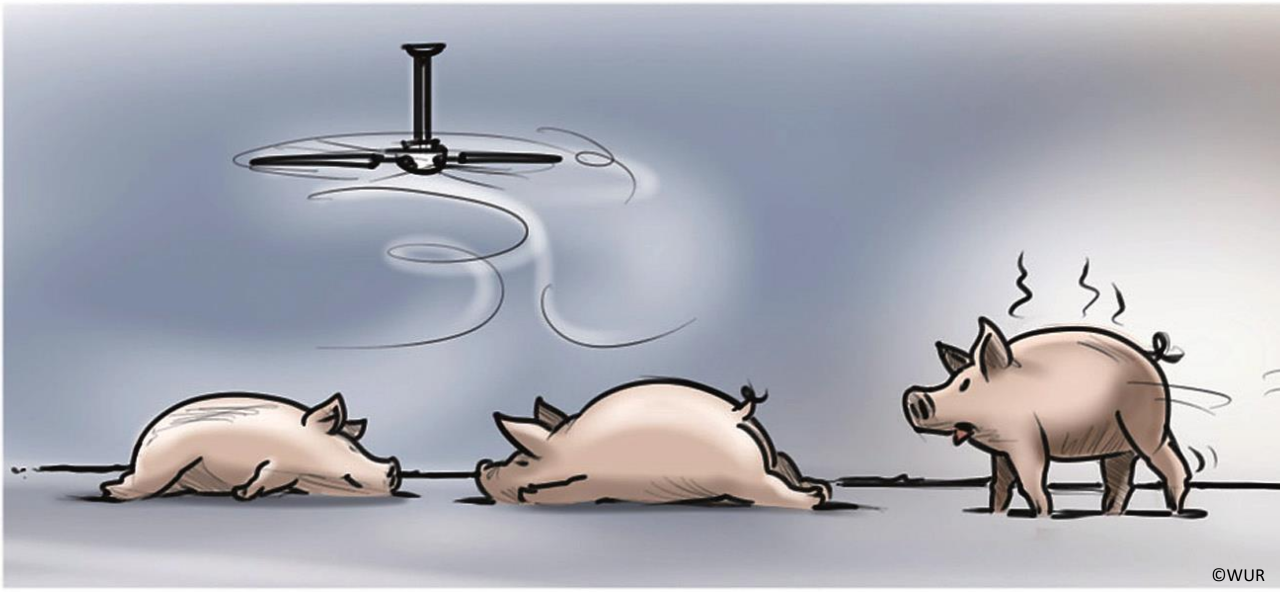
EU Reference Centre
for Animal Welfare *Pigs*

Review on cooling technologies for pigs

Herman M. Vermeer, Anita I.J. Hoofs



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This review aims to support welfare inspectors in the field of climate control on pig farms, in particular at high temperatures by providing information on cooling technologies.

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Contents

1 Executive Summary

With increasing global temperatures, the risk of heat stress for farm animals is growing. As pigs are not able to sweat and in livestock houses they generally do not have the opportunity to wet themselves, an ambient temperature above the upper critical temperature (UCT) leads to reduced welfare and performance. In this review technologies are described on cooling the pig (sprinkler/shower, floor cooling, fans for air circulation) and on cooling the environment (heat exchanger, fog/mist, cooling pads, air conditioner, underground tubes, underfloor air inlet) for pigs kept on farms. The knowledge in this review aims to support welfare inspectors in the field of climate control on pig farms, in particular at high temperatures.

2 Introduction

European summers became hotter in recent years with the expectation that this trend will continue, with negative effects on welfare, health and physiology of production animals (Ross et al., 2015). Compared to the outdoor temperature the indoor temperature will be even more effected (Schauberger et al., 2019). The scientific knowledge in this review aims to support welfare inspectors in the field of climate control on pig farms, in particular at high temperatures. Possible solutions to heat stress can help to prevent welfare problems. In this review we focus on the most relevant scientific information and if available we refer to more background sources from e.g., EFSA, EURCAW-Pigs, scientific journals, applied research and practical examples. Heat stress in all pig categories will be described, but with the focus on lactating sows and finishing pigs. These categories have the highest heat production due to high daily feed intake per kg bodyweight and a high body weight to skin surface ratio.

This review is about cooling facilities in pig houses, on farm and not during transportation and at abattoirs. Although temperature differences between countries during summer are large, the information and recommendations are valid for all European pig farms. There are not many legal requirements included in the respective EU Welfare Directives on indoor climate in pig houses, although some countries have more detailed rules. This implicates that inspectors need both animal based and environment based indicators to assess whether pigs experience heat stress and to enforce these open formulated legislative requirements by applying cooling technologies (Vermeer and Aarnink, 2023). Theoretically heat stress starts when the ambient temperature exceeds the upper critical temperature (UCT) of the thermoneutral zone. Above the UCT pigs will actively increase heat loss to maintain their core body temperature. It should be noted that also between the upper limit of the comfort zone and UCT pigs already make adaptations to increase heat loss, but these changes do not affect heat production. Active changes in pigs to increase heat loss are physiological (e.g., increase in respiration rate) and/or behavioural adaptations (e.g., lying on slatted floor instead of on an insulated solid floor). The UCT depends on age (body weight) and stage of production. When the UCT is not exceeded it is both beneficial for animal welfare as for profitability. Figure 1 shows a schematic presentation of the thermal requirements of pigs with the red box indicating occurrence of heat stress (EFSA, 2004).

