Controlling Heat Pads with Dicam

Some simple principles

New born pigs do not produce enough heat to sustain body temperature in room temperatures which are acceptable to the sow. High room temperatures inhibit sow feed intake and thereby milk output.

Pigs lose heat to the air, depending on the difference between skin temperature and air temperature - how much colder the air is than they are. If it's a little colder - say 1º, they lose a little; 2º colder, they lose twice as much and so on.

Young pigs produce a lot of heat per kilogram, but they have a large surface area, so they lose heat more easily than the sow. So the temperature needs of the piglet and the sow are markedly different.

Unless young piglets are kept in an enclosure which is hotter than the room - i.e. a creep box - they lose more heat than they produce. Creep boxes - if properly designed - reduce the piglet heat loss because the air around the piglets is not so cold.

Heat pads in open creeps work in a quite different way. They don't reduce piglet heat loss to the air - the pigs are still exposed to room air temperature. Instead, they supplement the piglets' heat production, which means they can afford to lose the same amount without losing body temperature.

Heat pads work by conduction - direct contact between the skin and the pad. Simple physics says that heat "flows downhill" - i.e. from hotter to colder. (To be pedantic, it flows both ways, but the net flow of heat is from hotter to colder.)

For heat to flow from the pad into the pig's skin, the pad must be warmer than the pigs skin. Simple as that. If the pad is colder than the pig, heat flows from the pig to the pad.

Pig skin is roughly 36ºC (a little below the core body temperature). So if the pig lays on the pad - without any electrical heating of the pad - it will heat the pad up to about 36ºC. If you want heat to flow from the pad to the piglet, the pad must be hotter than this.

The amount of heat the piglet gains from the pad depends on the surface area in contact, and the temperature difference. If the pad is 1º hotter, *x* watts can flow from pad to pig; if it's 2º hotter, it's 2x watts; 3º hotter, it's 3x watts, and so on. (Roughly speaking.)

BUT there are several other factors to bear in mind.

The pig is not just a "lump of meat lying on the hot plate". It has thermo-regulation mechanisms. It only wants as much as it needs. If - by lying on the pad - it gets more than it needs, it will try to reduce it. Either by lying partly off the pad, or lying somewhere else entirely.

When new born, the piglet needs a lot of heat supplement, but it drops rapidly as it grows towards weaning age.

There is a limit to how hot the pad can be - if it's too hot, the piglet either won't lie on it at all, or not for very long. The limit is not exactly clear, but it's somewhere about 42ºC (for staying on the pad).

SO the usable heat pad temperature range is fairly small - only from around 36ºC to around 42ºC.
In between these values, it gets more or less heat from the pad, depending on the exact temperature.
Below 36º, it gets nothing, because the pig is heating the pad, not the other way around. Above 42ºC, it gets nothing, as it won't lie on the pad.

If the wrong temperature range is used - whether too high or too low - pigs look for another place to lie - such as next to the sow, leading to overlying losses.

For a given power input, the pad temperature goes up when pigs get off the pad. This is because heat transfer is more effective by conduction (to the pig) than by convection (heating the air). Generally, pads are designed for a particular power rating, not a particular temperature. Some makes of pad (with a high power rating but low surface area) can reach high temperatures in free air (i.e. when losing heat only by convection).

Heat pads are an effective way of getting heat to young pigs, but it is not nearly so foolproof as some heat pad makers and sellers might have you think.

Getting it wrong can be expensive. Either in wasted electricity or - far more expensive - unviable pigs, or high pre-weaning losses.

In summary, it is important to :
- Control the temperature of the pad within close limits (about 36 to 42ºC)
- Change pad temperatures gradually as pigs grow

Some common errors and misconceptions about heat pad control

"The heat used by the pad is so low that it isn't worth controlling".

This is a little like saying "this tap dribbles so slowly it's not worth turning off". If the pad has enough power when the pigs are young, it is too much when they are older. If it's enough when they are older, it'snot enough when they are new born.

You still have to regulate the level to as much as they need, which changes as they grow older. An unregulated mat can only supply one power level, which is like a stopped clock.

Besides, it still adds up to a fair sum over the year. If a 250W lamp used 3 weeks out of 4 uses £70 a year, then a 125W pad still uses £35 - that's still over £3,000 a year for a 500 sow unit. If you can save some of that (and do a better job at the same time), it's still worth doing.

"You can't control pad temperature properly because pigs lie on the sensor".

Some people think this because they've used the wrong set temperatures. Many producers in the past have set target pad temperatures to those they would use for air temperatures. For example, they have set pad temperature to 32ºC. As explained above, if you set pad temperature to anything less than about 36ºC, the pad will always be off, because the pigs heat it up to this temperature using their own body heat.

Heat pads only work if they are hotter than the pig (about 36º to 42º). It does matter whether the pig is lying over the sensor - because this affects the rate of heat loss - but it doesn't affect the temperature you want.

