



Automating the sensible heat computation

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Abstract

The results presented in this paper are obtained within the framework of the research involving among other things a database integrated application for adapting and restructuring of natural and artificial environment protection factors in agricultural and animal breeding farms. It is an interdisciplinary project based specially on the experiments and measurements collected in ten farms from Romania, where we developed our research. We will present an automatic mode to compute the sensible heat, which is a term of the external heat balance of a closed precinct. Programming was done using the SQL language.

Key words: Farms, experiments, automatic mod, sensible heat.

Introduction

In computer science, a database is a structured collection of records or data that is stored in a computer so that a computer program can consult it to answer queries ³. The records retrieved in answer to queries are information that can be used to make decisions. The computer program used to manage and query a database is known as a database management system (DBMS). The properties and design of database systems are included in the study of information science.

The central concept of a database is that of a collection of records, or pieces of information. Typically, for a given database, there is a structural description of the type of facts held in that database: this description is known as a schema. The schema describes the objects that are represented in the database and the relationships among them.

Within the framework of our research project, we have built among other things a database where we registered the main values of some microclimate factors that influence the farm production. The obtained results have determined us to consider useful to write a software that process data necessary to check the heat balance for the stables ⁴. The heat balance is important for improving the efficiency of the thermal energy usage, by adapting constructive solutions able to reduce the heat loss through the envelope (covering, wrapper etc.) of the stables.

Material and Methods

The thermal quality of a stable results from its heat balance ^{1,2}. The quantity of heat which is lost by the thermal transfer of its closure elements plus the heat lost by heating the ventilation air must be equilibrated by the biological heat resulted from the animals body and the heat produced by the heating system if exists.

When an supplementary heat source exists, the heat balance is: $Q_s + Q_{source} = Q_{ct} + Q_v$ [W] where Q_s is the sensible heat; Q_{source} is the heat from the heating system; Q_{ct} is the heat lost

by the building envelope; Q_v is the heat spent on heating the ventilation air.

The database obtained after the measurements done over the three years of research in ten farms contains values that are used by the software we are presenting in this paper together with the way we computed the sensible heat as a component of the heat balance ^{5,6}. The database has tables containing collected data and SQL queries returning the resulting values. These values are then used to propose methods to improve the efficiency of the stables.

Results and Discussion

The animal body can be seen as an engine where energetic transformations are taking place as a result of the assimilation and disassimilation of the food chemical energy. The animal body is heating the environment by the thermal energy emitted by radiation, conduction and convection, in other words by the sensible heat. In order to determine the value of the sensible heat, we started from the basal metabolism and the corporal body mass of the animals.

For storing the basal metabolism and the corporal body mass of the animals, we created a database in Microsoft Access. The queries are implementing the computation formulae and the forms are designed for simplifying searching and displaying the results

The maintenance metabolism and the production metabolism are computed as follows:

$$M_l = K_l \times M_b \text{ [W]}$$

$$M_p = K_p \times M_b \text{ [W]}$$

where M_b is the basal metabolism (stored in tables and depending on the corporal body mass); K_l and K_p are constant multiplicative factors for the basal metabolism (Fig. 1). We support also the

intensive metabolism but it is not used yet. Based on this query we designed the below form, where based on corporal body mass we obtain the values for the basal, maintenance and production metabolism (Fig. 2).

```
MetabolismIntretinereSiProductie : Select Query
SELECT Greutatea, [MetabolismBazal], [MetabolismBazal]*2.1 AS MetabolismIntretinere,
[MetabolismBazal]*2.8 AS MetabolismProductie,
[MetabolismBazal]*3.3 AS MetabolismIntensiv,
FROM MetabolismBazal;
```

Figure 1. Maintenance and production metabolism SQL.

Maintenance and Production Metabolism

Maintenance and Production Metabolism

Weight:

Basal Metabolism:

Maintenance Metabolism:

Production Metabolism:

Record: 1 of 14

Figure 2. Maintenance and production metabolism form.