3 Scientific knowledge on the behaviour and physiology of pigs in relation to heat stress

This chapter provides scientific knowledge on behavioural and physiological needs of pigs regarding thermal environment. By addressing these specific needs within this chapter, certain "heat stress indicators" will be identified. These indicators point at potential welfare risks. The scientific knowledge presented in this chapter can help inspectors to understand the relevance of the indicators for the welfare of pigs and why it is important to focus on these indicators during inspections.

3.1 Thermoneutral zone and thermal comfort

Pigs are homeothermic animals, and thus heat production and heat loss should be balanced. For this the environment surrounding the pig should fulfil certain requirements. Pigs have different strategies to influence heat production and heat loss (Aarnink et al., 2006). Under normal conditions, heat production is mainly influenced by feed intake. Heat can be lost through the following pathways: convection (air flow), conduction (contact), radiation (electromagnetic waves) and evaporation (water to water vapor). Heat loss through the first three mechanisms (convection, conduction and radiation) mainly depends on the temperature difference between the skin and the environment.

The pig is special among mammals because it has a very limited number of sweat glands, and therefore a limited capacity to lose heat by evaporation from the skin (Yousef, 1985). In pigs, evaporative heat loss mainly depends on the water vapour pressure difference between inhaled and exhaled air and the respiration volume. Thus, the major way pigs thermoregulate is via behavioural adaptation. In nature, pigs will increase respiration rate (and pant), seek shade, lie down laterally on cooler surfaces without physical contact to other pigs, and wallow in water or mud in order to cool down (Bracke, 2011). The wallowing is not only because the mud is cooler, but also to wet themselves to enhance evaporation. The specific biology of pigs means that they are vulnerable to heat stress, if the ambient temperature and humidity are high and the environment, for example during confinement, does not allow the required thermoregulatory behaviour to keep the animal inside the thermoneutral zone (Figure 3.1.1).

Mount (1979) developed a general concept of thermo-regulation of animals which was modified by Yousef (1985) (Fig. 3.1.1). This modified concept is based on a certain level of feed intake under stable or resting conditions. Within the temperature zone **A - D** pigs can keep their core temperature constant. This thermoneutral zone can be defined as the range of environmental temperatures within which metabolic rate and heat production are (fairly) minimal, constant, and independent of the ambient temperature. Point A is called the lower critical temperature (LCT), while point **D** is called the upper critical temperature (UCT). The thermoneutral zone will vary depending e.g., on the size of the animal (Figure 3.2.1), its breed, feed intake and environmental factors such as heat loss to the floor, air velocity around the animal, but also on metabolic heat production and motoric activity.

