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

電子報第 211 期

活動訊息

◆ 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
論文摘要集暨會員大會手冊連結網址及QR Code：
https://www.tscfa.org.tw/ec99/rwd1480/news.asp?newsno=49
活動精選照片

◆ ***Supergreen 2024 (The 13th International Conference on Supercritical Fluids)***
時間：2024年**11月29日-12月1日**
地點：韓國首爾

◆ ***14 th ISSF(International Symposium on Supercritical Fluids)& 9th ISHA (International Solvothermal and Hydrothermal Association Conference)***
日期：**JUNE 15-20, 2025**
地點：Bali, Indonesia
CHAIR：JAEHOON KIM, SOUTH KOREA
Scientific Meetings – ISASF (supercriticalfluidsociety.net)
※協會將組團由理事長帶隊前往，屆時歡迎會員踴躍參加！

會員動態

- **恭喜亞果生醫高階醫療器材去細胞真皮微粒 ADM Scaffold 取得美國 FDA 510 K 認證!未來將可應用在傷口照護以及可能的毛髮增生應用！！**

淨零永續

- 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

- 台超萃取洗淨精機股份有限公司

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 11/18~11/22

技術文摘

- A numerical investigation of the thermal characteristics of supercritical carbon dioxide (sCO_2) flowing through mini serpentine channels (超臨界二氧化碳(sCO_2)流經微型蛇形通道之熱特性數值研究)
- Analysis of heat and mass transfer characteristics of supercritical CO_2 in vertical U-tube (超臨界 CO_2 在立式 U 形管內傳熱傳質特性分析)
- Automated multifactorial design of experiment and Bayesian optimisation algorithm approaches to method development for the green analysis by supercritical fluid chromatography of a pharmaceutical ingredient (自動化多因子實驗設計與貝葉斯最佳化演算法開發藥物成分之超臨界流體色譜綠色分析方法)
- Discussion and perspectives for improvements of heat transfer correlation capabilities for fluids at supercritical pressure (超臨界壓力流體傳熱關聯能力改進的討論與展望)
- Nonideal Compressible Fluid Dynamics of Dense Vapors and Supercritical Fluids (稠密蒸氣和超臨界流體的非理想可壓縮流體動力學)
- Scenarios, prospects, and challenges related to supercritical fluid impregnation in the food industry: a scoping review (2018–2023) (食品業超臨界流體含浸相關的情境、前景與挑戰：範圍界定回顧(2018-2023))
- Subcritical and supercritical Rankine steam cycles, under elevated temperatures up to 900°C and absolute pressures up to 400 bara (下之亞臨界和超臨界朗肯蒸汽循環溫度高達 900°C，絕對壓力高達 400 bara)

TSCFA 台灣超臨界流體協會

第十一屆理監事當選名單

理事

編號	姓 名	單 位	職稱
01	梁明在	喬璞科技有限公司	總經理
02	蘇至善	國立台北科技大學化工系	教授
03	余榮彬	財團法人安全衛生技術中心	總經理
04	吳弦聰	明志科技大學化學工程系	教授
05	孫傳家	全研科技有限公司	處長
06	徐榜奎	綠茵生技股份有限公司	總經理
07	連培榮	金屬中心能源與精敏系統設備處	副處長
08	王順仁	聯華氣體工業股份有限公司	經理
09	梁茹茜	烜程系統科技有限公司	總經理
10	葉樹開	國立台灣科技大學材料科學與工程系	教授
11	謝介銘	國立中央大學化材系	副教授
12	賴秉杉	國立中興大學化學系	教授
13	楊顏福	中平有限公司	總經理
14	游議輝	濾能股份有限公司	處長
15	陳余芳	品蓁國際貿易有限公司	總經理
備 1	謝昌衛	國立宜蘭大學	副校長
備 2	吳永泰	金屬中心天然物創新應用組	副組長
備 3	魏毅明	冷研科技有限公司	總經理
備 4	陳韻茹	亞果生醫股份有限公司	經理
備 5	黃俊豐	東聯化學股份有限公司	經理

