Ashrae H Fundamentals Chapter 35

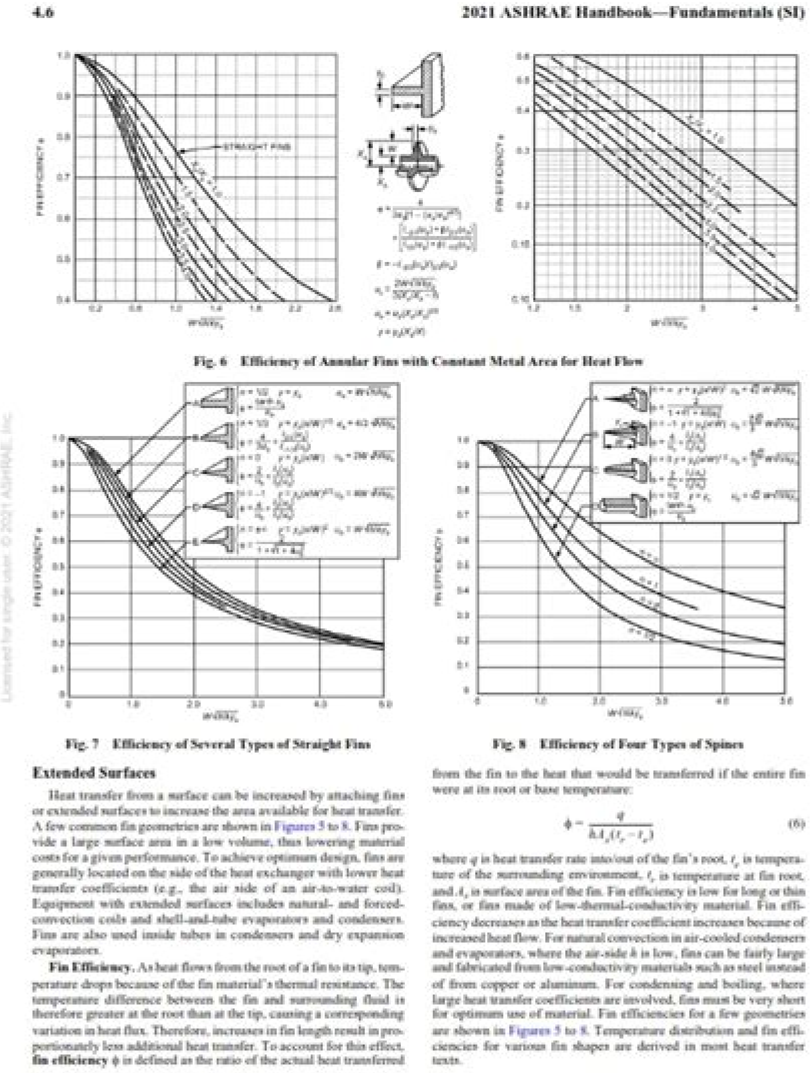
4.6 2021 ASHRAE Handbook—Fundamentals (SI)

Fig. 6 Efficiency of Annular Fins with Constant Metal Area for Heat Flow

Fig. 7 Efficiency of Several Types of Straight Fins

Fig. 8 Efficiency of Four Types of Spines

Extended Surfaces

Heat transfer from a surface can be increased by attaching fins or extended surfaces to increase the area available for heat transfer. A few common fin geometries are shown in Figures 5 to 8. Fins provide a large surface area in a low volume, thus lowering material costs for a given performance. To achieve optimum design, fins are generally located on the side of the heat exchanger with lower heat transfer coefficients (e.g., the air side of an air-to-water coil). Equipment with extended surfaces includes natural- and forced-convection coils and shell-and-tube evaporators and condensers. Fins are also used inside tubes in condensers and dry expansion evaporators.

Fin Efficiency. As heat flows from the root of a fin to its tip, temperature drops because of the fin material's thermal resistance. The temperature difference between the fin and surrounding fluid is therefore greater at the root than at the tip, causing a corresponding variation in heat flux. Therefore, increases in fin length result in proportionately less additional heat transfer. To account for this effect, **fin efficiency** ϕ is defined as the ratio of the actual heat transferred from the fin to the heat that would be transferred if the entire fin were at its root or base temperature:

$$\phi = \frac{q}{hA_s(t_r - t_e)} \quad (6)$$

where q is heat transfer rate into/out of the fin's root, t_e is temperature of the surrounding environment, t_r is temperature at fin root, and A_s is surface area of the fin. Fin efficiency is low for long or thin fins, or fins made of low-thermal-conductivity material. Fin efficiency decreases as the heat transfer coefficient increases because of increased heat flow. For natural convection in air-cooled condensers and evaporators, where the air-side h is low, fins can be fairly large and fabricated from low-conductivity materials such as steel instead of from copper or aluminum. For condensing and boiling, where large heat transfer coefficients are involved, fins must be very short for optimum use of material. Fin efficiencies for a few geometries are shown in Figures 5 to 8. Temperature distribution and fin efficiencies for various fin shapes are derived in most heat transfer texts.

Understanding ASHRAE H Fundamentals Chapter 35

ASHRAE H Fundamentals Chapter 35 delves into the critical aspects of refrigeration and heat pump systems, providing essential guidelines and standards for professionals in the HVAC (heating, ventilation, and air conditioning) field. This chapter is a crucial part of the ASHRAE Handbook, which serves as a comprehensive reference for engineers, designers, and technicians. Here, we will explore the key concepts, applications, and implications of Chapter 35, highlighting its significance in modern

HVAC practices.