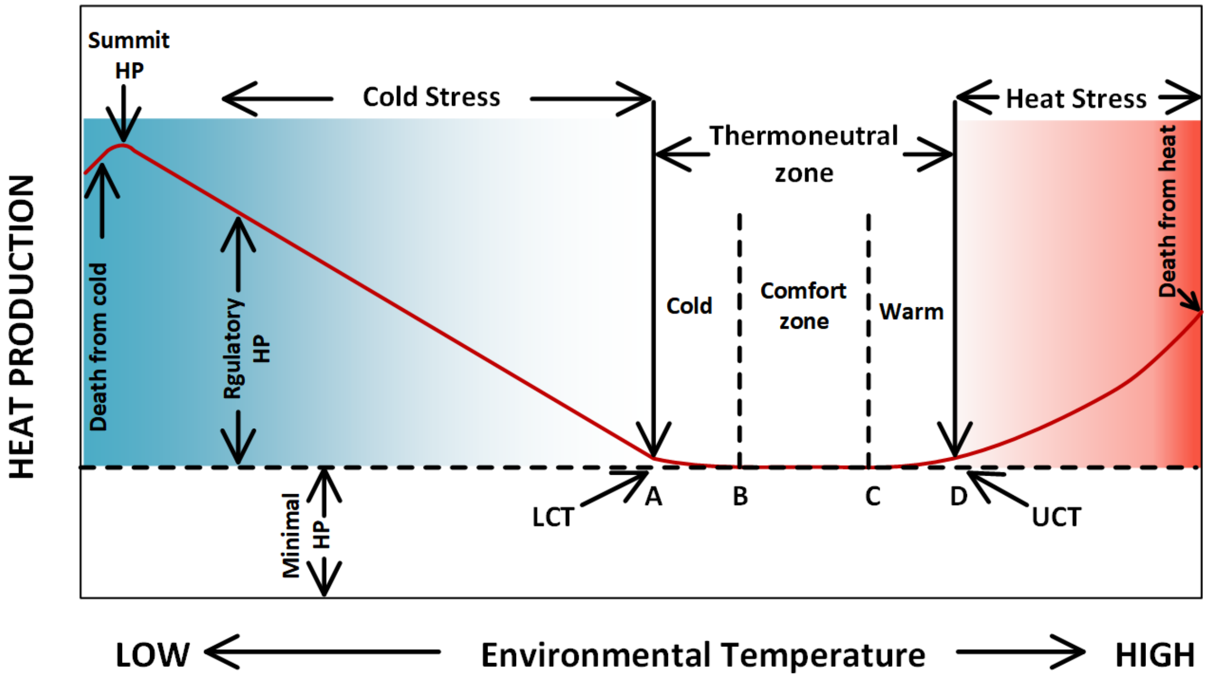

Figure 3.1.1: The concept of thermal neutrality and thermal comfort (CT) (modified after Yousef, 1985). LCT=Lower Critical Temperature, UCT=Upper Critical Temperature; the red box marks the condition with heat stress but can already develop from C; the capitals A-D are explained in the text below the figure.

Ambient temperatures below **A** cause the body temperature to fall if little or no extra heat production is possible (e.g. during starvation), while above **D** the body temperature rises. Zone **A – D** is the thermoneutral zone and can be divided into zones **A - B** and **C – D**:

- Heat production below the LCT (**<A**, cold stress) can be increased by shivering (shivering thermogenesis) and by producing extra heat without shivering (non-shivering thermogenesis by activated energy metabolism).
- Within zone **A – B** (cool) heat loss can be reduced by behavioural changes, e.g., by huddling with other animals in the group to lower heat dissipation by body surface.
- In zone **B – C** (comfort zone) no effort is needed to balance heat loss with heat production. To compensate for the rising ambient temperatures, heat loss is kept at the same level mainly by lowering the skin resistance (vasodilatation).
- In zone **C - D** (warm) heat loss is regulated by behavioural, e.g. lying on cool places (e.g. slatted floor instead of insulated solid floor) or on wet areas to increase convective, conductive and evaporative heat loss (behavioural thermoregulation), and physiological changes, e.g. small increase of respiration rate. Pig can already start to experience heat stress in zone **C – D**.
- Above the UCT (**>D**, heat stress) high respiration rates and panting are shown as a sign of heat stress. Above point D, pigs will also lower their feed intake.

In the zone from the upper threshold of the comfort zone (**C**) to the UCT as a limit of the thermoneutral zone (**D**), evaporative heat loss increases by increased respiration rate. At higher environmental temperatures, above the UCT, pigs show increased panting with more heavy abdominal breathing and a decreased voluntary feed intake. Furthermore, the effects of high relative humidity levels on pigs are expected to be more pronounced at high environmental temperatures (SCAHAW, 2002), because their evaporative capacity is limited. It becomes less pronounced if they can wet their skin by sprinklers or wallowing on the condition that the water is removed by ventilation. Feed restriction increases the ambient temperature at which welfare is compromised due to heat stress. This is caused by feed intake as the main factor for heat production in pigs.

3.2 Implications of heat-stress

Above certain ambient temperatures, starting at approximately 22°C, clear physiological changes occur in finishing pigs (Brown-Brandl et al., 2001). Higher production with a higher metabolism make pigs more vulnerable to heat stress. The upper threshold level decreases with increasing body weight (Figure 3.2.1), e.g., for lactating sows, with a high feed intake, the temperature threshold for physiological changes is considerably lower. The physiological indicators of heat stress include increased respiration rate and water-to-feed ratio (thirst), followed by decreased feed intake and heat production, and finally increased rectal core body temperature ultimately leading to death. Decreased feed intake and increased rectal temperature are good indicators of decreased performance in heat-stressed pigs, but their welfare will already be challenged at an earlier stage. The disruption in Figure 2 around weaning will be lower at a higher weaning age because the solid feed intake and the body weight are higher. More gradual transitions between the colours in Figure 2 will be closer to reality.

