# **Recommendation 1: Install Air Curtain Systems on Doorways**

Recommended Action

Install air curtains to reduce heat transfer through doorways in the production area.

Summary of Estimated Savings and Implementation Costs

|  |  |
| --- | --- |
| Annual Cost Savings | $11,871 |
| Implementation Cost | $23,000 |
| Payback Period | 2.0 years |
| Annual Electric Savings | 166,317 kWh |
| Annual Demand Savings | 167 kW |
| ARC Number | 2.2523.3 |

Current Practice and Observation

In this plant, there are three docking doors that are opened for loading and unloading operations. These docking doors are in open position for about two hours a day during the summer, and the room is kept at freezing temperature to keep the ice from melting. In this case, installing air curtains on doorways will reduce the infiltration of outside air and therefore make-up requirements. Air curtains create a barrier of high velocity air between different environments and that is strong enough to stop winds up to 25 mph. However, closing the doors is more efficient.

Anticipated Savings

It was generally noticed that there is a large amount of heat transferred through doors that are open during loading and unloading. By installing air curtains on doors, the heat transfer can be significantly reduced. The heat transfer through an open door, HT, can be estimated from the Figure below. However, the heat transfer should be modified for the number of operating days, OD, and the average outside temperature to correct for the experimental conditions in the chart below. The summer heat transfer, SHT, is obtained from the following equation:

SHT = HT × (OD / TC) × (TI -TO) / ΔT,

where,

HT = Heat transferred from 3 doors: 300 MMBtu/yr

OD = Number of operating days per week: 7 days per week

TI = Room temperature: 30oF

TO = Average outside summer temperature: 75oF

C1 = Correction Coefficient: 293 kWh/MMBtu

TC = Time correction based on experimental chart below: 5 days per week

ΔT = Temperature difference correction based on chart below: 13oF

There are three doors in the building and the location and dimension of the doors are given in the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Location** | **Number of**  **Doors** | **Width**  **(ft)** | **Height**  **(ft)** | **Area, each**  **(ft2)** |
| Ice storage | 3 | 8 | 9 | 72 |
| **Total** | **3** |  |  | **216** |

**Table 9: Location and Dimension of the Doors in the Building.**

The opening area of the door was calculated as 72 ft2. It is estimated that each door is kept open for about two hours a day. From the attached graph, the heat transfer factor, HTF, is estimated to be at about 100 MMBtu/yr per door.

The temperature near the door is 30oF. The average summer outside temperature is about 75oF. For the plant conditions of interest, the summer heat transfer, SHT, is:

SHT = 300 MMBtu/yr × (7/5) × 293 × (75 – 30) / 13

= 425,976 kWh/yr.

The air curtain doors are generally 80 percent efficient. Thus, the summer energy savings, SES, is calculated to be:

SES = SHT × (ηAC - ηExist)

where,

SHT = Summer heat transfer, 425,976 kWh/yr

ηAC = Efficiency of air curtain, 80[[1]](#footnote-1),[[2]](#footnote-2)%

ηExist = Efficiency of existing solution (strip curtains) 40%

SES = 425,976 kW/yr × (80% - 40%)

= 170,390 kWh/yr.

The summer demand savings, SDS, for the doors are calculated below:

SDS = ES / OHS × C2 × CF

where,

C2 = Conversion constant; 6 months/yr

CF = Coincidence factor – probability that the equipment contributes to the facility peak demand; 100%/mo

OHS = Summer operating hours for HVAC system; 4,368 hours (24×7×26)

SDS = 170,390 kWh/yr / 4,368 hrs/yr × 6 mos/yr × 100%/mo

= 234 kW/yr

One air curtain system uses approximately 5 HP motor for its operation. The operational costs of air curtain system are calculated as follows:

EU = Electricity usage of the air curtain system

= HP × C3 × OHAC

where,

C3 = Conversion constant, 0.746 kW/HP

HP = Total power of three air curtain motors; 15 HP

OHAC = Operating hours of air curtains, 364 hrs/yr (2 hours per day, 7 days per week, 26 weeks per year)

EU = 15 HP × 0.746 kW/HP × 364 hrs/yr

= 4,073 kWh/yr

DU = Demand usage of the air curtain system

= HP × C3 × C2 × CF

= 15 HP × 0.746 kW/HP × 6 mos/yr × 100%/mo

= 67 kW/yr

The annual cost savings, ACS of the recommendation is calculated as:

ACS = (SES - EU) × electricity cost + (SDS - DU) × demand cost

= (170,390 kWh/yr - 4,073 kWh/yr) × $0.054/kWh + (234 kW/yr - 67 kW/yr) × $4.16/kW

