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EVALUATION MICROCLIMATE IN THE STABLE NATIONAL STUD FARM IN KLADRUBY NAD LABEM

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Abstract: The measurement of temperature, humidity and dew point in the selected stable, and for the comparison also in the courtyard, took place continuously from 1.4.2011 to 31.3.2012. Because of its technical demands, the measurement of stable gases took place roughly 1x in a month and that in the 24 h cycle.
This work should answer the questions, how much is the stable microclimate dependent on the ambient environment - current weather, whether there are suitable conditions in the stables of National Stud-Farm in Kladruby nad Labem with respect to the welfare of horses, how much is the concentration of stable gases in enclosed areas according to the presence of horses changing and, possibly, how much affects the horse breeding the environment.

Keywords: stable microclimate, temperature, humidity, dew point, airflow, stable gases

INTRODUCTION

Historie man is since ancient times connected with the history of horses. Horses are a significant share in the history all over the world, not them a big influence on the development of human society. From the moment man tamed the ruler of the steppes and began acting in confined spaces, with the horses more or less changed the conditions in which they were used to live and which suit them (Dobroruka and Kholová, 1992). The popularity of the horses in today's time is still rising and new and new people make decisions that they raise horses. As a result of poor housing, inadequate health care,

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inadequate nutrition and poor health care leads to the neglect of the horses and to a variety of health complications (Sode, 1992). Many diseases can be prevented by proper prevention and it should begin at the compliance with the essential requirements for housing and feeding. The horse is the origin of the steppe animal that should sufficient movement (Bird) and (Edwards, 1991). Due to lack of exercise and inadequate conditions, they can begin to explore a variety of health problems, such as. rot hooves, infections of the upper and lower respiratory tract infections, allergies caused by mold particles manifested by shortness of breath, or digestive problems (Ende, 2000).

Stable microclimate (kryptoklima) has reared animals big impact, because in these confined spaces present a substantial part of the day. Formulated by actual outdoor environment, animal physiology, the type and number of animals housed type of technology, business machines, people and also respect for the fundamental principles of animal husbandry which includes regular removal of manure, dust control spraying tunnels and regular ventilation (Kic, 1996). The aim of the ventilation system is bringing fresh air into the stables and exhaust stale air saturated barnyard gases, dust and water vapor out of the barn (Kic and Brož, 2000).

Stable environment has a significant effect except for housed animals and the employees own their buildings and technological equipment (Kic, 1996). The initiators of corrosion of buildings are especially high content of moisture and stable gas (Hujňák, 1997).

Stable bioclimate is to be kept at an appropriate level because it is one of the key factors affecting performance and health status of the animals. Exceeding the range of optimal conditions bioclimate, the bioclimate becomes a limiting factor negative relationship microclimate - energy metabolism - performance (Šoch, 2005).

Livestock (mainly cattle and swine) also has an impact on the environment. Therefore, and environmental aspects should be taken into account in project proposals, the actual construction and operation. Technical measures for the creation of stable environment should fulfill these requirements effectively assist (Kic 1996). By following the recommended parameters stable environment can also provide extra energy savings (Franěk et al., 1965).

Description stables

This stable is rectangular basic dimensions of 9.4 meters and 46.3 meters. Height Stable is 4.0 meters.

Horses, however, occur in an area of approximately 9.4 meters to 38 meters. The remaining part of the stable area occupies space for prep and unloading yard hay.

The stable door leading to the yard and the passage to other neighboring stables. Gates to the court are 2.9 meters wide and 3.2 meters high. The passage has a width of 2.6 meters and height of 2.9 meters. The passage is closed for most of the bottom half of the door, the door to the courtyard are open to the weather (the horses in the courtyard to prevent the escape of a double barrier).

The barn is a total of 14 identical windows. On the long side of the barn opposite the gate of the courtyard is 9 windows on the short wall opposite the passage is 1 window on the other long side of the barn are three windows to the right of the door and one window to the left of the door. The window width is 1.3 meters and height of 1.5 meters. The entire area of the window is divided into two independently doors and shutters. They are from December to February is fully closed. For most of the two shutters opened to about 30 % in the summer to open completely, but always in a way that did not originate in a stable draft. The windows are about the height of a horse's head.

