Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2017, 4(12):156-159**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Determination of Climatic Project Criteria Depending on Different Seasons for Planning of Animal Production Structures Located in the Thrace Part of Istanbul Province

I. Kocaman, H. C. Kurc, C. B. Sisman

Namik Kemal University Agricultural Faculty Biosystems Engineering Department, TR-59030 Tekirdag Turkey

Abstract This study was carried out in order to determine the climatic project criteria related to planning of animal production facilities in Thrace part of Istanbul Province depending on different seasons. As a result of the study, it was found that the project outdoor temperature could be taken as 1.0 ^{o}C for winter season and 26.6 ^{o}C for summer season. Also project indoor temperature could be taken as 13.0 ^{o}C for winter season and 25 ^{o}C for summer season. While, 95.6 % and 84.1% of outdoor relative humidity were recommended for winter and summer seasons respectively, 75 % and 80 % of indoor relative humidity were suggested for winter and summer seasons respectively.

Keywords Animal barns, heat-humidity balance, temperature, relative humidity

1. Introduction

The environmental factors, which are physical, chemical, social and microbiological factors should be assessed very well in the design of animal barns. The main reason is that environmental factors can affect structural characteristics and barn costs as well as animal health and production. Climatic factors within physical factors should be assessed primarily in the design of animal barns. In particular, the selection of project values for temperature and relative humidity of region and determination of their effects on the structural properties have great importance. The aim here is to provide an appropriate balance between inside and outside of barn in the economic direction.

Despite the fact that it is not possible to put forward certain rules in the selection of the temperature value of outdoor air, various approaches have been made in this regard and project values have been determined according to the conditions of country [1]. This study was carried out in order to determine the climatic project criteria related to planning of animal production facilities in Thrace part of Istanbul Province depending on different seasons.

Material and Method

In this study, Catalca and Arnavutkoy districts which are located in the Thrace part of Istanbul province were selected as research material. The long-term data of Catalca and Arnavutkoy meteorological stations were obtained [2] and they were evaluated in order to determine climatic project criteria for research area. Temperature and humidity measurements were made with temperature-humidity datalogues at intervals of 10 minute along a year. Also, several methods which were suggested by various literatures were used to determine the project criteria for winter, transition and summer seasons.

Climatic Project Criteria of Research Area Depending on Different Seasons

a. Determination of Project Outdoor Temperature Criteria for Winter Season: In order to ensure suitable barn conditions in our country where climate conditions show difference depending on location, it is necessary to prepare and improve barn plans with regard to specific climatic conditions of regions.

In the planning of animal barns, appropriate and economical balance between optimal barn environmental conditions and region climate conditions should be provided. For this reason, one of the most important issues for providing optimum environmental conditions of barns, calculations of heat and humidity balance and selection of economic construction for buildings is to determine climatic project criteria related to indoor and outdoor air

There are different approaches in the planning of animal barn to determine project outdoor temperature of the winter season. In this study, the project outdoor temperature criteria were determined by different methods. The values of project outdoor temperature criteria were given in Table 1.

Table 1: The Values of Project Outdoor Temperature for Winter Season

Method	**Values of Project Outdoor Temperature (^oC)**
Average temperature of coldest month	3.5
Average low temperature of coldest month	0.5
Lowest temperature	-10.8
Average of lowest temperatures	-6.6
Median of lowest temperatures	-6.7
Pendant	-1.0
Lowest temperature seen at 97.5% of the time	-3.0
Average of lowest temperatures + 2.8	-3.8
Lowest temperature+ 2.8	-8.0
Lowest temperature+ 5.6	-5.2
Lowest temperature+ 8.3	-2.5
Average temperature of coldest month- 8.3	-4.8

Taking average temperature of coldest month for project values in the calculations of heat and humidity balance may lead to moisture condensation on the inner surface of building elements in very cold periods. Also, indoor temperature may drop to undesirable values. For this reason, it has been evaluated that the average temperature of coldest month was not suitable to be used as the project outdoor temperature for this study.

It is clear that considering lowest temperature, average of lowest temperatures and median of lowest temperatures as the project outdoor temperature increase requirement of thermal insulation. This situation increases the barn cost, so these methods are not suitable to use for this region. Although the design of structures according to extreme values reduces the risk of failure, these extreme values are shown for short time in long period. So, this situation makes unnecessary to use extreme values.

