Applications of Psychrometrics to Heating and Cooling Systems

An Online Continuing Education Course for Engineers

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Applications of Psychrometrics to Heating and Cooling Systems

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Psychrometrics is a science that deals with the determination of the thermodynamic properties of moist air. Heating, Ventilation, and Air conditioning (HVAC) systems deal with changing the properties of moist air to provide comfortable environments.

A psychrometric chart that presents the properties of mixtures of moist air on a single graph is an invaluable aid when looking at the air conditioning problems and manipulating air properties. For example, psychometrics will answer why heated air can hold more moisture, and conversely, how allowing moist air to cool will result in condensation. It will also answer why it is impossible to remove moisture from air without bringing the air near to the saturation line.

To enable you to take an active part in the design, installation, or operation of HVAC services, the familiarity and understanding of psychrometric charts is a must for the HVAC designer. This course provides intensive learning of the essential psychrometrics principles and applications to HVAC systems. The course includes many practical problems and solutions.

This course is aimed at both new and experienced practitioners who need to understand the basis and application of psychrometric charts for the analysis and design of air-conditioning and ventilation systems.

The course will benefit HVAC design engineers, energy engineers, HSE professionals and facility managers, O&M engineers, architects working with contractors, and anyone interested in learning HVAC and Refrigeration Systems.

Key Learning

At the successful completion of the course, the reader should be able to:

- List out the key parameters and definitions that are needed to describe air properties,
- Read psychrometric charts and apply them to air conditioning applications,
- Define the relationship of the 7 air properties: DBT, WBT, RH, dew point, absolute humidity, enthalpy, and specific volume,
- Explain how the condition of the air may be reliably measured,
- Use a psychrometric chart to plot individual points and processes,
- Apply the chart to identify various psychrometric processes viz. sensible heating and cooling, cooling and dehumidification, evaporative cooling, heating and humidification, and air mixing,
- Analyze the practical problems with sample calculations.

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Chapter 1: HVAC and Psychrometrics

1.0. Introduction

Buildings exist primarily to provide a healthy and comfortable environment where people can work and live. The indoor environment must be maintained at a comfortable temperature, free from damp, adequately ventilated with fresh air, be free from draughts and pollutants, and be quiet. A comfortable indoor environment must rely on the use of heating, ventilation, and air conditioning (HVAC) systems.

Because buildings encompass complex interactions between different subsystems such as local climate, human occupancy, appliances load, ventilation air, exhaust air, infiltration, and varying temperature and humidity needs, care must be taken when changes are made to any single aspect so that it does not have a detrimental effect on the operation of HVAC systems. Application of "Psychrometrics" is very important when selecting the proper air conditioning equipment and determining the environmental conditions that affect human thermal comfort.

As HVAC engineers, we manipulate the moisture and/or airflow to keep space conditions within a certain range, but psychrometrics tells us how careful we must be. For example, what happens when you bring 10-degree outdoor air at 60% RH into a building and heat it up to 70 degrees? You drastically reduce the relative humidity!

Psychrometric analysis allows you to visualize, track, monitor, and diagnose environmental problems such as how hot air can hold more moisture, and conversely, how cooling moist air to its dew point will produce condensation. To predict whether or not moisture condensation will occur on a given surface, you need three pieces of information: (a) the temperature of the air, (b) the relative humidity of the air, and (c) the surface temperature. The psychrometric chart explains that by raising the surface temperature or by lowering the moisture content of the air or some combination of both can avoid surface condensation. A rule of thumb is that a 10°F rise in air temperature can decrease relative humidity 20 percent. The use of a psychrometric chart will show that this is true.

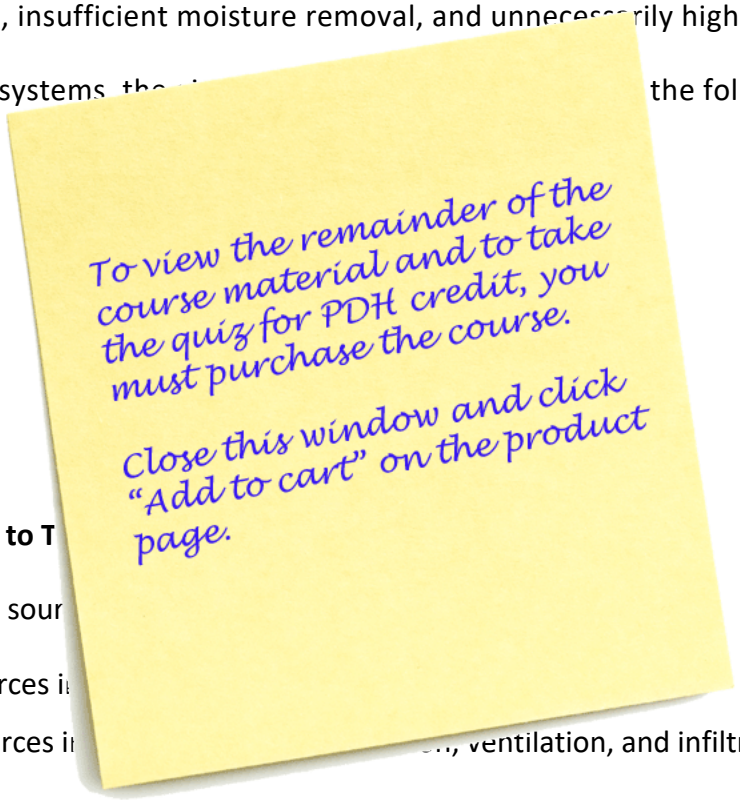
A psychrometric chart also helps in calculating and analyzing the work and energy transfer of various air-conditioning processes. In the field, the most common psychrometric analysis made by HVAC contractors involves measuring the dry and wet-bulb temperatures of air entering and leaving a cooling coil. If these temperatures are known along with the volumetric airflow rate (CFM) through the coil, the performance and the cooling capacity of a unit can be verified.

1.1 Goal of HVAC Systems

The basic purpose of an HVAC system is to provide interior thermal conditions that a majority of occupants will find acceptable. Providing for occupant comfort will require that an HVAC system add or remove heat to or from building spaces. In addition, it is normally necessary for moisture to be removed from spaces during the summer; sometimes, moisture will need to be added during the winter.

The heat and moisture control functions of HVAC systems provide the foundation for the sizing of key system components. Get the sizing wrong, and you'll be facing problems such as insufficient cooling, insufficient moisture removal, and unnecessarily high electricity bills.

In air conditioning systems, the air ... the following processes:



1.1.1. Approaches to T...

There are two main sour...

a. Internal sources i...
b. External sources i... ventilation, and infiltration.