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Design, Implementation and Performance Evaluation of Coriolis Mass Flow Measurement System for Accurate LDO Consumption in Thermal Power Plants

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***Abstract* - Accurate measurement of diesel oil consumption is essential for efficient monitoring, cost control, and operational reliability in thermal power plants. Conventional *turbine-type flow meters* often fail to provide reliable measurements under low and intermittent flow conditions, particularly during boiler light-up and emergency firing operations. This study presents the design, implementation, and performance evaluation of a *Coriolis-based mass flow measurement system* to overcome these limitations. The system was installed in one generating unit and integrated with control and monitoring infrastructure including distributed control system, supervisory interface, and *data historian*. A totalization logic was developed for continuous tracking of oil consumption. Performance validation was carried out through comparison with tank level-based calculations. The results demonstrate improved accuracy, stable measurement under varying conditions, and elimination of manual estimation methods. The study highlights the practical advantages of *mass flow measurement* technology and establishes its suitability for large-scale deployment in power plant applications.**

Keywords – Coriolis Mass Flow meter , DCS Historian , Conventional Turbine Flow Meters, DCS Logic , Totalizer Logic.

I. INTRODUCTION

Accurate measurement of fuel consumption is a critical requirement in thermal power plant operations for ensuring efficient performance, cost optimization, and reliable energy accounting. *Light Diesel Oil* is widely used for boiler light-up, flame stabilization, and emergency firing operations. Traditionally, *volumetric flow measurement* devices such as *turbine flow meters* have been employed for such applications due to their simple working principle and ease of installation. Previous studies and industrial practices indicate that turbine flow meters perform satisfactorily under steady and moderate flow conditions; however, their accuracy decreases significantly under low and fluctuating flow regimes due to dependency on *flow velocity* and mechanical movement. In practical operating scenarios, especially during boiler start-up and emergency operation, the flow of oil is *intermittent* and often below the optimum operating range of turbine meters. This creates a significant research gap, as reliable and accurate measurement of fuel consumption under such conditions remains a challenge. The inability to capture real-time consumption leads to dependency on indirect estimation methods such as *tank level variation*, which are prone to errors due to temperature changes, tank geometry assumptions, and manual calculations.

The primary objective of this study is to address these limitations by implementing a *Coriolis-based mass flow measurement system* and evaluating its performance in comparison with the conventional turbine-type flow meter. The scope of the study includes installation, system integration with *Distributed Control System*, and validation through comparative analysis with tank level-based consumption data.

II. MATERIALS AND METHODS

This study involves the replacement of an existing *turbine-type volumetric flow meter* with a *Coriolis mass flow meter* for accurate measurement of *Light Diesel Oil consumption* in a thermal power plant unit. The implementation also includes ensuring measurement reliability through *uninterrupted power supply*, availability of *spare Distributed Control System channels*, and integration with *OSI PI system* for advanced monitoring and digitization.

A. Materials Used :-

- *Coriolis mass flow meter* (Endress+Hauser Promass)
- *Uninterrupted Power Supply* for flow meter
- Existing *LDO supply pipeline* to boiler gun system

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- *Distributed Control System modules* and spare *analog channel* for signal integration
- *SCADA interface* for monitoring and visualization
- Tank level measurement system for comparative validation
- Further taking the signal to *OSIPI* for further analysis and monitoring

B. Methodology/Procedures :-

The following step-by-step procedure was adopted to ensure reproducibility of results:

1. *Assessment of Existing System* The performance of the *turbine flow meter* was evaluated under *low flow* and *intermittent operating conditions*, highlighting its limitations in accurate measurement.
2. *Technology Selection* A *Coriolis mass flow meter* was selected based on its capability to measure mass flow independent of *fluid density*, *temperature*, and *flow profile variations*.
3. *Installation of Flow Meter* The existing turbine meter was removed, and the Coriolis meter was installed in the *LDO supply line* with necessary piping modifications ensuring proper mechanical alignment.
4. *Power Supply Arrangement* The flow transmitter was connected to a *dedicated uninterrupted power supply system* to ensure continuous operation during power disturbances and avoid data loss.
5. *DCS Integration* The transmitter output signal (4–20 mA) was wired to a *spare Distributed Control System input channel*, and parameters such as instantaneous flow and cumulative consumption were configured.
6. *Totalizer Development* A *totalizer logic block* was developed in the control system to compute and display cumulative LDO consumption for operational monitoring.
7. *SCADA Visualization* Real-time flow rate and totalized consumption values were integrated into the *SCADA interface* for easy access by operators.
8. *OSI PI Integration for Digitization* Flow and consumption data were transmitted to the *OSI PI system* to enable centralized data logging, historical trend analysis, and digital monitoring of fuel consumption.
9. *Validation of Measurement Accuracy* Data from the Coriolis flow meter was compared with oil consumption estimated through *tank level variation* and tank geometry calculations to ensure accuracy.
10. *Performance Monitoring* Continuous monitoring was carried out during *boiler light-up* and *emergency gun operation* to validate performance under critical conditions.
11. *OSI PI Integration for Digitization* Flow and consumption data were transmitted to the *OSI PI system* to enable centralized data logging, historical trend analysis, and digital monitoring of fuel consumption.
12. *Validation of Measurement Accuracy* Data from the Coriolis flow meter was compared with oil consumption estimated through *tank level variation* and tank geometry calculations to ensure accuracy.
13. *Performance Monitoring* Continuous monitoring was carried out during *boiler light-up* and *emergency gun operation* to validate performance under critical conditions.

