Journal of Mechanical Design and Testing 6(2), (2024), 66-71
DOI:
e-ISSN: 2685-8029, ISSN: 2716-1293

Improved Power Plant Performance Utilizing Hybrid Performance Test Execution (HYPER-X)*

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Abstrak

Seiring dengan Program Transformasi PLN, digitalisasi telah menjadi fondasi penting yang terus dikembangkan oleh perusahaan di tengah berbagai gangguan yang disebabkan oleh teknologi modern. Upaya ini bertujuan untuk membangun proses yang ramping dan efisien dari segi biaya. Dengan demikian, perusahaan dapat memastikan keberlanjutan dan menjaga daya saing di tengah persaingan yang semakin ketat di masa mendatang. Saat ini, pengujian kinerja dilakukan secara konvensional dengan mengumpulkan data melalui tren DCS (*Distributed Control System*) dan memproses data menggunakan excel, yang dilakukan sebulan sekali untuk setiap unit. Dari sini, hasil pengujian kinerja setiap unit hanya diperoleh sebulan sekali, sehingga kinerja unit baru hanya dapat dilihat dalam jangka waktu yang lebih lama. Oleh karena itu, diperlukan periode yang lebih lama untuk mengamati kinerja unit-unit baru. Untuk mengatasi masalah tersebut, proses uji kinerja unit dibuat dengan konsep yang lebih baru, yaitu dengan menambahkan unsur digitalisasi yang disebut uji kinerja hibrida atau Hyper-X. Harapannya, mulai dari pengumpulan hingga pemrosesan data dapat dilakukan dengan cepat sehingga kondisi kinerja unit dapat diperoleh lebih cepat dan dapat dipantau secara real-time. Hasil yang diperoleh dari Hyper-X mencakup indikator daya energi, kehilangan *heat rate*, biaya, serta analisis dan rekomendasi yang dapat memberikan panduan operasi agar unit dapat beroperasi lebih optimal dan efisien. Hyper-X dapat mengurangi potensi kehilangan *heat rate* sebesar 35 kcal/kWh atau setara dengan Rp141.560.000,00. Manfaat lainnya termasuk memudahkan identifikasi area yang mengalami kehilangan *heat rate*, menentukan langkah-langkah lanjutan untuk perbaikan, serta mendorong budaya profesional dan pembelajar dalam menyelesaikan masalah.

Kata kunci : Performance Test, Unit Performance Contracts.

Abstract

Alongside the PLN Transformation Program, digitization has emerged as a crucial foundation that the company continues to develop amidst the disruptions caused by modern technology. This effort aims to establish lean and cost-efficient processes. Therefore, companies ensure sustainability and maintain competitiveness amidst increasingly fierce future competition. To establish lean and cost-efficient processes Currently, performance tests are carried out conventionally by collecting data through trending DCS (Distributed Control System) and processing data using Excel, which is carried out once a month for each unit. From this, the performance test results for each unit are only obtained once a month so that the performance of new units can be seen over a long period. Therefore, a longer period is required to observe the performance of new units. To solve the problem above, a performance test unit process was made with a newer concept, namely by adding digitization in it, namely hybrid performance test execution, abbreviated as Hyper-X, the hope is that from the start data collection and processing can be done quickly so that unit performance conditions can be obtained more quickly. Fast and can be monitored in real time. The results obtained from Hyper-X are in the form of energy power indicators, heat rate losses, and costs as well as analysis and recommendations that can provide operating guidelines so that the unit operates more optimally and efficiently. Hyper-X can reduce the potential loss heat rate by 35 kcal/kwh or equivalence with IDR 141,560,000.00. As for other benefits obtained, it facilitates the identification of areas experiencing heat rate losses determines the follow-up execution steps for repairs and fosters a professional and learner culture to solve problems.

Keywords: Performance Test, Unit Performance Contracts.

Artikel ini dipresentasikan dalam Science Technology and Management Meetup (STEM MEET UP) 2023, PT. PLN Indonesia Power, 21-23 November 2023 di Batam

1. INTRODUCTION

The performance test is an activity in the generating unit whose final results provide an overview of the calculation of the baseline parameter numbers against the actual parameter numbers, the performance test is an illustration of the main equipment parameters that generate equipment loss values and affect the performance value of Specific Fuel Consumption (SFC), the SFC value affects the Key The Performance Index (KPI) of Unit Management Contracts and Departments/Divisions/Groups that have been determined refers to and is aligned with PT PLN Indonesia Power's Corporate Management Contract targets to PT PLN as holding company.