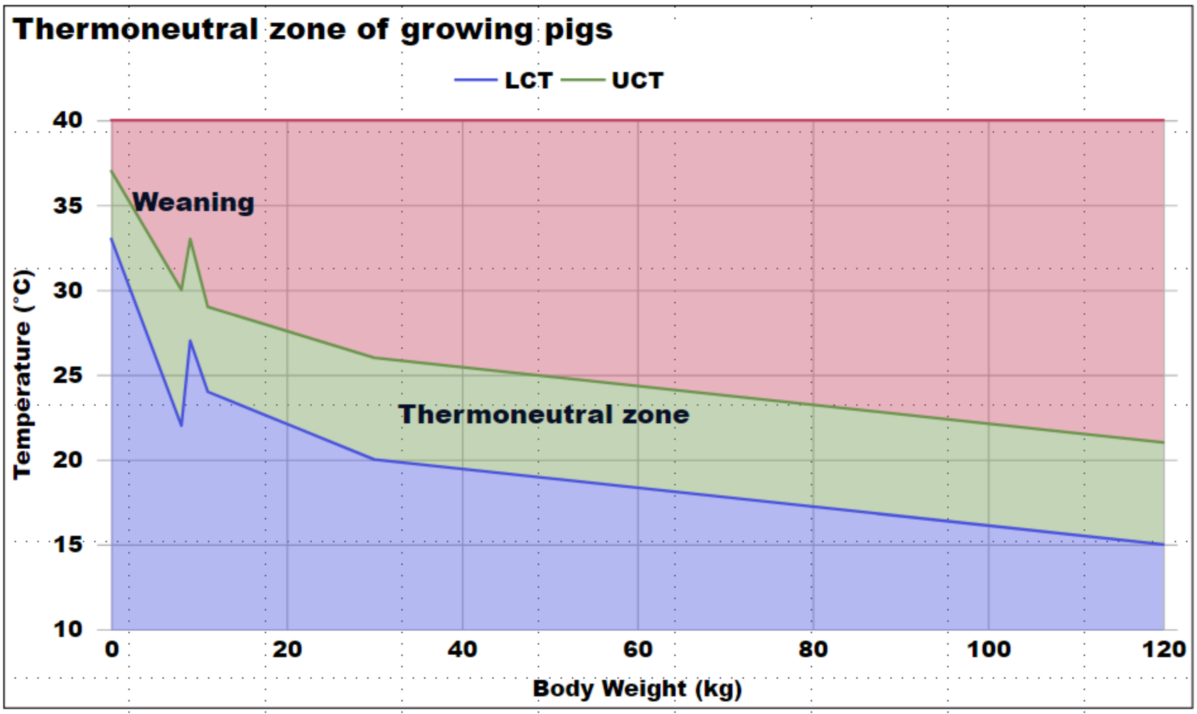

Figure 3.2.1: Schematic relation between thermoneutral zone and bodyweight; the red area indicates heat stress (Payola and Piriou, 2021)

The different strategies for heat dissipation are also based on different critical temperatures (Figure 3.2.2). In order of appearance during rising ambient temperatures at first pigs are going to lie apart from each other, firstly they reduce huddling and then reduce physical contact. This is followed by increased lying on the slatted floor (instead of choosing an insulated solid floor), increased excretion on a solid floor, a higher respiration rate, a decreased feed intake and finally an increased rectal temperature.

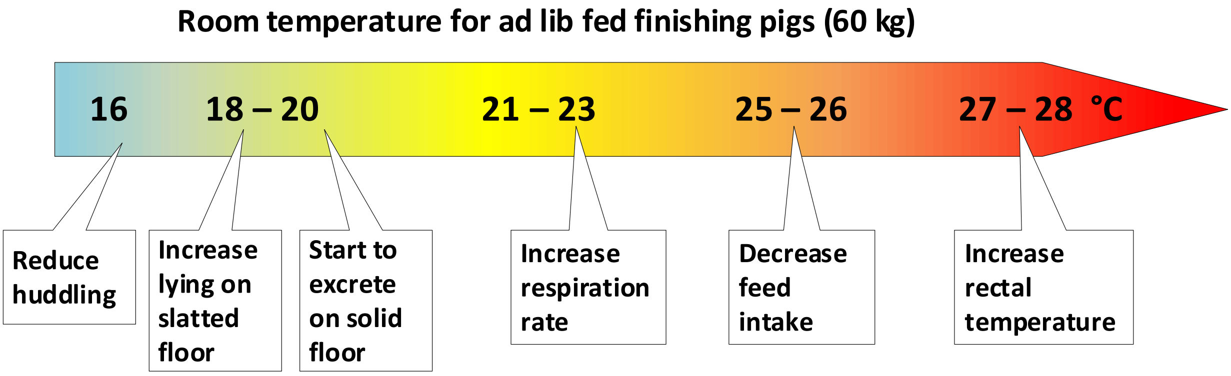

Figure 3.2.2: Chain of pigs' responses to increasing ambient temperatures (adapted after Huynh, 2005); the given temperatures are valid for an ad libitum fed finishing pig of approximately 60 kg.

3.3 Thermal requirements

The thermal requirements of pigs are depending on different factors. In Table 3.3.1 an indication is given of the upper limits of the comfort zone and the thermo-neutral zone for the different categories of animals. In housing systems with well insulated solid floors (-2°C) or bedded lying areas (-4°C) the limits are lower compared to fully slatted floors.

Table 3.3.1: Indication of the upper limit of the comfort zone and thermo-neutral zone (in °C) of the different categories of pigs (Sterrenburg and Van Ouwerkerk, 1990).

Pig category	Upper limit **Comfort Zone**	Upper limit **Thermo-Neutral Zone**
Piglet 8 kg	31	35
Piglet 20 kg	26	30
Grower 30 kg	24	28
Finisher >60 kg	20	25
Empty sow	25	29
Pregnant sow	23	26
Lactating sow	18	21

3.4 Relative Humidity (RH) and THI

The water content of the indoor air determines the capacity of the expired air to "absorb" evaporated water from the pig (breath) and if possible also from the skin. The combination of temperature and relative humidity (THI) determines the amount of energy (enthalpy) in the air. This THI can be expressed in a formula like $THI=(1.8\times T+32)-[(0.55-0.0055\times RH)\times(1.8\times T-26)]$. The higher the THI the more difficult it is to lose body heat. The THI is often suggested as a tool to assess the temperature-humidity combination in heat-stress risky situations. However, in non-sweating animals like pigs, the indoor

temperature is the most important determinant for heat stress (Huynh, 2005).
As is valid for UCT every category of pigs needs it owns THI table with thresholds for T/RH combinations. However, specific porcine limits for different thresholds for different levels of heat stress were never developed.