監事

編號	姓 名	單 位	職稱
01	邱永和	台超萃取洗淨精機股份有限公司	協理
02	廖怡禎	愛之味股份有限公司	所長
03	馮瑞陽	國立高雄大學電機工程學系	副教授
04	翁堉翔	台灣中油股份有限公司綠能科技研究所	組長
05	張立勳	聚紡股份有限公司	副總經理
備	潘博緯	金屬中心天然物創新應用組	副組長

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

第 18 屆台灣超臨界流體技術研究優良論文獎
得獎名單

◆ 「優良海報論文獎」得獎名單：

陳維珊 (國立臺北科技大學化學工程與生物科技系)

吡咯烷(Pyrrolidine)與哌啶(Piperidine)水溶液中二氧化碳水合物生成熱力學與動力學特性之研究

包曉青 (喬璞科技股份有限公司)

以超臨界流體萃取與層析技術萃取分離牛樟芝中三萜類化合物

蘇亦晨、林郁員 (國立中央大學化學工程與材料工程學系)

以機器學習模擬固體藥品於超臨界二氧化碳中之溶解度

◆ 「佳作海報論文獎」得獎名單：

楊勝然(國立高雄大學電機工程學系)

輔以超流體技術製備 Ti3C2 二維過渡金屬碳化物奈米片之技術開發

陳冠宇(明志科技大學化學工程系)

超臨界輔助霧化法製備單分布蛋白質微粒

恭賀所有獲獎名單及其團隊!!!

台超萃取洗淨精機股份有限公司

關於台超

專業設備製造廠 深耕台灣，佈局全球

提供全方位萃取、洗淨處理方案的創新團隊 ！

全球唯一具備超臨界流體與超音波清洗

雙核心技術 設備製造廠

「台超萃取洗淨精機股份有限公司」擁有超臨界流體 (Supercritical Fluid)與超音波(Ultrasonic)雙技術突破性整合的堅強團隊，是全球唯一具備超臨界流體與超音波設備製造雙實力之公司。

國際級認證 自製設計及設備製造廠 設備品質優良

台超萃取洗淨精機的核心競爭力「萃取、洗淨技術的專業，專注與創新」！超臨界流體設備與超音波設備榮獲多項國際認證，為世界少數、更是國內唯一通過德國萊因公司 ISO 9001:2015 設計、開發、製造、銷售等全項認證以及相關生產設備通過 CE 認證。

台超萃取洗淨精機累積多年之設備開發經驗，專注於技術研發、流程改善、機構設計與設備製造，為產業提供全方位萃取、洗淨的解決方案。

自製設備 行銷全球 深獲國際肯定 品質更有保障

立足台灣，展望全球！台超萃取洗淨精機行銷高品質的超臨界流體與超音波設備製造之外，更具獨立開發實力與 ODM、OEM 技術，領先大亞洲地區，也深獲歐美等先進國家的國際肯定！

公司願景

為人類創造

更潔淨、更環保、更健康的生活

Clean、**Green**、**Healthy**

目標

專注於「萃取」與「洗淨」技術的創新!

成為世界的領導品牌！

經營理念

以人性為本、科技為用，

成就一個"追求價值創新與環境永續"的企業。

台超萃堅信『技術不斷創新與服務全面升級才是企業的永續競爭力』。唯有將每一位客戶視為共同創造利潤的事業夥伴，自我提昇為『新製造服務業』，才能真正掌握在地深耕，佈局全球的最大利基!

台超萃的 『新製造服務業』主張 ：

1.創新、務實、誠信的企業精神

以最穩健、務實的態度，專注於企業核心價值的經營；堅持在核心技術上不斷創新、精益求精；堅守對客戶夥伴永續服務、長期合作的承諾!

2.創造高技術門檻，成為環保潔淨技術的領導者

充分掌握製造與研發技術的自主性，創造高技術競爭力!

