW 內流式徑向超臨界 CO_2 渦輪機 的影響

By **Syed J. Hoque, Pramod Kumar, Pramod Chandra Gopi**

Indian Institute of Science, Bengaluru 560012, India

Department of Mechanical Engineering, Interdisciplinary Center for Energy Research (ICER), Indian Institute of Science, Bengaluru 560012, India

Abstract

Highly compact and efficient design makes inward flow radial (IFR) turbine a preferred choice for kilowatt scale supercritical CO_2 (sCO_2) power blocks. The influence of geometric design parameters on sCO_2 turbine performance differs from gas turbines because of their small size, high rotational speeds, and lower viscous losses. The paper presents a computational fluid dynamics (CFD) study for a 100 kW IFR turbine to arrive at optimal geometric design parameters—axial length, outlet-to-inlet radius ratio, number of rotor blades, and velocity ratio, and understand their influence on the turbine's performance. The results are compared with well-established gas turbine correlations in the specific speed range of 0.2 to 0.8 to understand the implications on sCO_2 IFR turbines. The analysis shows significant variations in the optimal values of design parameters when compared with gas turbines. It is found that sCO_2 turbines require fewer blades and higher velocity ratios for optimal performance. The maximum turbine efficiency (~82%) is achieved at a lower specific speed of ~0.4 compared to a gas turbine with specific speed varying between 0.55 and 0.65. Additionally, higher negative incidence angles in the range of −50 deg to −55 deg are required at high specific speeds to counter the Coriolis effect in the rotor passage. The paper presents the variation of stator, rotor, and exit kinetic energy losses with specific speeds. The cumulative losses are found to be minimum at the specific speed of ~0.4.

Keywords: velocity ratio, radius ratio, Coriolis effect, Ns–Ds diagram, meanline design, radial turbine losses

資料來源： https://doi.org/10.1115/1.4055714

Numerical simulation of flow and heat transfer performance during supercritical water injection in vertical wellbore: A parameter sensitivity analysis

豎井超臨界注水流動熱傳性能數值模擬：參數敏感性分析

Qiuyang Zhao[a], Yuhuan Lei[a], Hui Jin[a,b], Lichen Zheng[a], Yechuan Wang[a,b], Liejin Guo[a]

[a] State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xi'an, 710049, China

[b] Xinjin Weihua Institute of Clean Energy Research, Foshan, 528216, China

Abstract

Supercritical water injection is a promising technology for heavy oil thermal recovery. Predicting and regulating the thermophysical parameters of supercritical water at bottomhole are the prerequisite for achieving high recovery efficiency. In this paper, a novel numerical model was proposed to simulate wellbore flow and heat transfer of supercritical water injection. A modified correlation of frictional coefficient was developed to calculate water flow resistance near its critical point, where its properties change abruptly. The unsteady heat loss to the formation was calculated directly by solving two-dimensional unsteady heat conduction equations. They were respectively coupled in momentum and energy balance equations using an iterative scheme. This model was proved to be accurate by two oilfield cases in which the relative errors of wellbore fluid pressure and temperature are less than 1%. Then parameters sensitivity analysis of the injection pressure, temperature, mass flux and the apparent heat conductivity of insulating tube was conducted. The results indicated that the temperature variation of wellbore fluid depended on both enthalpy drop (or heat loss) and Joule-Thomson effect. An abnormal phenomenon that the fluid temperature increased with wellbore depth near the critical and pseudo-critical points was found because of the sudden increase in high heat capacity and Joule-Thomson coefficient of water. Raising the bottomhole fluid temperature was the key to enhanced oil recovery by supercritical water injection. Low apparent heat conductivity of insulating tube contributed richly to raise bottomhole fluid temperature by enlarging thermal resistance and reducing wellbore heat loss. There existed an optimal mass flux for maximizing bottomhole temperature, because when the mass flux increased, the shortened resident time within wellbore and the decreased fluid pressure favored temperature increase and decrease respectively. Selecting an injection pressure near the critical or pseudo-critical point and raising the injection

temperature would increase the bottomhole temperature and reduce relative fluid heat loss.

Keywords: Supercritical water injection, Wellbore flow and heat transfer, Joule Thomson effect, Near-critical area, Parameter sensitivity analysis

資料來源： https://doi.org/10.1016/j.ijthermalsci.2022.107855

Solubility of probenecid in supercritical carbon dioxide and composite particles prepared using supercritical antisolvent process

丙磺舒在超臨界二氧化碳中的溶解度及超臨界反溶劑法製備的複合顆粒

By **Salal Hasan Khudaida [a], Wei-Yang Hsieh [b], Yu-Zhe Huang [a], Wei-Yi Wu [a], Ming-Jer Lee [b], Chie-Shaan Su [a]**

[a] Department of Chemical Engineering and Biotechnology, National Taipei University of Technology, 1, Zhongxiao East Road, Section 3, Taipei 106–08, Taiwan

[b] Department of Chemical Engineering, National Taiwan University of Science and Technology, 43, Keelung Road, Section 4, Taipei 106–07, Taiwan

Abstract

The solubilities of probenecid in supercritical carbon dioxide (CO_2) were measured in terms of mole fraction ranging from 0.13×10^{-5} to 1.45×10^{-5} at temperatures from 313.2 K to 353.2 K and pressures from 15 MPa to 31 MPa. The solubility data were correlated with the dimensionally consistent Chrastil equation, Garlapati and Madras equation, Mendez-Santiago and Teja equation, Kumar and Johnston equation, and the Peng-Robinson equation of state to deviations of 12.3 %, 6.7 %, 9.7 %, 8.1 %, and 16.2 %, respectively. Due to the low solubility nature, supercritical antisolvent (SAS) process was used for designing composite particles of probenecid and poly(lactide-co-glycolide) (PLGA). The effects of operating parameters on particle morphology, recovery and drug loading were studied. Through SAS, PLGA coated probenecid particles were successfully obtained. The recovery could be higher than 80 %, and the probenecid concentration could be up to 75 mg/mL. Moreover, results of dissolution studies reveal the PLGA coated composite particles can accelerate the dissolution rate by about 10 and 2.4 times, comparing with the unprocessed probenecid and SAS-processed probenecid without PLGA.

Keywords: CO_2, Solubility, Particle design, PLGA, Probenecid, SAS

資料來源： https://doi.org/10.1016/j.supflu.2023.105851