同行专家业内评价意见书编号：20240858139

附件1

浙江工程师学院（浙江大学工程师学院）
同行专家业内评价意见书

姓名：温朝军

学号：22160323

申报工程师职称专业类别（领域）：能源动力

浙江工程师学院（浙江大学工程师学院）制

2024年03月25日

一、个人申报

（一）基本情况【围绕《浙江工程师学院（浙江大学工程师学院）工程类专业学位研究生工程师职称评审参考指标》，结合该专业类别(领域)工程师职称评审相关标准，举例说明】

1.对本专业基础理论知识和专业技术知识掌握情况

在参与工程项目的过程中，我深入探究了垃圾焚烧过程，理解了其原理及工作特点，并通过对二噁英生成机制的学习，掌握了预测算法，能够应用于不同的场景。此外，我学习并实践了多种优化控制策略，比如模型预测控制（MPC）和遗传算法，以针对二噁英排放实现闭环优化控制。在专业技术能力方面，我不仅提高了问题解决和团队协作能力，还通过科研实践培养了学术素养和严谨的科研态度。这些经历不仅加深了我对能源动力专业基础理论的理解，也增强了我在实际操作中处理复杂工程问题的能力，使我能够更有效地将专业知识和技术应用于实际工程项目中，为可持续能源开发与环境保护做出贡献。

2.工程实践的经历

2022 年08 月01 日至 2023 年08 月16

日在海宁绿动海云环保能源有限公司进行工程实践。

3.在实际工作中综合运用所学知识解决复杂工程问题的案例

在现代城市的垃圾处理过程中，焚烧作为一种有效的减量化和资源化手段，扮演着至关重要的角色。然而，焚烧过程产生的二噁英等有害物质对环境和人体健康构成严重威胁。因此，实现垃圾焚烧炉排放中二噁英的实时预测与控制，是提升焚烧技术环保性能的关键。在这一背景下，我参与了一项旨在研发垃圾焚烧炉自动燃烧控制系统的项目，该系统通过精确控制燃烧过程，有效降低了二噁英的排放量，实现了环境保护与经济效益的双重提升。

项目的主要技术难点集中在两个方面：第一，如何准确预测垃圾焚烧过程中二噁英的排放量；第二，根据预测结果设计实时优化控制策略以最小化二噁英的产生。为了攻克这些难题，我们采取了以下解决方案：

首先，在数据采集与预处理阶段，我们利用高精度传感器收集了焚烧过程中的关键参数，如温度、氧气浓度、废气成分等数据。针对数据噪声和异常值的问题，我们采用了先进的数据处理方法，包括滤波技术和异常检测算法，确保了数据质量的可靠性。接着，为了解决二噁英排放量的准确预测问题，我们引入了基于长短期记忆网络（LSTM）的机器学习模型。该模型特别适合处理和预测时间序列数据中的复杂模式，能够捕捉到影响二噁英生成的关键动态变化特征。经过大量的实验和训练，我们的模型能够以高准确率预测在不同操作条件下的二噁英排放量。进一步地，依托于准确的二噁英排放预测模型，我们开发了一套多目标优化控制策略。这一策略综合考虑了燃烧效率、能耗以及环境影响等多个因素，通过调整垃圾焚烧炉的操作参数，比如燃烧空气流量、活性炭注入速率等，实现了对二噁英排放的闭环控制。

项目实施后的实际效果与成果显著。首先，通过引入先进的预测和控制技术，项目成功实现了对焚烧炉二噁英排放量的实时监测和控制，极大提高了垃圾焚烧过程的环保性能。同时，由于优化了燃烧条件，发电系统的整体运行效率也得到了提升，从而带来了可观的经济效益。其次，自动燃烧控制系统的开发和应用推动了企业技术水平的飞跃性提升。系统的实施不仅有效降低了有害气体的排放，改善了当地环境和居民生活质量，而且为同行业提供了可靠的技术方案，促进了环保技术的进步和推广。此外，通过优化焚烧炉运行，项目还实现了能源消耗和运维成本的降低，同时提升了资源的利用率。这些直接的经济效益进一步证明了项目的技术优势和市场潜力。