4 Heat stress indicators to focus on during welfare inspections

When visiting a pig facility it is necessary to have a toolbox of indicators to detect welfare consequences of heat stress. There are many indicators available, both environmental (risk factors) and animal based, of which some show an acute (skin temperature), others a longer term effect (pen fouling) of heat stress (Guevara et al., 2022). Different housing systems may have a strong effect on heat stress risk. However we will describe these risk factors separately and not as a combination.

From the previous EURCAW review on heat stress (https://eurcaw-pigs.eu/search/result/review-on-heat-stress-in-pigs-on-farm-(version-1.0)?id=1193583) **temperature** (T), **relative humidity** (RH), **panting** and **pig fouling** are considered as the most useful and proven indicators and will be described in more detail in indicator factsheets for heat stress.

5 Cooling technologies

Before introducing cooling technologies it's efficient to "block" any additional heat sources: insulation of walls and roof and prevent too much window area on the South. If possible construct windows on the North side of buildings (walls and/or roof) or cover the windows (partly) with paint (chalk) during the summer and maintain the light level indoors, in line with (national) welfare regulations (Bjerg et al., 2019; ILVO-Coolpigs, 2022). The described cooling technologies are restricted to indoor housing systems. Schauberger et al. (2020) gives a complete overview of the adaptation measures. Pertagnol et al. (2020) concludes that water evaporation in the air inlet have the highest cooling efficiency.

5.1 Pig cooling technologies (increasing the upper threshold of the comfort zone)

Evaporation directly from the pig skin or a cool surface for conduction leads to a very effective way of heat loss. Wallowing in the manure in conventional pens can be functional but is not preferred by the pigs and is not recommended (Huynh, 2005). Cooling by evaporation can be realized with **sprinklers (shower)** and by conduction with **floor cooling** (Godyń et al., 2020). The use of showers significantly reduced pen fouling while simultaneous reducing ammonia emission by 43% (Jeppsson et al., 2021). The absence of these cooling devices will increase heat stress. In housing systems with bedded or insulated floors (without much slatted or wet areas) pigs do not have opportunities for cooling during the summer (Fraser, 1985). In these systems heat stress develops already at lower temperatures and **fans for air circulation** can be used to increase airspeed. These three technologies will be elaborated in the next sections.

Sprinklers (shower)
Water sprinklers (showers) can be used to increase heat loss by evaporation from the skin. Both sprinkling directly on the skin, or indirectly by wetting the floor and giving the pigs the opportunity to wallow can be used. Shallow wallows can be very functional, but in indoor systems not applicable. Renaudeau (2012)

stated that pigs can be cooled by moistening the skin with or without supplemental airflow to increase the rate of evaporation of additional water. Making 1 g of water warmer by 1°C costs 1 calorie of energy, whereas evaporating 1 g of water costs 580 calories. The evaporation of water absorbs heat directly from the skin (blood) of the animal and also absorbs heat from the surrounding air (Renaudeau, 2012). The water can be provided to the skin with a sprinkler installation. However, such equipment is known to generate a large volume of water to be processed. This system is widely used on pig farms to reduce heat stress and is very efficient compared with other cooling methods (Nichols *et al*., 1979).

Floor cooling

Both Maskal et al. (2018) and Brandt et al. (2022) found lower respiration rates in farrowing sows or finishing pigs with floor cooling. Maskal et al. (2022) also observed lower rectal temperatures in sows with floor cooling. In both situations the water was continuously circulating, but in the finishing room the system was only working above a temperature threshold depending on age. Opderbeck et al. (2020) found a preferred lying on the floor cooling system with low fouling levels.

Systems with circulation of water between older and younger pigs can theoretically transport heat from the older to the younger pigs but are not very efficient under practical conditions (Sefeedpari, 2023).

Fans for air circulation

The increase of airflow in swine facilities reduces the effects of thermal stress especially on growing pigs and lactating sow performances. A provision of supplemental fresh air directly over the animal can be a very efficient way to improve performance of the heat-stressed animal (Renaudeau, 2012). Fans in the room create circulation of air to cool the pigs, they create air movement (wind), but don't enter fresh air. To create a chill factor around the pigs, the air speed should be focussed on the pig level. Increasing the air speed from 0.2 to 2.0 m/s will raise the Upper Critical Temperature of the Comfort Zone with 4 – 6 °C (Figure 5.1.1). This is the temperature a dry pig experiences related to the air speed. With a higher air speed the heat loss will be higher. When the pig has a wet skin the experienced temperature will be even lower. For an optimal air mixing effect the fans should be placed in the fresh air inlets and not too close to the wall. A check with a smoke test is recommended as well as a control of draft "high air speed with lower temperature".