The whole area of the stables, used horse is about 15 - 20 cm tall bedding of straw. On it is a means of stable led about one meter wide strip of hay. In this way, all horses (mares or mares with foals) ensuring equal access to food. Skybal and wet straw is regularly cleaned every day. About 1 month to cleaning out all the bedding and carried out disinfection.

MATERIALS AND METHODS

For continuous measurement of temperature, humidity and dew point were two devices commetr D3120, which is actually a thermometer, hygrometer and barometer. Measurements were carried out from 1.4.2011 to 31.3.2012. The first unit was installed in the stable so that it reached the horses and also to interfere with the operation stable. The second commetr D3120 placed in the courtyard. Approximately every month, the measured data from these instruments pulled into the laptop and then to statistically processed in Microsoft Excel and Statistica. Both commetry measured at hourly intervals temperature, humidity and dew point. Record the measurement gas was set to 10 minute interval.

Once a month, carried 24 hourly measurements of stable gas. It was also always measured airflow with open windows and doors, surrounded by stables and courtyard. Airflow is unfortunately not continuously recorded.
Records of ambulatory measurement of air flow is used as supporting arguments for describing stable environment. It was also made the focus dimensional stable (length, width, height), windows, door to courtyard and passage into the next stall.

RESULTS AND DISCUSSIONS

A) Relationship outdoor macroclimate the microclimate stable

The air temperature in the barn followed the course of the air temperature in the courtyard (Figure 1). Never but did not reach such extremes (even lows or highs). Of course the air temperature in the barn can also find good social effects - the weekly frequency of the operating mode nurse for horses put out to pasture. Highest level of dependence between the air temperature and the temperature in the stable air courtyard we find in the spring and autumn months.

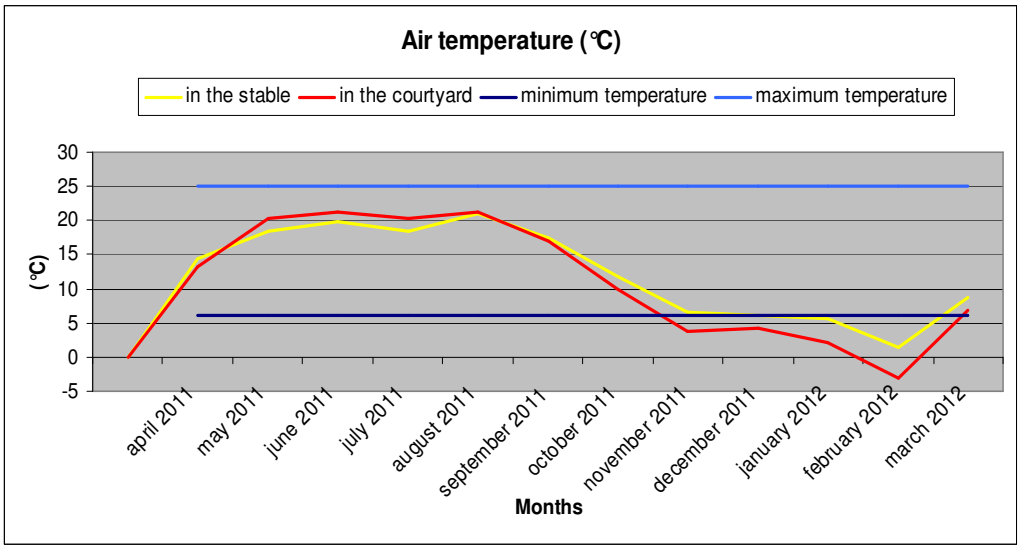

Figure 1. The minimum temperature = recommended minimum air temperature, maximum temperature = maximum recommended temperature Vejčík (2001).

Humidity (Figure 2) was highest in winter, late autumn and early spring. In autumn and spring, extra values fluctuated widely. The most significant is

the humidity in the barn showed prolonged outdoor high relative humidity. On the contrary, most of the humidity in the barn are the summer months when the humidity is generally low.

