The principles of energy management

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Hatcheries are significant producers of heat energy. Throughout the incubation of chicken eggs, a very large amount of embryonic heat is produced that, in turn, requires water chillers to remove it.

As an example, a hatchery producing just over three million chicks per week will produce 800kW of heat energy. In a typical installation this heat would be removed by two or more water chillers.

However, since the heat emitted by the eggs and chicks is basically constant, these chiller units will be working 365 days a year, winter and summer. A common situation that often arises during winter is that the hatchery is using electrical energy to remove heat from the chilled water system, then using gas energy to place heat into the air supply – while disposing of the heat it paid to remove from the water!

The result is high energy bills, higher equipment maintenance and all of the expensive heat energy being exhausted through the roof into the environment!

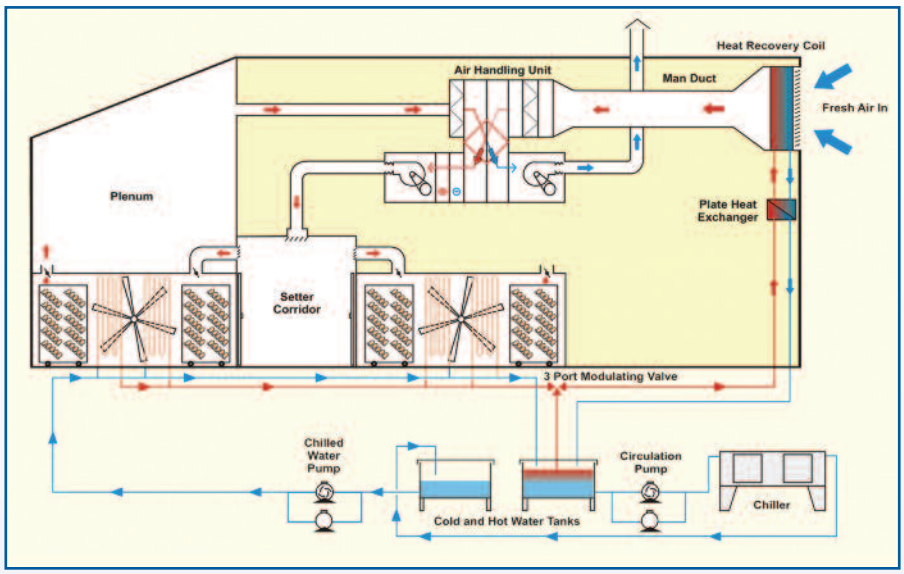

Fig. 1. Diagram of the heat recovery and energy management system. Top right is the heat recovery coil through which warmed 'cooling' water from the setters is passed. Fresh incoming air passes over the warmed coil using recycled heat for the hatchery rooms. Heat exhausted from the setters is also used to further warm the incoming air in the air handling unit.

Recycled heat

Chick Master have developed a system that recovers heat from the developing embryos and recycles it into the incoming hatchery air. This is achieved by removing the heat from the warmed water cooling return line by using a heat recovery coil, through which the warm water is channelled while passing the incoming cold air over the coil.

The result is a double benefit since we not only have warmed incoming air that requires little or no extra heating, but the warmed water in the heat exchanger returns to the chiller colder.

Not only are we saving valuable gas or oil energy for the heating of the incoming air, but we are also saving valuable electrical energy from the much reduced or virtually eliminated use of the water chillers. This form of heat recovery is known as primary heat recovery and is responsible for the major share of heat energy recovered and electrical energy saved.

In addition to the heat recovered from the primary source, a secondary source of heat recovery can be found in the exhaust air from the setters. There is also heat energy available from the hatcher exhaust, which requires a greater investment to facilitate recovery due to the dirty air being exhausted. This is known as secondary heat recovery. This source is also extremely valuable mainly due to the fact that setter exhaust air is typically around 36°C (about 97°F).

Heat recovery made from the setter exhaust air carries absolutely no danger of cross contamination since the system uses fixed plate heat exchangers that separate the supply air from the exhaust air.

When outside temperatures are close to freezing the primary heat source would raise the incoming air temperature to approximately 15°C (59°F). The air to air heat recovery system would then play its part in the process by raising that warmed air even further, potentially up to the target temperature for the setter room air supply. All this without using gas or oil to provide the heat!

It has to be remembered that this level of recovered heat utilisation is only available where air to air heat recovery is possible. Nevertheless, the example above demonstrates that in many parts of the world it is possible to raise the temperature of ambient air at freezing point all the way to 25°C (77°F) purely from 100% recovered heat energy!

The operation of the system

The higher the air volume passing over the primary heat recovery coil the more efficient the coil will be at removing the heat energy. That energy is from warmed cooling water from the incubators.

