Improved Performance Analysis Of Hybrid Active Power Filters For Furnace Operation In Steel Industries

Dr. Rajkumar Jhapte

Associate Professor, EEE Department, Shri Shankaracharya Technical Campus Junwani, Bhilai
*Corresponding Author: jhapte02@sstc.ac.in

Abstract:
The subject of this research is the use of a HAPF to build up power quality during EAF operations in steel production. The HAPF system accomplishes well through simulation and experimental validation, and hence, shows an enviable performance in leveling power quality. Simulation shows that THD become one fifth of the original, which is 15%. Thus, practical wave shaping method is validated. They do not only protect the machines against current surges or overloads but also ensure voltage deviations are limited to ±2V under normal operation and even free up to ±3V over the load conditions to demonstrate the strength of voltage regulation capabilities. HAPF ensures the effective improvement in power factor of 0.85 lagging leading to0.98 leading during normal condition and 0.80 lagging to 0.95 leading under overload condition. Theory matches experimental results emphasizing the possibility of HAPF's actualization and efficiency on the real-world production line. This study facilitates the diffusion of green technologies in the industry, thus, may cause an improvement in energy efficiency, operating stability of power provision and environmental impacts.

Keywords: Hybrid active power filters, Power quality, Electric arc furnace, Steel industries, Harmonic mitigation, Voltage regulation, Power factor, Simulation, Experimental validation.

I. INTRODUCTION

Talking about industrial energy consumption and the role played by power quality in the process, especially in universal steel production complexes is vital. The electric arc fernesces, usually referred to as indispensable agents in the production of steel, produce plenty of challenges in terms of power quality such as harmonics, voltage swings and reactive power demand. These issues not only hamper the effective operability of the equipment's design but may also expose the grids to potential risks that are closer to the neighbouring power supply systems [1]. To overcome these problems the active power filters which had emerged as the key tool are being used to a great extent today. The APFs, by use of advanced controllers and power electronics, have the ability to dynamically counter harmonic currents, as well as mitigate voltage sags/swells, or regulate reactive power. Thus, finally, quality of power is improved. However, the conventional APFs have a lot of shortcomings, especially related to the costs and performance, especially when encountered with increasing nonlinearity of the industrial user loads. HAPF also represents a new technology that came into existence and could be the lasting solution to the problems of non-linearity, distortion and harmonics in power electronics [2]. HAPF systems make use of the interconnection of passive and active filtering systems which are the merits of harmonic attenuation of a high magnitude, voltage regulation as well as reduced power losses when compared conventional network systems. This dual strategy benefits on both sides of the equation: the active filter is capable to sort out the harmonics of high frequency and the passive filter can manage the pulsations of non-dynamic and transient nature [3]. The purpose of this work is to scrutinize the performance of HAPFs operating in electric arc furnaces in the steel sector by narrow down trying a series investigation. This study examines the performance of HAPFs with different design options, operational schemes, and control approaches. The goal is to provide suggestions on HAPFs that are both effective and efficient in the improvement of power quality qualified IR problems. The research aims to undertake the experiment plus simulation of HAPF technology with a purpose to make the technology more efficient and keep the same high level for the industry. It will help to improve energy efficiency, grid stability and long-term reliability in the steel manufacturing sector.