3.提供客戶導向的全方位服務

藉由持續地研發創新，提供客戶更高品質解決方案，與完善售後服務，以達成客戶100%滿意度為最高目標。

4.提供最具環保優勢的解決方案

全方位評估客戶需求，為客戶量身打造最佳效益、最具環保競爭力的解決方案。

5.締結價值鏈的新夥伴關係

與上下游價值鏈客戶群共同建構成一支互利共生的競爭力團隊，建立長期、合理及相互信賴之關係。

服務項目

超音波清洗與超臨界清洗設備之設計與製造

以超音波清洗、超臨界流體清洗，以及二氧化碳系清洗技術為核心，多元整合其他配套清洗技術，依客戶量身規劃全方位的清洗解決方案!

- **超臨界流體萃取與超音波萃取設備之設計與製造**

可分別因應各類實驗室研究，或生物科技、食品香料、製藥萃取等大型量產產業之不同需求標準，提供獨家技術之設備設計與製造服務。

- **專業技術諮詢及完善售後服務**

>提供免費、快速萃取與洗淨技術諮詢，以解決您遇到的問題。

>本着服務客戶的精神，不論您的機台是否為台超萃所製造，我司均可提供便捷、確實的維修服務，使您的機台早日恢復正常運作。

- **專業代工服務**

提供特殊需求之代工萃取服務。

>代工萃取

>代工測試

- **專業潔淨室配置**

提供客戶需求之潔淨室配置。

- **大宗供應各類輔助溶劑及洗淨藥液**

提供各項專業、環保、高效能之清洗、萃取輔助溶劑之大宗銷售。

專業領域

- 超臨界二氧化碳萃取及清洗技術
- 超音波清洗及萃取技術
- 提供清洗及萃取製程的解決方案

產品

- 萃取設備：超臨界 CO_2 萃取設備、超音波萃取設備、客製化萃取設備
- 清洗設備：超音波清洗設備、高壓噴洗設備、表面處理設備、客製化洗淨設備
- 染色設備：超臨界 CO_2 染色設備
- 實驗室設備規劃服務：CO_2 萃取機配備、CO_2 萃取機週邊系統
- 輔助清洗劑：洗淨專用
- 代工服務：萃取測試
- 民生應用：家庭用品

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：**113/11/18~11/20 08:00~17:00；11/21~11/22 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 11/18~11/22	
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

2024/11/18 (一)	08:00 ~ 17:00
2024/11/19 (二)	08:00 ~ 17:00
2024/11/20 (三)	08:00 ~ 17:00
2024/11/21 (四)	08:00 ~ 17:00 (實習第 1 組)
2024/11/22 (五)	08:00 ~ 14:00 (實習第 1 組)

A numerical investigation of the thermal characteristics of supercritical carbon dioxide (sCO_2) flowing through mini serpentine channels

超臨界二氧化碳(sCO_2)流經微型蛇形通道之熱特性數值研究

By **Hyun Su So, Yoon Hyeok Bae, Jeong-Heon Shin, Ho-Myung Chang**

Department of Mechanical & System Design Engineering, Hongik University, 94 Wausan-ro, Mapo-gu, Seoul 04066, Republic of Korea

Abstract

In this study, we numerically investigate the heat transfer characteristics of CO_2 during phase transitions in its supercritical state in serpentine channels. Four different inclination angles are applied to three different radii of curvature flow channels with the same diameter of 2 mm. The supercritical state is maintained by assuming that the mass flux is approximately 191 kg/m^{2}s, the inlet temperature is 298.15 K, and the operating pressure is 7.65 MPa. To ensure a consistent total heat input, different heat flux values are applied to the three different cases, eliminating the potential impact of the increased surface area on the heat transfer performance and allowing a clearer investigation of the geometric effects within the same temperature range. In a channel with a constant radius of curvature, the centrifugal force has a dominant influence on the heat flow compared to gravitational buoyancy, showing a flow phenomenon independent of the angle. In contrast, in a flow channel with a varying radius of curvature, the gravitational buoyancy fluctuates depending on the local area. As a result, the ratio of the centrifugal force to the gravitational buoyancy decreases, causing more variations with changes in the inclination angle. As the centrifugal force contributes significantly to turbulent mixing, the average heat transfer coefficient is highest in the flow channel with the shortest wavelength. As the wavelength increases, the ratio of centrifugal force to buoyancy begins to affect density stratification, especially in gas-like regions, leading to buoyancy. The local heat transfer coefficient at points around the circumference of the cross-section affected by buoyancy and in the film is analyzed, which is closely related to the centrifugal buoyancy and gravitational buoyancy, and their ratio. To express this influence in a correlation equation, a new *Nu* correlation with an error of less than 25 % is proposed using *De*, which combines the centripetal force and Reynolds number, ratio of centrifugal buoyancy and gravitational buoyancy, Φ, and *Pr* as.Nu=0.849De0.541⌀-0.154Pr-0.160

