Heat Treatment Calculator

Software program helps determine how much energy is needed to heat a building

Heat treatment workshops have become an annual event at Kansas State University (KSU). The most recent workshop was held Aug. 4-6 in the KSU Department of Grain Science and Industry.

At each of the workshops, participants witness how a heat treatment is done. They walk through a heated pilot flour and feed mills to monitor temperatures and observe effects on insects typically found in these mills.

Participants engage in "heated" discussions at these workshops about the amount of energy utilized during the heat treatment and an objective basis for calculating the actual costs of heating our mills.

Companies that do heat treatments have been reluctant to share such information in a public forum, despite repeated requests from the participants.

The engineers and representatives that work for heat treatment companies are competent and know the amount of heat energy that is required to heat up a mill.

My research group at KSU has been making progress in developing a software program for making heat energy calculations that millers and others can use to optimize heat treatments.

The program, for lack of colorful words, is called the Heat Treatment Calculator (HTC).

What follows is a brief description of the HTC and its potential benefits. Information about the fully-compiled program was presented at our recent heat treatment workshop at KSU, sponsored by the American Feed Industry Association (AFIA).

Milling Journal will have a report on the workshop in its 2003 Fourth Quarter issue.

Introduction

The HTC is a software program coded in Visual Basic using Microsoft Visual Studio.NET.

The HTC is designed to calculate the amount of energy needed to heat a building to the required temperature, and predict the quantity of fuel needed to get this energy and the cost estimate for the required fuel consumption.

HTC is designed to calculate the amount of energy needed to heat a building to the required temperature, predict the quantity of fuel needed to get this energy, and the cost estimate for the required fuel consumption.

The HTC produces datasheets that

could be used to create graphs depicting these variations.

Brief Description

The HTC is an interactive program. The user inputs the temperature requirements such as the ambient temperature and the desired temperature.

The desired temperature is generally 122 to 130 degrees F for most mill heat treatments.

The user then gives the description of the building subjected to heat treatment.

This description includes the number of floors and rooms, as well as walls, doors, windows, floors, and ceilings in these rooms subjected to heat treatment.

Using this description, the HTC keeps an internal representation of the building and allows the user to select the building material used for each component that involves heat loss.

HTC can be used to study the variations of energy, fuel, and cost with respect to changes in the heating requirements and weather conditions.

The HTC connects to a database to get the values of the required physical constants of these building materials. These values are used in the heat-loss equations (see chart on page 48).

Equations and Formulae

The software is based on the principles of air conditioning of industrial buildings. It uses equations from air conditioning that can be applied to practical situations.

These equations are used to calculate heat loss from the building subjected to heat treatment and the necessary energy consumption to heat the building to the desired temperature.

For these calculations, a database that includes U values, K values, and other useful properties of different building materials is used.

Potential Uses

Here are several benefits of using the HTC:

- The HTC can be used to study the variations of energy, fuel, and cost with respect to changes in the heating requirements and weather conditions.

For example, the user can choose different ambient and desired temperatures and determine how the energy requirements change with ambient conditions during different times of the year.

- This HTC software enables the user to arrive at a price estimate of heat treatment under the given climatic conditions.

Typically, prices vary over time and with the type of fuel used for heat treatments, so the user has the ability to input this information and also examine how price fluctuations affect the cost of a heat treatment.

- It helps the user to choose optimal conditions for cost effectiveness, without actually doing the heat treatment.
- Given the temperature and heating parameters, the HTC can help us develop the most optimal heat treatment schedule for a specific building at a specific location.

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Heat Treatment Calculator from p. 47

Single Surface	▶	Know U Value? q = ÄT * A * U. Else Select Material Get k. Select Thickness Get x, q =ÄT * (x/k)* A.
Composite Surface	▶	Know U Value? q = ÄT * A * U. Else $1/U = /1/f_i + x_1/k + 1/c_1 + ...+ 1/c_{n-1} + x_n/k_n + 1/f_o$. Repeat for each room and for each floor.
Floors	▶	ÄT is the temperature difference between the outer surface of the floor and the temperature of the ground in the location. q = ÄT * A * U.

Infiltration: q = 0.018 * ÄT.

Terms in the equations

ÄT: Temperature difference of the exposed wall.
A: Area of the exposed surface.
U: Coefficient of heat transfer.
k: Thermal conductivity.
f: Surface coefficient of heat transfer.
c: Conductance.
x: Thickness.

Algorithm for heat calculations of exposed surfaces and ceilings.

Alternatively, one can change the building specifications and determine how building materials affect heat energy costs. This may help engineers determine what building materials are appropriate, if a new mill is being constructed with built-in heaters for conducting in-house heat treatments.

Target Users

This software can be used by personnel responsible for planning a heat treatment or by milling companies. The user should have access to the measurements of the buildings.

These include the length and breadth of exposed areas, the volume of the building, and the building materials used for the construction of the building subjected to heat treatment.

The program has values for most materials. However, if your building materials are not listed, we would appreciate you providing those values to us so we can update our program.

Acknowledgments

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