Heat Rate Methods Training

Outline

This course covers the basic methods of measuring the efficiency of a coal-fired electric power plant. The objective is to understand how each method works, and any issues with measurement. Overall power plant efficiency is expressed as Heat Rate. Typically expressed as Btu (Kcal) per kilowatt. This efficiency is made up of two main efficiencies, Boiler, and Turbine.

1. Plant efficiency as measured by heat rate methods covered
    a. Input /Output – Btu (Kcal)/Kilowatt
    b. Turbine Heat Rate /Boiler Efficiency
    c. Corrected Design
    d. Stack CO2 flow /kW

    Learning outcome is a better understanding of four different heat rate measurement methods.

The objective of this section is to obtain an overall view of how average heat rate can be obtained using coal use and inventories.

2. Coal Balance – Tracking
    a. Stockpile inventories
    b. Weighing accuracy
    c. CV change – Loss

    Learning outcome is to understand how coal use over time can indicate average heat rate.

This section's objective is to review and understand the most common method of heat rate measurement. Fuel heat content use per kW. Fuel heat content is less accurate than kW measurement.

3. Input /Output Method
    a. Heat Input – not as accurate as output, kW
        i. Weight
            1. Accuracy Handbook 44
            2. Material Testing
            3. Consistent vs Accurate
        ii. Coal Sample
            1. Mechanical is best
            2. Hard work
            3. High ash or moisture impacts accuracy
    b. Output is accurate – kW(hr)
    c. Does not Identify individual issues
    d. Some plants use port or mine analyses

Learning outcome is to understand how hard it is to weigh and sample coal input, creating potential for error in heat rate calculation. No specific problem areas identified.

The objective of this section is to use the two main efficiencies that make up unit heat rate, the turbine efficiency, and the boiler efficiency. The design turbine efficiency is adjusted to actual using control room or independent measurements. Boiler efficiency is measured using the Heat Loss Method, which is less sensitive than I/O method to coal sampling and other potential errors.

4. Turbine Heat rate /Boiler Efficiency
    a. Turbine heat rate adjusted from design
        i. Input – SH/RH flow, temp, and pressure
        ii. SH/RH attemperator flows
        iii. Feedwater heater performance
        iv. Output – Condenser conditions
        v. Helps identify issues
    b. Boiler Efficiency
        i. Output /Input
            1. Steam flow and conditions
            2. Coal flow and sample
        ii. Heat loss method
            1. Need air heater leakage
            2. Excess air
            3. Coal sample for ultimate analysis
            4. Exit gas conditions – Temps
            5. Ash sample for LOI – carbon loss
            6. Helps identify issues
            7. Might be more accurate, less sensitive to flow measurement

Outcome of this section is to learn how to determine heat rate using turbine and boiler efficiencies (heat loss).

The objective of this section is to use control room readings and compare them to design parameters. This is how an online heat rate monitoring system could be developed.

5. Compare design performance values to control room readings and recalculate performance
    a. Steam conditions
    b. Condenser conditions
    c. Boiler parameters

Learning outcomes are the ability to look at plant operating conditions and comparing them to design and estimating impact of non-design conditions.

If the plant is equipped with a continuous emissions monitor (CEM) that measures CO2 flow to estimate heat input, it may be used to compare to other heat input methods.

6. CO2 method for Heat Input
    a. Must measure CO2 and gas flow
    b. Might not be as accurate as method (4.)

Learning outcome is to be able to obtain another heat input value.

The objective of this section is to look at major potentially controllable heat rate parameters and look at ways to reduce negative impacts.

7. What can you do to improve efficiency? – How to optimize heat rate
    a. Burn dry coal
    b. Good combustion
    c. Minimal deposits
    d. Lower gas temperatures
    e. Minimize attemperator sprays
    f. Condenser back pressure
    g. Pay attention to air-heater and other leakages

Learning objective is to try to minimize the impact of operating conditions on heat rate.

Understanding how the heat rate is measured, allows for useful and manipulation of values.

8. Heat rate cheating – what heat rate do you want, back calculation methods
    a. HR x KW / fuel flow = CV

Learning outcome is to recognize usefulness of good heat rate, and how values can be manipulated.

The objective of this section is to see how others improved heat rate by adjusting operations, and repairs.

9. Case Studies
    a. Slag and RH sprays
    b. Retube condenser
    c. AH leakage repair

Students learn from examples of heat rate reduction.

10. Questions and Answers

References

The Babcock & Wilcox Company “Steam, Its Generation and Use” 38th Edition, 1975

ASTM PTC 4.1 - link to standards:
https://www.asme.org/codes-standards/publications-information/performance-test-codes