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CHAPTER 29

AIR CONDITIONING FOR ANIMALS

Physiological Reactions, Body Temperature, Heat Production and Dissipation, Reproduction, Growth and Production, Other Physiological Reactions, Methods of Controlling Environments, Types of Systems in Common Use, Design Factors, Insulation, Equipment and Controls, Air Filters

As agriculture strives for greater efficiency and a better quality product in livestock production, increasing attention is focused on the need for controlling the environment within livestock shelters. To effectively develop this information, joint effort is required by the engineers, physiologists, nutritionists, geneticists, and veterinarians. Information is needed not only on the relation between environment and such economic factors as production, growth, efficiency of feed conversion, and animal health, but also an understanding is required of the *means* by which the animals adjust to various thermal environments. Research in all of these areas has greatly increased within the last ten years and relatively new endeavor has progressed sufficiently to justify recording the present state of art.

PHYSIOLOGICAL REACTIONS

The effects of both thermal environments and air quality have been studied. Both need consideration. Thermal environments include all factors concerned with heat transfer. Air quality considerations include removal of excess CO_2, ammonia (generally a problem only with poultry), odors, dust, and moisture. Dust and moisture serve as carriers for pathogenic microorganisms.

All areas within the United States have climatic conditions that exceed the zone of thermal comfort for farm livestock. Either or both the upper and lower limits of thermal comfort may be exceeded.

Thermal comfort is an indefinite term which may imply: (1) no visible signs of discomfort, (2) a condition wherein physiological heat regulation mechanisms operate at *normal* levels, (3) a condition wherein physiological mechanisms are capable of maintaining normal body temperatures, or (4) a condition wherein animals produce well and remain healthy. The last meaning is implied when the term is used in this chapter. Visible signs of discomfort are only a rough index. In cold weather animals may appear quite comfortable, but at the expense of increased feed consumption which lowers the efficiency of production. In hot weather many animals will appear uncomfortable (restless with markedly increased respiration rates) yet produce well.

For convenience of discussion physiological reactions are grouped under headings of body temperature, heat production and dissipation, reproduction, growth and production, and other physiological reactions.

Body Temperature

The ability of animals and birds to maintain a nearly constant internal body temperature over a wide range of climatic conditions is identified as homeothermy. Rectal temperature is usually used as a measure of internal body temperature and is useful in identifying abnormal physiological behavior. However, such measurements must be interpreted with care. Any abnormalities may be indicative of illness as well as the effects of adverse thermal environments. Rectal temperature also tends to vary slightly with age and level of feeding. There is a small diurnal cycle (even under constant environmental conditions) and one associated with oestrous.

Although abnormal variations (more than 1 F deg among cattle) may occur for brief periods within a day without lowering production, conditions that cause such a reaction should be avoided.

Rectal temperatures, generally considered as normal for various farm livestock, are shown in Table 1. Within a species the rectal temperatures of the newborn or recently hatched may differ considerably from those shown but generally homeothermic mechanisms take over *rapidly*.

Heat Production and Dissipation

Heat production is a result of the processes by which feed is converted into body tissue and energy for other life processes. Consequently, the rate of heat production varies with size, breed, health, stage of growth, nature and level of feed intake, level of production, gestation, age, degree of activity, and environment.

Standing hens may have 40 to 45 percent greater heat production than sitting hens.[1] There may be 25 to 50 percent higher heat production during the day than at night.[2] Roughages generally have a larger heat increment than concentrates.

Much of the early heat production data for farm animals were obtained under basal conditions (a condition wherein all life processes were at a minimum level). The more useful data to the engineer is heat production under conditions of normal metabolic activity. Such heat production data are now available for most farm animals. These are reflected in the load calculation data given in the section Design Factors in this chapter.

The rate of heat production is generally adjusted for body size by expressing it as the ratio of some measure of body size such as body weight or surface area. Although some fractional power of body weight may be more accurate,[3] such refinement is unnecessary and body weight is sufficiently accurate for air-conditioning engineers to use as an adjustment factor.

Heat production, and consequently feed consumption, decreases with increasing ambient air temperatures. This provides an economic justification for maintaining a degree of warmth in a livestock shelter above that required for thermal comfort.

Table 1 .... Average Normal Rectal Temperatures of Farm Livestock

Type	Temp, F	Type	Temp, F
Horse	100.0	Goat	103.8
Cow	101.0	Pig	102.5
Sheep	102.3	Chicken	107.1