Research Issue: Sustainability Design for Production Area

Goals

The research issue I will investigate pertains to the sustainable design of production facilities. I will utilize the availability I already have to the Food Science Building's Production Area as my case study that I will evaluate. Through examination of the Food Science Building's Production Facility I can evaluate its' sustainability. Including these results with others that I will discover through the course of my research I hope to compile a list of useable guidelines that may be applied to production facilities in general.

I will utilize all resources available to myself to perform the most well rounded research possible. Some initial considerations I will use include the U.S. Department of Health and Human Services, FDA (Food & Drug Administration) Manuals, and job-site contacts I have made through my on-site internship with Gilbane Building Co. (the CM) on the Food Science Project. I anticipate that the most beneficial research performed will come from the on-site project contacts I will make. The food processing engineer and food production contractor will be the first two people I will begin my investigation with. In addition, I may interview the mechanical and possibly the plumbing contractor to find their views on the situation.

Next, I will talk with Penn State University's project manager, whom was involved in the project from the initial design phase until now. I feel that this would be a good place to begin the initial investigation of the design. After that, I will move on to the user group and interview with the man in charge of the PSU Creamery.

I feel that through reviewing the manuals mentioned above I will have a good understanding of the minimum requirements necessary for a production facility. Next, I will combine these minimum requirements with the good practice techniques I hope to reveal through talking with the on-site experts that build these facilities everyday. A compilation of all this information into a chart, advantage / disadvantage format will then be produced showing all of the results found.

Analysis

The preliminary investigation into the Production Area uncovered some unexpected results. The Production Area in the Food Science Building can not be classified as a typical Production Area. It is classified as a Milk Processing Facility which holds significantly stricter standards. A milk processing facility actually has an entirely different set of guidelines and minimum standards it must maintain.

However, the same study as mentioned above can still take place and the same results can be produced just for a more limited set of facilities as you will find out below. A set of sustainable guidelines can be developed specifically for milk processing facilities and/or for production facilities and areas that are required to be ‘cold areas’, for example large loading docks that must be maintained a certain cold temperature or large storage cooler and freezers. In addition, facilities that require extreme heat for cleanliness purposes, etc. can benefit from the results found below.

Reutilization of left-over ‘By Product’

The first issue investigated was the reutilization of the left-over by product of the facility. At the beginning I reviewed the food processing drawings and began to understand the multiple systems uses and flows: clean in place system, batch plant, homogenizer and separator, pasteurization, flavor vats and ingredient feeders, ice cream tanks, milk filling, cream vats, and cheese vats. Each of these systems quickly became complicated and difficult to follow. At this point, is when I began my discussion with the food processing engineer. The end result of the discussion was: in a milk processing facility there is very little left-over ‘by product’ waste that is not used in the production of some milk based product. Nevertheless, the minimal left-over ‘by product’ can not even be considered for any other use due to the fact of how quickly milk spoils.

Refrigeration / Cooling Systems

The second concern found is choosing the correct type of refrigeration / cooling system in your facility. Dependant upon the needs of your facility some exceptionally large areas may need to be kept at extremely low temperatures. For example, the

Production Facility at the PSU Creamery contains a 20’x55’ x 30’high freezer that must maintain a temperature of -20^{o}, a 20’x25’ x30’high freezer @ -25^{o}, and a 25’x60’ x30’high cooler @ +34^{o}. In addition to these areas there are also a few smaller cooler and freezers that require the same temperatures as the bigger ones mentioned above. The cooling costs in these areas are an extremely significant cost in the operation of the facility.

There are mainly three different fluids that can be used when considering cooling loads such as these: water, freon, and ammonia. Water is the least desirable due to the amount of energy required to cool the fluid to achieve the desired temperatures. Additionally, if you wish to cool an area below freezing such as a freezer, water is unable to so based upon the simple fact that the water in your lines will freeze at 32^{o} (if you are even able to achieve the incredible amount of energy necessary to keep flowing water at 32^{o}). The next alternative is well known to everyone, freon. Freon, when considering energy required too cool is drastically more efficient than water. However, when considering sustainability freon is considered awful for the obvious reasons of its extremely negative affect on the environment. Lastly, ammonia is currently the best choice out there to use for such cooling situations; due to its chemical make-up it requires the least amount of energy to cool and can become just about as cold as necessary. The downside to ammonia is if you would have a leak in your system the concentration of ammonia in some facilities could be fatal if inhaled for an extended period of time. Therefore, ammonia detectors must be put in with the installation of your ammonia cooling system. Another positive to an ammonia system is that if a leak occurs and the ammonia needs to be discarded it can be processed and spread on farming fields for fertilization. Additionally, specialized ammonia cooling contractors are becoming more prevalent thus costs of these systems are becoming cheaper through competitive bidding.