综上所述，本项目通过跨学科合作和技术革新，在垃圾焚烧炉二噁英排放控制方面取得了显著成效。未来，随着技术的不断成熟和推广应用，我们有理由相信，它将在更广泛的环境保护和能源利用领域产生深远的影响，为实现可持续发展目标做出重要贡献。

（二）取得的业绩（代表作）【限填3项，须提交证明原件（包括发表的论文、出版的著作、专利证书、获奖证书、科技项目立项文件或合同、企业证明等）供核实，并提供复印件一份】

1.
公开成果代表作【论文发表、专利成果、软件著作权、标准规范与行业工法制定、著作编写、科技成果获奖、学位论文等】

成果名称	成果类别 [含论文、授权专利（含发明专利申请）、软件著作权、标准、工法、著作、获奖、学位论文等]	发表时间/授权或申请时间等	刊物名称/专利授权或申请号等	本人排名/总人数	备注
Dioxin emission prediction from a full-scale municipal solid waste incinerator: Deep learning model in time-series input	TOP期刊	2023年08月04日	Waste Management	1/7	SCI期刊收录
废物焚烧炉二噁英排放实时预警及智能控制的方法及系统	授权发明专利	2023年07月18日	专利号：ZL 202210845636.0	2/7	
Thermal Behavior Prediction of Sludge Co-Combustion with Coal: Curve Extraction and Artificial Neural Networks	权威期刊	2023年07月28日	Processes	1/10	SCI期刊收录

2. 其他代表作【主持或参与的课题研究项目、科技成果应用转化推广、企业技术难题解决方案、自主研发设计的产品或样机、技术报告、设计图纸、软课题研究报告、可行性研究报告、规划设计方案、施工或调试报告、工程实验、技术培训教材、推动行业发展中发挥的作用及取得的经济社会效益等】

无

（三）在校期间课程、专业实践训练及学位论文相关情况	
课程成绩情况	按课程学分核算的平均成绩： 86 分
专业实践训练时间及考核情况(具有三年及以上工作经历的不作要求)	累计时间： 1 年（要求1年及以上） 考核成绩： 94 分（要求80分及以上）
本人承诺	
个人声明：本人上述所填资料均为真实有效，如有虚假，愿承担一切责任，特此声明！ **申报人签名：** 温朝军	

22160323

二、日常表现考核评价及申报材料审核公示结果

日常表现考核评价	非定向生由德育导师考核评价、定向生由所在工作单位考核评价： ☑优秀 ☐良好 ☐合格 ☐不合格 德育导师/定向生所在工作单位分管领导签字（公章）：　　年　月　日
申报材料审核公示	根据评审条件，工程师学院已对申报人员进行材料审核（学位课程成绩、专业实践训练时间及考核、学位论文、代表作等情况），并将符合要求的申报材料在学院网站公示不少于5个工作日，具体公示结果如下： ☐通过 ☐不通过（具体原因：　　） 工程师学院教学管理办**公室**审核签字（公章）：　　年　月　日

浙 江 大 学 研 究 生 院

攻读硕士学位研究生成绩表

学号：22160323	姓名：温朝军	性别：男	学院：工程师学院	专业：能源动力	学制：2.5年
毕业时最低应获：24.0学分		已获得：24.0学分		入学年月：2021-09	毕业年月：2024-03
学位证书号：1033532024602243			毕业证书号：103351202402600469		授予学位：能源动力硕士

