Installation, Operation and Maintenance of Central Boiler Plants

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Module 1: General Considerations

Learning Objectives

By the end of this section, you will be able to:

- **Evaluate** the economic and operational advantages of High Temperature Water (HTW) systems versus traditional steam systems.
- **Identify** the ten major categories of equipment essential to a central boiler plant.
- **Select** the appropriate boiler plant type based on specific facility requirements.

Executive Summary: Central Boiler Plants are designed to produce and distribute energy economically. While steam is necessary for specific process loads, High Temperature Water (HTW) systems generally provide superior efficiency, safety, and reduced maintenance costs due to their closed-loop design.

Section I: Introduction

Central Boiler Plants

The primary purpose of a Central Boiler Plant is to economically produce energy for distribution. This energy is carried to buildings, hospitals, and laundries for heating, cooling, and sterilization. Condensate or hot water is returned to the plant to be reheated and recycled.

Types of Central Boiler Plants

Energy for heating or process use is generally produced in one of five forms:

- **Low Temperature Water (LTW):** Up to 250 degrees F, less than 160 psig.
- **Medium Temperature Water (MTW):** 251 degrees F to 350 degrees F.
- **High Temperature Water (HTW):** 351 degrees F to 450 degrees F.
- **Low Pressure Steam (LPS):** Up to 15 psig.
- **High Pressure Steam (HPS):** Above 15 psig.

Comparison of High Temperature Water and Steam

The major advantages of HTW and MTW systems result from the **closed-loop distribution** system, which recycles unused energy and results in minimal water losses.

Energy Losses from a Steam System

Steam systems incur significant losses through flashing and unreturned condensate.

- **100 psig System:** Condensed water at 338 degrees F contains 26% of the original energy. When discharged from a trap, 13% of the water flashes to steam.
- **15 psig System:** Condensed water contains 19% of original energy at 250 degrees F. When discharged, 4% flashes to steam.
- **Condensate Loss Impact:** If a 100-psig system has 20% condensate loss, 5.2% of total energy produced is wasted.

