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Research Paper

ENERGY CONSERVATION THROUGH EFFECTIVE UTILIZATION OF VAPOUR COMPRESSOR SYSTEM IN DAIRY PLANT

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The aim of this paper is to address the energy demand and its maximum utilization of available energy in many industries. In this paper a simple Vapour compression Refrigeration System available in a dairy plant is taken as a system for analyzing its energy transactions. The ammonia which is used as a refrigerant typically reaches a temperature of around 120 °C. Further the dairy plant also requires hot water and steam for its working which is met by a separate wood fired boiler. The heat energy of ammonia is untapped until now. Based on the energy audit carried out now it is recommended to introduce a Double pipe heat exchanger in which the untapped heat energy of ammonia is transferred to water for producing steam and hot water for the internal need of dairy plant. This in turn cuts the usage of boiler and results indirectly in savings of fuel cost.

Keywords: Vapor compression cycle, De super heater (plate heat exchanger), Energy conservation

INTRODUCTION

Dairy farms today face challenges and opportunities fueled by rapidly rising energy cost and concerns about environmental impacts. Dairy farms use more energy is used in the milking process, and for cooling and storing milk, heating water. Determining the best energy efficiency opportunities for dairy farms will help reduce energy costs, enhance Environmental quality and increase productivity and profitability.

Energy efficiency is often an inexpensive, quick and simple way to save money. Dairy farms can become more energy efficient by upgrading older equipment, installing new technologies and changing the equipment used for reducing energy consumption. Opportunities for cost savings and improved process include the implementation of vapour compression cycle.

- *International Journal of Refrigeration*, Vol. 31, 2008, pp. 279-286, presented a Novel

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Auto cascade Refrigeration Cycle (NARC) with an ejector. In the NARC, The ejector is used to recover some available work to increase the compressor suction pressure. The NARC enables the compressor to operate at lower pressure ratio, which in turn improves the cycle performance.

- *International Journal of Refrigeration*, Vol. 35, 2012, pp. 68-78. For developed a refrigeration system which combines a basic vapour compression refrigeration cycle with an ejector cooling cycle. The ejector cooling cycle is driven by the waste heat from the condenser in the vapour compression refrigeration cycle. The additional cooling capacity from the ejector cycle is directly input into the evaporator of the vapour compression refrigeration cycle the system analysis that is refrigeration system can effectively improve the COP by the ejector cycle with the refrigerant which has high compressor discharge temperature.
- *International Journal of Refrigeration*, Vol. 31, 2008, pp. 1398-1406, presented the results of an investigation on the efficacy of hybrid compression process for refrigerant HFC 134 a in cooling applications. The conventional mechanical compression is supplemented by thermal compression using a string of adsorption compressors. It is that almost 40% energy saving is realizable by carrying out a part of the compressor compared to the case when the entire compression is carried out in a single-stage mechanical compressor. The hybrid compression is feasible even when low grade heat is available.
- *International Journal of Refrigeration*, Vol. 29, 2006, pp. 1160-1166. Investigate the experimental analysis of the performance of a vapour ejector refrigeration system. The system uses R 134 a as working fluid and has a rated cooling capacity of 0.5 KJ/sec. The influence of generator, evaporator and condenser temperature on the system performance studied. For a given ejector configuration, there exists an optimum temperature of primary vapour at a particular condenser and evaporating temperatures, which yields maximum entrainment ratio and cop.
- *International Journal of Refrigeration*, Vol. 32, 2009, pp. 1173-1185, presented an improved cooling cycle for a conventional multi-evaporators simple compression system utilizing ejector for vapour pre compression is analyzed. The ejector enhanced refrigeration cycle consists of multi-evaporators that operate at different pressure and temperature levels. The theoretical results that the cop of the novel cycle is better than the conventional system.
- *International Journal of Engineering Business and Enterprise Applications (IJEBEA)*, 2013. For COP of vapour compression cycle is increased by lowering the power consumption/work input or increasing the refrigeration effect. By using sub-cooling and using diffuser at condenser inlet refrigerating effect increases and power consumption or work input decreases. Thus performance of cycle is improved. High velocity refrigerant has various serious affect on vapour compression refrigeration system such as liquid hump, undesirable splashing of the liquid refrigerant in the condenser and damage to the condenser tubes by vibration,

pitting erosion. Diffuser is such a device to reduce high velocity of refrigerant is the conversion of some amount of kinetic energy into pressure energy without work consumption.

