Psychrometrics Through Computer Simulation

An Online Continuing Education Course for Engineers

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HVAC APPLICATIONS THROUGH COMPUTER SIMULATION

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INTRODUCTION

One of the intentions of this course is to provide a very powerful tool to the student that is interested or is very familiar with HVAC. Computer simulation of processes is this tool. In this course there is discussion of some of the equations that are needed to simulate these processes. Most of the accuracy of the results in these simulations is quite good, however, some more refinement may be needed in some areas to slightly improve the final accuracy. In general the results can provide a good and sound answer to many typical engineering problems.

Much of the course is based on the individual simulations of HVAC processes. At the end a small section is designed to address the simulation of a complete system. A copy of the attached programs with this simulation is provided with the course. If the student is motivated to continue working with computer simulation problems for HVAC, he/she will have the tools to develop his/her own programs that can address much more complex problems than the ones included in this course.

This course is designed to be a continuation to the previous course "PSYCHROMETRICS AND ITS USE IN HVAC". The previous course covered most of the theory that is needed to solve typical HVAC applications. Some of the topics from the previous course are covered again in this course, but with a deeper concentration on the topics that are used to develop a computer simulation. The material of this course is more advanced, and should be a good refresher course for a Mechanical Engineer. The discussion of the theory is directed more towards practical application of HVAC using a computer to simulate the processes.

The material is also covered by a number of examples where most of the equations used are similar to the ones used throughout the simulations.

The purchase of this course will include an Excel file that the student can use to enter initial conditions and to solve for the specific applications. The applications included in this Excel file are the following:

A) Process of two air streams mixing
B) Process of a cooling coil
C) Process of a heating coil
D) General process of air conditioning space
E) HVAC system simulation
F) Psychrometric formulas used in the computer simulation

Specific set of screens of the regular excel sheets are shown at the end of the REFERENCE section of this course.

Even though the accuracy of the simulation programs is well within the typical engineering expectations, the student may be able to develop his/her own programs to cover more accurate conditions, if needed.

This course includes a more advanced Psychrometric chart calculator that includes the calculation of the dew temperature, that is so widely used in the cooling coil simulation.

It is strongly recommended that the student, prior to using the Excel program included in this course, makes sure that the original program is saved and a copy is used for the test and experimentation. Always keep an original copy in case any problems develop.

The student can contact the author at the email address indicated on the front page.

WHY USE COMPUTER SIMULATION?

Simulating a process in the computer normally translates into improved results and significant reduction in time. Most people that own a computer today also own Microsoft Excel or other spreadsheet program. In addition, most engineers are very familiar with this type of spreadsheet program and will find the applications very simple to use.

Most of the computer simulations in the area of Thermoscience are designed around the basic laws of Thermodynamics. The equations used are typically the mass and energy balance conservation principles which are essential and widely used in the design of the of the computer programs.

In the previous course "Psychrometrics and its use in HVAC", a sample of a psychrometric calculator was provided that uses the formulas required to create the psychrometric chart. This calculator provides the psychrometric chart information in a numerical form. This type of application is a very beneficial tool that can simplify calculations and increase accuracy in many practical situations.

In addition to the benefits mentioned before (time and accuracy) of the individual computer simulation processes, the great benefit exists when the output from one process (program) is used as the input to another process. In this way, solutions to several processes can be linked together. As an example, the simulation results of a mixing process of two air streams (outside air and return air) can be used as the input to the entrance to a cooling coil. After the evaluation of these two processes simulation, the output can be used as the input to another process such as the heating coil process and later on as the conditioned space process.

As the student can see, the simulation of several of these processes can lead to the complete simulation of a much more complex simulation process. This is probably one of the greatest benefits of this type of process simulation.

Because the programs are designed in plain excel (no macros are used in these simulations), the student can very easily connect the outputs from one process to the input of another process when using this concept in his/her own applications.

The student can use these types of programs to simulate the most typical HVAC processes regardless of how elaborate the systems may be.

MASS AND ENERGY BALANCE EQUATIONS

From a course in thermodynamics we know that the first law of thermodynamics indicates that mass and energy is conserved throughout a process. This process can be a mixing, heating, cooling, humidification or drying process.

In this course we will concentrate on HVAC applications, but the use of these principles is much broader and can be expanded to many more applications.

The mass conservation equation can be

In

The moist air.

A ge water from a
syste solve a
probl d or
remov

and water are added and or removed.

The energy balance equation in this illustration is as follows:

$$\mathbf{Q = \Sigma\, m_{out} * h_{out} - \Sigma\, m_{in} * h_{in}}$$

$$\mathbf{Q = m_{a2} * h_{a2} + m_{w2} * h_{w2} + m_{w4} * h_{f4} - m_{w3} * h_{f3} - m_{a1} * h_{a1} - m_{w1} * h_{w1}}$$

Where: h_{f4} and h_{f4} are the enthalpies of the water, as a liquid added and removed from the system.