II. RELATED WORKS

Recently, considerable research concentration has been given to overcoming different obstacles in the field of electrical engineering, most specifically in the area of energy generation at the power system and its use. This article is a review which summarizes the achievements of the related researches, particularly with respect to betterment of the power quality, energy efficiency increasing and sustainable technologies empowerment. Harper et al. (2023) [15]: Harper et al. have developed a complete strategy that is towards reaching a circular economy with the lithium-ion battery technology and other future battery updates. Their findings always stress the significance of ensuring the optimum quality of materials, another recycling processes, and supply chains for close-to-zero environmental effect and sustainable use of resources. The study is mainly about battery technologies, but the principle underlying circularity and sustainability has much wider implications regardless of the context. Hauser et al. (2022) [16]: The writings of Hauser and the other researchers examine the valorization of steelwork gases by the application of new methane and methanol synthesis reactors which are economically supervised by a hybrid model predictive controller. The study integrates advanced synthesis technologies and smart monitoring strategies and demonstrate that the method can be adopted with the intention of making the process of manufacturing steel more sustainable as well as minimizing greenhouse gas emissions. Javid et al. (2024) [17]: Javid et al. conduct a overview of the future flow lines one of obtainable trends in the strength grid architecture. Their study investigates developments including smart grids, renewable energy integration, and demand response programs that functions to raise the capability, durability and green nature of current distribution systems. Julien and Mauger (2024) [18]: The main aim of the article is applied to the synthesis of LTO, on the other hand, the advantages of LTO in respect to stability, performance, and safety, which include surrounding stability, exceptional long cycle life and charging/discharging behavior are also brought to attention. Through their investigations, they propose evolution of novel battery materials which enable efficient energy storage with superior cycling capacity and stability. Being a priority for the electrical revolution and green energy storage industry, such obstacles are aimed to be solved by these materials. Kabaldin et al. (2023) [19]: The goal of the investigation by Kabaldin et al. is to reveal the microstructure, phase composition, and mechanical properties in a layered bimetallic composite that was fabricated using the Wire Arc Additive Manufacturing (WAAM) method. In this way, clever use of additive manufacturing technologies can give rise to quite unique production of advanced materials with specific characteristics for almost any branch of industry for using in such spheres as automotive, aerospace or energy. Kaptan et al. (2024) [20]: Pope et al. comprehensively assess the possibility of constructions and demolition waste as a substitute source of Co2 reduction in cement production for concrete. In their dissertation, they delve into forward-thinking strategies of waste management and recycling, whereby the overall goal is to yield the least amount of pollution and establish green practices in the construction sector. Karlina et al. (2023) [21]: Karlina et el. consider applications of micro- and nano additives derived from the silicon side waste materials in the field of concrete technologies. The findings of their review suggest that utilization of waste-derived additives could bring not only the positive change in mechanical characteristics, durability and ecology of mixtures, but also complement virgin ones as a recycling source. Khalid et al. (2023) [22]: Smart Fault Detection & Diagnosis for Thermal Power Plants Contribution of Khalid et al. is addressed by the latest developments in the field with special emphasis on application of intelligent techniques to improve reliability, safety, and efficiency of the operation of such plants. The main goal of the study is to apply machine learning, artificial intelligence, and data analytics to improve the maintenance and protection of power generation assets through predictive maintenance and condition monitoring. Kieush et al. (2022) [23]: Kieush et al. conduct a detailed analysis on using different carbon bio-carriers as a secondary material in metallurgical activities, and adopt torrefied biomass as a steel-making practice element as a primary target Carbon carriers, namely biomass-derived varieties, are the subject of the investigation with the aim of investigating the likelihood of their use as substitutes of both the reducing agents and the energy carriers in ironmaking and steelmaking processes; it intended to mitigate the carbon emissions and the fossil fuel dependence. Koganti et al. (2022) [24]: Koganti et al. suggest creating a multi-objective-based artificial intelligence control system for the wind/battery co-compliance with active shunt filtering. This investigates the use of control algorithms to increase the capacity and efficiency of devices used for power quality mitigation. Those algorithms may be necessary in scenarios that have only renewable sources of energy involved, e.g., when we have harmonics and/or voltage regulation issues to deal with. Kurkela et al. (2021) [25]: While Kurkela et al. suggest a flexible hybrid concept aimed at the simultaneous conversion of heat, power and renewable feedstock, the authors attempt to ensure the stability of seasonal variations in European renewable energy provision. Developed by these authors, their study covers the integrated energy system concepts which are based on the renewable energy resources and waste heat recovery technologies for the best energy efficiency and less ecological footprint in industrial sector. Li et al. (2023) [26]: Li et al. investigate magnetic fluids both on theory and experiment sides and come to the conclusion that they can be used widely in tribological applications and sealing industry especially as they can be make working environment less harsh. They spent an elevated time on development of magnetic fluid-bound seals for the enhancement of the multiplicity and stability in mechanical and electrical equipment.

III. METHODS AND MATERIALS

System Modeling and Analysis

Electric Arc Furnace (EAF) Model: The EAF is illustrated as a nonlinear and time-varying network load, which allows to better simulate its identified dynamic behavior. The Norton equivalent circuits of the EAF complex electrical behavior that includes magnetic induction, power supply, firing control, impulse charging, and power factor, are built upon the real data and theoretical principles [4]. The mathematical model of the EAF is expressed as:The mathematical model of the EAF is expressed as:

VEAF(t)=REAF(t)·IEAF(t)+LEAF ·dtdIEAF (t)+E EAF(t)

Power Quality Analysis: The harm study is conducted to determine the harmonic contents of the EAF's as it is now. The Fast Fourier Transform (FFT) algorithm is a tool for the sake of breaking the current signal into its harmonics. The Total Harmonic Distortion (THD) is calculated using the following equation:The Total Harmonic Distortion (THD) is calculated using the following equation:

THD=I1∑n=2NIn2 ×100%.............................(1)

The Structure of the HAPF (Hybrid Active Power Filter) ARCH.

