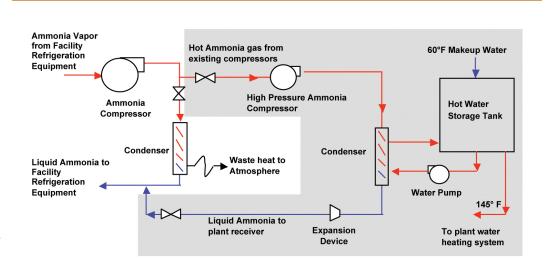


New Approach Offers Opportunity for More Efficient Waste Heat Recovery from Refrigeration Systems

By Randy Wynn, Industrial Sales Manager - Alabama Power

Energy costs seem to be on an endless rise. They are beginning to represent a significant portion of the cost of production for the poultry processor. The typical poultry facility purchases some form of petroleum product to heat water for use in processing poultry. Then in the same process the facility purchases electricity to remove heat from the poultry being processed. The heat removed from the poultry is typically discharged to the environment. The processor spends money to buy heat and then spends money to reject heat to the environment. As a result of utility cost increases, processors can no longer afford to continue this vicious circle and remain competitive.

What can be done to stop this? The answer lies in waste heat recovery. The processing facilities use refrigeration systems to remove heat from the poultry being processed. Depending on the plant size, the heat removed can be 70,000 MMbtu/h annually or more. Ironically, the energy purchased to heat water for the process can be 50,000 MMbtu/h annually or more. That means most poultry processing facilities are rejecting more heat from refrigeration than they are generating using purchased fuel oil and



Schematic of ammonia heat recovery system concept (shown in shaded area). Installing an ammonia heat recovery system will capture the heat rejected from the ammonia refrigeration cycle, boost the temperature of that rejected heat, and use it to generate 145° F hot water for the purpose of pre-feeding the existing hot water system. This will displace some (if not most) of the heating demand supplied by the boiler.

natural gas. The challenge in trying to recover the waste heat for use in hot water generation is that the rejected heat is typically verylow-grade heat. Typically, heat is rejected from the facility at temperatures

around 95° F to 100° F. However, this low-grade heat can be recovered and raised to higher temperatures through the use of the refrigeration cycle.

Most poultry facilities use an ammonia refrigeration system to remove heat from the process. The refrigeration system sends liquid ammonia to the process where it removes heat from the poultry by boiling the refrigerant at temperatures of approximately 34° F to 40° F. The ammonia vapor then is piped back to the refrigeration plant carrying the heat from the product. The vapor is compressed to a higher pressure through the use of a compressor. This gas then goes to a condenser (typically an evaporative condenser) where the gas has the heat removed at temperatures of approximately 85° F to 90° F. The existing refrigeration systems raise the state of the heat from around 35° F to 90° F. Why stop at 90° F? Why not raise the gas pressure up to a higher pressure and condense the gas at a higher temperature and use the higher state of the waste heat to heat water to 145° F?

This can be accomplished through the use of a high pressure ammonia compressor. The gas discharged from the existing ammonia compressors can be piped to another compressor which will raise the ammonia gas to a pressure of approximately 450 psi. The condensing temperature of the ammonia gas will now be 155° F. The gas can be condensed in a shell and tube or plate and frame heat exchanger using water. This will heat the water to 145° F which can be used for process and cleaning. The cost of the power required to run the additional compressor will be a fraction of the cost required to purchase natural gas or fuel oil to heat the water.

Using a 275,000 birds per day processing plant as an example, a typical facility uses 350,000 gallons of 145° F water per day (process water is used at lower temperatures than 145° F, but the usage has been converted to 145° F for these calculations). The facility also has a minimum continuous refrigeration load of 800 tons. The heat recovery ammonia system will be sized to recover the heat from 800 tons of refrigeration which is equal to 9,516 Mbtu/h. The compressor motor will add an additional 1,690 Mbtu/h of heat to the gas stream for a total 11,206 Mbtu/h heat output from the recovery system. This will be capable of heating a 260 gpm water flow from 60° F to 145° F which will provide all the process hot water needs of the facility. The following are the operating parameters of the system:

- The equivalent natural gas required for the steam boiler system with a net thermal efficiency of 75% to heat the 350,000 gallons per day will require 92,435 MCF of natural gas.
- At a cost of \$10 per MCF, the annual natural gas cost will be \$920,435.
- The power requirements for the ammonia heat recovery system will be 3,034,900 kWh.
- \bullet At \$0.06 per kWh, the operating cost of the heat recovery system will be \$182,100 annually.
- The net annual cost savings are \$783,335.
- The installed cost of the heat recovery system is estimated to be \$1,200,000 with a simple payback of 1.6 years.

The heat recovery system will reduce the load on the existing evaporative condensers by 800 tons. This will result in a reduction of water usage and fan power providing additional savings not included in the analysis.

The use of this heat recovery system will also reduce the production of greenhouse gases from natural

gas combustion. The example given will reduce carbon dioxide emissions by 10,815,000 pounds per year. Nitrous oxide and sulfur dioxide emissions will also be reduced which will benefit facilities in non-attainment areas.

Waste heat recovery can provide some stability to operating cost budgets by reducing the process facility's dependence on fossil fuels and lower operating cost. It will also reduce environmental pollution. Waste heat recovery is a win-win for all involved. Can poultry processors afford not to consider an ammonia heat recovery system in their processing operations?

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