SYSTEM DESCRIPTION

Simple Vapour Compression Cycle: Dry saturated vapour coming from evaporator is compressed in compressor so presser is increases superheated vapor is passed through condenser where vapour is condensed by flowing the cooling water in condenser. Dry saturated liquid is passed through expansion valve where expansion takes place so pressure is decrease by expansion after expansion liquid is passed in evaporator where it absorb the heat of storage space and evaporate so cooling process in storage space is achieved, thus cycle is complete.

COP = Refrigeration Effect/Work Done

Using Heat Recovery Unit

Refrigeration Heat Recovery unit (RHR) capture the waste refrigerant heat from the condenser to pre heat water before is transferred to a makeup water storage tank or some processing for directly using. An RHR unit can recover 20 to 60% of the energy that is required to cool milk for storage. Depending upon capacity of plant being milked, the RHR storage tank should be sized to provide enough hot water for milking. This includes hot water for washing the milking system and for washing the bulk tank. The payback for purchasing an RHR unit depends on the savings from heating water and will vary greatly from farm to farm.

Figure 1: Vapour Compression Cycle

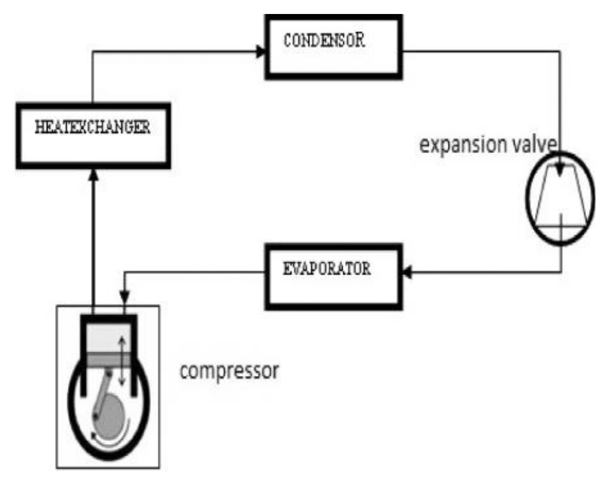
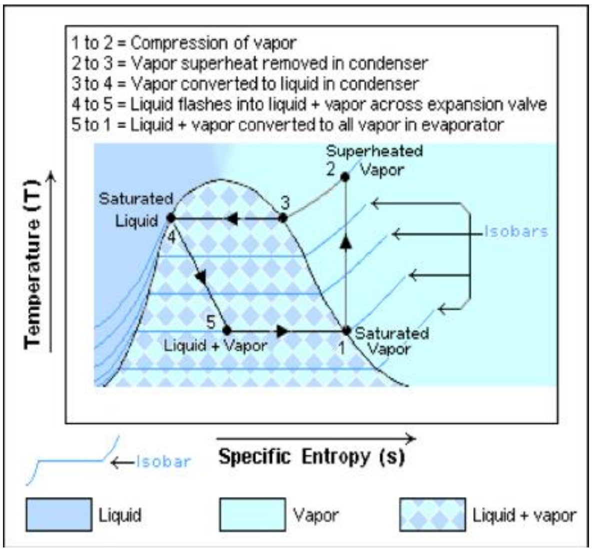


Figure 2: T S Diagram



Types of Refrigeration Heat Recovery Units

There are two types of RHR units: desuperheating and fully condensing unit.

A desuperheating unit operates only when the refrigeration system operates and produces water temperatures around 95 to 115 degrees. These units can be inexpensive to add, but only part of the available heat can be transferred to the water. Nearly all of the available refrigeration heat is recovered as hot water from a fully condensing unit, with temperature reaching 120 to 140 degrees. This type of RHR unit meets the requirements of the cooling system by using a valve to control the flow of cold water through the heat exchanger. Once the storage tank is fill, excess warm water can continue to be used and not wasted. A fully condensing RHR unit replaces the need for regular condenser in the refrigeration system and is best integrated as part of a new or replacement refrigeration system. if nearly all of the energy captured by the RHR unit is used for pre heating water, then pre-coolers is not needed to remove heat from the milk and may, in fact, increase overall energy costs.