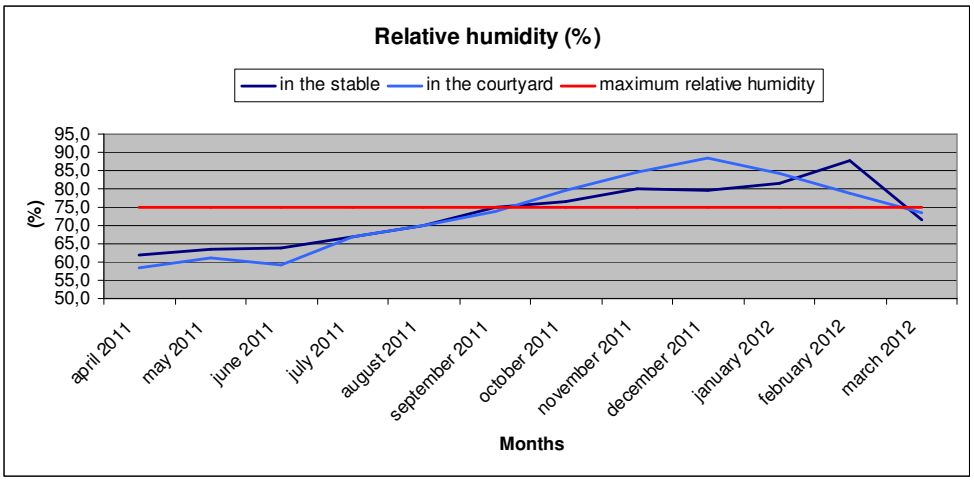

Figure 2. Relative humidity

Dew point is a specific value, based on temperature and relative humidity. Therefore for most months was correlation to temperature or relative humidity very tight, as Figure 3 shows.

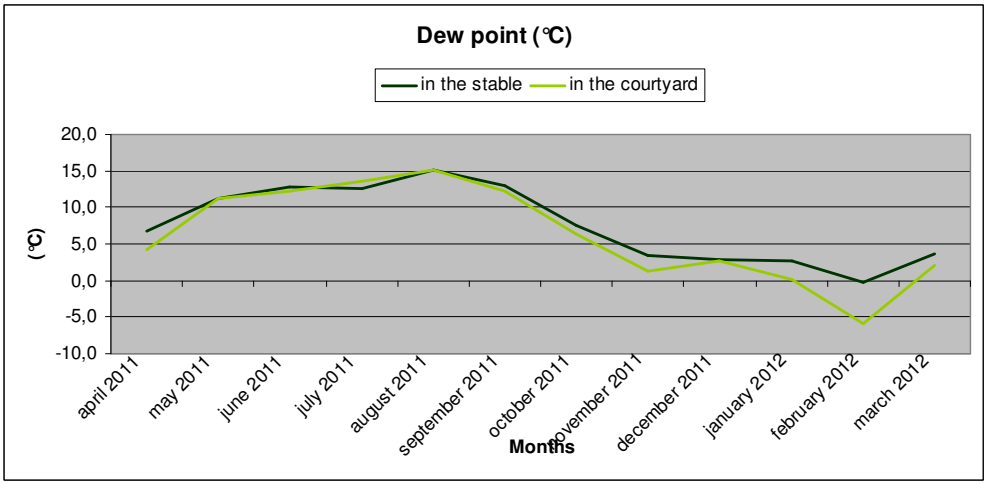

Figure 3. Dew point

B) An assessment of the suitability of the National Stud Farm stables in Kladruby in terms of welfare of horses

Vejčík (2001) shows the maximum summer temperature in horse stable 25 °C and winter minimum 6 °C. Optimum while between 10 and 14 °C. ČSN 73 0543-2 (1998) reported the optimum temperature for stable mares with foals 15 °C. The measurements presented in Table 1 show that the month April 2011 and May 2011 were at the limit, in the months of June 2011, July 2011 and August 2011 were at a higher temperature - typically ranged from 25 to 30 °C in the barn, but the court were routinely achieved temperature about 35 - 40 °C. 28. 6. 2011, even in the courtyard of measured temperature 46 °C. In September 2011 and October 2011, the temperature optimum. In November 2011 and December 2011, the temperature in the barn around 5 °C. In January 2012, the Stable temperature held for most of the month of around 6 °C, but at the end of this month, the outside temperature was around -5 °C. In terms of the minimum temperature has been the most problematic in February 2012, which are also held in a stable temperature below 0 °C, more specifically around -4 °C on 4. – 13. February 2012.