Performance tests are carried out routinely at the power plant unit, the results of the analysis are used to determine the heat loss of the plant which is then arranged into Pareto heat loss and sorted from the largest heat loss, the results of the analysis are used for further processes such as identification, inspection, repair or replacement of equipment that has the highest Pareto, it is expected that the Pareto heat loss can be minimized so that the generator can operate and achieve optimal efficiency values. Performance tests so far require a lot of manpower and take up time in carrying out their activities, so a method was created to carry out a hybrid performance test where activities are carried out semi-online for the main test data retrieval and offline for additional test data retrieval, with real-time expected results. transactions that allow monitoring from anywhere, with data integrity maintained continuously at any time.

The main objective is to facilitate planning in knowing the final value of the NPHR (Nett Plant Heat Rate) also SFC (Specific Fuel Consumption) unit performance contracts, speeding up the anticipation, mitigation process if there is a unit performance contract value that is not achieved, and facilitating monitoring of power plant performance. Hyper-X objectives replacing old methods with new methods, This method proves that the SFC was reached at 0.6248 from the upper limit target of 0.6259 [1] with consideration of reducing manpower and activities that are less necessary (saving time and saving manpower).

2. METHODOLOGY

There are several methodologies used, literature study, determining the need for parameter data (input-output), application creation, risk, and financial analysis, implementation, monitoring, and evaluation. wo important methods that will be explained next, namely the performance test and its integration with PI Vision, as follows:

A. The performance test is carried out by testing the heat rate of PLTU Pelabuhan Ratu on 4 (four) loading patterns, namely at a gross load setting of 340 MW, 300 MW, 260 MW, and 220 MW [2] or when performance is often carried out with one full load visualized in Table 2.1.

Table 2.1 Performance Test Results in 4 Testing Time

Hasil Performance September 2022 - JPR Pusertif				
PLTU Pelabuhan Ratu #1	Uji 1	Uji 2	Uji 3	Uji 4
Pembebanan gross (MW)	220,9	259,1	300,0	340,9
Pembebanan nett (MW)	203,9	242,8	282,4	322,2
Pemakaian Sendiri	17,1	16,3	17,6	18,8
Coal Flow (t/h)	142,5	163,3	181,5	206,1
NK (kCal/kg)	4916,0	4916,0	4916,0	4916,0
Heat Input (kcal)	700579,2	802930,3	892204,8	1013138,4
Heat Rate (kCal/kWh)	3436,7	3307,0	3159,4	3144,9

The coal used during the test is taken directly from the Coal Yard with the following performance test conditions [3]:

1. The unit operates with CCS (Coordinated Control System) control mode
2. Make-up water supply in open condition
3. The desuperheater is operated normally.
4. No soot blowing during data collection.
5. CBD (Continuous Blowdown Drain) valve opening 0% (fully closed)

The use of SST (Station Service Transformer) energy during heat rate testing is only diverted to units other than those where performance tests are carried out. The measuring instruments used are the existing measuring instruments in the unit, except for the flue gas analyzer and ambient humidity meter, data on gross energy production and UAT (Unit Auxiliary Transformer) are taken from the kWh-meter counter readings in the Relay Room, net energy production and SST are taken from readings the kWh-meter counter in the GIS (Gas Insulated Switchgear), while the coal usage data was obtained based on the recording of the coal totalizer in each coal feeder that was operating during the test. Coal samples were taken from the taping holes of all

operating coal feeders. Coal sampling was carried out 3 (three) times at each load. Fly ash samples were taken at the ESP Hopper, while bottom ash samples were taken at the silo bottom ash. Withdrawals are made once for each load before the end of the recording period [4].

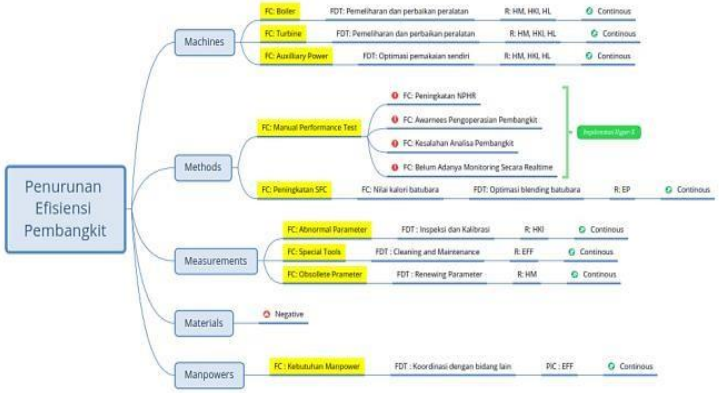

Figure 2.1 RCFA Decreased Efficiency

We also complement this method with root cause failure analysis by considering various possibilities that cause plant efficiency not to be achieved, as shown in Figure 2.1 RCFA Decreased Efficiency

