

台電工程月刊 894 期(2 月)目錄

新及再生能源：

NEW AND RENEWABLE ENERGY：

- 鹼性膜電解產氫電堆特性研究及商用系統架構分析丁富彬 等(1)
Stack Study of Anion Exchange Membrane Electrolysis and Architecture
Analysis of Commercial System for Green Hydrogen Production Ting, Fu-Pin et al.(1)

火力發電：

FOSSIL POWER GENERATION：

- 台中電廠 5 到 8 號機靜電集塵器效率提升實例谷震遠 等(10)
A Case of Taichung Power Plant ESP Efficiency ImprovementGuu, Jenn-Yeuan et al.(10)

配 電：

DISTRIBUTION：

- 邁向淨零排碳 - 火力電廠減碳轉型之可行解方高靖棣 等(18)
Toward Net Zero Carbon Emissions-Feasible Approaches of Carbon Reduction
and Transformation for Thermal Power PlantsKao, Ching-Ti et al.(18)
- 材料供應鏈品質溯源管理數位轉型計畫張聖安 等(32)
Quality Traceability Management and Digital Transformation of Material
Supply Chain Chang, Sheng-An et al.(32)

電力系統：

POWER SYSTEM：

- 電力系統韌性與韌性指標文獻回顧分析吳宇軒(46)
Literature Review on Power System Resilience and Resilience MetricsWu, Yu-Hsuan(46)

化學與材料：

CHEMISTRY AND MATERIAL：

- 聚合礙子使用於輸電線路材料特性及測試案例分析鄭錦榮(62)
Material Characteristics and Case Study on the Use of Polymer Insulators to
Transmission Lines Cheng, Jiin-Rong(62)
-

鹼性膜電解產氫電堆特性研究及商用系統架構分析

Stack Study of Anion Exchange Membrane Electrolysis and Architecture Analysis of Commercial System for Green Hydrogen Production

丁富彬*
Ting, Fu-Pin

周儷芬*
Chou, Li-Fen

林國興**
Lin, Kuo-Hsin

黃筱君**
Huang, Hsiao-Chun

賴建銘**
Lai, Chien-Ming

蔡麗端**
Tsai, Li-Duan

摘要

在全球積極推動淨零發展的趨勢下，台灣 2050 淨零碳排路徑已於今年公布，規劃以去碳電力為主軸，促使能源轉型，預計 2050 再生能源佔比達 60 - 70%，同時氫氣佔比達 9 - 12%。此外，將同步推動氫能管理專法，使發展餘電製氫於法有據。本研究針對新型鹼性膜電解技術於國際間發展現況與趨勢進行解析，並針對自主研發之新型鹼性膜電解產氫電堆技術之研究成果進行細部研析，包括：5 kW 電堆結構設計、電堆檢測分析、測試平台建立與商規電堆/系統架構分析。研究中所探討之新型鹼性膜電解產氫技術，具有產氫高效率及低成本且與再生電力高相容等技術優勢，發展綠電製氫已是全球趨勢，建立自主化電解水產氫技術可做為未來台灣能源轉型之基礎基石。

Abstract

To cope with the global trend of carbon reduction, Taiwan announced its roadmap toward 2050 Net Zero Emissions (NZE) earlier this year. To facilitate energy transition, decarbonization is essential for power sectors. In 2050, the percentages of renewable generation and hydrogen, comparing with total generation, will reach 60-70% and 9-12%. Therefore, legislation aiming for hydrogen energy management needs to be drafted and submitted to the Legislation Yuan for review, so as to facilitate producing hydrogen with surplus renewable generation, i.e., green hydrogen. Apart from the development trend and current situations of related technologies, we studied the design, inspection procedures and testing platform of 5 kW stack, and the commercial stack/system analysis of advanced Anion Exchange Membrane (AEM) electrolysis stack. Utilizing AEM electrolysis technology to produce green hydrogen is not only cost-effective, but also highly compatible with the intermittent characteristics of renewable generation. In short, self-owned capability of electrolysis technology may be the most fundamental and urgent mission for Taiwan to meet the target of 2050 NZE.