Table 1. Overview of the measured values

Overview of the measured values

Months	Air temperature (℃)		Relative humidity (%)		Dew point (℃)		Stable gas (ppm)			
	stable	courtyard	stable	courtyard	stable	courtyard	NH_3	CH_4	H_2S	CO_2
april 2011	14,3	13,2	62,0	58,4	6,8	4,3	x	x	x	x
may 2011	18,5	20,3	63,4	61,1	11,2	11,3	x	x	x	x
june 2011	19,9	21,3	64,0	59,4	12,7	12,3	5,7	14,8	0,8	735,6
july 2011	18,3	20,2	67,0	67,0	12,6	13,5	5,8	13,3	0,8	742,8
august 2011	20,9	21,3	70,0	69,9	15,2	15,2	5,7	15,2	0,8	748,9
septemb. 2011	17,5	17,1	74,9	74,0	12,9	12,2	5,5	14,9	0,8	743,9
october 2011	11,7	9,9	76,6	79,7	7,6	6,4	5,6	14,3	0,8	734,9
november 2011	6,7	3,7	80,0	84,7	3,5	1,3	5,7	15,2	0,8	827,3
december 2011	6,2	4,3	79,7	88,4	2,9	2,6	5,6	15,3	0,8	749,3
january 2012	5,6	2,2	81,7	84,1	2,7	0,1	5,6	18,3	0,8	704,2
february 2012	1,5	-3,2	87,6	78,9	-0,2	-6,0	5,6	15,9	0,8	686,2
march 2012	8,7	6,8	71,5	73,4	3,6	2,0	5,6	15,4	0,8	829,9

Although it should be noted that at this time the whole Czech Republic plagued by prolonged frosts and many meteorological stations fell temperature records. Several times he even thought that he could fall even absolute temperature record of -42.6 °C Litvínovice near the České Budějovice. In those days it was in Kladruby measured in the courtyard of -15 °C. This period lasted frosts in Klatruby 11 days. The temperature in the stable in the month of March 2012 was down to one short period in the first third of the month to comply.

Horse breeding is further limited by the maximum recommended humidity, which would Vejčík (2001) did not exceed 85 %, whereas the ČSN 73 0543-2 (1998) allows only 75 %. At the same time in the stables should prevent drafts. April 2011 by the criteria of maximum humidity in the barn was up to one day satisfactory. May 2011 was quite satisfactory and in June 2011 was satisfactory up to two days in which as well as outdoor humidity reached 98 %. In July 2011, a few short periods when outdoor humidity and thus then the humidity in the barn was about 90 %. In August 2011, September 2011 and October 2011, the humidity in the barn with a few days to comply. Humidity in November 2011 was relatively stable, holding around 80 %. In December 2011, there were significant differences in humidity between the days, the daily average humidity but held about 80 %. In January 2012, the humidity ranged between 80 and 90 %, which was higher than the recommended value. February 2012 was also problematic month ratio humidity when most months humidity was just under 90 %. The beginning and end of this month, however, was satisfactory. March 2012 has been quite volatile, but up to two to three days from the beginning of the month and then one day at the end of the month to comply.

Navrátil (2007) lists the recommended maximum concentration of stable gas for horse breeding as follows: CO_2 = 2 500 ppm, NH_3 = 25 ppm and H_2S = 10 ppm. However, Kic and Brož (1995) states the following maximum recommended concentration: CO_2 = 3000 ppm, NH_3 = 25 ppm and H_2S = 7 ppm. The measured values of CO_2 ranged from 600 to 950 ppm, and it has yet to calculate the net emissions must be deducted from the value of 380 ppm. Ammonia concentrations ranged from 5.6 to 6.0 ppm. Hydrogen sulfide throughout the measurement interval of 0.7 to 0.8 ppm. It follows, therefore, that the concentrations of gases are not stable in the stables of the National Stud Farm in Kladruby problems. Measurements have taken place only in one barn, but because all are similarly stable technology solution, so it can be assumed that the gas concentrations will be no problems in other stables.

To assess the welfare of horse breeding is also necessary to take into account the speed of the airflow. This quantity was measured but only about 1 per month outpatient, therefore it is not possible to evaluate. To complete the recommended maximum air velocity in the stables for horses. According Kic and Brož (1995), the minimum flow rate from 0.15 to 0.25 m/s, the optimum flow velocity 0.25 m/s maximum velocity of 0.5 m/s.

C) The concentration of stable gases in the presence of horses in the stable

The relationship between the concentration of ammonia in the presence of a stable of horses in the stable is low, as Figure 4 shows. This is probably due to the fact that this gas is generated from products of metabolism and the horses in the stables found in small quantities still.