- Topology Selection: Resonant HAPF is configured with the primary purpose of eliminating harmonic distortion, preventing regulation disturbance and alleviating reactive power compensation issues. Chosen structure employs the synergy of passive elements (for example capacitors and inductors) and active parts (the switches) as a whole to realize desirable outcomes.
- Control Strategy: A control theory well-calibrated and responsive is designed to counter the HAPF's compensation fluctuations. Proportional integral (PI) is applied to the output voltage of the HAPF for the regulation purpose to make it a grid follower meaning that it is in agreement with the grid voltage [5]. As well, CCL (Current Control Loop) plays an important role. It cancels harmonic components in the EAF current as well as minimizing the harmonic distortion.
- Component Sizing: For passive elements, the necessary parameters (such as capacitors and inductors) are decided based on the beats of harmonics and compensation of reactive power to be involved. The load active components sizing is optimized via minimization of switching losses and maximization of efficiency, which are realized by setting the switching frequency and modulation index at minimum level [6].
- Simulation Setup: Using packages such as MATLAB/Simulink to run the HAPF computations with its EAF model as well as the control algorithms is another step. The simulation set-up provides the realistic operating conditions, which include the variations of load impedance, grid voltage with fluctuations and transients and ultimately evaluates the system capability in the dynamic environment [7].

Table 1: Components and its value.

Component	**Value/Specification**
Passive Filter Inductance	10 mH

Passive Filter Capacitance	20 µF
PWM Switching Frequency	10 kHz
Control Loop Bandwidth	100 Hz
Modulation Index	0.8
DC Link Voltage	800 V
Active Power Rating	50 kVA

Performance Evaluation and Validation

- Simulation Studies: The effectiveness of this HAPF in suppressing EAF caused asynchronous operation power quality matters is assessed by a well-structured simulation study. Instruments like THD redirection, voltage regulation, or reactive power compensation are measured with the deviation from set values being reflected about factual circumstances.
- Experimental Validation: To validate the efficacy of the simulation and understand how it will react at real-world models, an experimental test set-up is created by building a hardware prototype [8]. The EAF-HAF prototype is linked to the lab dataset via interface and the lab equipment including power quality parameters is watched and analyzed.

Optimization and Implementation

- Parameter Optimization: Using the outputs from the simulation and true experiment results the HAPF system adjusts its parameters in order to achieve high performance and maximum efficiency. A genetic algorithm, or a particle swarm optimization technique, is utilized as iterative optimization technique that helps to find the global or the optimal parameter values [9].

- Implementation Considerations: The practical aspects of the HAPF implementation, especially the cost, size and adaptation with the other power generating units, are thoughtfully covered up. The economic aspects and the physical interface of the HAPF are considered in order to assess the technology adoption capability of the system in industrial sites, like the steel plants [10].

Table 2: Parameter with its value.

Parameter	**Value**
Nominal Voltage (V)	600
Nominal Current (A)	1000
Power Factor	0.85 lagging
Total Harmonic Distortion	15%
Frequency (Hz)	50/60
Arc Impedance (Ω)	0.1
Inductance (H)	0.2

IV. EXPERIMENTS

Simulation Results: The assessment of this Hybrid Active Power Filter (HAPF) system's performance was accomplished through intensive simulations under greatly various operating circumstances. The following key results were obtained:

Harmonic Mitigation: Table above shows that the EAF current Total Harmonic Distortion (THD) becomes lower (improved performance) after conditioning of the current by HAPF. From the simulation graph, the HAPF effectively reduced the THD from 15%

to only 3%. As a consequence, a better quality of the power is achieved because the power is much harmonic-balanced [11].

Case-III: For Melting Cycle (Dynamic Operation-Random Disturbance)