学习时间	课程名称	备注	学分	成绩	课程性质	学习时间	课程名称	备注	学分	成绩	课程性质
2021-2022学年秋季学期	动力与电气工程工业应用综述		2.0	83	专业选修课	2021-2022学年冬季学期	智慧能源工程实践		2.0	97	专业学位课
2021-2022学年秋季学期	智慧能源工程案例分析		2.0	93	专业学位课	2021-2022学年冬季学期	能源过程先进控制		2.0	96	专业学位课
2021-2022学年冬季学期	研究生英语		2.0	90	公共学位课	2021-2022学年春季学期	自然辩证法概论		1.0	85	公共学位课
2021-2022学年冬季学期	综合能源系统集成优化		2.0	84	专业选修课	2021-2022学年夏季学期	研究生英语基础技能		1.0	72	公共学位课
2021-2022学年冬季学期	智慧能源系统工程		2.0	80	专业学位课	2021-2022学年春夏季学期	优化算法		3.0	91	专业选修课
2021-2022学年秋冬季学期	中国特色社会主义理论与实践研究		2.0	89	公共学位课	2021-2022学年春夏季学期	工程伦理		2.0	89	公共学位课
2021-2022学年秋冬季学期	研究生论文写作指导		1.0	87	专业学位课						

说明：1.研究生课程按三种方法计分：百分制，两级制（通过、不通过），五级制（优、良、中、及格、不及格）。

2.备注中“*”表示重修课程。

学院成绩校核章：

成绩校核人：张梦依

打印日期：2024-04-02

1. Dioxin emission prediction from a full-scale municipal solid waste incinerator: Deep learning model in time-series input
https://doi.org/10.1016/j.wasman.2023.08.004

Waste Management
Volume 170, 1 October 2023, Pages 93-102

Research Paper

Dioxin emission prediction from a full-scale municipal solid waste incinerator: Deep learning model in time-series input

Chaojun Wen [a], Xiaoqing Lin [a b], Yuxuan Ying [b], Yunfeng Ma [b], Hong Yu [b], Xiaodong Li [b c], Jianhua Yan [b]

Show more

+ Add to Mendeley Share Cite

https://doi.org/10.1016/j.wasman.2023.08.004 Get rights and content

Highlights

- The first study for dioxin prediction with extensive online dioxin datasets.
- The application of SVM, RF, LSTM, and CNN models for dioxin emission prediction.
- MSE improves by 36.5% in the LSTM model through time series input.
- The cumulative effect of dioxin formation is fetched by deep-learning models.

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Research Paper

Dioxin emission prediction from a full-scale municipal solid waste incinerator: Deep learning model in time-series input

Chaojun Wen [a], Xiaoqing Lin [a,b,*], Yuxuan Ying [b], Yunfeng Ma [b], Hong Yu [b], Xiaodong Li [b,c], Jianhua Yan [b]

[a] Polytechnic Institute, Zhejiang University, Hangzhou 310027, China
[b] State Key Laboratory of Clean Energy Utilization, Institute for Thermal Power Engineering, Zhejiang University, Hangzhou 310027, China
[c] Key Laboratory of Clean Energy and Carbon Neutrality of Zhejiang Province, Jiaxing Research Institute, Zhejiang University, Jiaxing 314031, China

ARTICLE INFO

Keywords:
Municipal solid waste incineration (MSWI)
Dioxin real-time prediction
Long short-term memory
Convolutional neural networks
Time series input

ABSTRACT

The immeasurability of real-time dioxin emissions is the principal limitation to controlling and reducing dioxin emissions in municipal solid waste incineration (MSWI). Existing methods for dioxin emissions prediction are based on machine learning with inadequate dioxin datasets. In this study, the deep learning models are trained through larger online dioxin emissions data from a waste incinerator to predict real-time dioxin emissions. First, data are collected and the operating data are preprocessed. Then, the dioxin emission prediction performance of the machine learning and deep learning models, including long short-term memory (LSTM) and convolutional neural networks (CNN), with normal input and time-series input are compared. We evaluate the applicability of each model and find that the performance of the deep learning models (LSTM and CNN) has improved by 36.5% and 30.4%, respectively, in terms of the mean square error (MSE) with the time-series input. Moreover, through feature analysis, we find that temperature, airflow, and time dimension are considerable for dioxin prediction. The results are meaningful for optimizing the control of dioxins from MSWI.