Figure 3: Refrigeration Heat Recovery Units

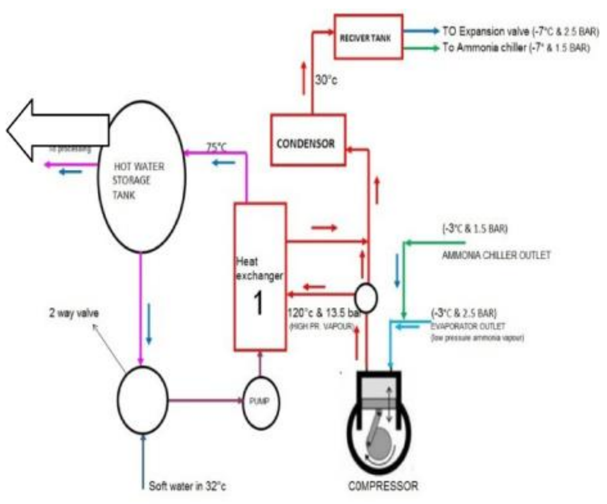
Heat Exchangers

Heat exchangers used for under cooling of ammonia transfer the heat from the water to an intermediate cooling fluid, such as well water or ammonia-water solution, by having the ammonia and coolant flow in concurrent or counter flow configurations. In a concurrent flow configuration, the ammonia and coolant flow in the same direction. The fluids flow pattern counter flow systems allow for lower ammonia temperatures. The amount of cooling that takes place depends on the flow of the ammonia in relation to the flow of the coolant, in addition to the heat transfer area, the number of times the ammonia passes through the coolant and the temperature of the coolant.

Heating of Water

Hot water is essential for producing high-quality milk on dairy farms and is primarily used for cleaning milking systems. The amount of hot water required varies from farm to farm and depends on the size of the milking herd and the type and size of the milking systems. Hot water is generally produced by water heaters that use either fuel oil, natural or propane gas, solar energy or electricity. But in thus systems to make a water heat exchanger used to flow of refrigerant before condenser. For reducing the 80% of heat recovered to makeup water around 75 °C. The electric energy savings for 20%. For some dairy farms,

Figure 4: Analysis of Vapor Compression Cycle: Modified System



heating water can account for about 25% of the total energy used on the farm.

Energy Management Policy

1. Continual up gradation of technology, system and services to optimize the energy cost.
2. Monitor and control the energy consumption effectively.
3. Providing resources to achieve measurable objectives when every necessary.
4. Educate and motivate all the people concerned through effective communication and Regulation.
5. To establish Bench marking Standards in industry in Energy management.

Types of Energy Audit

The energy audit orientation would provide positive results in reduction energy billings for which suitable preventive and cost effective maintenance and quality control programmers are essential leading to enhanced production and economic utility activities. The type of energy audit to be performed depends upon the function or type of industry. There can be three types of energy audit.

1. Preliminary energy audit
2. General energy audit
3. Detailed energy audit

Preliminary Energy Audit

The preliminary energy audit alternatively called a simple audit screening audit or walk through audit, is the simplest and quickest type of audit. It is carried out in a limited span of times and it focuses on major energy supplies and demands. It aims at taking steps which are necessary for implementation of energy conservation program in an establishment. It involves activities related to collection, classification, presentation and analysis of available data in arising at the most appropriate steps to be taken in establishing energy conservation.

General Energy Aduit

The general energy audit is also called a mini audit or site energy audit or complete site energy audit. It expands on the preliminary audit by collecting more detailed information about facility operation and performing a more detailed evaluation of energy conservation measures identified. This type of audit will be able to identify all energy conservation measures appropriate for the facility given its operating parameters. A detailed financial analysis is performed for each measures based on detailed implementation cost estimates, site specific operating cost savings and the customer's investment criteria. Sufficient detail is provided to justify project implementation.

Detailed Energy Audit

Detailed energy audit is also called comprehensive audit or investment grader audit. It expands on the general energy audit. Thus, the scope of this audit is to formulate a detailed plan on the basis of quantitative and control evaluation, to evolve detailed engineering for options to reduce total energy costs, consumption for the product manufactured. It should be at 8 to 10% savings, detailed audit study shall be completed in a period of three weeks from date of commencement. Project commissioned.

Table 1: Project Commissioned

S. No.	Description	Electricity (KWH)	Use of Energy Wood (tones)	Achievement of Energy Savings per Year (in Rs.)
1.	Condenser Water Pump Size Reduced (15 H.P to 7.5 H.P)	3.38 lakh	—	19,00,000.00
2.	Heat Recovery Unit	—	175.200	1,50,000.00
			Total	**20,50,000.00**

CONCLUSION

In this system modified to effectively utilizing of waste heat recover the vapour Compression cycle. A famous quit "energy saved is Energy generated". The energy that apart from increasing the generation capacity at high cost, one must go for the energy audit to save the electric energy and fuel at much lower cost. Because the demand for electrical energy and fossils fuel is continuously growing and it is putting stress on the capacity to meet the demand. So, we have undertaken studies of an industry are the major energy consumers. The data provided in this paper shows that how we can save the electrical energy and fuel energy by incorporating some changes in the installation and making it energy efficient, and recovering the waste heat does not a affect the atmosphere.

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