LITERATURE REVIEW

Efficiency is the top priority for any industry, especially in the case of nuclear power stations' energy production. A discussion about the working parts in the power production line is crucial to monitor & maintain by the technicians and the engineers in the power station. Economics plays a critical role in the whole operations of power production at a large scale, as mentioned before in our case the nuclear power stations or power plants as many call them. In 1977 T. H. Fenring, Project Admin of Wisconsin Electric Power Co. & R. A. Gaggioli, Prof. of the Mechanical Engineering Department, Marquette University worked together to understand the economics of a Feedwater Heater replacement which is a fundamental component for any sort of power-plants to preheat the water before it enters the actual steamer. In the work (Fehring & Gaggioli, 1977) has done to understand the replacement economics of a feedwater heater, it's been ruled out that understanding the deterioration of performance of a feedwater heater is calculated by the useful energy concept is extremely difficult and fruit-less. However, a more reliable method requires evaluation of the 2nd-law efficiency of the devices only once during the unit's lifetime. As the economic factors are discussed, a feedwater heater in a power plant extends the topic of the component's preservation, maintenance, and evaluation. In 1998, B. R. Becker an Assc. Prof. & B. A. Fricke a research assistant of the Mechanical Engineering, University of Missouri-Kansas City, & R. E Pearce - Senior Engineer, Kansas City Power & Light Company have collaborated to conduct a study on the life management of the feedwater heater in the power station. Determining the replacement and repair costs helps evaluate costs to extend the life of the feedwater heater without high expenditure and improve the power station's efficiency (Becker et al., 1998). Since then the efficiency of the feedwater heater was analyzed by employing the 2nd law of thermodynamics until 2006 when Gerald Weber from Midwest Generation EME, LLC & Michael C. Catapano used the PEPSE (Power plant thermal cycle modeling, design, diagnostics, and performance analysis) software to computerize the calculations for replacement feedwater heater(FWHs) performance modeling and rating (Weber & Catapano, 2006), this helped them to analyze the performance data generate the appropriate replacement heater specifications. While we talked about replacements & analyzing the performance of the FWHs in a nuclear power plant, a discussion about the FWH itself was coined, leading to a deeper understanding of the provided issue. As we understood the analysis around the feedwater heater and its importance, Y. M. Ferng & C. T. Hung in 2007 talked about

Wall-Thinning in the feedwater heater which raised concerns about its adverse effects on whole operations in the Taiwan Power Company. Understanding and predicting wear sites in the shell wall of the FHW at the Taiwan Power Company using a two-phase model (Ferng & Hung, 2007). Using advanced physics simulations & statical models (Ferng & Hung, 2007) were able to predict accurate results of droplet wall collisions using the two-phased model which is inclusive of the Eulerian/Lagrangian flow model & the droplet-impingement wear model. Automation & digitalization of the processes, data recording & monitoring enabled the engineers in the power plants to acquire invaluable data, due to the incorporation of the DCS (Distributed control system) Technology in the power stations (Li et al., 2008). Using the continuously acquired data in discrete time intervals from the machinery, mathematical models & soft computing models such as neural networks, principal component analysis, fuzzy logic, and evolutionary algorithms were used to predict faults of pumps, FWHs, pulverizers & other power production components.
In 2009 Fan Li & Belle R. Upadhyaya from the Department of Nuclear Engineering, University of Tennessee, and Lonnie A. Coffey from Combustion Consultants, Tennessee collaborated to understand the fault diagnosis approach based on the GMDH (Group Method of Data Handling) Technique(Li et al., 2008). Soft computing techniques are profoundly showing highly accurate & promising results for fault detection of components at a power plant, interest in the performance, efficiency, and safety of the power plants & their components, mainly the FWHs(Feedwater heaters). FWHs develop pipe leakages and damage over time due to wear & tear, predicting and detecting this will help understand the life management of the FWHs and schedule repairs as well as maintain safety in the power plant, without careful and proper maintenance of the FWHs can result in fatal accidents. In 2011 Gyunyoung Heo from Kyung Hee University, Republic of Korea & Song Kyu Lee, KEPCO Engineering & Constructions, Republic of Korea collaborated to develop a diagnosis system using feed-forward neural networks to understand the thermal performance and leakage detection(Heo & Lee, 2011). To make monitoring easy and accessible to the technicians & engineers of nuclear power plants an online monitoring system was developed by Hang Wang, Min-Jun Peng, Shou-yu Cheng of Fundamental Science on Nuclear Safety and Simulation Technology Lab, Harbin, China & Peng Wu at Nuclear and Radiation Safety Center, Ministry of Environmental Protection, Beijing, China(Wang et al., 2015). In 2016, Using fuzzy inference system was introduced by researchers at the Department of Nuclear Engineering, Kyung Hee University, South Korea & Central Research Institute, Korea Hydro &

Nuclear Power Co. LTD, South Korea. The fuzzy system helped in the diagnosis & simulations of FWHs in a Nuclear power plant(Kang et al., 2016). Soft computing methods are computationally expensive due to the overwhelming data that is being produced by the components at the power plant Seagull Optimization Algorithms which is a nature-inspired soft computing technique are introduced to reduce redundancy and depend on the ever-growing computational needs(Dhiman & Kumar, 2018). In 2020, a simulation-based analysis of a heat exchanger as a feedwater heater was discussed, the simulation was considered to be conducted on AutoCAD but ANSYS 2019 software was used to understand Thermo-structural fatigue and the lifetime analysis of a heat exchanger was used. The results indicated that the heat exchanger wasn't as greatly efficient but rather worse compared to the typical FWH(Hoseinzadeh & Heyns, 2020). To improve maintenance scheduling operations an inspection policy is proposed for the analytical hierarchal process at a nuclear power plant, this is a multi-component system as all the components suffer from various failure modes. Each mode has multiple maintenance strategies(Du et al., 2020). While the detection of possible damages and efficacy of the already existing feedwater heater was discussed researchers at Business School, Shanghai, China have coined a discussion about Factors Affecting the FWH's Quality and what could be improved to make a better feedwater heater. While considering the quality of water and maintenance methods used by the NPP(Nuclear power plants) the analysis was conducted & revealed a huge change in the performance as well as the life of the FWH itself(Pan & Xu, 2022). Artificial intelligence has taken the technology spotlight by storm which only gives it a boost to make use of certain AI models and techniques for almost anything as we observe, a Deep transfer learning for failure prediction method was introduced by Zhe Li and colleagues(Li et al., 2022). Which gives better, more accurate, and more efficient results for understanding & prediction across a list of failure types by leveraging the said AI models & techniques. As we have an impediment in this literature review toward our prospective goal we have a good understanding of the references that understanding the foundations of an FWH is of the utmost priority where Aref Shokri & Mahdi Sanavi have discussed the same(Shokri & Sanavi Fard, 2023). As we understand more about the economics of component replacement and replacement prediction using AI models of any sort of component, in this age of AI and Automation and the new Industry 4.0 we can use much more advanced predictive algorithms which are better than ever before in every possible way. This allows us to be more ready for any sort of unprecedented event in the Nuclear power station or plant(Dursun, Akcay & Van Houtum, 2024).

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