III. RESULTS AND DISCUSSION

The study confirms that the Coriolis mass flow meter provides accurate, reliable, and continuous measurement of LDO consumption, with deviations within acceptable engineering limits when compared to conventional tank level-based methods.

A. Consumption Comparision

TABLE-1 – The above comparison data were proven during the lighup of Boiler and Oil Consumption were found accurate . The error % was +/- 0.5% which is under limits.

LightUp Date	***01st and 2nd AUG***	***6th April***
Back Calulation	**38680**	**54200**
Promass DCS (Totalizer)	**38728**	**54220**
Totalizer Actual	**38728**	**54220**
Difference (Tank & DCS)	**-48**	**-20**
ERROR%	**-0.123941334**	**-0.036886758**

NOTE:- ALL ABOVE UNITS ARE IN LITERS

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B. Figures :-

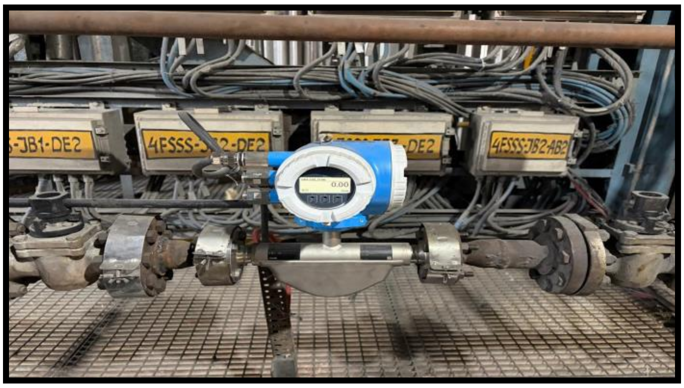

Figure-1 : New Promass Coriolis Flow meter installation.

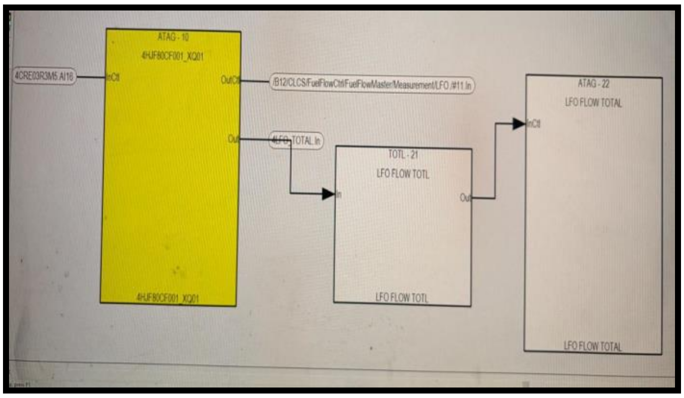

Figure-2 : Logic Development and Totalizer Block Integration Done in Functional Block Diagram in DCS .

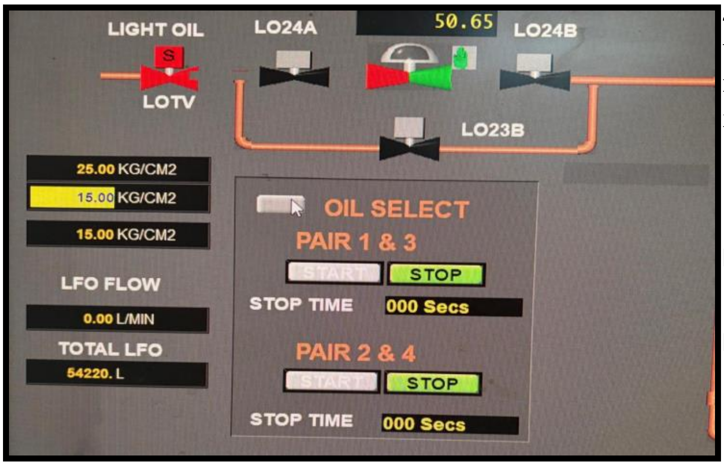

Figure-3 : SCADA Development Done in DCS along with Historical Trend Configuration.

$$\alpha + \beta = \chi. \quad (1)$$

IV. CONCLUSION

The present study demonstrates a significant improvement in the accuracy and reliability of *Light Diesel Oil consumption measurement* through the replacement of a conventional *turbine-type flow meter* with a *Coriolis mass flow meter*. The upgraded system successfully addressed the limitations of low and intermittent flow measurement, providing consistent and precise real-time data during critical operations such as boiler light-up and emergency firing.

The integration of the flow meter with the *Distributed Control System*, *SCADA system*, and *OSI PI data historian*, along with the implementation of a *totalizer logic*, enabled continuous monitoring, data digitization, and improved operational transparency. The provision of *uninterrupted power supply* further ensured reliability and data availability under all operating conditions.

The novelty of the work lies in the practical application of *mass flow measurement technology* combined with advanced control and data systems to achieve accurate fuel accounting in an industrial environment. The implemented solution eliminated manual tank level-based calculations and enhanced operator efficiency.

Based on the successful performance in Unit#4, the study validates the suitability of the proposed system for wider implementation across multiple units, contributing to improved process efficiency, accuracy, and digital monitoring

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