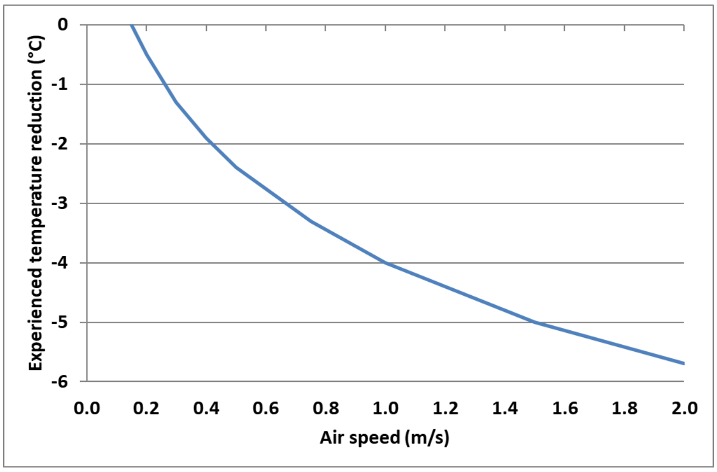

Figure 5.1.1. Experienced temperature of finishing pigs related to air speed (Modelled with data from Verstegen & Van der Hel (1976); Verhagen (1987); Bjerg (2016)).

5.2 Air cooling facilities (not affecting the upper threshold of the comfort zone)

Cooling of the incoming air by a **heat exchanger** with cool water (e.g., from ground water) or by evaporative cooling by direct **spraying of miniscule water droplets** (fog/mist) in the air inlet or by **cooling pads** can lower the room temperature significantly (Häussermann et al., 2007). Even an **airconditioner** (heat pump) can make the indoor climate cooler. When moistening the air just before it enters the building the indoor relative humidity will not raise to too high levels because of the increase in air temperature by the heat production of the pigs. Air inlet via **underground tubes** or via an **underfloor channel** is also a robust cooling system (Godyń et al., 2020). The effectiveness of these techniques can only be assessed by comparing the outdoor temperature and the temperature of the fresh air entering the pig house. These six technologies will be elaborated in the next sections.

Heat exchanger
When outside warm air passes a grid of tubes with a cool liquid, for instance ground water, the temperature of the incoming air can be lowered significantly, depending on the capacity of the installation. This system can both be used to cool the air during summer and to heat the air during winter. The ground water is used as a buffer in this situation.

Spraying water (fog/mist)
Evaporative cooling systems use the energy from the incoming air to evaporate water and evaporation of water into warm air reduces the air temperature while increasing RH. Fogging systems use very fine droplets of water in order to increase the water surface in contact with the air. The water is evaporated into the air causing a reduction in air temperature. These systems are most effective in dry areas but can also be used in high humid regions during daytime hours when RH is low. As the water is completely evaporated, fogging systems do not waste water. In humid climate, mist droplets are too large to fully evaporate before setting the ground and can wet the bedding and feed. Misting installations can inject water under high pressure into a stream of air. This system was found to be very effective to reduce the temperature during the hottest periods of the day, with the condition that RH was low. The system has to be operated as "on – off" mode controlled controlled by a RH-sensor, integrated in the climate control system, to avoid unwanted increase of the enthalpy which would cause heat stress itself. In swine production, fogging systems allow the improvement of growth performance by 5% to 10%, especially in finishing pigs (Nichols et al., 1979; Dutertre et al., 1998; Häussermann et al., 2007).

In the EU-PiG project the best innovations from practice were chosen from yearly challenges. In the challenge to reduce heat stress (EUPiG, 2020) the high pressure fogging to cool the incoming air was the winning technology. In extreme weather from 36 to 40 °C the temperature of the incoming air will be around 6 °C lower. A system with a lower pressure can also be efficient and with lower costs. Almost every pig house can be provided with a fogging system. The farmer experience from the EU-PiG project was that sows give birth to about 0.8 more piglets in the next litter. Furthermore, daily gain was about 50 grams per day higher and feed conversion 0.1 lower if there was less heat stress (EUPiG, 2020).

Cooling pads

With a pad cooling system, the ambient air within the building is cooled by forcing air into the building through wet pads in front of the air inlet (Renaudeau et al., 2012). The water evaporates from this grid with a large surface. However, there is a risk that evaporative cooling pads can result in an increase of relative humidity so a RH-sensor is required to control the system (Dutertre et al., 1998; Sartor et al., 2003). Pad cooling is effective to lower the temperature in closed pig houses, but it is an expensive means to reduce heat stress.

A major benefit of this cooling method is its capability to cool air efficiently, coupled with low energy consumption. In the summer, the temperature in the sow house was reduced by up to 7°C. The water is recycled and only the evaporated water is supplemented. However, in existing buildings it's more difficult to install the panels, because they require some space in the fresh air inlet. In new buildings it's easier to plan some space for the system.