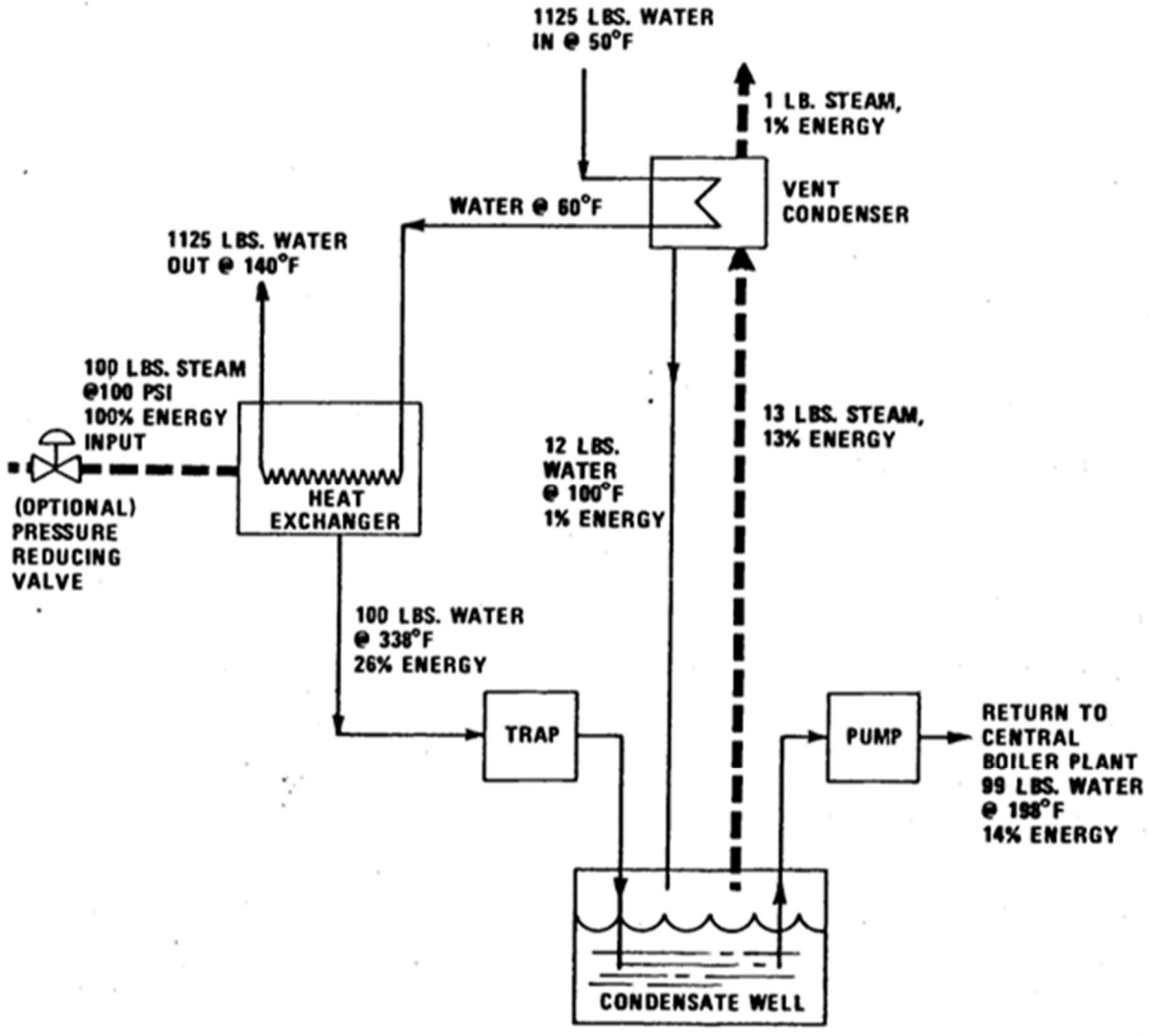

Figure 1-1: 100 PSI Steam Heat Balance

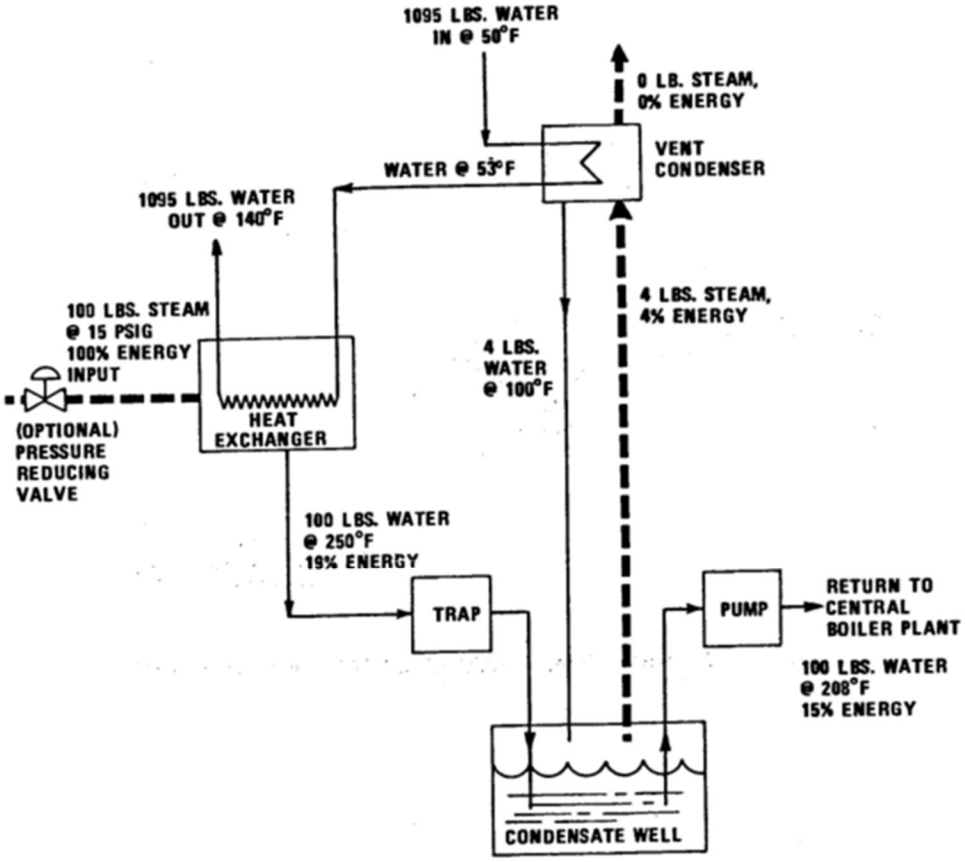

Figure 1-2: 15 PSI Steam Heat Balance

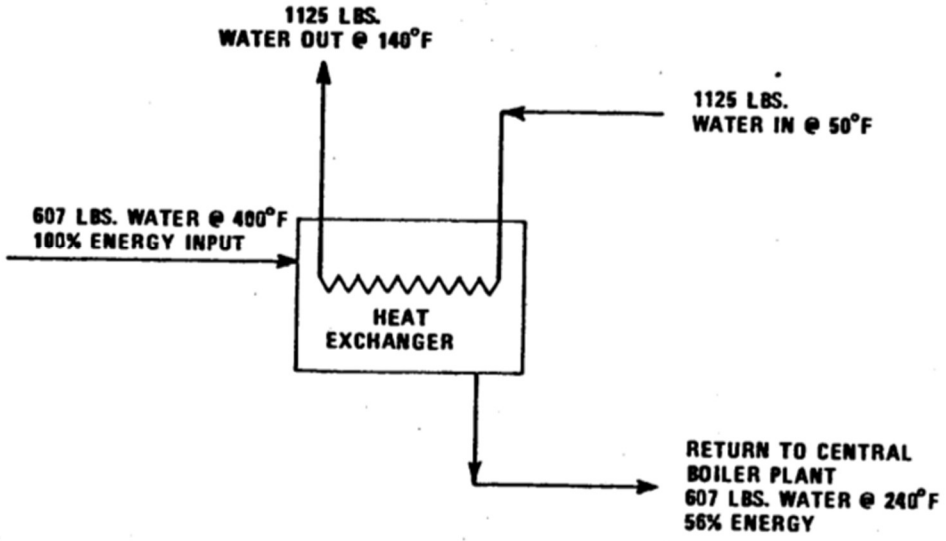

Figure 1-3: High Temperature Water Heat Balance

Performance Factors

- **Corrosion:** Closed-loop HTW systems inherently reduce distribution system corrosion compared to steam/condensate systems.
- **Stored Thermal Energy:** The large amount of stored energy in HTW/MTW systems allows for better response to peak load requirements. Boiler load swings are reduced, enabling more accurate combustion control.
- **Safety:** HTW systems are safer; in a line rupture, the energy exiting is only 5% to 10% of that from a ruptured steam line of the same size.
- **Water Treatment:** Due to low makeup water requirements, HTW plant treatment capacity is a small fraction of that required for steam plants.

Equipment Categories

A Central Boiler Plant comprises ten major equipment categories:

1. **Heat-Absorbing Equipment:** Transfer combustion heat to water via the furnace, boiler, economizers, or air heaters.
2. **Fuel-Handling Equipment:** Facilities for coal storage, ash removal, oil storage/pumping, or gas pressure reduction.
3. **Combustion Equipment:** Safety shut-off valves, burners, and stokers designed to ignite and burn fuel efficiently.
4. **Air-Handling Equipment:** Forced draft (FD) and induced draft (ID) fans used to manage combustion air and flue gas flow.
5. **Controls and Instrumentation:** Burner safety controls, feedwater regulators, and meters to ensure optimum operation.
6. **Pollution Control Equipment:** Systems like fabric filters, electrostatic precipitators, and wet scrubbers to limit particulate, SOx, and NOx emissions.