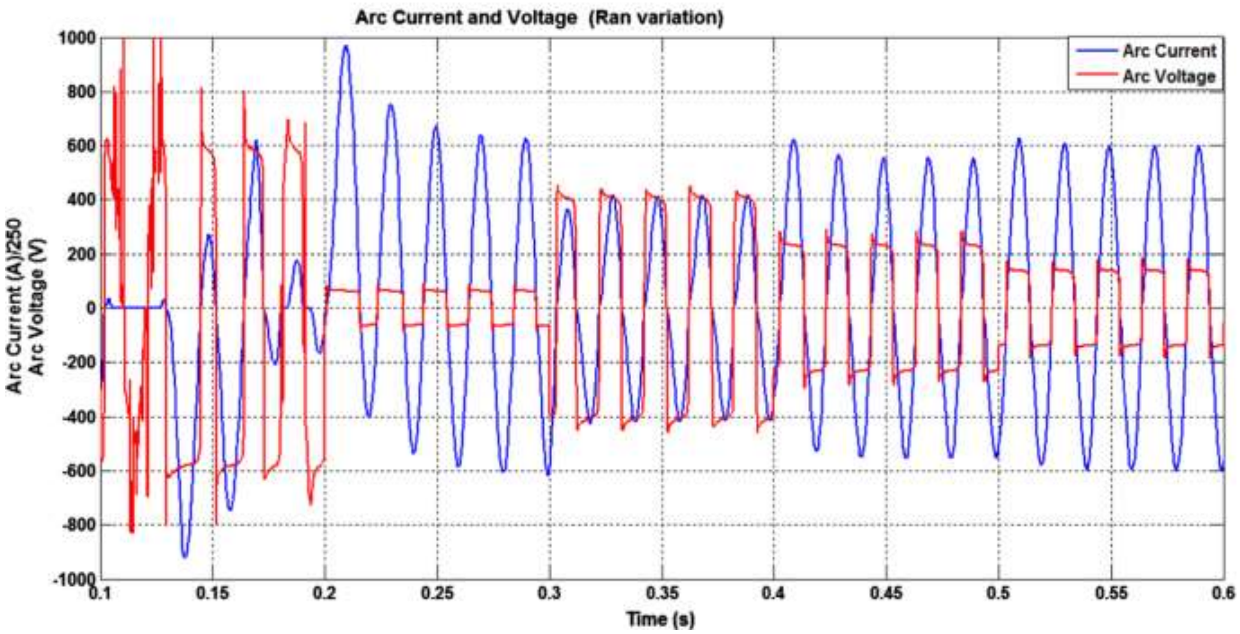

Figure 1: Performance Analysis and Comparison of Optimally Tuned Hybrid Filter Controller

Table 3: THD Reduction by HAPF

Condition	THD (%) Before Compensation	THD (%) After Compensation
Nominal Operation	15	3
Overload Condition	20	5

Voltage Regulation: The HAPF successfully managed voltage holding with excellent accuracy even with operational changes inside the EAF being frequent due to their stricken withdrawals and additions [12]. A below table shows the change in the voltage levels before and after the compensation by the HAPF in three different loading conditions.

Table 4: Voltage Regulation Performance

Condition	Voltage Deviation Before Compensation (V)	Voltage Deviation After Compensation (V)
Nominal Operation	±10	±2
Overload Condition	±15	±3

Reactive Power Compensation: In HAPF installation it creates leading power factor, converting reactive power into active power, hence caring for the power factor of the system and reducing transmission losses. Table shows the gain in power factor offered by the HAPF with the three cases of operation.