Air conditioning

Air temperature can be lowered by air conditioning, but the expense of this type of mechanical air cooling makes it impractical for cooling livestock (Renaudeau et al., 2012; West et al., 2003). However, it can be used to overcome shorter peaks of heat stress in combination with a basic cooling system with lower energy costs.

Underground tubes

Underground tubes can be used in combination with mechanical ventilation. Fresh air flows through profiled tubes buried in the soil outside the pig house (Figure 5.2.2) before it enters the central alley of the building (Figure 5.2.1). During winter the air will be heated 4-6°C and during summer, it will be cooled by 4-6°C under NW-European conditions. This technique saves energy, results in a more stable indoor climate and prevents heat stress (Van 't Klooster et al., 1991). It also stabilizes the indoor air distribution because it buffers temperature extremes (Tiedemann, 1991). However because the resistance in the air inlet system is increased the fan capacity should be well dimensioned. The system depends on the temperature difference between the air and the soil, determined by soil type and level of the ground water. Deeper in the soil the fluctuations in soil temperature are smaller.

Characteristics of underground tubes:

- Profiled waterproof plastic tubes with a diameter of 200 mm and a length of 20 m. The capacity of these tubes is 200 m^3 per hour per tube;
- Outside or under pig house with a slope of 1-2% and drainage system;
- Depth 2.0-2.5 m, mostly in two layers with a distance of 0.5 m;
- Air speed at maximum 0.2 m/s;
- To prevent heating of the cooled fresh air it is advised to use a system with a lowered (underfloor or door) air inlet system into the room.

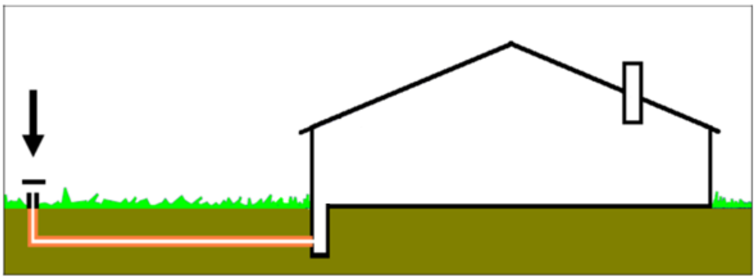

Figure 5.2.1: Schematic cross section of underground tube ventilation (©WUR)

Figure 5.2.2: Installation of underground tubes used as an air inlet (©WUR)

The benefits of the system are the buffering capacity (cooling and heating), more stable climate, less wind effect, minimal higher energy costs, robust system. The disadvantages are the required area close to the building and during longer periods of heat or cold the thermal buffer in the soil can become exhausted.

Underfloor air inlet

With an underfloor air inlet, fresh air enters the central corridor, directly from outside in a channel under the animals' solid lying area. Here the air is distributed over the length of the room. The air is coming up through a slatted floor or an air inlet gap into the room and then flows over the front pen partition into the pen and replaces the "old air" (see blue arrows in Figure 5.2.3). The system is more difficult to apply in fully slatted systems because an underfloor air channel is lacking.

Ventilation via an underfloor air inlet has a number of advantages: Incoming air is cooled in summer and air is heated in winter. Day and night fluctuations are also levelled. The fresh air first reaches the animals before it mixes with the air in the room. This is an effective ventilation system. The standard ventilation rate can be set approximately 30% lower, which results in energy savings through less ventilation and less heating (conditioning effect).

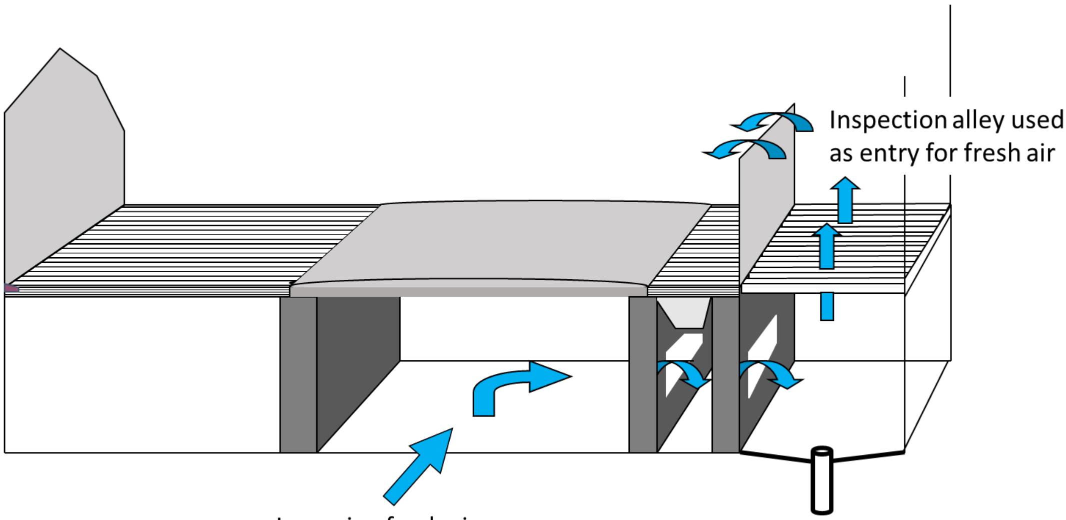

Figure 5.2.3: Cross section of underfloor air inlet in a pig house (©WUR)

The inspection alley fills with incoming fresh air and at low ventilation rates the fresh air slowly enters the pen. The air flow is just over the front pen partition and at higher ventilation rates, the air rises higher before it flows in the direction of the pigs (Figure 5.2.4).