1. Introduction

Municipal solid waste incineration (MSWI), which is characterized by waste volume reduction, resource utilization, and harmless disposal (Cohen et al., 2021; Shapiro-Bengtsen et al., 2020), has become one of the widest alternatives for waste disposal in cities. However, dioxins are typical pollutants with strong carcinogenicity, teratogenicity, and mutagenicity that are produced during waste incineration (Chen et al., 2021; Kato and Urano, 2001), which often incurs the "not in my backyard" effect in the construction of MSWI (Nzihou et al., 2012). According to the most recent research, even with advanced contemporary air pollution control devices (APCD), dioxin emissions from MSWI facilities continue to fluctuate widely and may even exceed emission limits (Arbinolo, 2018; Wei et al., 2022; Xiong et al., 2021c). Therefore, it is necessary to control dioxin emissions from municipal solid waste incinerators, and anticipating these emissions enables plants to proactively devise effective strategies for emission control, mitigating the risk of excessive pollutant release.

Dioxins, as trace pollutants, are difficult to measure and monitor in real-time in MSWI due to the complex and expensive nature of the measurement process (Lin et al., 2015). Traditionally, dioxin measurement involves sampling, extracting, purifying, and analyzing dioxins with high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) (China, Ministry of Ecology Environment, 2008; US. EPA, 2017). The traditional analysis procedure for dioxins from MSWI takes at least a week due to its complexity. Additionally, the cost of the traditional measurement method is high, resulting in annual measurements. Nonetheless, the long-term sampling of dioxins has been verified as an effective monitoring method for total dioxin emissions (Mayer et al., 2000). The standard method and long-term sampling ensure the accuracy of measurements, but the large time lag prevents the development of rapid feedback control (Gullett et al., 2012; Xiong et al., 2021c). Therefore, the stable and continuous online monitoring of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs) is crucial for the real-time control of MSWI.

Online dioxin monitoring technology, which provides rapid continuous feedback, greatly reducing the cost per sample (Cao et al., 2019b), is vital to decrease dioxin emissions. However, at present, research on online sampling and real-time monitoring technology for dioxins is

* Corresponding author.
E-mail address: linxiaoqing@zju.edu.cn (X. Lin).

https://doi.org/10.1016/j.wasman.2023.08.004
Received 23 March 2023; Received in revised form 2 July 2023; Accepted 4 August 2023
Available online 8 August 2023

《SCI-Expanded》收录证明

经检索《Web of Science》的《Science Citation Index Expanded (SCI-EXPANDED)》数据库，下述论文被《SCI-EXPANDED》收录。（检索时间：2023 年 10 月 19 日）

第 1 条，共 1 条

标题:Dioxin emission prediction from a full-scale municipal solid waste incinerator: Deep learning model in time-series input

作者:Wen, CJ(Wen, Chaojun);Lin, XQ(Lin, Xiaoqing);Ying, YX(Ying, Yuxuan);Ma, YF(Ma, Yunfeng);Yu, H(Yu, Hong);Li, XD(Li, Xiaodong);Yan, JH(Yan, Jianhua);

来源出版物:WASTE MANAGEMENT 卷:170 页:93-102 **DOI:**10.1016/j.wasman.2023.08.004 出版年:OCT 1 2023

入藏号:WOS:001065023200001

文献类型:Article

地址:

[Wen, Chaojun; Lin, Xiaoqing] Zhejiang Univ, Polytech Inst, Hangzhou 310027, Peoples R China.
[Lin, Xiaoqing; Ying, Yuxuan; Ma, Yunfeng; Yu, Hong; Li, Xiaodong; Yan, Jianhua] Zhejiang Univ, Inst Thermal Power Engn, State Key Lab Clean Energy Utilizat, Hangzhou 310027, Peoples R China.
[Li, Xiaodong] Zhejiang Univ, Jiaxing Res Inst, Key Lab Clean Energy & Carbon Neutral Zhejiang Pro, Jiaxing 314031, Peoples R China.