Overview of ASHRAE

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) is a global leader in the advancement of HVAC technologies and practices. Founded in 1894, ASHRAE develops standards and guidelines that promote sustainability, energy efficiency, and health in indoor environments. The ASHRAE Handbook is a vital resource that encompasses various chapters focusing on different aspects of HVAC, including design, equipment, and applications.

Purpose of Chapter 35

Chapter 35 specifically addresses refrigeration and heat pump systems, which are instrumental in various applications ranging from commercial refrigeration to residential heating and cooling. The chapter aims to provide:

- A comprehensive understanding of refrigeration cycles.
- Insights into the design and selection of equipment.
- Guidelines for effective system operation and maintenance.
- Best practices for energy efficiency and sustainability.

Key Concepts in Chapter 35

Understanding the fundamental principles outlined in Chapter 35 is essential for anyone involved in the design, installation, and maintenance of refrigeration systems. Here are some of the key concepts:

Refrigeration Cycle

At the heart of any refrigeration system is the refrigeration cycle. Chapter 35 details the four main processes involved:

1. **Evaporation:** The refrigerant absorbs heat from the environment, turning from a liquid to a gas.
2. **Compression:** The gaseous refrigerant is compressed, increasing its pressure and temperature.
3. **Condensation:** The high-pressure gas releases its heat and condenses back into a liquid.
4. **Expansion:** The liquid refrigerant undergoes expansion, reducing its pressure and temperature before re-entering the evaporator.

This cycle is crucial for understanding how refrigeration systems operate and how they can be optimized for efficiency.

Types of Refrigerants

Chapter 35 emphasizes the importance of selecting appropriate refrigerants based on environmental impact, efficiency, and application. The chapter covers various types of refrigerants, including:

- **Natural Refrigerants:** Such as ammonia, carbon dioxide, and hydrocarbons. These are often favored for their low environmental impact.

- **Synthetic Refrigerants:** These include hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs), which have been commonly used but are being phased out due to their global warming potential.

The choice of refrigerant affects system performance, energy efficiency, and compliance with environmental regulations.

Heat Pump Technology

Heat pumps are versatile systems that can provide both heating and cooling. Chapter 35 explains the principles of heat pump operation, including:

- Air-source heat pumps, which extract heat from the ambient air.

- Ground-source (geothermal) heat pumps that utilize the stable temperatures of the earth.

- Water-source heat pumps, which draw heat from bodies of water.

The chapter also discusses the efficiency ratings of heat pumps, such as the Coefficient of Performance (COP) and Seasonal Energy Efficiency Ratio (SEER), which are crucial for evaluating their performance.

Design Considerations

When designing refrigeration and heat pump systems, several factors must be taken into account. Chapter 35 provides guidelines to ensure effective design and operation:

System Sizing

Proper sizing of refrigeration and heat pump systems is vital for efficiency and performance. Oversized or undersized systems can lead to inefficiencies and increased operational costs. The chapter outlines methods for accurately sizing systems based on:

- Cooling and heating loads.
- Building characteristics and insulation levels.
- Climate conditions and geographical location.

Energy Efficiency

Energy efficiency is a core focus of Chapter 35, reflecting the industry's shift towards sustainable practices. The chapter discusses various strategies, including:

- Utilizing high-efficiency equipment.
- Implementing variable speed compressors and fans.

- Incorporating smart controls and automation systems.

These strategies not only help in reducing energy consumption but also lower operational costs and enhance system reliability.

System Maintenance

Regular maintenance is critical for the longevity and efficiency of refrigeration and heat pump systems. Chapter 35 emphasizes the importance of:

- Routine inspections and servicing.
- Monitoring system performance and refrigerant levels.
- Cleaning and replacing filters and coils.

Implementing a proactive maintenance schedule can significantly reduce the risk of system failures and improve overall performance.

Conclusion

In conclusion, **ASHRAE H Fundamentals Chapter 35** is an invaluable resource that provides comprehensive insights into refrigeration and heat pump systems. By understanding the fundamental principles of refrigeration cycles, refrigerant selection, heat pump technology, and design considerations, professionals in the HVAC field can enhance their knowledge, improve system performance, and contribute to sustainable practices in the industry. As the demand for efficient and environmentally friendly HVAC solutions continues to grow, the guidelines and standards outlined in Chapter 35 will remain crucial in shaping the future of refrigeration and heat pump technologies.

Frequently Asked Questions

What is the main focus of Chapter 35 in the ASHRAE Handbook: HVAC Applications?

Chapter 35 primarily focuses on the principles and practices of thermal comfort, detailing the factors influencing human comfort in indoor environments and providing guidelines for achieving optimal conditions.

How does Chapter 35 address humidity control in HVAC systems?

Chapter 35 discusses the importance of maintaining appropriate humidity levels to ensure comfort and prevent issues such as mold growth, outlining methods for effective dehumidification and moisture management in HVAC design.

What are the key thermal comfort factors outlined in Chapter 35?

Key thermal comfort factors include air temperature, radiant temperature, humidity, air velocity, and metabolic rate, all of which interact to affect human comfort levels in indoor spaces.

What design considerations are highlighted in Chapter 35 for improving indoor air quality?

Chapter 35 emphasizes the importance of ventilation, filtration, and regular maintenance of HVAC systems to enhance indoor air quality, alongside strategies for minimizing pollutants and ensuring a healthy indoor environment.

How does Chapter 35 recommend addressing varying occupancy levels in spaces?

Chapter 35 recommends using demand-controlled ventilation and zoning strategies to adapt HVAC performance to varying occupancy levels, ensuring comfort and energy efficiency in spaces with fluctuating use.

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Explore the ASHRAE H Fundamentals Chapter 35 to enhance your understanding of HVAC systems. Discover how to optimize efficiency and improve performance. Learn more!

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