資料來源：https://doi.org/10.1016/j.applthermaleng.2024.123023

Analysis of heat and mass transfer characteristics of supercritical CO_2 in vertical U-tube

超臨界 CO_2 在立式 U 形管內傳熱傳質特性分析

By **Chenhong Bai[1*], Ying Huang[1] and Xinjun Li[2]**

[1] Shanghai Aircraft Design and Research Institute, Shanghai, China

[2] School of Energy and Mechanical Engineering, Nanjing Normal University, Nanjing, China

Abstract

The heat and mass exchange of CO_2 in a vertical U-tube under supercritical pressure was simulated. The effects of the geometry of the bend area, The center arc radius of the bend area and the different bend orientations on the flow heat transfer of supercritical CO_2 in the U-tube were analyzed. The results show that in the bend area, the flow is affected by the combined action of centrifugal force and gravity, as well as the pipe structure, so the flow mixing is intense, and the heat transfer capacity is significantly enhanced. When the direction of the bend changes, the interaction between centrifugal force and gravity will affect the heat transfer at pipe bending. When the central arc radius r of the bend area increases from 0.5D to 3D, the heat transfer at the bend can be strengthened, but will weaken the heat transfer at the bend outlet area.

資料來源：https://doi.org/10.1051/e3sconf/202447801017

Automated multifactorial design of experiment and Bayesian optimisation algorithm approaches to method development for the green analysis by supercritical fluid chromatography of a pharmaceutical ingredient

自動化多因子實驗設計與貝葉斯最佳化演算法開發藥物成分之超臨界流體色譜綠色分析方法

By

Claudio Brunelli[a], Ryan Osborne[a], Greg Yule , Tom Dixon[b], Isobel Bruce[a], Mark Taylor[a]

[a] Pfizer UK R&D Ltd, Analytical R&D, Ramsgate Road, Sandwich -Kent CT13 9ND, United Kingdom

[b] University of Leeds, Institute of process research and development (iPRD). Woodhouse, Leeds LS2 9JT, United Kingdom

Abstract

During drug development, chromatography is frequently used for purity and stability testing of both drug substance and drug product. Reversed phase liquid chromatography (RPLC) is one of the most widely used methodologies due to its wide scope of application. In the later stages of drug development, the specified impurities and degradation products that define the critical quality attribute of the final API, also known as *Key Predictive Sample Set* (KPSS), are usually well defined and controlled. At this point, a method review enables selecting the most appropriate technique which should be the one providing optimal robustness (ICH-Q14[1]), with the support of Quality by Design (QbD) approaches. Supercritical Fluid Chromatography (SFC) is a preferred technique for its proven diversity in selectivity. The adoption of a technique which presents the most favourable environmental impact, such as, but not limited to, SFC, is also becoming increasingly important as laboratories strive to reduce carbon footprint. *Re*-developing a method requires high resource-demands in terms of staff, materials, and time. Any step of the process that can be automated can facilitate this approach, speeding up the delivery of the method whilst preserving robustness.

In this article we describe how an SFC method was developed for the purity profiling of a late-stage oncology candidate, taking advantage of the superior selectivity of SFC towards structurally similar analytes, owed to the high orthogonality with R^2 as low as 0.014 towards the KPSS. We describe two approaches to automate the method development. Firstly, a multifactorial design of experiments (DoE) and secondly, an optimization via a Bayesian algorithm, which was completed in one night,

highlighting the potential and limitations, with an insight into the robustness. Both methods achieved baseline separation with varying levels of automation embedded into the process and a large reduction of the resource demands when compared to traditional optimisation methods. Finally, we describe the beneficial environmental impact that implementing SFC methods can yield, with a calculated green score reduced to a value between 17 and 30 % compared to RPLC, depending on the number of runs per sequence.