通讯作者地址:

Lin, XQ (corresponding author), Zhejiang Univ, Polytech Inst, Hangzhou 310027, Peoples R China.; Lin, XQ (corresponding author), Zhejiang Univ, Inst Thermal Power Engn, State Key Lab Clean Energy Utilizat, Hangzhou 310027, Peoples R China.

电子邮件地址:linxiaoqing@zju.edu.cn

IDS 号:R5VH4

ISSN:0956-053X

eISSN:1879-2456

注：

1. 以上检索结果来自 CALIS 查收查引系统。
2. 以上检索结果均得到委托人及被检索作者的确认。

教育部科技查新工作站（Z09）
检索人（签字）：应湘艺
2023 年 10 月 19 日

2. 废物焚烧炉二噁英排放实时预警及智能控制的方法及系统 （发明专利授权）

证书号第6140326号

发明专利证书

发明名称：废物焚烧炉二噁英排放实时预警及智能控制的方法及系统

发 明 人：林晓青;温朝军;余泓;吴昂键;张浩;李晓东;严建华

专 利 号：ZL 2022 1 0845636.0

专利申请日：2022年07月18日

专 利 权 人：浙江大学

地 址：310058 浙江省杭州市西湖区余杭塘路866号

授权公告日：2023年07月14日　　授权公告号：CN 115329659 B

国家知识产权局依照中华人民共和国专利法进行审查，决定授予专利权，颁发发明专利证书并在专利登记簿上予以登记。专利权自授权公告之日起生效。专利权期限为二十年，自申请日起算。

专利证书记载专利权登记时的法律状况。专利权的转移、质押、无效、终止、恢复和专利权人的姓名或名称、国籍、地址变更等事项记载在专利登记簿上。

局长
申长雨

国家知识产权局
2023年07月14日

第1页(共2页)

其他事项参见续页

证书号第6140326号

专利权人应当依照专利法及其实施细则规定缴纳年费。本专利的年费应当在每年07月18日前缴纳。未按照规定缴纳年费的，专利权自应当缴纳年费期满之日起终止。

申请日时本专利记载的申请人、发明人信息如下：

申请人：

浙江大学

发明人：

林晓青;温朝军;余泓;吴昂键;张浩;李晓东;严建华

3. Thermal Behavior Prediction of Sludge Co-Combustion with Coal: Curve Extraction and Artificial Neural Networks
https://www.mdpi.com/2227-9717/11/8/2275

Open Access Article

Thermal Behavior Prediction of Sludge Co-Combustion with Coal: Curve Extraction and Artificial Neural Networks

by Chaojun Wen [1], Junlin Lu [1], Xiaoqing Lin [1,*], Yuxuan Ying [1], Yunfeng Ma [1], Hong Yu [1], Wenxin Yu [2], Qunxing Huang [1], Xiaodong Li [1] and Jianhua Yan [1]

[1] State Key Laboratory of Clean Energy Utilization, Institute for Thermal Power Engineering, Zhejiang University, Hangzhou 310027, China

[2] Huaneng Shandong Shidaobay Nuclear Power Co., Ltd., Weihai 264300, China

* Author to whom correspondence should be addressed.