= 166,317 kWh/yr × $0.054/kWh + 167 kW/yr × $4.16/kW

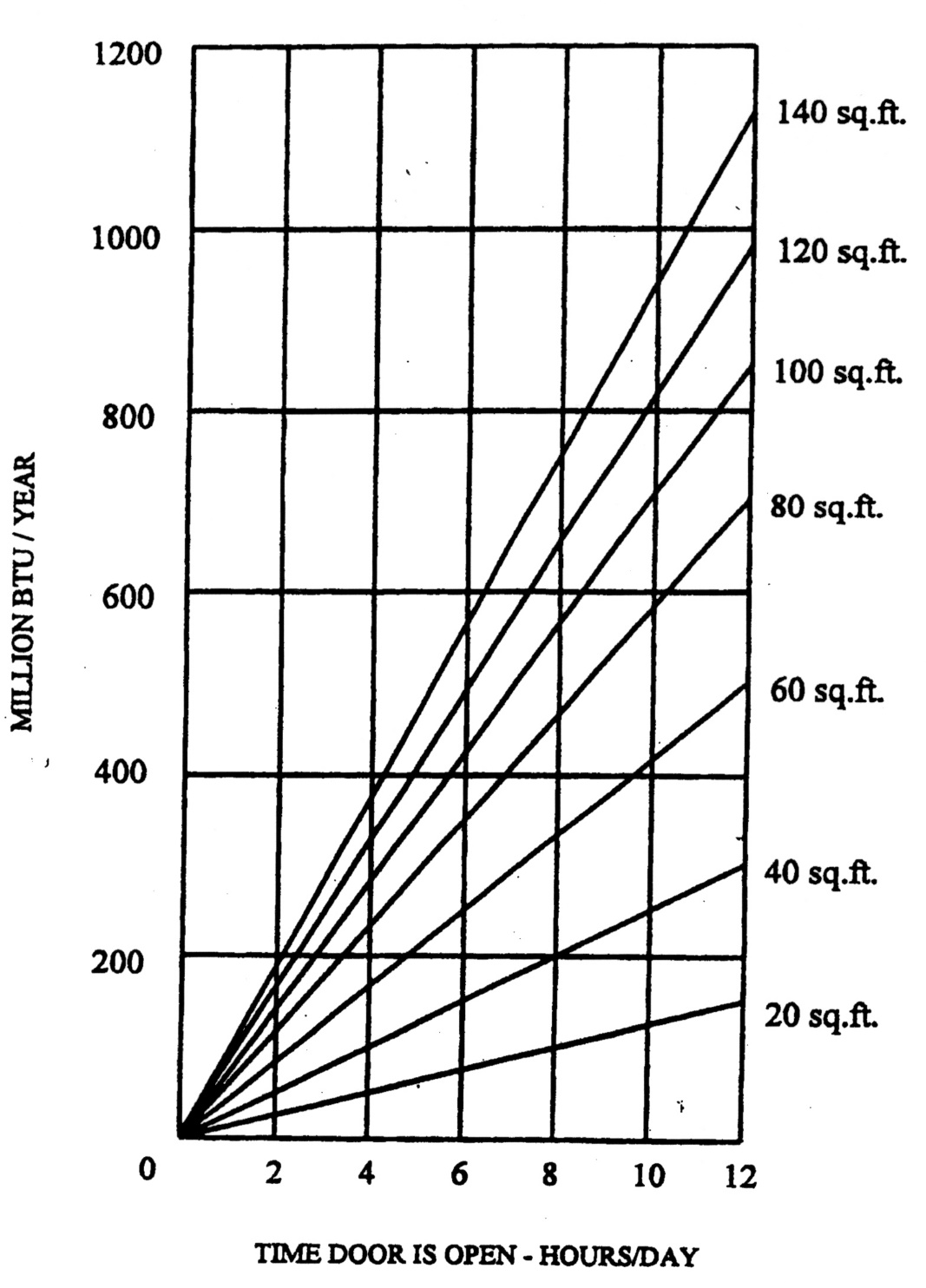
= $8,981/yr + $695/yr

= $9,676/yr

Implementation Cost

The cost of an air curtain system is estimated to be $6,000 each. The labor cost for installation of the whole air-curtain system is estimated to be about $5,000. The total implementation cost is $23,000. It is also recommended that these doors are to be installed with new insulations.

**The annual electric energy savings for this recommendation is 166,317 kWh and annual demand savings is 167 kW. The estimated annual cost savings is $11,871 and, with an implementation cost of about $23,000, the payback period would be about 2.3 years.**



**Figure 1: Annual Heat Transfer from Doors\*.**

\*Source: Georgia Technical Experimental Station.

1. https://www.bluegiant.com/Files/White-Papers/Benefits-of-Air-Curtains.aspx [↑](#footnote-ref-1)
2. Hong Ye et al. Study on the influence of air curtain barrier efficiency on infiltration air volume and temperature distribution in large space in winter, Procedia Engineering [↑](#footnote-ref-2)