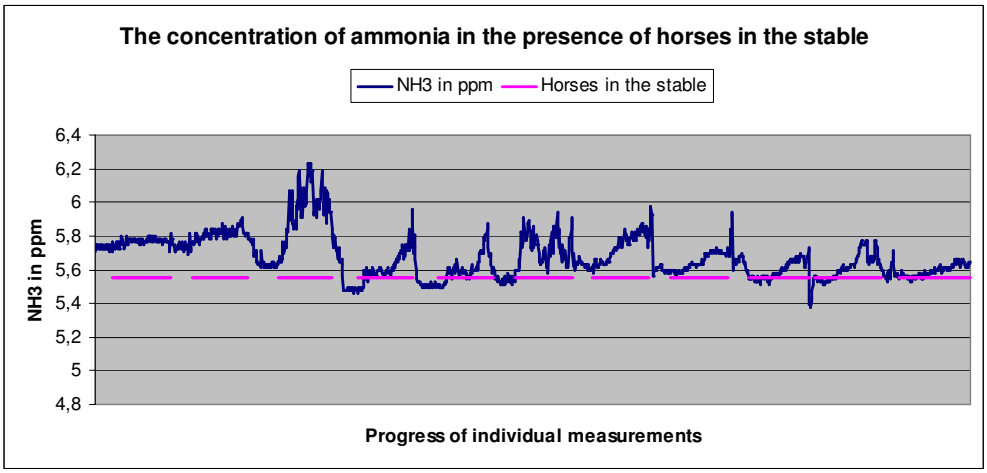

Figure 4. The concentration of NH_3

A similar situation applies for methane (Figure 5). For this gas, it is clear that the concentration of a delayed reaction to the arrival of horses in the stable. The concentration is also dependent on the intensity of the ventilation and air velocity outside the stable. On days when the weather was windy, the concentration of this gas was at its minimum value, even if the horses were in the barn. In addition, the individual measurements also show that the concentration of this gas in the stable decreases with decreasing physical activity horses. Therefore, in the period from midnight to about three o'clock concentration of this gas also keeps to its minimum level.