By allowing all of the hatchery fresh air requirement to pass over the primary heat recovery coil it is possible to increase the air temperature serving all areas of the hatchery. Consequently, the gas or oil energy normally required to heat the incoming air for the complete hatchery will be substantially reduced.

To achieve the maximum energy savings potential, the hatchery must utilise one common air intake (man duct). The primary heat recovery coil is installed at the front of the air intake and the air handling units are

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then coupled to the common duct. This maximises the heat recovered from the incubator's warm water return line.

However, this is not to say that significant savings cannot be obtained in those hatcheries that receive air from multiple entry points. The savings that can be obtained through retrofit of those systems can be impressive.

Another important requirement in maximising the design of hatchery energy efficiency is the chilled water system so that correctly sized return buffer tanks allow the process pump to manage the temperature differential between the setter flow and return lines.

● **Germany – Leipzig**
Conditions: Temperature ranging from -1°C (30°F) in the winter to +34°C (93.2°F) in the summer. For a hatchery setting 1.4 million chicks per week, the calculated electrical and gas energy requirement to heat the incoming air and run the water chillers would be $109,844 per year (excluding all other energy costs).

With the Chick Master heat recovery system installed, it is calculated that an impressive 61% of this energy bill could be recovered, representing a saving of over $67,000 per year.

The objective is to have the water flowing through the primary heat recovery coil at the highest possible temperature consistent with cooling the setters and hatchers with minimal air flow. The higher the return water temperature from the incubators the higher the air temperature will become as it passes over the primary heat recovery coil.

The heart of the primary heat recovery system is the control system itself.

Temperature sensors, water flow sensors and pressure sensors monitor the entire process at all times by constantly analysing the myriad of control inputs. The control system also manages the frequency drives for the chilled water process circulation pumps, the water flow rate within the system and the control of water flow through the heat recovery system.

The control system also monitors the primary heat recovery and can communicate with all other hatchery ventilation control equipment. The Chick Master Galaxy hatchery monitoring system has been adapted for centralised monitoring and control of the complete process and can even show water flow rates, valve positions, operating pressures and other energy saving related factors.

A typical heat recovery and energy management control system, ducting and air handling unit.

Energy savings

Typically for every 2kW of cooling energy dissipated, the water chiller will consume on average 1kW of electricity. The heat energy from the developing embryos can now be utilised through the primary heat recovery system to increase the temperature of the hatchery's incoming air.

By reducing the load on the chiller (and occasionally eliminating the need to run the water chiller at all) it is possible to make substantial reductions in electrical consumption. This is in addition to the gas energy saved from the substantially reduced heating requirement for the air serving the hatchery.

The system will continue to facilitate energy savings even in the summer months principally due to the cool nights (evening temperatures drop well below target hatchery air temperature for much of the year in most areas of the world).

The innovative control system can maximise the warm water return temperature to optimise its heat exchange potential as long as the ambient temperature is less than that required by the hatchery (typically 26°C or 78.8°F) the system will still benefit from significant energy savings.

Typical examples

Chick Master is now installing their revolutionary new systems in hatcheries in Northern and Southern Europe, USA, Canada and Russia. Those that have begun operations are all experiencing substantial financial benefits as well as reducing their carbon footprint.

Inset are three typical examples of the energy savings potential that heat recovery systems can deliver from three different areas of the world working on the basis that 1kW/hour of electricity will cost $0.04/kW and 1kW/hour of gas energy will cost $0.035/kW. ■

● **Russia – Rostov**
Conditions: Temperature ranging from -25°C (-13°F) in the winter to +28°C (82.4°F) in the summer. For a hatchery setting 1.3 million chicks per week, the calculated electrical and gas energy requirement to heat the incoming air and run the water chillers would be $147,514 per year (excluding all other energy costs).

With the Chick Master heat recovery system installed, it is calculated that 62% of this energy bill could be recovered, representing a saving of over $92,000 per year.

Chick Master's interactive Galaxy hatchery control system monitors and controls the heat recovery and energy management process in its entirety. You can monitor and change the function of all processes and even monitor and calculate your savings in real time throughout every single part of the system.

● **USA – Missouri**
Conditions: Temperature ranging from -14°C (6.8°F) in the winter to +32°C (89.6°F) in the summer. For a hatchery setting 790,000 chicks per week, the calculated electrical and gas energy requirement to heat the incoming air and run the water chillers would be $72,000 per year (excluding all other energy costs).

With the Chick Master heat recovery system installed, it is calculated that 50% of this energy bill could be recovered, representing a saving of over $36,000 per year.