7. **Water Treatment Systems:** External (softeners, deaerators) and internal (chemical injection) techniques to prevent scale and corrosion.
8. **Water Supply Equipment:** Centrifugal or reciprocating pumps to supply feedwater or circulate water through HTW systems.
9. **Distribution Systems:** Insulated pipelines, valves, and heat exchangers that carry energy to end-users and return it for recycle.

10. **Miscellaneous:** Unique maintenance tools, electrical distribution, and emergency generator sets.

Section II: Elementary Combustion Principles

Fossil Fuels

Coal

Coal is a solid fossil fuel whose characteristics are determined by age (Lignite to Anthracite).

Table 1-1: Classification of Coal

Class	Group	Fixed Carbon Limits Percent (Dry, Mineral-Matter-Free Basis)		Volatile Matter Limits, Percent (Dry, Mineral-Matter-Free Basis)		Calorific Value Limits Btu Per Pound (Moist, Mineral-Matter-Free Basis)	
		Equal or Greater Than	Less Than	Greater Than	Equal or Less Than	Equal or Greater Than	Less Than
I. Anthracitic	1. Meta-anthracite	98			2		
	2. Anthracite	92	98	2	8		
	3. Semianthracite	86	92	8	14		
II. Bituminous	1. Low volatile bituminous coal	78	86	14	22		
	2. Medium volatile bituminous coal	69	78	22	31		
	3. High volatile A bituminous coal	--	69	31	--	14 000	
	4. High volatile B bituminous coal					13 000	14 000
	5. High volatile C bituminous coal					11 500	13 000
						10 500	11 500
III Subbituminous	1. Subbltumlnous A coal					10 500	11 500
	2. Subbltumlnous B coal					9 500	10 500
	3. Subbltumlnous C coal					8 300	9 500
IV Lignitic	1. Lignite A						
	2. Lignite B					6 300	8 300
							6 300

Oil

Oil is refined by fractional distillation into light distillates (No. 1, No. 2) and heavy residuals (No. 6).

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