資料來源：https://doi.org/10.1016/j.chroma.2024.465214

Discussion and perspectives for improvements of heat transfer correlation capabilities for fluids at supercritical pressures

超臨界壓力流體傳熱關聯能力改進的討論與展望

By

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Abstract

The paper addresses the present engineering predictive capabilities for heat transfer at supercritical pressures, with main reference to the studies in support to the design of supercritical water nuclear reactors. The work that was made in the frame of the EU ECC-SMART Project by participants, in assessing existing correlations in front of different experimental data sets by a variety of means, is taken as a basis for discussing the adequacy of some of the available formulations. In particular, previously proposed correlations have been assessed in a stand-alone fashion or by the use of in-house and existing system codes. Specific computer programs have been also set up to try optimising the parameters of classical correlation forms when applied to selected experimental data sets. The obtained results show the present difficulties in predicting specific heat transfer regimes of interest for supercritical reactors, with main reference to deteriorated heat transfer, though some correlations have been found to represent at least qualitatively the increase of wall temperature observed in some tube or rod bundle experiments, providing hope of a reasonable quantitative description. A reflection on the different forms in which deteriorated heat transfer is observed in experiments and suggestions for possible improvements of the adopted modelling strategy are also provided in the paper, trying to investigate possibly promising lines of future research.

Keywords: *SCWR, Supercritical pressure, Heat transfer, Correlations, Robustness, APROS, Transfer Matrix Method*

資料來源：https://doi.org/10.1016/j.nucengdes.2024.113085

Nonideal Compressible Fluid Dynamics of Dense Vapors and Supercritical Fluids

稠密蒸氣和超臨界流體的非理想可壓縮流體動力學

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Abstract

The gas dynamics of single-phase nonreacting fluids whose thermodynamic states are close to vapor-liquid saturation, close to the vapor-liquid critical point, or in supercritical conditions differs quantitatively and qualitatively from the textbook gas dynamics of dilute, ideal gases. Due to nonideal fluid thermodynamic properties, unconventional gas dynamic effects are possible, including nonclassical rarefaction shock waves and the nonmonotonic variation of the Mach number along steady isentropic expansions. This review provides a comprehensive theoretical framework of the fundamentals of nonideal compressible fluid dynamics (NICFD). The relation between nonideal gas dynamics and the complexity of the fluid molecules is clarified. The theoretical, numerical, and experimental tools currently employed to investigate NICFD flows and related applications are reviewed, followed by an overview of industrial processes involving NICFD, ranging from organic Rankine and supercritical CO_2 cycle power systems to supercritical processes. The future challenges facing researchers in the field are briefly outlined.

Keywords: *nonideal compressible fluid dynamics, nonideal thermodynamics, fundamental derivative of gas dynamics, supercritical carbon dioxide flows and power systems, organic Rankine cycle power systems, supercritical injection*

資料來源：**https://doi.org/10.1146/annurev-fluid-120720-033342**

Scenarios, prospects, and challenges related to supercritical fluid impregnation in the food industry: a scoping review (2018–2023)

食品業超臨界流體含浸相關的情境、前景與挑戰：範圍界定回顧(2018-2023)

By **Erick Jarles Santos de Araujo, Julian Martínez**

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Abstract

Supercritical fluid impregnation (SFI) is an emerging technique for the incorporation of target compounds into solid matrices. It has attracted attention in the food industry, where it can be applied. As it does not use organic solvents and supercritical CO_2 is the most commonly used fluid, SFI is considered to be an ecofriendly and 'green' strategy. A review of the literature is essential in order to understand the complex interactions that occur in SFI. This is a scoping review of SFI applied to the food industry from 2018 to 2023. The search used the Web of Science, Scopus, and Science Direct databases. Guiding questions were identified, publications related to the topic were selected, and the information was extracted, organized, and grouped. An overview of the SFI, its operational characteristics, challenges, prospects, and strategies is presented. Initially, 329 records were found; 38 publications were eventually selected for inclusion in this scoping review. The results indicate that the packaging sector has been the focus of publications. However, trends include applications of SFI in micronization, developing of food waste biorefineries, and food protection from direct impregnation. This scoping analysis is therefore a powerful tool for creating new research into the application of SFI to food.