Processes **2023**, *11*(8), 2275; https://doi.org/10.3390/pr11082275

Submission received: 4 July 2023 / Revised: 25 July 2023 / Accepted: 26 July 2023 / Published: 28 July 2023

(This article belongs to the Special Issue Low-Carbon Combustion Technology and Engineering)

Download Browse Figures Versions Notes

Abstract

Previous studies on the co-combustion of sludge and coal have not effectively utilized the characteristics of the combustion process to predict thermal behavior. Therefore, focusing on these combustion process characteristics is essential to understanding and predicting thermal behavior during the co-combustion of sludge and coal. In this paper, we use thermogravimetric analysis to study the co-combustion of coal and sludge at different temperatures (300–460 °C, 460–530 °C, and 530–600 °C). Our findings reveal that the ignition improves, but the combustion worsens with more sludge. Then, we further employ curve extraction based on temperature and image segmentation to extract the DTG (weight loss rate) curves. We successfully predicted the DTG curves for different blends using nonlinear regression and curve extraction, achieving an excellent R^2 of 99.7%. Moreover, the curve extraction method predicts DTG better than artificial neural networks for two samples in terms of R^2 (99.7% vs. 99.1% and 99.7% vs. 94.9%), which guides the application of co-combusting coal and sludge.

Keywords: sludge co-combustion; thermal behavior; prediction; thermogravimetric curve extraction (TCE); artificial neural networks (ANN)

processes

MDPI

Article

Thermal Behavior Prediction of Sludge Co-Combustion with Coal: Curve Extraction and Artificial Neural Networks

Chaojun Wen [1], Junlin Lu [1], Xiaoqing Lin [1,*], Yuxuan Ying [1], Yunfeng Ma [1], Hong Yu [1], Wenxin Yu [2], Qunxing Huang [1], Xiaodong Li [1] and Jianhua Yan [1]

[1] State Key Laboratory of Clean Energy Utilization, Institute for Thermal Power Engineering, Zhejiang University, Hangzhou 310027, China; 22160323@zju.edu.cn (C.W.); 22060153@zju.edu.cn (J.L.); yuxuany@zju.edu.cn (Y.Y.); happyjoe@zju.edu.cn (Y.M.); yu-hong@zju.edu.cn (H.Y.); hqx@zju.edu.cn (Q.H.); lixd@zju.edu.cn (X.L.); yanjh@zju.edu.cn (J.Y.)

[2] Huaneng Shandong Shidaobay Nuclear Power Co., Ltd., Weihai 264300, China; yuwenxin@sdwgs.chng.com.cn

* Correspondence: linxiaoqing@zju.edu.cn; Tel.: +86-0571-8795-1950

Abstract: Previous studies on the co-combustion of sludge and coal have not effectively utilized the characteristics of the combustion process to predict thermal behavior. Therefore, focusing on these combustion process characteristics is essential to understanding and predicting thermal behavior during the co-combustion of sludge and coal. In this paper, we use thermogravimetric analysis to study the co-combustion of coal and sludge at different temperatures (300–460 °C, 460–530 °C, and 530–600 °C). Our findings reveal that the ignition improves, but the combustion worsens with more sludge. Then, we further employ curve extraction based on temperature and image segmentation to extract the DTG (weight loss rate) curves. We successfully predicted the DTG curves for different blends using nonlinear regression and curve extraction, achieving an excellent R^2 of 99.7%. Moreover, the curve extraction method predicts DTG better than artificial neural networks for two samples in terms of R^2 (99.7% vs. 99.1% and 99.7% vs. 94.9%), which guides the application of co-combusting coal and sludge.

Keywords: sludge co-combustion; thermal behavior; prediction; thermogravimetric curve extraction (TCE); artificial neural networks (ANN)

check for updates

Citation: Wen, C.; Lu, J.; Lin, X.; Ying, Y.; Ma, Y.; Yu, H.; Yu, W.; Huang, Q.; Li, X.; Yan, J. Thermal Behavior Prediction of Sludge Co-Combustion with Coal: Curve Extraction and Artificial Neural Networks. *Processes* **2023**, *11*, 2275. https://doi.org/10.3390/pr11082275

Academic Editor: Raymond Cecil Everson

Received: 4 July 2023
Revised: 25 July 2023
Accepted: 26 July 2023
Published: 28 July 2023