B. PI Vision is an intuitive web client visualization tool that provides fast, easy, and secure access to all PI System data. With PI Vision, you can easily perform ad hoc analysis, find answers, and share insights with others. Support for mobile browsers and customized views that can access critical process information from any device. PI Vision provides users with a quick and easy way to share views to collaborate in all fields. PI Vision is easy to deploy, upgrade, and maintain using a single web server hosting PI Vision for modern desktop browsers and mobile devices [5]. We use PI Explorer to calculate related data before displaying it to PI Vision as shown in Figure 2.2

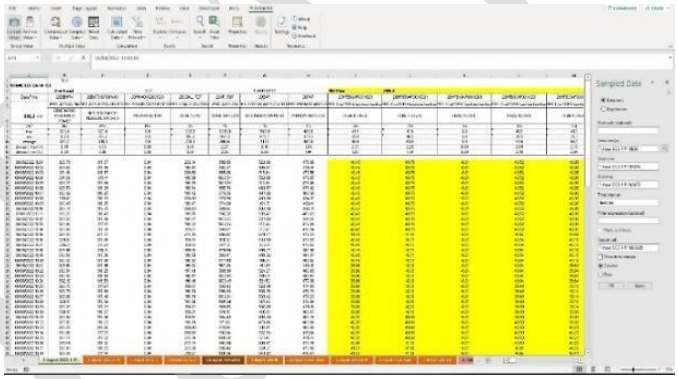

Figure 2.2 PI Explore Interface

3. RESULT & DISCUSSION

A. Identification of Problems

The previous performance test was carried out offline with an implementation schedule for each unit once a month and required quite a lot of personnel to collect data. The results of the performance test accompanied by analysis and recommendations for increasing the efficiency of each unit can only be obtained once a month.

Problems that contribute to unit efficiency must be repaired as soon as possible, therefore a performance test implementation method is needed that can get information about unit performance quickly and precisely so that losses that occur in the unit can be resolved immediately which makes the unit's KPI value either SFC or NPHR can be maintained to achieve. This method succeeded in reducing NPHR by 23 kcal to maintain SFC performance, amounting to IDR 13.6 billion per year, equivalent to a reduction in BPP C of IDR 1.98/kwh, as shown in figure 3.1 NPHR Business Report 2022 – 2023*.

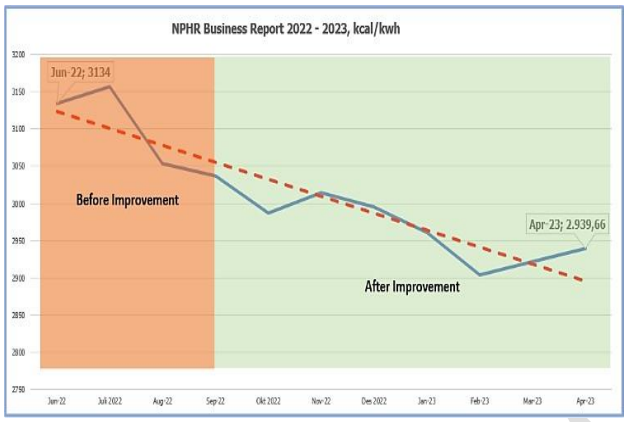

Figure 3.1 NPHR Business Report 2022 – 2023*

B. Problem-Solving Analysis

Based on the identification of existing problems, namely how to get information about performance along with analysis and recommendations for increasing unit efficiency quickly and precisely. The performance test results in the form of losses that occur can be executed quickly so that unit efficiency can increase which in the end the unit performance value can be achieved. So that the processes are not confused or precede each other, a simple flowchart is created so that the processes carried out are sequential and orderly, as shown in Figure 3.2 Hyper-X Flowchart Processing Design.

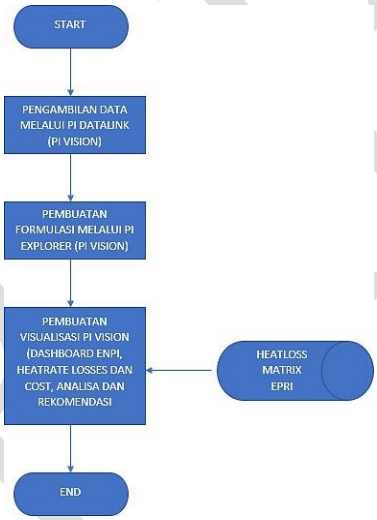

Figure 3.2 Hyper-X Flowchart Processing Design

C. Hyper-X Work Design

Making Hyper-x utilizes and uses tools in Excel where the format is connected to the PI Data Link, then the formula for calculating the performance test is applied and adapted to PI Vision.