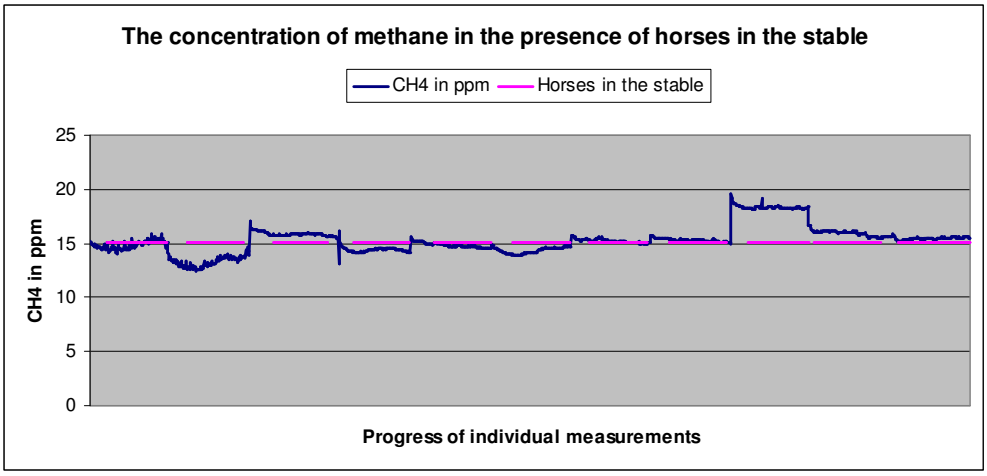

Figure 5. The concentration of CH_4

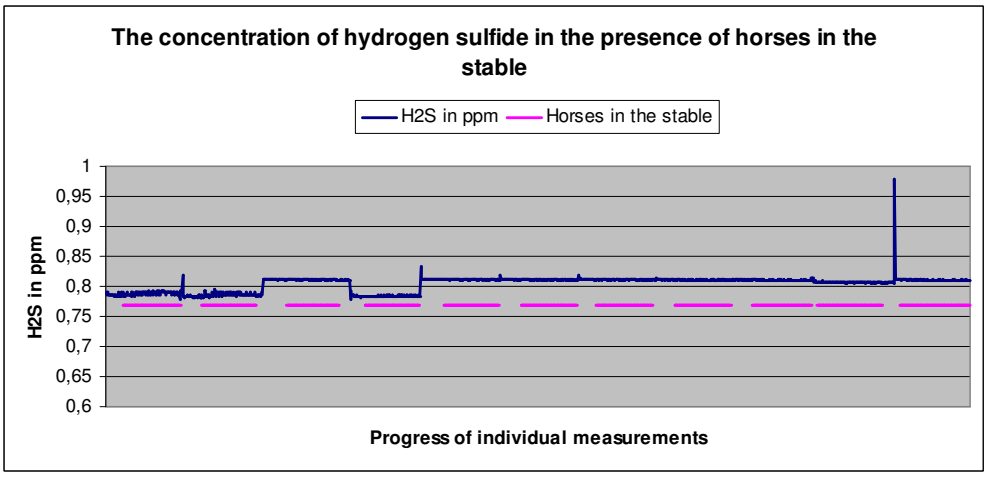

Figure 5. The concentration of H_2S

Staying horses in the stable is the concentration of hydrogen sulfide in the barn negligible. Probably for the same reason as in ammonia.

The most important and best peer statistically differences between the concentrations of carbon dioxide when it is empty, and stable when in the horse. In an empty stable levels are around 250 ppm, but the horses in the stable, so the value of this gas is very quickly get to the level of 450 - 550 ppm. And approximately in this range can also vary. There are also short-term peak around 650 ppm. It is obvious that the concentration of this gas is

very closely tied to the presence of horses in the stable and on their physical activity.

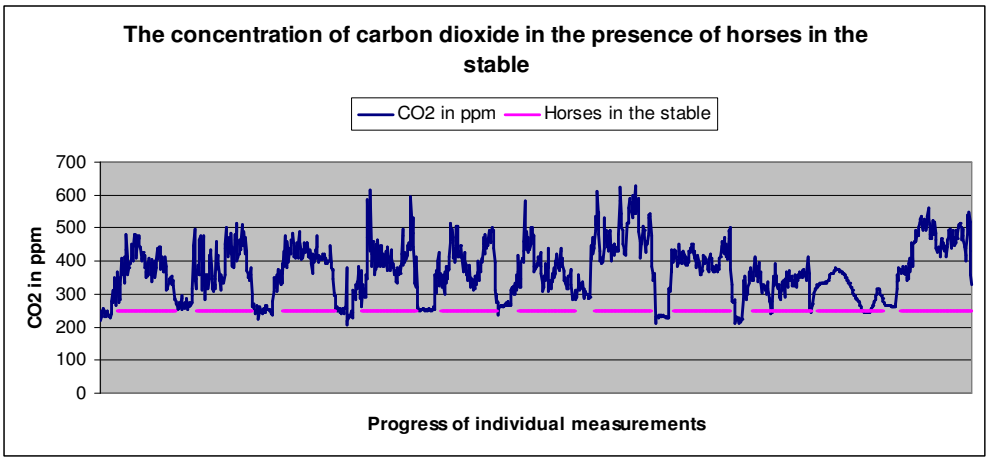

Figure 6. The concentration of CO_2

CONCLUSIONS

Based on twelve measurements at the National Stud Farm in Kladruby was found that the local microclimate stable in all the aspects of the suits in the late spring, summer and autumn months, the recommended values and meets the conditions for the welfare of horses. In the winter months in the stables increased relative humidity, while the low temperature. This combination can result in respiratory disease of horses. Concentrations were stable gas during a measurement in the desired values.

During measurements in Kladruby began conservation efforts of the State to enforce their views on repairing local stables, which are among the national cultural monuments and other objects protected by the Heritage Act. It is certainly important to be mindful of the historical context and to protect old monuments, previously used architectural styles, but in the case of stables in Kladruby is very good that was given to ensure adequate living conditions for horses who have spent much of his life, before some proposals conservationists. These historical and aesthetic proposals will be fully implemented in other buildings, not the stables.

The planned construction work will need to remove higher relative humidity in the stable, and low air temperature especially during the winter months using a suitable ventilation system. The basic division is natural and forced.

The aim of ventilation is diversion of carbon dioxide and other gases out of the barn, reduce relative humidity below the maximum value in winter to minimize heat loss from the barn and in summer the drain as much as possible the heat of the barn.
Ensuring optimal values of microclimate in the stables is one of the most challenging tasks in the design and operation of the stables.

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