Heating Systems

Subsequently, the next cost that may become significant for a processing facility is the heating costs. The heating costs considered in this instance though are not the costs associated with heating the area to an acceptable working temperature. The heating costs

in this consideration is the cost to heat the water to a required temperature for the necessary equipment or for cleanliness purposes. For example, at Food Science 160^{o}+ water is required for the continuous pasteurizer and 180^{o}+ water is required for the clean in place machine used to sanitize all tools, etc.

There are also three main ways to heat the water in these types of facilities to the required temperatures: electricity, heating hot water, or steam. Electricity, is entirely energy inefficient to heat the continuous water supply to the necessary temperature for a facility such as this. Utilizing your buildings heating hot water source to provide this service is actually sometimes logical with the right upgrades but still not the cheapest solution. Steam is the cheapest alternative to suffice your facilities extreme hot water needs. Steam is the cheapest and cleanest heat to produce and through a heat exchanger you can acquire any hot water temperature necessary. Although, steam is not always a readily available utility source such as it is at the Penn State Campus steam loop. In this case the cost of the boiler at your facility would have to be compared to the duration of your facility's intended operations life and an individually based cost analysis would have to be performed. It is possible in such situations it could be best to use a basic heating hot water system.

GMP's (Good Manufacturing Practices)

The PSU Creamery facility was designed to allow for exemplary Good Manufacturing Practices (GMPs). Service connections and ease of equipment egress and ingress was carefully studied. As well provisions were made with great consideration for the pick-up and delivery of both the Creamery and the Pilot processing facilities. The provisions include the flow of work inside being coordinated with the placement of the multiple loading dock zones around the buildings north side and the loading zones being easily accessible by tractor-trailer. Independent air-handling systems were also required to eliminate concerns of possible contamination of the Creamery Processing/Manufacturing area by the microbiology research and teaching laboratories.

Additional considerations that were accounted for at the PSU Creamery facility were high speed quick rolling overhead doors and some redundancy in critical materials such as insulation. As stated above a substantial cost that a facility such as this incurs is the cooling costs for the large coolers and freezers. Each time that one of the doors in those areas are opened for a fork-lift, etc. an excessive amount of cold air is lost. To boot, say that the fork lift operator is moving in and out of the area each day and not getting off of the machine each time he goes in and out and closes the door behind them. Consider the amount of energy lost throughout the course of one day just by this one action, not closing a door. Thus at the PSU Creamery they installed high speed quick rolling doors at each location such as this. These doors are all sensory or sound operated so that the operator never has to leave the machine. For example, when the forklift breaks the laser beam, the door opens at a speed of 100 in./sec. and as soon as the laser beam is whole again (when he leaves the door closing area) the door closes behind him, thus increasing production and decreasing the amount of cold air lost through the entrance.

Another sustainable GMP is to use HCFC-free insulated composite metal panels. These types of insulated metal panels are among the best building materials for freezer and cooler wall panels and are accepted as a sustainable product by the U.S. Green Building Council's LEED Rating System. Sustainable benefits include recyclability of metal, reuse of entire panels, can be refinished, energy saving efficiency of isocyanurate insulation, long term panel durability, minimal landfill waste, minimal job site impact, low maintenance requirement.

Conclusion

In the beginning of my analysis I soon found that a few of my initial considerations were incorrect. The PSU Creamery's Production Facility which I used for the basis of my case study in some ways can not be compared to all production facilities. The fact that it is a milk processing facility varies it significantly from other facilities. Although, the issues that I investigated can be directly related to and applied to any facility which requires cold storage and extreme cleanliness requirements.

The reutilization of any 'left-over' by product from a milk processing facility is impossible due to the fact that milk spoils so easily.

Thus, the next most significant issue for a sustainable production facility is the systems chosen for the cooling of the freezers and coolers and the heating for the water cleanliness and equipment requirements. The most sustainable fluid and system to be used for refrigeration / cooling is a compressed ammonia system. Ammonia has the best properties for efficiency when cooling to such cold temperatures with significant loads. It is also the most environmentally friendly system readily available right now. The most sustainable system to use for heating is a steam system due to its high efficiency and cleanliness manner in which it produces heat.

A few good GMP's (Good Manufacturing Practices) that can be incorporated into a sustainable design are the use of high speed quick rolling doors and HCFC-free insulated composite metal panels. High speed quick rolling doors drastically decrease the amount of energy loss each time the cooler/freezer is entered. It decreases the amount of time the door is open and cold air is lost and eliminates the reliability to the workers. The HCFC-free insulated composite metal panels are the best sustainable material choice for a cooler / freezer wall as suggested by the U.S. Green Building Council's LEED Rating System.