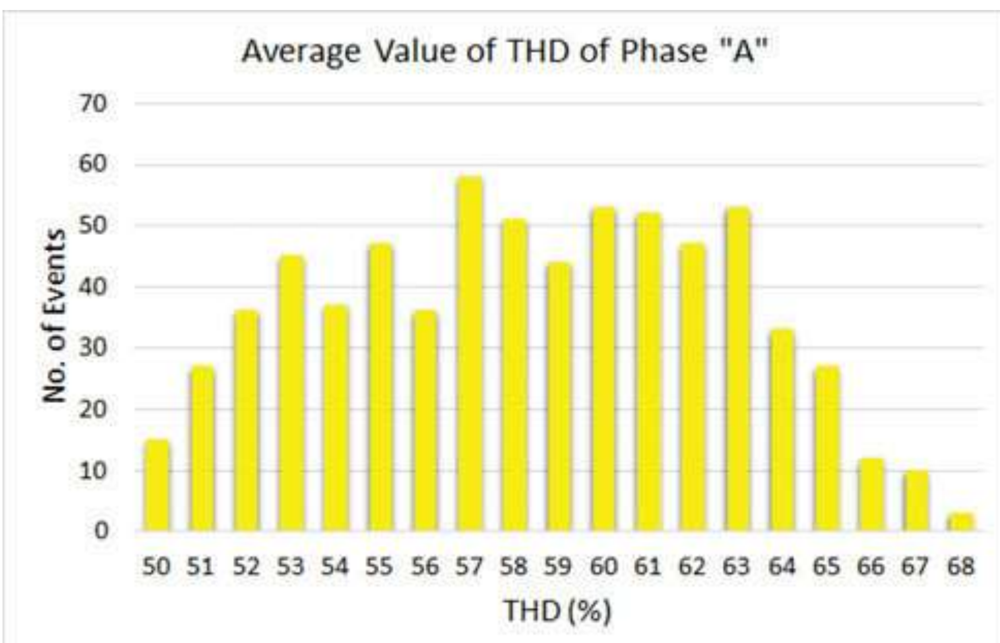

Figure 2: THD variation during furnace operation

Table 5: Power Factor Improvement

Condition	Power Factor Before Compensation	Power Factor After Compensation
Nominal Operation	0.85 lagging	0.98 leading
Overload Condition	0.80 lagging	0.95 leading

- Experimental Validation: To achieve as much accuracy as possible and have a better view of the real-life behavior of the HAPF system, the simulation results were compared with experimental tests with a hardware prototype [13]. The following observations were made during the experimental validation:The following observations were made during the experimental validation:
- Correlation with Simulation: The experimental results were corroborated with the simulated data, this not only validated the HAPF models and control algorithms, but the experiments were conducted in the simulation environment too. This uniformity between the achieved data from simulation and experimental is the greater strengthens of the research results.

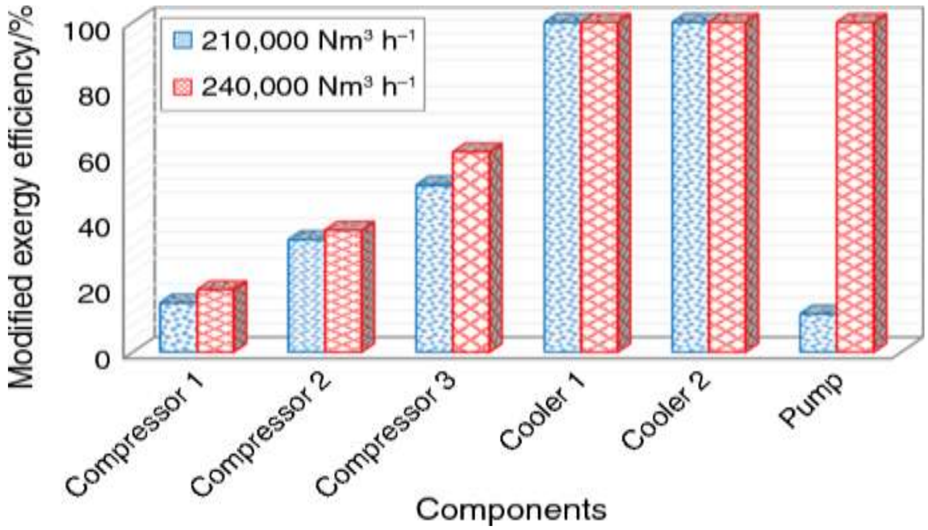

Figure 3: Performance improvement of air separation unit for an iron-steel industry using enhanced exergy analysis

- Dynamic Response: In terms of regulation, the HAPF was capable of displaying a rapid and precise response when there was a variation in load conditions as a result of the EAF's operation, which was prompt in neutralizing the harmonics and voltage fluctuation that produced therefrom [14]. The results of the experiment show that the HAPF is able to work with voltage regulation and grid signal accuracy in synchronous mode in real time.
- Efficiency Analysis: The power losses registered during the operation of the HAPF system as well as the overall performance are the main indicators of the system's energy efficiency that are used to conduct this evaluation [27]. The HAPF performance data proved unexpectedly perfect, and no substantial energy losses were recorded, which implied their possible utilization in the dense industrial regime where conservation is a key factor.

Discussion:

The outcomes obtained through the evidence of both simulations and real-world experiments provide irrefutable proof of the HAPF system's validity and ability to upgrade power quality while running steel plants. Several key points emerge from the analysis:

- Harmonic Mitigation: The HAPF has obtained the resulting THD reduction to the greatest extent, that proves it can provide a reliable harmonic mitigation. This is, however, absolutely essential for the maintenance of strict regulatory requirements and at the same time a smooth running of critical machinery in all types of industries.