Figure 5.2.4: Examples of a smoke test with fresh air slowly entering the pig pens (©WUR)

The advantages of underfloor ventilation is the cooling in the summer and heating during winter, but also buffering extremes on a daily basis. Figure 5.2.5 shows the buffering capacity of the system with the outdoor temperature and the temperature of the incoming fresh air with less extremes. The buffering capacity is determined by the heat exchange between soil and air inlet channel and the duration of stay. The system results in a good air distribution in all seasons and good air quality at the pigs, because the majority of the fresh air arrives at the pigs before mixing with the "old air".

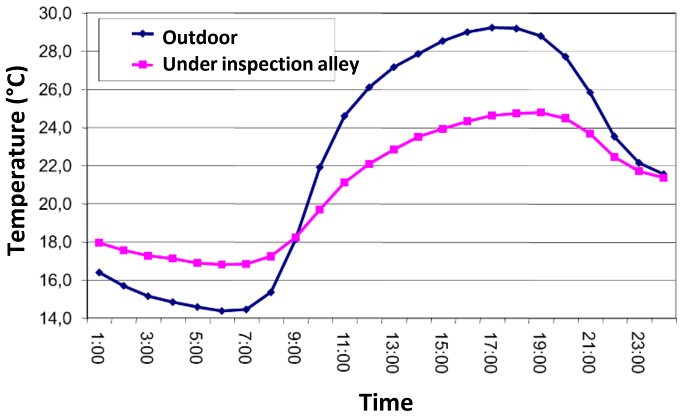

Figure 5.2.5: Example of outdoor temperature and temperature of the incoming fresh air in a finishing pig house with underfloor air inlet (data VIC Sterksel, 2001).

The disadvantages of the system are that periodical cleaning of the air channel in the inspection is necessary, additional heating of the fresh air during cold periods is necessary and the cooling capacity is not sufficient to prevent heat stress on hot days.

Schauberger et al. (2020) list a number of cooling measures and conclude that cooling air by evaporation and by the air inlet via the soil (groundwater) are very efficient and cost effective measures.

6 Legal requirements

There are hardly climatic legal requirements for pigs in the EU-regulations. However, on a national level rules can be in place, but often formulated as "open standards". Directive 98/58/EC states that the accommodation should "not be harmful" to the pigs, which can only be checked by animal based indicators given in section 4.2. However, legal limits are not available in most countries, with difficult enforcement as a consequence.

COUNCIL DIRECTIVE 2008/120/EC 3 (EU, 2008)
Annex I, Chapter I, Article 3: The accommodation for pigs must be constructed in such a way as to allow the animals to:
*- have access to a **lying area physically and thermally comfortable** as well as adequately drained and clean which allows all the animals to lie at the same time.*

Directive 98/58/EC (EU, 1998)

Annex: Buildings and accommodation
*Article 10: Air circulation, dust levels, **temperature, relative air humidity** and gas concentrations must be kept within limits which are not harmful to the animals.*

Acknowledgements

We thank the authors of the EURCAW "Review on Heat Stress in Pigs", because we used a substantial part of their text (Vermeer & Aarnink, 2023).

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EU Reference Centre for Animal Welfare *Pigs*

About EURCAW-Pigs

EURCAW-Pigs is the first European Union Reference Centre for Animal Welfare. It focuses on pig welfare and legislation, and covers the entire life cycle of pigs from birth to the end of life. EURCAW-Pigs' main objective is a harmonised compliance with EU legislation regarding welfare in EU Member States. This includes:

- for pig husbandry: Directives 98/58/EC and 2008/120/EC;
- for pig transport: Regulation (EC) No 1/2005;
- for slaughter and killing of pigs: Regulation (EC) No 1099/2009.

EURCAW-Pigs supports:

- inspectors of Competent Authorities (CA's);
- pig welfare policy workers;
- bodies supporting CA's with science, training, and communication.

Website and contact

EURCAW-Pigs' website www.eurcaw-pigs.eu offers relevant and actual information to support enforcement of pig welfare legislation.
Are you an inspector or pig welfare policy worker, or otherwise dealing with advice or support for official controls of pig welfare? Your question is our challenge! Please, send us an email with your question and details and we'll get you in touch with the right expert.

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- **Legal aspects**
  European pig welfare legislation that has to be complied with and enforced by EU Member States;
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  Animal welfare indicators, including animal based, management based and resource based indicators, that can be used to verify compliance with the EU legislation on pigs;
- **Training**
  Training activities and training materials for inspectors, including bringing forward knowledge about ambivalence in relation to change;
- **Good practices**
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- **Demonstrators**
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