關鍵詞 (Key Words)：電解(Electrolysis)、產氫(Hydrogen Production)、淨零碳排(Net-Zero)、陰離子交換膜(Anion Exchange Membrane)、膜電極組(Membrane Electrode Assembly)。

*台灣電力公司綜合研究所

**工業技術研究院材料化工研究所電子材料元件研究組

台中電廠 5 到 8 號機靜電集塵器效率提升實例

A Case of Taichung Power Plant ESP Efficiency Improvement

谷震遠*
Guu, Jenn-Yeuan

林千民*
Lin, Chien-Min

蔡景棋*
Tsai, Jing-Chi

蔡東昇**
Tsai, Tung-Sheng

徐榮彬***
Hsu, Jung-Pin

賴怡妉***
Lai, Yi-Wen

摘要

台中電廠於 106 年到 108 年之間進行 5 到 8 號機靜電集塵器(Electrostatic Precipitator, ESP)改善升級，藉由更新運轉 20 年之老舊機械零件為硬管式極線(Rigid Discharge Electrode, RDE)，安裝在 ESP 的第一二排區域，使運轉更穩定並延長設備使用壽命。此外，將傳統變壓器整流器組升級為最新電源供應系統技術高頻變壓器整流器組(High Frequency Transformer Rectifier, HFTR)則能增加輸出功率，使集塵效率更進一步提升。此改善策略等於在原有基礎上再加強，且利用一般大修停機時間即可完成，改善後 ESP 出口粉塵亦可降低至 10mg/Nm³ 以下。相較於針對機組全套設備進行改善的空氣品質控制系統改善計畫，針對 ESP 單一設備之效率改善在成本、施工時間皆更有彈性，亦對粒狀物控制達到相同效果。

Abstract

From 2017 to 2019, Taichung Power Plant (TPP) carried out an Electrostatic Precipitator (ESP) efficiency improvement on unit #5 to #8 that had been in operation for more than 20 years by replacing the 1st and 2nd rows of old Discharge Electrode with Rigid Discharge Electrode (RDE) in order to achieve steadier operation and longer lifespan. Furthermore, conventional transformer rectifier had also been upgraded to High Frequency Transformer Rectifiers (HFTR) that gives higher power output resulting in improved dust collection efficiency. Both RDE and HFTR upgrades were conducted during TPP's annual overhaul. After the retrofit, the ESP outlet emission has been successfully reduced to below 10mg/Nm³. While AQCS plan aims to upgrade all air quality control related devices at once, ESP upgrade only focuses on a single device. Thus, it is more flexible in construction scheduling and costs less, but still able to achieve the same results of particulate control.

關鍵詞(Key Words)：靜電集塵器(Electrostatic Precipitator)、粒狀物排放(Particle Emission)、高頻變壓器(High Frequency Transformer Rectifier)。

*台灣電力公司水火力發電事業部台中發電廠

**昇台工程股份有限公司

***台耘工業股份有限公司

邁向淨零排碳-火力電廠減碳轉型之可行解方

Toward Net Zero Carbon Emissions-Feasible Approaches of Carbon Reduction
and Transformation for Thermal Power Plants

高靖棣*
Kao, Ching-Ti

楊明偉*
Yang, Ming-Wei

摘要

電力部門在各國所規劃的減碳路徑中，普遍被要求最首要且最急迫需執行的目標。臺灣現今的發電來源超過六成來自化石燃料，對於火力電廠未來該如何因應減碳的做法，以及在未來低碳排甚至零碳排的轉型與存續，是極需規劃與考量的課題。本文針對火力電廠未來兩種最可行的減碳與轉型方式，包含加裝碳捕集與封存裝置，以及利用低碳燃料包含氫與氨的混燒與專燒取代傳統化石燃料，收集現今趨勢與技術進行分析，並嘗試提出兩者適合應用於火力電廠的情景與時機點。

Abstract

Many countries nowadays have regarded electric industry as the priority one and most critical sector to meet the target of 2050 Net Zero Emissions (NZE). In Taiwan, more than 60% electricity generation is from fossil fuels. Thermal power plants (TPPs) therefore are obliged to take positive actions on this issue, which is also a critical issue for power companies. In this article, we introduce two approaches, carbon capture and storage (CCS) and low carbon fuels, and the scenarios and timings of the said two approaches.

