Energy Savings Model

Research Team

Yuan Lu

Yiming Rong

Richard D. Sisson, Jr.

Introduction

Most heat treating companies can save 10-25% of their current energy cost if they take action to reduce current energy losses [1]. The DOE PHAST [2] program can be used to estimate the energy usage, identify loss, and develop plans for loss reduction.

In this project, the utility of PHAST software was determined by applying it to natural gas furnace and vacuum furnace. Among all the energy losses, flue gas losses, wall losses and fixture losses were found as three major energy losses. For vacuum furnace, using carbon-carbon composite materials to replace nickel alloy fixture can decease energy cost.

Methodology

The project focused on three tasks:

Use the DOE PHAST program for energy use and reduction in natural gas furnace and vacuum furnace:

1) Validation or corrections,

2) Analysis major energy losses and provide solutions,

3) Provide possible energy saving solutions with estimated cost savings

Salient results

For natural gas furnaces, energy losses can be divided into eight different losses, which are flue gas losses, wall losses, fixture losses, atmosphere losses, opening losses, water cooling losses, heat storage losses and other losses. The diagram from PHAST that assesses these losses is presented in Figure 1.

Among all the losses, flue gas losses, wall losses and fixture losses are three major energy losses. Usually, flue gas losses are about 30% of total energy consumed, fixture losses are about 12% and wall losses are about 10%.

To reduce flue gas losses, flue gas could be used to preheat the load, fixture and the combustion air. To reduce fixture losses, minimizing the weight of fixture and selecting fixture materials with low heat capacity are important. To reduce wall losses, a schedule for repair and maintenance of insulation wall is needed.

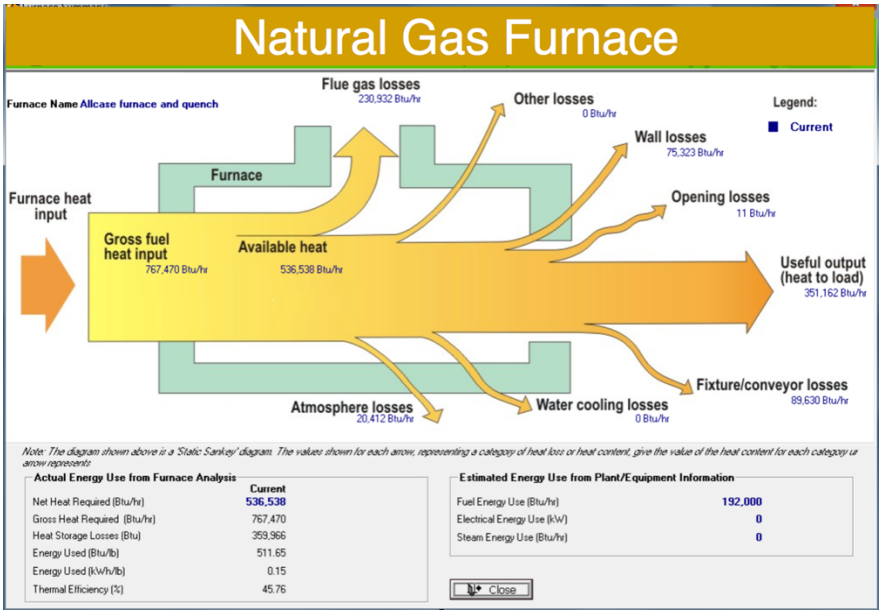

Figure 1. Energy losses in typical natural gas furnace

The furnace efficiency will increase after applying these improvements. As presented in Figure 2, when using high temperature flue gas to preheat the load and fixture, the gross heat input will be reduced by 10% to 25%.

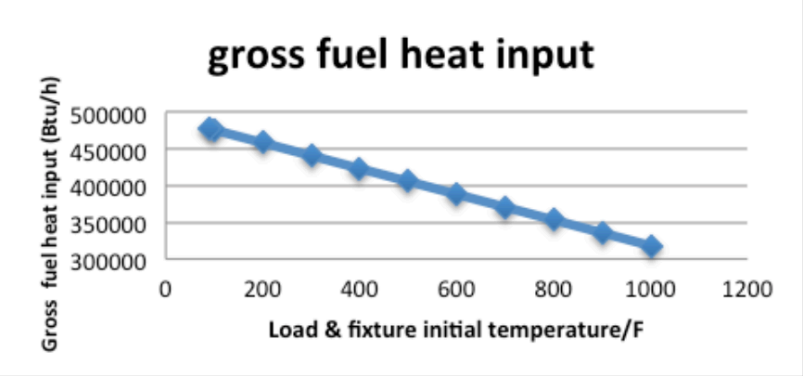

Figure 2. Gross fuel heat input when preheat the load and fixture

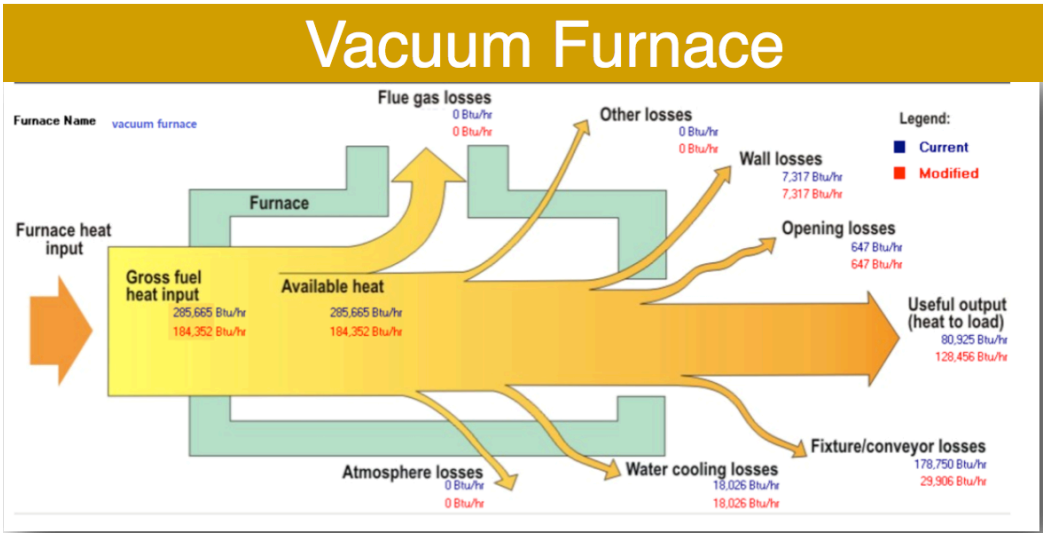

Figure 3. Energy losses in typical vacuum furnace

For vacuum furnace, as shown in Figure 3, after using carbon-carbon composite materials to replace nickel alloy fixture, the gross heat input will decrease by 18%.

Reference:

[1]. Thekdi, A.C., Energy efficiency improvement opportunities in process heating for the forging industry, 2010, E3M, Inc.: https://www.forging.org/system/files/field_document/Arvind_Thekdi.pdf.

[2]. Process Heating Assessment and Survey Tool Homepage. Available from: http://www1.eere.energy.gov/manufacturing/tech_deployment/software_phast.html.