Energy Tips – Process Heating

Process Heating Tip Sheet #10 • January 2006

Industrial Technologies Program

Suggested Actions

Questions to ask when evaluating the use of waste gases for heating secondary processes:

1. Is there a less expensive way to heat the secondary process?
2. Is the temperature of the flue gases high enough to heat the secondary process?
3. Do the flue gases contain enough transferable energy?
4. Are the flue gases compatible with the secondary process (as to cleanliness, corrosiveness, etc.)?
5. Can the primary process deliver energy to the secondary process in time?
6. Are the two processes close enough together to avoid excessive heat losses during waste gas transport?
7. Will the flue gases leave the secondary process at a high enough temperature to avoid problems with moisture condensation?
8. Can the exhaust ductwork and secondary process be designed to avoid excessive pressure resistance to the flue gases, or are additional means like exhaust fans necessary?

Resources

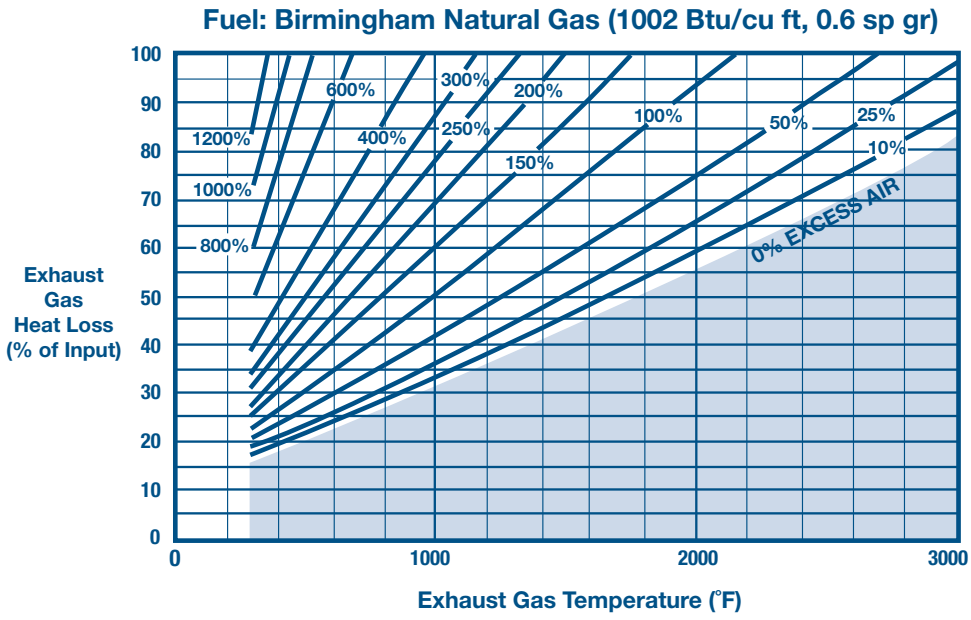
See also the *ASM Handbook*, Volumes 1 (1990) and 2 (1991), Materials Park, OH: ASM International; *Combustion Technology Manual*, Fifth Edition, Cincinnati, OH: Industrial Heating Equipment Association (IHEA), 1994; *Handbook of Applied Thermal Design,* E.C. Guyer and D.L. Brownell, eds., London: Taylor & Francis Group, 1999.

U.S. Department of Energy— For additional information on process heating system efficiency, to obtain DOE's publications and Process Heating Assessment and Survey Tool (PHAST) software, or learn more about training, visit the BestPractices Web site at www.eere.energy.gov/industry/bestpractices.

Using Waste Heat for External Processes

The temperature of exhaust gases from fuel-fired industrial processes depends mainly on the process temperature and the waste heat recovery method. Figure 1 shows the heat lost in exhaust gases at various exhaust gas temperatures and percentages of excess air. Energy from gases exhausted from higher temperature processes (primary processes) can be recovered and used for lower temperature processes (secondary processes). One example is to generate steam using waste heat boilers for the fluid heaters used in petroleum crude processing. In addition, many companies install heat exchangers on the exhaust stacks of furnaces and ovens to produce hot water or to generate hot air for space heating.

Figure 1. Heat loss in exhaust gases at various exhaust gas temperature and excess air percents[1]



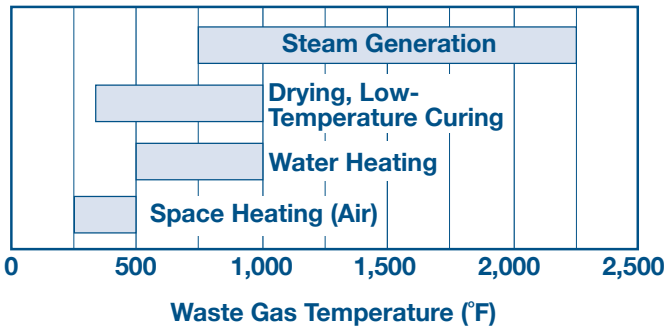
Before attempting to use energy from higher temperature flue gases in lower temperature processes, engineers should take the following technical issues into consideration:

- *Nature or quality of the flue gases.* Flue gases from the primary processes should be clean and free of contaminants such as corrosive gases and particulates. Contaminants pose special handling problems for the gases and might affect the quality of work in the secondary process.
- *Temperature of primary process flue gases.* The temperature difference between the primary and secondary process should be high enough (at least 200°F), and there should be a sufficient amount of usable waste heat.
- *Matching the heat demand of the secondary process with the heat supply from the primary process.* The heat supply from the primary process should be sufficiently high to meet a reasonably high percentage of the secondary process heat demand.

- *Matching the timing of the heat supply from the primary process and the heat demand in the secondary process.*
- *Placement of primary and secondary heating equipment.* The closer the primary and secondary process can be situated, the better.

Figure 2 shows some heating processes that commonly use waste heat from a higher temperature process, and the approximate range of waste gas temperatures they require. Sometimes lower temperature gases can be used if the heat recovery device is deliberately oversized.

Figure 2. Typical secondary processes and approximate exhaust temperatures [2]



Example

A plant uses a furnace with a firing rate of 10 MMBtu/hr, which discharges flue gases at 1,400°F (primary process). The plant also has a drying oven that operates at 400°F and requires 2.5 MMBtu/hr of heat (secondary process). The recoverable heat can be estimated using Figure 1. At 1400°F, the heat content of the exhaust gases (at 10% excess air) is about 42% of the heat furnace input. Again using Figure 1, the heat content of exhaust gases at 400°F is approximately 20% (at 10% excess air). The *approximate* amount of heat that can be saved is 42% – 20% = 22% of the heat input to the primary process. The net heat available for the secondary process is approximately 0.22 x 10 MMBtu/hr = 2.2 MMBtu/hr. Actual savings would be greater than this because the available heat at the 400°F exhaust gas temperature is approximately 80% (see Figure 1 in Process Heating Tip Sheet #9, *Load Preheating Using Flue Gases from a Fuel-Fired Heating System*). The actual savings for the oven are thus 2.2/0.8 = 2.75 MMBtu/hr.

In this case, there is more than enough heat to meet the heat demand for the drying oven. It would be necessary to use additional heat in the oven if the exhaust gas heat from the furnace were not sufficient to meet the oven heat demand. At a fuel cost of $8.00 per MMBtu, the company can save $22.00 in fuel costs per hour. Assuming 8,000 hours of operation per year, annual savings are $175,000.

[1] Calculations by Richard Bennett, Janus Technology Group.

[2] Figure by Richard Bennett, Janus Technology Group.

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