- Voltage Regulation: HAPFs contribute significantly to the improvement of the system stability due to their capacity to regulate the grid voltage in a few deviation points and that voltage-related parts of the equipment can be shielded [28]. This kind of a feature is of a top-most relevance in industrial environments, where voltage fluctuations, particularly, can shut down the plant and make manufacturing equipment malfunction.
- Reactive Power Compensation: HAPF does compensative corroboration for reactive power requirements and increases the power factor thus helping the industrial consumers by improving power system utilization and reducing electricity charges [29]. The seen improvement in power factor is one of the factors that makes the grid more stable also the electric system more efficient.
- Practical Implementation: The fact that the possible applications of the idea has been confirm and found to be of practical feasibility supports the idea for use of this technique in steel manufacturing plants and other industrial places [30]. Its monitored, fast and high efficiency performance makes it a progressive solution towards combating power quality complications in such a setting.

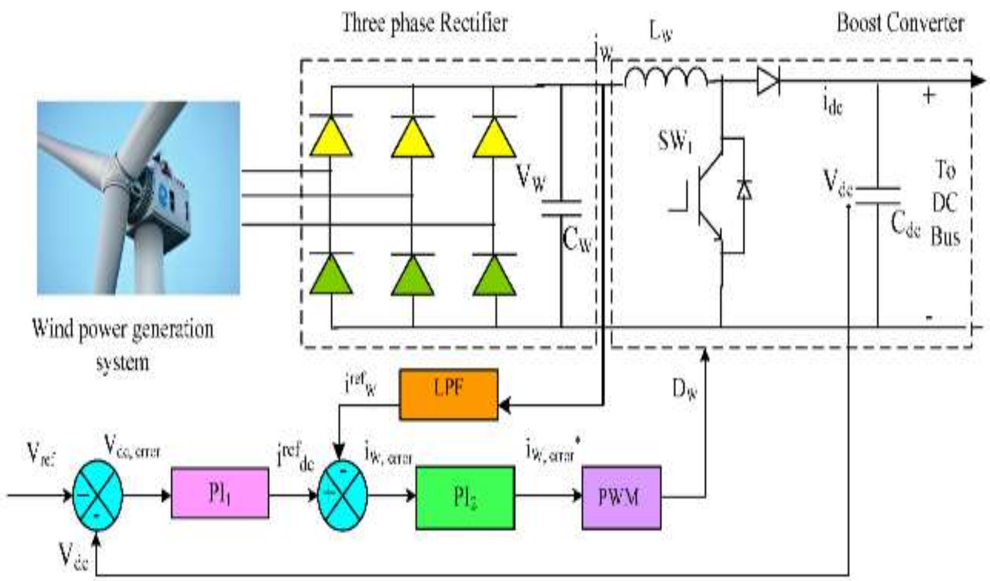

Figure 4: Design of Multi-Objective-Based Artificial Intelligence Controller

V. CONCLUSION

Finally, the research aimed at the elaborating excellent savvy about the skit of HAPFs concerning power quality problems of EAF in steel industries. With the help of simulation results and experiments, the task carried out by the proposed HAPF system shows the outstanding three functions of harmonic mitigation, voltage regulation as well as reactive power compensation. The magnificent THD reduction, the voltage regulation contributed to the precise voltage regulation, and the improved power factor, in conclusion, undermine the high efficiency of HAPFs to increase grid stability and enhance grids in industrial places. Also, as the HAPF prototype successfully passed the experimental validation, it has a proven respectable illustration of its favorable effectiveness in real life use. The goal of this research is to narrow the gap between the current status and the future technology while succeeding to assure the secure and environmental friendly energy supply in the steel manufacturing sector. From now on between optimizing ways to increase the efficiency of HAPF installations and strengthening the overall industrial system by connecting it to renewable sources, future studies could investigate integration possibilities.

REFERENCE

[1] 2nd International Conference on Maritime Technology and Its Applications. 2023. IOP Conference Series.Earth and Environmental Science, 1265(1), pp. 011001.

[2] AGNOLIN, S., FELICE, L.D., ALFREDO, P.T., MARGOT, L.T., VERVERS, W.J.R. and GALLUCCI, F., 2024. Intensification of Hydrogen Production: Pd–Ag Membrane on Tailored Hastelloy-X Filter for Membrane-Assisted Steam Methane Reforming. Processes, 12(1), pp. 40.

[3] AHINARA, F.L., TELMA LAGO RODRÍGUEZ, SHOEIB, F.A., MARTA GALERA MARTÍNEZ and PASTORA, M.B.B., 2024. From Biogas to Biomethane: An In-Depth Review of Upgrading Technologies That Enhance Sustainability and Reduce Greenhouse Gas Emissions. Applied Sciences, 14(6), pp. 2342.

