

## **Types of Efficiencies**

**Combustion efficiency** is a calculated measurement (in percent) of how well the heating equipment is converting a specific fuel into useable heat energy at a specific period of time in the operation of a heating system. Combustion test instruments evaluate these combustion gases.

Complete combustion efficiency (100%) would extract all the energy available in the fuel. However, 100% combustion efficiency is not realistically achievable due to stack loss and boiler shell losses. Various combustion processes produce efficiencies from 0% to 95+%. Combustion efficiency calculations assume complete fuel combustion and are based on three factors:

1. The chemistry of the fuel (the various proportions of hydrogen, carbon, oxygen and other compounds) and how much energy is chemically bound in the fuel.
2. The net temperature of the stack gases or how much heat is not being used.
3. The percentage of oxygen (O<sub>2</sub>) or carbon dioxide (CO<sub>2</sub>) by volume after the combustion process or how much O<sub>2</sub> did the fuel completely burn.

If your calculation shows that your equipment is losing 25% of the maximum theoretical heating value of the fuel through stack losses, your equipment is running at 75% efficient.

**Steady State Efficiency (SSE)** is defined as the point at which combustion gas content reaches equilibrium and stack temperatures stabilize. The SSE calculated by an instrument is only reflective of fuel consumption through the heating season when O<sub>2</sub>/CO<sub>2</sub>, CO and stack temperatures are within the manufacturer's specifications.

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BACHARACH, INC.
PCA 25
*****
TIME 04:48:35 PM
DATE 04/27/97

FUEL
OIL NO. 2

STACK-TEMP 382 °F
AMB.-TEMP 59.5 °F
O2 5.8 %
CO2 11.3 %
CO 2 PPM
O% COR CO 2 PPM
EFFICIENCY 87.7 %
EX. AIR 35.61

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COMMENTS.....

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Printout of Combustion Test Results

*Readings outside these specifications indicate that the equipment is not operating as it was engineered and designed. For example, the test results to the left show high SSE, however, the boiler is not designed to operate with a 302° stack temperature. As a result, this is a false SSE calculation and is actually reading Combustion Efficiency.*

***Thermal Efficiency*** reflects the rate at which heat exchange surfaces transfer heat to the transfer medium (generally water or air). Three types of heat movement impact thermal efficiency.

- Conductive/Convective heating surfaces – also referred to as secondary or indirect heating surfaces including all surfaces exposed only to hot combustion gases.*
- Radiant heating surfaces – also called direct or primary heating surfaces and consist of heat exchanger surfaces directly exposed to radiant heat from the flame. Radiant heat transfer is tremendously more effective than conductive/convective heat transfer and, contrary to commonly accepted belief, is where most of the heat transfer occurs in a boiler or forced air system.*

***Seasonal Efficiency or Annual Fuel Utilization Efficiency (AFUE)*** is defined as actual fuel costs throughout the heating season.

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