關鍵詞 (Key Words)：減碳(Carbon Reduction)、火力發電廠(Thermal Power Plant)、碳捕捉與封存技術(Carbon Capture and Storage, CCS)、低碳混燒技術(Low Carbon Co-firing Technology)。

材料供應鏈品質溯源管理數位轉型計畫

Quality Traceability Management and Digital Transformation of Material Supply Chain

張聖安*	蔡明耀*	徐銘鏞**	劉家綦*
Chang, Sheng-An	Tsai, Ming-Yao	Hsu, Ming-Kai	Liu, Chia-Chen
溫景翔*	鍾錦鈞*	邱垂泓**	陳彥學*
Wen, Ching-Hsiang	Chung, Jin-Chin	Chiu, Chui-Hung	Chen, Yen-Hsueh

摘要

為推動台電公司供應鏈管理數位轉型及達成智能化與科技化策略目標，依照品質溯源管理所需的物料控管項目，盤點分析如 SCM、ERP、LSMS、TFMS 等材料供應鏈相關系統，建立跨系統之資料溯源鏈結核心，促使物料於各應用階段相互扣合追溯，完成開發品質溯源管理平台。結合台電內、外部資料，分析材料品質相關因子，採用變異數及相關係數分析方法，觀察單一材料及單一廠商在品質因子間的顯著差異，探尋影響材料檢修的潛在因子。為優化品質管理制度，協助導入 ISO 9001:2015 品質管理系統，建立標準化品質管理流程及機制，藉由文件與知識管理，以利業務經驗的傳承，提升業務執行效率。此外，本團隊成員隨同台電進行中檢訪視，了解各供應商之製作流程，分析攜回之變壓器零組件，了解、分析各零組件特性，分別就材料選用及製作流程兩個面向提出優化建議。

Abstract

Digital transformation of supply chain management (SCM) is a route that Taipower must take to achieve the strategic goals of intelligentization and technicalization. By reviewing related information, e.g., SCM, ERP, LSMS, TFMS, we aim to fix the broken point of "defect process operating procedures" and "testing data collection", and to develop "smart mobile app" for on-site personnel. Quality traceability management (QTM) platform may integrate different entities, including corporate units responsible for material use and quality control, and material suppliers, to get together to collaborate with each other. In addition, with the aid of internal and external data, accompanied with factor analysis related to material quality, whether there is significant quality factor difference between specific material and specific manufacturer may thus be observed, to serve as reference for quality control. In the aspect of system operation, we otherwise help introduce a quality management system titled ISO 9001:2015, and establish a quality management mechanism aiming for key materials. In short, through document and knowledge management, experiences amid entities may be shared, and complete data of key materials may be established.

關鍵詞(Key Words)：品質溯源(Quality Traceability)、數位轉型(Digital Transformation)、資料分析(Data Analytics)。

*工研院資通所

**工研院材化所

電力系統韌性與韌性指標文獻回顧分析

Literature Review on Power System Resilience and Resilience Metrics

吳宇軒*

Wu, Yu-Hsuan

摘要

近年來因極端氣候事件對於電力系統造成的衝擊，無論在影響規模或是發生頻率都有逐漸上升的趨勢，使得對於電力系統韌性的探討再次浮上檯面。然而，經查閱韌性與韌性指標的相關文獻資料後，我們發現對於此二詞彙的定義尚未凝聚出共識，且常與「可靠度」產生混淆，此一現象不利於討論與因應策略形成。本文透過文獻回顧的方式進行電力系統韌性與韌性指標的分析，探討晚近不同期刊文獻、研究報告對於韌性一詞的定義與相關討論，歸納出韌性定義應具備的三大要素，並依此給出本文認為合理且具操作性的韌性定義；此外，本文針對文獻提及的韌性指標進行分析，以效能、屬性類型和單一、複合面向兩大維度進行分類，以釐清在前述韌性定義下適用之評估指標。