Projections of animal barns with 2.8 ^oC, 5.6 ^oC and 8.3 ^oC higher than lowest temperature value, 2.8 ^oC higher than average of the lowest temperatures and 8.3 ^oC lower than average temperature of coldest month do not require insulation in building elements. But, it may cause problems about removal of humidity deposit from barn.

If lowest temperature seen at 97.5% of the time is considered as project outdoor temperature, sensible heat emerged from animals can meet heat loss from ventilation under optimum temperature conditions in animal barns. However, heat and humidity balance calculations to be made according to this method may increase wall thickness and thus affect construction cost negatively.

The use of pendant method was recommended in this study to determine project outdoor temperature. Because, when long-term meteorological data of any region is well analyzed and, it provides more appropriate and economical results in the calculation of heat and humidity balance and in the construction of building materials. On the other hand, drawbacks at critical times can be removed by increasing animal frequency in the barn, lowering the barn temperature below proper temperature and allowing relative humidity to rise to a certain level.

b. Determination of Project Outdoor Temperature Criteria for Transition Season: During transition seasons, project outdoor temperature can be taken as 3-10^{o}C lower than project indoor temperature for transition seasons [3]. According to this, 18^{o}C was chosen as the project indoor temperature for the transition seasons and 10 ^{o}C was determined as project outdoor temperature. The measured temperature for spring during research period and long-term meteorologic data were considered to determine these values.

c. Determination of Project Outdoor Temperature Criteria for Summer Season: For summer season, it is advisable to take highest temperature seen as 97% of the total hours during summer months [4], However, taking average high temperature for warmest month of summer gives more favorable results [3]. The values of project outdoor temperature criteria were given in Table 2.

Table 2: The values of project outdoor temperatures for summer

Method	Values of Project Outdoor Temperature (^{o}C)
Highest lowest temperature seen at 97.5% of the time	34
Average high temperature for warmest month	26.6

To get better results in the heat balance calculations, 26.6 ^{o}C considered as the project outdoor temperature.

d. Determination of Indoor and Project Outdoor Relative Humidity Criteria for Winter, Transition and Summer Seasons: Highest of average relative humidity values for winter season can be taken as project outdoor relative humidity [3]. The project outdoor relative humidity was determined as 95.6 % in the research area based on long-term meteorological data and measured relative humidity.

In transit and summer seasons, highest of average monthly relative humidity values during relevant seasons can be taken as project outdoor relative humidity [5]. Accordingly, the outdoor project relative humidity values were determined as 85.1 % and 84.1 % for transit and summer seasons respectively.

e. Determination of Indoor Project Temperature and Relative Humidity Criteria in Optimum Conditions for Different Seasons:

Optimum and proper temperature limits affected by climate, environmental humidity, air movement, season, feeding and maintenance conditions, animal race, age and health status. For farm animals, it has been suggested that indoor temperature should be as minimum of 2^{o}C for winter season and maximum of 48 ^{o}C for summer season [6]. Optimum temperature for winter season is 13-18 ^{o}C and it is ranged between 20 and 40 ^{o}C for summer season [7].

The suggested indoor temperature and relative humidity values were given in Table 3.

Table 3: Indoor Temperature and Relative Humidity Values in Optimum Conditions for Different Seasons

Indoor Project Criteria	Seasons		
	Winter	Transition	Summer
Temperature (^{o}C)	13	18	25
Relative Humidity (%)	75	75	80

Conclusion

The determination of climatic project criteria for indoor and outdoor air in the design of animal barns is important as it has direct impact on animal welfare and building cost.

In this study, the suggested project outdoor temperature values were -1.0 ^{o}C, 10.0 ^{o}C and 26.6 ^{o}C for winter, transit and summer seasons respectively. Also, these values for indoor conditions were 13.0 ^{o}C, 18 ^{o}C and 25 ^{o}C for winter, transit and summer seasons respectively.

Outdoor project values for relative humidity were determined as 95.6 % for winter, 85.1 % for transition and 84.1 % for summer season. Indoor project values for relative humidity were suggested as 75 % for winter and transition seasons, 80 % for summer season. It will be possible to control the climatic environment within economic boundaries for different seasons in the research area with taking these results into consideration.

Acknowledgement

This work contains a part of TOVAG 115O602 project supported by TUBITAK. We are grateful to Presidency of TUBITAK for supporting the project.

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