

# Waste heat boiler research engineering essay



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Incorporates a boiler economiser, incorporates the waste heat from the boilers hot stack and transfers this waste heat to the boilers feed water. The boiler feed water will then be hotter and therefore requires less heat energy to boil it after

A boiler economizer is a device that reduces the overall fuel requirements a boiler requires which results in reduced fuel costs as well as fewer emissions - since the boiler now operates at a much higher efficiency. Boiler economizers recover the "waste heat" from the boiler's hot stack gas from transfers this waste heat to the boiler's feed-water. Because the boiler feed-water is now at a higher temperature that it would have been without a boiler economizer, the boiler does not need to provide as much additional heating to produce the steam requirements of a facility or process, thereby using less fuel and reducing the fuel expenses. Boiler economizers also help improve a boiler's efficiency by extracting heat from the flue gases discharged from the final super-heater section of a radiant/reheat unit or the evaporative bank of a non-reheat boiler. Heat is transferred, again, back to the boiler feed-water, which enters at a much lower temperature than saturated steam.

Boiler Economizers are a series of horizontal tubular elements and can be characterized as bare tube and extended surface types. The bare tube includes varying sizes which can be arranged to form hairpin or multi-loop elements. Tubing forming the heating surface is generally made from low-carbon steel. Because steel is subject to corrosion in the presence of even low concentrations of oxygen, water must be practically 100 percent oxygen

free. In central stations and other large plants it is common to use deaerators for oxygen removal.

#### \* Waste Heat Recovery

Many industrial processes generate large amounts of waste energy that simply pass out of plant stacks and into the atmosphere or are otherwise lost. Most industrial waste heat streams are liquid, gaseous, or a combination of the two and have temperatures from slightly above ambient to over 2000 degrees F. Stack exhaust losses are inherent in all fuel-fired processes and increase with the exhaust temperature and the amount of excess air the exhaust contains. At stack gas temperatures greater than 1000 degrees F, the heat going up the stack is likely to be the single biggest loss in the process. Above 1800 degrees F, stack losses will consume at least half of the total fuel input to the process. Yet, the energy that is recovered from waste heat streams could displace part or all of the energy input needs for a unit operation within a plant. Therefore, waste heat recovery offers a great opportunity to productively use this energy, reducing overall plant energy consumption and greenhouse gas emissions.

Waste heat recovery methods used with industrial process heating operations intercept the waste gases before they leave the process, extract some of the heat they contain, and recycle that heat back to the process.

Common methods of recovering heat include direct heat recovery to the process, recuperators/regenerators, and waste heat boilers. Unfortunately, the economic benefits of waste heat recovery do not justify the cost of these systems in every application. For example, heat recovery from lower

temperature waste streams (e. g., hot water or low-temperature flue gas) is thermodynamically limited. Equipment fouling, occurring during the handling of “ dirty” waste streams, is another barrier to more widespread use of heat recovery systems. Innovative, affordable waste heat recovery methods that are ultra-efficient, are applicable to low-temperature streams, or are suitable for use with corrosive or “ dirty” wastes could expand the number of viable applications of waste heat recovery, as well as improve the performance of existing applications.

### Various Methods for Recovery of Waste Heat

**Low-Temperature Waste Heat Recovery Methods** - A large amount of energy in the form of medium- to low-temperature gases or low-temperature liquids (less than about 250 degrees F) is released from process heating equipment, and much of this energy is wasted.

**Conversion of Low Temperature Exhaust Waste Heat** - making efficient use of the low temperature waste heat generated by prime movers such as micro-turbines, IC engines, fuel cells and other electricity producing technologies. The energy content of the waste heat must be high enough to be able to operate equipment found in cogeneration and trigeneration power and energy systems such as absorption chillers, refrigeration applications, heat amplifiers, dehumidifiers, heat pumps for hot water, turbine inlet air cooling and other similar devices.

**Conversion of Low Temperature Waste Heat into Power** -The steam-Rankine cycle is the principle method used for producing electric power from high temperature fluid streams. For the conversion of low temperature heat into

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power, the steam-Rankine cycle may be a possibility, along with other known power cycles, such as the organic-Rankine cycle.

Small to Medium Air-Cooled Commercial Chillers – All existing commercial chillers, whether using waste heat, steam or natural gas, are water-cooled (i. e., they must be connected to cooling towers which evaporate water into the atmosphere to aid in cooling). This requirement generally limits the market to large commercial-sized units (150 tons or larger), because of the maintenance requirements for the cooling towers. Additionally, such units consume water for cooling, limiting their application in arid regions of the U. S. No suitable small-to-medium size (15 tons to 200 tons) air-cooled absorption chillers are commercially available for these U. S. climates. A small number of prototype air-cooled absorption chillers have been developed in Japan, but they use “ hardware” technology that is not suited to the hotter temperatures experienced in most locations in the United States. Although developed to work with natural gas firing, these prototype air-cooled absorption chillers would also be suited to use waste heat as the fuel.

#### Recovery of Waste Heat in Cogeneration and Trigeneration Power Plants

In most cogeneration and trigeneration power and energy systems, the exhaust gas from the electric generation equipment is ducted to a heat exchanger to recover the thermal energy in the gas. These heat exchangers are air-to-water heat exchangers, where the exhaust gas flows over some form of tube and fin heat exchange surface and the heat from the exhaust gas is transferred to make hot water or steam. The hot water or steam is then used to provide hot water or steam heating and/or to operate thermally

activated equipment, such as an absorption chiller for cooling or a desiccant dehumidifier for dehumidification.

Many of the waste heat recovery technologies used in building co/trigeneration systems require hot water, some at moderate pressures of 15 to 150 psig. In the cases where additional steam or pressurized hot water is needed, it may be necessary to provide supplemental heat to the exhaust gas with a duct burner.

In some applications air-to-air heat exchangers can be used. In other instances, if the emissions from the generation equipment are low enough, such as is with many of the microturbine technologies, the hot exhaust gases can be mixed with make-up air and vented directly into the heating system for building heating.

In the majority of installations, a flapper damper or “ diverter” is employed to vary flow across the heat transfer surfaces of the heat exchanger to maintain a specific design temperature of the hot water or steam generation rate.

#### Typical Waste Heat Recovery Installation

<http://www.bchp.org/images/2-3-3HeatRecovery.gif>In some co/trigeneration designs, the exhaust gases can be used to activate a thermal wheel or a desiccant dehumidifier. Thermal wheels use the exhaust gas to heat a wheel with a medium that absorbs the heat and then transfers the heat when the wheel is rotated into the incoming airflow.

A professional engineer should be involved in designing and sizing of the waste heat recovery section. For a proper and economical operation, the <https://assignbuster.com/waste-heat-boiler-research-engineering-essay/>

design of the heat recovery section involves consideration of many related factors, such as the thermal capacity of the exhaust gases, the exhaust flow rate, the sizing and type of heat exchanger, and the desired parameters over a various range of operating conditions of the co/trigeneration system – all of which need to be considered for proper and economical operation.