資料來源：https://doi.org/10.1002/bbb.2671

Subcritical and supercritical Rankine steam cycles, under elevated temperatures up to 900°C and absolute pressures up to 400 bara

下之亞臨界和超臨界朗肯蒸汽循環，溫度高達 900°C，絕對壓力高達 400 bara

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Abstract

The Rankine cycle is a conceptual arrangement of four processes as a closed vapor power thermodynamic cycle, where a working fluid (especially water as a liquid, as a vapor, and as a liquid-vapor mixture) can be used to convert heat into mechanical energy (shaft rotation). This cycle and its variants are widely used in electric power generation through utility-scale thermal power plants, such as coal-fired power plants and nuclear power plants. In the steam-based Rankine cycle, water should be pressurized and heated to be in the form of very hot high-pressure water vapor called "superheated steam," before the useful process of expansion inside a steam turbine section occurs. If the absolute pressure and temperature of the superheated steam are both above the critical values for water (220.6 bara and 374.0°C), the cycle is classified as "supercritical." Otherwise, the cycle is classified as "subcritical." This study considers the impact of the temperature and pressure, independently, on the performance of a steam Rankine cycle. Starting from a representative condition for a subcritical cycle (600°C peak temperature and 50 bara peak absolute pressure), either the peak temperature or the peak absolute pressure of the cycle is increased with regular steps (up to 900°C, with a temperature step of 50°C, and up to 400 bara, with a pressure step of 50 bar). The variation of five scale-independent performance metrics is investigated in response to the elevated temperature and the elevated pressure. Thus, a total of 10 response curves are presented. When the temperature increased, all the five response variables were improved in a nearly linear profile. On the other hand, increasing the pressure did not give a monotonic linear improvement for each response variable. In particular, the cycle efficiency seemed to approach a limiting maximum value of 45% approximately, where further increases in the pressure cause diminishing improvements in the efficiency. When varying the peak pressure, an optimum minimum ratio of (water-mass-to-output-power) is found at 203 bara, although the cycle efficiency still increases beyond this value. In the present research work, the web-based tool for calculating steam properties by the British company Spirax Sarco Limited, and the software program mini-REFPROP by NIST

(United States National Institute of Standards and Technology) were used for finding the necessary specific enthalpies (energy content) of water at different stages within the steam cycle. Both tools were found consistent with each other, as well as with the Python-based software package Cantera for simulating thermo-chemical-transport processes. The results showed that if the peak temperature reaches 900°C, a gain of about 5 percentage points (pp) in the thermal cycle efficiency becomes possible (compared to the case of having a base peak temperature of 600°C), as the predicted efficiency was found to increase from 38.60% (base case) to 43.67%. For the influence of the steam peak pressure, operating in the subcritical regime but close to the critical point appears to be a good choice given the gradual decline in efficiency gains at higher pressures. About 4.7 percentage point increase was found at the high subcritical peak pressure of 200 bara (compared to a base subcritical peak pressure of 50 bara). The results of this study also showed that the liquid water droplet mass fraction at the steam turbine exit diminishes from 11.00% at 600°C to only 1.48% at 900°C, which is favorable. This mass fraction grows from 11.00% at 50 bara to 27.89% at 400 bara, which is not acceptable. Every 100°C increase in the superheating temperature between 600°C and 900°C was found to cause aa increase in the cycle thermal efficiency by about 1.69 percentage points, and simultaneous a beneficial increase in the steam quality at the turbine exit by about 3.17 percentage points.

Keywords: *Steam, Rankine, superheated, power plant, mini-REFPROP, Spirax Sarco*

資料來源：https://doi.org/10.1177/168781322312210