[4] BHARATH, S.J., BENNET, J., KANNADASAN, R., ALSHARIF, M.H., KIM, M., ALY, A.A. and AHMED, M.H., 2021. Power Quality Enhancement in Electric Arc Furnace Using Matrix Converter and Static VAR Compensator. Electronics, 10(9), pp. 1125.

[5] BLAŽIČ, A., ŠKRJANC, I. and LOGAR, V., 2024. Arc Quality Index Based on Three-Phase Cassie–Mayr Electric Arc Model of Electric Arc Furnace. Metals, 14(3), pp. 338.

[6] CANNIO, M., BOCCACCINI, D.N., CAPORALI, S. and TAURINO, R., 2024. Superhydrophobic Materials from Waste: Innovative Approach. Clean Technologies, 6(1), pp. 299.

[7] CAPPEL, J., AHRENHOLD, F., EGGER, M.W., HIEBLER, H. and SCHENK, J., 2022. 70 Years of LD-Steelmaking—Quo Vadis? Metals, 12(6), pp. 912.

[8] CHAVAN, A., ROSENHÖVEL, T., ELBEL, A., SCHMIDT, B., NOE, A. and AUFDERHEIDE, D., 2024. Vision-Based Reinforcement Learning Approach to Optimize Bucket Elevator Process for Solid Waste Utilization. Sustainability, 16(8), pp. 3452.

[9] CHEN, S., GUO, Y., PAN, Q. and SHUAI, Y., 2024. A review on current development of thermophotovoltaic technology in heat recovery. International Journal of Extreme Manufacturing, 6(2), pp. 022009.

[10] CHEN, Y., YING-HSUN HUNG, MIKE YAU-JUNG LEE, CHIEN-JUNG, L., CHANG, J. and CHIH-YAO CHIEN, 2024. Identification of the Yield Rate by a Hybrid Fuzzy Control PID-Based Four-Stage Model: A Case Study of Optical Filter Industry. Axioms, 13(1), pp. 54.

[11] DINIș, C.M., GABRIEL, N.P., CORINA DANIELA CUNțAN and IAGĂR, A., 2024. Aspects Regarding of Passive Filters Sustainability for Non-Linear Single-Phase Consumers. Sustainability, 16(7), pp. 2776.

[12] DUC, M.L., HLAVATY, L., BILIK, P. and MARTINEK, R., 2023. Harmonic Mitigation Using Meta-Heuristic Optimization for Shunt Adaptive Power Filters: A Review. Energies, 16(10), pp. 3998.

[13] GABRIEL, N.P., DINIș, C.M. and IAGĂR, A., 2023. Investigations on Three-Section Plate-Type Electrostatic Precipitators Used in Thermoelectric Power Plants. Energies, 16(3), pp. 1186.

[14] GARG, R. and SINGH, S.K., 2022. Treatment technologies for sustainable management of wastewater from iron and steel industry — a review. Environmental Science and Pollution Research, 29(50), pp. 75203-75222.

[15] HARPER, G.D.J., KENDRICK, E., ANDERSON, P.A., MROZIK, W., CHRISTENSEN, P., LAMBERT, S., GREENWOOD, D., DAS, P.K., AHMEID, M., MILOJEVIC, Z., DU, W., BRETT, D.J.L., SHEARING, P.R., RASTEGARPANAH, A., STOLKIN, R., SOMMERVILLE, R., ZORIN, A., DURHAM, J.L., ABBOTT, A.P., THOMPSON, D., BROWNING, N.D., B, L.M., BAHRI, M., SCHANIDER-TONTINI, F., NICHOLLS, D., STALLMEISTER, C., FRIEDRICH, B., SOMMERFELD, M., DRISCOLL, L.L., JARVIS, A., GILES, E.C., SLATER, P.R., ECHAVARRI-BRAVO, V., MADDALENA, G., HORSFALL, L.E., GAINES, L., DAI, Q., JETHWA, S.J., LIPSON, A.L., LEEKE, G.A., COWELL, T., JOSEPH, G.F., MARIANI, G., SMITH, A., IQBAL, Z., GOLMOHAMMADZADEH, R., SWEENEY, L., GOODSHIP, V., LI, Z., EDGE, J., LANDER, L., VIET, T.N., ELLIOT, R.J.R., HEIDRICH, O., SLATTERY, M., REED, D., AHUJA, J., CAVOSKI, A., LEE, R., DRISCOLL, E., BAKER, J., LITTLEWOOD, P., STYLES, I., MAHANTY, S. and BOONS, F., 2023. Roadmap for a sustainable circular economy in lithium-ion and future battery technologies. JPhys Energy, 5(2), pp. 021501.