Abstract

The impacts of extreme weather events on power system are escalating, in terms of scale and frequency. Correspondingly, issues of power system resilience have been receiving a lot of public attention. However, literature review with reference to resilience and resilience metrics reveals that we can hardly differentiate the concepts of these jargons. Even more, the meanings of the terms of resilience and reliability are not clear and have been misused from time to time. The situation blocks effective discussion and strategy formation. By means of literature review, we herewith highlighted three elements to more properly define resilience. In addition, the resilience metrics, shown as literature review, were divided into 4 categories with two dimensions, namely performance-based vs attribute-based and single vs composite, to make sure that the resilience metrics in use is consistent with the definition of resilience.

關鍵詞(Key Words)：韌性(Resilience)、韌性指標(Resilience Metrics)、屬性類型韌性指標(Attribute-based Resilience Metrics)、效能類型韌性指標(Performance-based Resilience Metrics)。

聚合礙子使用於輸電線路材料特性及測試案例分析

Material Characteristics and Case Study on the Use of Polymer Insulators to
Transmission Lines

鄭錦榮*

Cheng, Jiin-Rong

摘要

輸電線路在大氣污染或鹽霧害嚴重地區常因環境因素造成線路跳脫事故，以致影響供電品質。除了加強維護，變更設計或實施塗佈矽油膏、高壓絕緣塗料(HVIC)等處理外，亦有使用能耐受污損的聚合礙子，以期減少維護人力，並增進線路之可靠性。對於耐鹽霧害聚合礙子之使用，供電處很早即開始引進聚合礙子試掛於高污損或高鹽害之 69kV、161kV 系統，至近年間達到使用高峰，經供電處定期追蹤觀察，使用情況大致良好，為了瞭解在實際線路上使用多年以後，此種礙子在絕緣特性、材質方面之狀況，需進行研究及試驗加以探討，以便作為往後運用及維護上之參考。本文主要針對聚合礙子的維護方式進行探討，例如檢測聚合礙子之劣化情況，以及建立聚合礙子目視檢查劣化或損壞、失效的統一判斷標準模式，將有助於現場人員對聚合礙子在應用及維護上的參考。

Abstract

Environmental factors such as severe air pollution and salt fog often cause tripping accidents of transmission lines, and cast negative impact on the quality of power supply. Apart from maintenance enhancement and design modification, innovative practices such as silicone paste, high-voltage insulating coating (HVIC) and polymer insulators are conducive to contamination withstanding, which, in turn, help reduce manpower required for maintenance and improve circuit reliability. With regard to the use of salt spray resistant polymer insulators, the Department of Power Supply, Taiwan Power Company began introducing polymer insulators to its 69kV and 161kV systems, liable to high pollution or salt damage, in the early years. The related work reaches the peak in recent years. Regular follow-up observation shows that the condition of usage is pretty good. Nevertheless, to serve as reference for future maintenance, it is necessary to further understand the insulation characteristics and material conditions of these after-years-of-use insulators. In view of this, this article aims to discuss the maintenance methods of aggregation insulators, e.g., detecting the deterioration conditions of aggregation insulators, and establishing a set of unified judgment standard modes, to visually inspect insulators' conditions- deterioration, damage, or failure. The results of this research may serve as reference for on-site engineers.

關鍵詞(Key Words)：聚合礙子(Polymer Insulator)、劣化(Deterioration)、侵蝕(Erosion)、損壞(Damage)、擊穿破壞(Puncture)、電蝕/碳化(Tracking/ Carbonising)、機械性失效(Mechanical Failure)、脆性破斷(Brittle Fracture)。