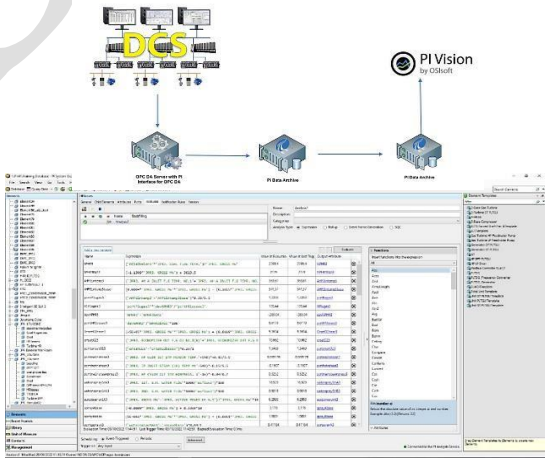

Figure 3.3 Hyper-X Work Design (Part 1)

Configuration developed to implement the design connecting from DCS to PI Vision, so that the data displayed is truly real-time and precise, which can be seen in Figure 3.3 Hyper-X Work Design

D. Implementation

Making hyper-x utilizes and uses tools in Excel where the format is connected to the PI Data Link, then the formula for calculating the performance test is applied and adapted to PI Vision. The results of Hyper-X have been implemented in a performance test activity with Pusertif in 2022.

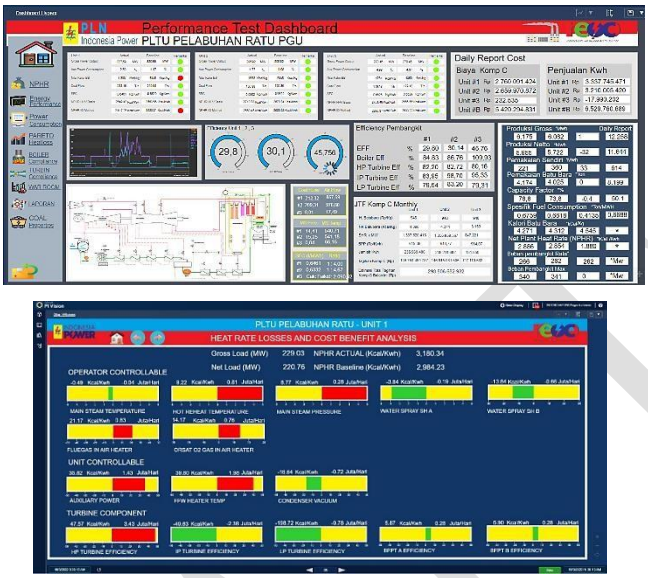

Figure 3.3 Hyper-X Work Design (Part 2)

Besides being used for monitoring performance test parameters, the results from Hyper-X are also used to monitor the daily performance of units and also the results from the dashboard are shared with management and interested parties. Before the existence of the Hyper-X performance unit performance test results could only be obtained once a month.

After Hyper-X, information regarding performance and losses that occur, accompanied by analysis and recommendations for increasing unit efficiency, can be monitored every day, so that the most feasible improvements can be executed from the losses that occur. From this, we can increase unit efficiency quickly and precisely by reducing losses that occur so that unit performance can be achieved

E. Financial Benefit

Power Plant Performance Improvement with HyPer-X (Hybrid Performance Test Execution) does not directly affect financial benefits, but actively contributes to optimizing planning for equipment disruption repairs or can be calculated as follows.

Table 3.5 Potential Saving using Hyper-X

	Loses kcal	Asusmi BB	NK	Rp/Kcal	Asumsi kwh/hari	Biaya Produksi Mwh	Harian (Juta)	Mingguan (Juta)	Saving (Juta)
Potential	35	800	4600	0,173913	7752000	7752000000	47,19	330,30	141,56
Actual Losses	20	800	4600	0,173913	7752000	7752000000	26,96	188,74	

The saving calculation is obtained from the potential losses that occur minus the actual losses if the Huper-X method is not carried out directly, realization of implementing this application is that it can provide options/choices for the generator production process, units get estimates of generator performance faster than one week to one day. In addition, PI Vision has been integrated with the Hyper-X algorithm, making it easier to monitor the process and even execute operating parameters, the guide makes it easy to minimize heatrate losses in real-time.

4. CONCLUSION

Some conclusions that can be drawn are:

1. Makes it easier to monitor the achievement of unit performance values in the form of SFC or NPHR which are updated in real-time.
2. Performance test results can be obtained and conveyed to other fields quickly.
3. Power plant performance monitoring can be done anytime and anywhere.

Further improvements were made to create a full-digital online application and the database can be connected to several corporate applications (REOC) so that the database can be filled in real-time.

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Commissioning Document for baseline determination (SPERI)

External performance test documents (PLN Pusertif and PT EMI Persero to validate performance test calculation data

EPRI and SP PLN documents for determining turbine and boiler performance tests