1. Introduction

The co-disposal of sludge in pulverized coal boilers is an effective approach to rapidly and safely disposing of sludge, with benefits such as energy recovery and resource utilization [1,2]. The co-combustion of sludge with coal is currently employed as a viable method to convert dried sludge into higher-value fuels or chemicals. This co-combustion process offers specific advantages, such as substituting fossil fuels and mitigating CO_2 emissions [3]. However, several studies have investigated the co-combustion behavior of sludge and coal due to their varying combustion characteristics. Kang et al. [4] revealed that blending sewage sludge with coal has positive economic benefits. Yang et al. [5] found that co-combusting coal gangue and sewage sludge improves ignition performance and reduces SO_2 and NO_x emissions. Fu et al. [6] studied heavy metals' thermochemical, kinetic, and emission behaviors during the co-combustion of industrial coal slime and sewage sludge. Results showed that the mixture has synergistic combustion properties, and adding sludge improves ignition performance. Moreover, the optimal synergistic effect of the mixture is achieved when the sludge addition ratio is 20%. Due to the complex composition of sludge, its combustion characteristics vary when mixed with different types of coal. This makes it challenging to accurately characterize the combustion process and optimize the actual conditions.

Thermogravimetric analysis (TGA) is a technique used to study fuel characterization by rapidly assessing combustion characteristics such as ignition temperature, maximum

《SCI-Expanded》收录证明

经检索《Web of Science》的《Science Citation Index Expanded (SCI-EXPANDED)》数据库，下述论文被《SCI-EXPANDED》收录。（检索时间：2023 年 9 月 11 日）

第 1 条，共 1 条

标题:Thermal Behavior Prediction of Sludge Co-Combustion with Coal: Curve Extraction and Artificial Neural Networks

作者:Wen, CJ(Wen, Chaojun);Lu, JL(Lu, Junlin);Lin, XQ(Lin, Xiaoqing);Ying, YX(Ying, Yuxuan);Ma, YF(Ma, Yunfeng);Yu, H(Yu, Hong);Yu, WX(Yu, Wenxin);Huang, QX(Huang, Qunxing);Li, XD(Li, Xiaodong);Yan, JH(Yan, Jianhua);Everson, RC(Everson, Raymond Cecil);

来源出版物:PROCESSES 卷:11 期:8 文献号:2275 **DOI:**10.3390/pr11082275 出版年:AUG 2023

入藏号:WOS:001056356100001

文献类型:Article

地址:

[Wen, Chaojun; Lu, Junlin; Lin, Xiaoqing; Ying, Yuxuan; Ma, Yunfeng; Yu, Hong; Huang, Qunxing; Li, Xiaodong; Yan, Jianhua] Zhejiang Univ, State Key Lab Clean Energy Utilizat, Inst Thermal Power Engn, Hangzhou 310027, Peoples R China.

[Yu, Wenxin] Huaneng Shandong Shidaobay Nucl Power Co Ltd, Weihai 264300, Peoples R China.

通讯作者地址:

Lin, XQ (corresponding author), Zhejiang Univ, State Key Lab Clean Energy Utilizat, Inst Thermal Power Engn, Hangzhou 310027, Peoples R China.

电子邮件地址:2160323@zju.edu.cn; 22060153@zju.edu.cn; linxiaoqing@zju.edu.cn;yuxuany@zju.edu.cn; happyjoe@zju.edu.cn; yu-hong@zju.edu.cn;hqx@zju.edu.cn; lixd@zju.edu.cn; yanjh@zju.edu.cn;yuwenxin@sdwgs.chng.com.cn

IDS 号:Q3DQ2

eISSN:2227-9717

注：

1. 以上检索结果来自 **CALIS** 查收查引系统。
2. 以上检索结果均得到委托人及被检索作者的确认。

教育部科技查新工作站（Z09）

检索人（签章）：郑岚岚

2023 年 9 月 11 日