On the other hand, the physiological evapotranspiration is subtracting more heat from the body as latent heat. The latent heat is contributing to the environment heating only if the water vapor is condensing on cold surfaces of the precinct. The heat emitted is controlled by the animal body depending on the environment temperature. The optimal temperature for the animal accommodation corresponds normally to the thermal indifference zone.

The heat exchange between the animal body and the environment is done from the physiological point of view by respiration and transpiration. The thermolytic form of heat loss by pulmonary evaporation or skin evaporation is determined by the latent heat. This loss also depends on the air humidity level and on the tension difference of the water vapor at the evaporation surface respecting to the environmental air. As we said above, the latent heat is contributing to the environment heating only when the water vapor is condensing on a colder surface, because in this process the cold surface is absorbing the vapor heat.

The physiological evaporation is a measured value stored in the database and depending on the corporal body mass, so we created a helper query returning the value for water vapors mass at 3°C respectively 15°C which are the characteristic temperatures for cattle (Fig. 3). We also implement a form which allows you to view these values.

Given the values for the physiological evaporation at the established temperatures, we can calculate the latent heat using the formula: $Q_l = M_v \times 0.600 \times 1.163$ [W], where M_v is the physiological evaporation [g/h]; 0.600 [kcal/g] is the quantity of heat requested for evaporating 1 g of water; 1.163 is the conversion coefficient from kcal/h to W.

For this query we created corresponding form. As for the previous forms, we have a button for the research of the values corresponding to a given the corporal body mass of the animals. The SQL code is given in Fig. 3 and the form is given in Fig. 4.

Analogously, we have a form for the computation of the sensible heat using the following relations: $Q_s = M_i - Q_l$ [W] and $Q_s = M_p - Q_l$ [W], where M_i and M_p have the signification indicated above (Figs 5-7).

```
MetabolismIntretinereSiProductie : Select Query
SELECT MetabolismBazal.Greutatea,
MetabolismBazal.MasaDeVapori AS MasaDeVapori15Grade,
MasaDeVapori*0.7 AS MasaDeVapori3Grade
FROM MetabolismBazal;
```

Figure 3. Vapors mass SQL.

Vapor Mass

Vapor mass

Weight:

Vapor mass at 3 degrees:

Vapor mass at 15 degrees:

Record: 1 of 14

Figure 4. Vapor mass form.

```
MetabolismIntretinereSiProductie : Select Query
SELECT MetabolismBazal.Greutatea,
MasaDeVapori*0.6*1.163 AS CalduraLatenta15Grade,
(MasaDeVapori*0.7)*0.6*1.163 AS CalduraLatenta3Grade,
FROM MetabolismBazal;
```

Figure 5. Latent heat SQL.

Sensible Heat

Sensible Heat

Weight:

Maintenance sensible heat at 3 degrees:

Maintenance sensible heat at 15 degrees:

Record: 1 of 14

Figure 6. Sensible heat form.

Latent Heat

Latent Heat

Weight:

Latent Heat at 3 degrees:

Caldura Latenta la 15 Grade:

Record: 1 of 14

Figure 7. Latent heat form.

Conclusions

The presented software is helping us in any environment conditions and given the number of cattle in a stable and their corporal body mass, to compute the sensible (or free) heat. A building is losing heat mainly by the closure elements and the ventilation system. An equilibrated heat balance is obtained when the values of the two components, the biological heat resulted from the animal body on one hand and the lost heat have closed values. Otherwise we have to produce a supplementary heat from other sources. Knowing the elements of the heat balance of the stable, we can permanently monitor and manage: the energy consumption - nowadays saving energy is a national and global priority; the efficient usage of the existing buildings and propose improvements; the production of biological heat by using appropriate thermoinsulating materials and these solutions can be applied in new or older buildings; to adopt more efficient constructive solutions able to reduce the quantity of heat lost through the envelope of the stables.

Taking into account the variations of the external temperature, the reduction of the investment and operational costs and knowing in any moment the heat produced by the animals (the sensible heat) we can build cheap stables using thermal efficient materials.

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