HIGH EFFICIENCY TUNE-UP FOR CONVERSION BOILERS

Minneapolis Energy Office*

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Boiler Efficiency

"Efficiency" is a measure of how completely heat is transferred from the fuel source to the heat distribution medium (water, for most multi-family buildings). Combustion efficiency is defined as the total energy available in the fuel minus the energy lost up the stack. Energy is lost up the stack by three mechanisms:

1. In conventional boilers a certain minimum flue gas temperature is required to prevent the water vapor in the gases from condensing and damaging the vent, flue or boiler. If the boiler has natural draft, the flue gases must also be warm enough to rise naturally. The heat required to maintain this temperature is lost.

2. Since the fuel and air don't mix perfectly, some excess air is needed to insure complete combustion. The excess air is heated as it passes through the boiler, and the energy used to heat it is also lost.

3. Water vapor is a product of combustion. In conventional boilers this vapor is not allowed to condense, so the latent heat of vaporization is lost.

Combustion efficiency can be improved, then, by reducing the stack temperature and excess air to the safe minimum. Stack temperature can be measured directly. Excess air can be determined by measuring the O_2 or CO_2 content of the flue gases.

Which Boilers Can Benefit from a Tune-Up?

Two criteria must be met for a tune-up to be recommended. First, the present combustion efficiency must be low enough to allow significant improvement, typically 79% or less. Second, modifications must be feasible and legal. Because of legal restrictions and physical limitations, boilers originally designed to burn gas cannot generally be tuned up. But boilers converted to gas from coal or oil can usually be adjusted and modified to increase the efficiency to as much as 82%.

What the Tune-Up Should Include

The tune-up should start with basic maintenance service including:

1. Check and clean combustion chamber.
2. Check, clean and adjust pilot.
3. Check and clean burner and venturi or clean and adjust combustion blower. as applicable.
4. Inspect and adjust all operating and safety controls.
5. Inspect vents.
6. Adjust burner and gas input.
7. Clean fire tubes or other heat exchange surface.

This service should cost about $150 and should be repeated every one to three years. This should be complemented by annual draining and cleaning of the water side of the boiler and regular water treatment to prevent scale build up. Scale inhibits transfer of heat from the flue gases in the water and can also cause blistering and failure of the heat exchanger. Your boiler operator can clean the boiler and treat the water.

The high efficiency tune-up itself should include the following as applicable and necessary:

1. Adjust manual or motorized draft control.
2. Seal combustion chamber.
3. Install baffles on bridge wall.
4. Install flue restriction.
5. Derate to reduce stack temperature (lower gas pressure or install smaller orifice).
6. Check adequacy of combustion air intake.

These modifications are one-time adjustments that should not need to be repeated. In 1981 the Minneapolis Energy Office worked with Minnegasco's Commercial and Industrial Service Department to develop a high efficiency tune-up and retest service to include these measures. This service is now available from Minnegasco for $160.

Any contractor who performs a high efficiency tune-up should provide you with the initial and final net stack temperature, CO_2, and combustion efficiency. In general a CO_2 level of at least 8% (up to 9) should be achieved. A final net stack temperature of 240°F is often possible.

Ocasionally the stack temperature will still be quite high after the tune-up. In these cases it may be worthwhile to acid clean the water side of the heat exchanger to remove scale, or to install turbulators. These are more expensive measures and should not be done unless the tune-up alone does not achieve a high enough effiency.

Results of Energy Office Tests

In 1981 the Minneapolis Energy Office worked with Minnegasco to develop a high efficiency tune-up service for conversion boilers. Six boilers were tuned in the pilot project (table 1). Efficiency improvements ranged from 0.5% to 4.3% with an average of 2.9%. Assuming the annual savings in space heating costs are given by (1 - (initial efficiency/final efficiency)), the estimated savings range from 0.6 to 5.2% with an average of 3.6%. The associated dollar savings are $50 to $500 per year ($310 average). The savings actually are likely to be greater, since some of the modifications reduce off-cycle losses as well as on-cycle losses. Since the cost of a tune-up is $160, the average simple payback is less than one year.

For more information

A multi-family auditor can measure the current efficiency of your system, tell you whether a tune-up is advisable, and suggest adjustments that should be included. Call us at 348-4832 to set up an audit.

High Efficiency Tune-Up and Retest Pilot Project

Building Number	Type of Boiler	CO_2 Initial	CO_2 Final	Net Stack T Initial	Net Stack T Final	Efficiency* Initial	Efficiency* Final	Est. Savings %	Est. Savings $	Improvements Made
1830	brick set steel fire tube boiler, single tube pass, converted from coal, atmospheric burner, 2.17 MBH	7	9	360	345	78.4	81.0	3.2	360	HMC**, adjust linkages for motorized secondary air control, restrict flue
1820	same but 1.8 MBH	6.5	9	360	320	80.3	84.0	4.4	500	HMC, adjust secondary air control, restrict flue, derate
1816	same but 2.21 MBH	6.5	8	320	290	79.0	81.5	3.1	300	HMC, adjust secondary air control, restrict flue
2317	same but 1.29 MBH	5.5	8.5	280	240	79.1	83.4	5.2	330	HMC, adjust secondary air control, seal leaks in fire door and around conversion burner unit
3533	cast iron section boiler, two pass, converted from coal, power burner, 0.667 MBH	7.5	9	530	470	73.8	77.6	4.9	300	HMC, reduce excess air, derate (reduce manifold pressure)
619	packaged steel fire tube boiler, two tube passes, designed for oil and gas, atmospheric burner, 1.13 MBH	9	9.5	440	440	78.4	78.9	0.6	50	HMC, adjust secondary air control

*combustion efficiency
**Minnegasco Heating Maintenance Contract