[16] HAUSER, A., WOLF-ZOELLNER, P., HAAG, S., DETTORI, S., TANG, X., MIGHANI, M., MATINO, I., MOCCI, C., COLLA, V., KOLB, S., BAMPAOU, M., PANOPOULOS, K., KIEBERGER, N., RECHBERGER, K. and KARL, J., 2022. Valorizing Steelworks Gases by Coupling Novel Methane and Methanol Synthesis Reactors with an Economic Hybrid Model Predictive Controller. Metals, 12(6), pp. 1023.

[17] JAVID, Z., KOCAR, I., HOLDERBAUM, W. and KARAAGAC, U., 2024. Future Distribution Networks: A Review. Energies, 17(8), pp. 1822.

[18] JULIEN, C.M. and MAUGER, A., 2024. Fabrication of Li4Ti5O12 (LTO) as Anode Material for Li-Ion Batteries. Micromachines, 15(3), pp. 310.

[19] KABALDIN, Y., SHATAGIN, D., RYABOV, D., SOLOVYOV, A. and KURKIN, A., 2023. Microstructure, Phase Composition, and Mechanical Properties of a Layered Bimetallic Composite ER70S-6-ER309LSI Obtained by the WAAM Method. Metals, 13(5), pp. 851.

[20] KAPTAN, K., CUNHA, S. and AGUIAR, J., 2024. A Review: Construction and Demolition Waste as a Novel Source for CO2 Reduction in Portland Cement Production for Concrete. Sustainability, 16(2), pp. 585.

[21] KARLINA, A.I., KARLINA, Y.I. and GLADKIKH, V.A., 2023. Analysis of Experience in the Use of Micro- and Nanoadditives from Silicon

Production Waste in Concrete Technologies. Minerals, 13(12), pp. 1525.

[22] KHALID, S., SONG, J., RAOUF, I. and KIM, H.S., 2023. Advances in Fault Detection and Diagnosis for Thermal Power Plants: A Review of Intelligent Techniques. Mathematics, 11(8), pp. 1767.

[23] KIEUSH, L., RIEGER, J., SCHENK, J., BRONDI, C., ROVELLI, D., ECHTERHOF, T., CIRILLI, F., THALER, C., JAEGER, N., SNAET, D., PETERS, K. and COLLA, V., 2022. A Comprehensive Review of Secondary Carbon Bio-Carriers for Application in Metallurgical Processes: Utilization of Torrefied Biomass in Steel Production. Metals, 12(12), pp. 2005.

[24] KOGANTI, S., KRISHNA, J.K. and SURENDER, R.S., 2022. Design of Multi-Objective-Based Artificial Intelligence Controller for Wind/Battery-Connected Shunt Active Power Filter. Algorithms, 15(8), pp. 256.

[25] KURKELA, E., KURKELA, M., FRILUND, C., HILTUNEN, I., ROLLINS, B. and STEELE, A., 2021. Flexible Hybrid Process for Combined Production of Heat, Power and Renewable Feedstock for Refineries: Managing seasonal energy supply and demand for heat and power in Europe. Johnson Matthey Technology Review, 65(2), pp. 333-345.

[26] LI, D., LI, Y., LI, Z. and WANG, Y., 2023. Theory analyses and applications of magnetic fluids in sealing. Friction, 11(10), pp. 1771-1793.

[27] LI, H., LI, X., LIU, X., BU, X., CHEN, S., LYU, Q. and WANG, K., 2023. Prediction of the Vanadium Content of Molten Iron in a Blast Furnace and the Optimization of Vanadium Extraction. Separations, 10(10), pp. 521.

[28] MANDAL, D.K., BOSE, S., BISWAS, N., MANNA, N.K., CUCE, E. and BENIM, A.C., 2024. Solar Chimney Power Plants for Sustainable Air Quality Management Integrating Photocatalysis and Particulate Filtration: A Comprehensive Review. Sustainability, 16(6), pp. 2334.

[29] MELO, A., MAURÍCIO MELO CÂMARA and PINTO, J.C., 2024. Data-Driven Process Monitoring and Fault Diagnosis: A Comprehensive Survey. Processes, 12(2), pp. 251.

[30] NIKOLAEV, A., MAKLAKOV, A., BULANOV, M., GILEMOV, I., DENISEVICH, A. and AFANASEV, M., 2023. Current Electromagnetic Compatibility Problems of High-Power Industrial Electric Drives with Active Front-End Rectifiers Connected to a 6–35 kV Power Grid: A Comprehensive Overview. Energies, 16(1), pp. 293.