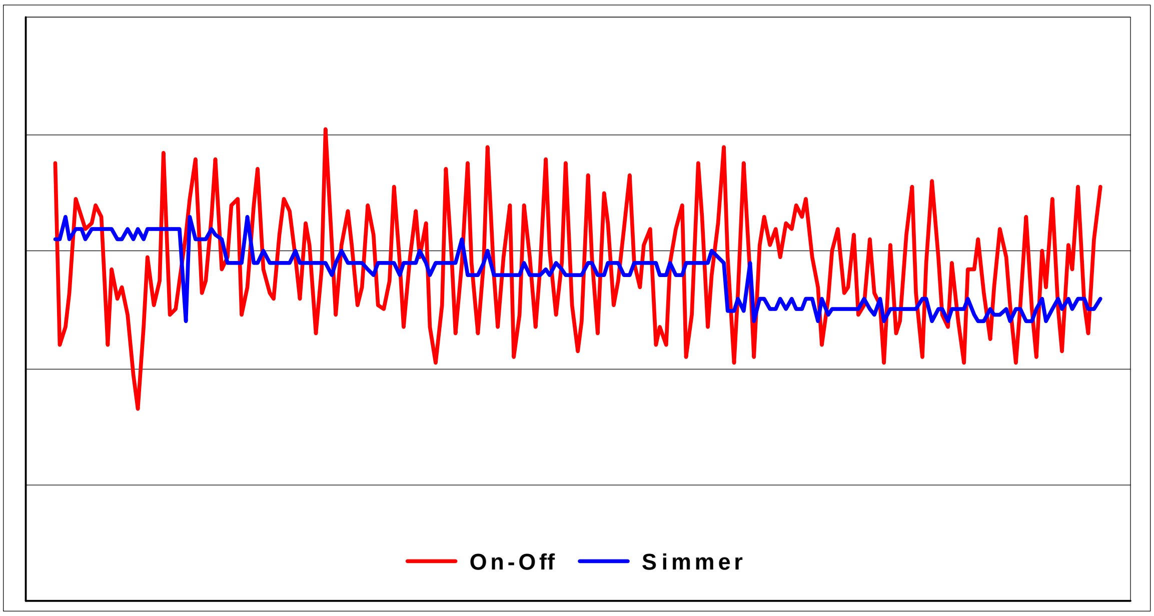
"You can do it as well or better with manual regulation."

A lot of people place great faith in "the eye of the experienced stockman". And yes, getting the balance of what they want and need is a skilled job, but you can't be there all the time, and it's easy to get wrong. Even with an experienced eye, there is a limited feedback on what is actually happening. Far more sense to observe - with the help of a temperature readout - and wrap up your experience in a temperature curve - than rely on the vagaries of chance to get it right by adjustment every day.

Besides, manual regulators don't actually save a great deal in terms of cost. Most of the cost is the regulation itself (if using a good quality regulator), and the temperature automation is only a marginal addition.

Manual regulation is only a lot cheaper (in installed cost) if you are comparing a cheap domestic quality regulator with a good proper livestock grade regulation system - which is not a realistic comparison. Is it worth entrusting care of valuable livestock to a cheap and unreliable dimmer?

"You just need a cheap thermostat."
The following chart shows the difference between proportional and thermostat (On-Off)control.



The chart shows temperatures in a heating control situation over a period of two days, recorded at 15 minute intervals (note the two temperature level changes). You can see that proportional control gives a steady temperature - only minor changes from one measurement to another - while On-Off control gives much greater temperature swings. (The horizontal lines are 1ºC intervals.)
The average temperatures are actually the same in both, but good proportional control gives much more steady conditions.

The word "thermostat" implies that temperature stays the same, but only relatively so. It takes a temperature change to switch the thermostat on and off, and combined with the thermal mass of the heater, you get temperature over-shoot and under-shoot. The temperature swing needed to switch on or off a thermostat is called the "hysteresis". A particular problem with electromechanical thermostats is that hysteresis - and therefor temperature swing - increases as the thermostat gets older (they gradually wear out).

It's not certain how much effect such temperature swings have on pigs, but any changes of temperature require a response by the pig and as such, represent a form of stress - mild or severe, depending on the temperature swing.

Low cost thermostats are also, typically, not very accurate. Not so much a problemin central heating systems, where they are in any cases adjusted for human comfort. Not so good for heat pad control where there is little temperature band to play with, and you need it reliable and repeatable.

Dicam control of heat pads

Dicam control for heat pads - as for virtually all other pig heating, ventilation and other control applications - contains all the essential features in an integrated economical package.

Digital setting and Temperature display

A key feature in both setting and using the system - giving feedback to help understand the best way to use a system, and achieve consistent results.

The easy to use digital menu also gives a readout of power levels, max-min temperatures, and contains special features making it easy to both check and monitor system operation and performance.

High Accuracy

Since the temperature range you need is so small, and small differences in setting can have a signifiant effect on both economy and pig reaction, high accuracy is essential.

Dicam temperature sensors are "point matched" - that means they have high accuracy and repeatability one to another. (Typical 0.2ºC.)

Many controls have digital displays where the resolution (units of measurement) ands much better than the accuracy. For example, they display to 0.1ºC, but the accuracy is only within 1ºC (or worse).

Curve (option)

A settings curve is a profile of temperature (and minimum output level if desired) over a period of days. A curve is important in matching temperatures to pig needs on a reliable and consistent basis, and achieving economy.

Dicam curves are more advanced, but much easier to use, than other control systems available. The program automatically calculates intermediate temperatures (adjusting gradually, not in steps). The curve is easy to set up, and rooms can be easily started or stopped, or advanced or retarded in the curve(s), according to judgement and needs.

When used for heat pads in weaner rooms, controls can have separate temperature curves for ventilation and pad temperature, but "day-linked" to make it easier to set and use.

Unlimited Power Handling

For economy of installation, pads are usually controlled on a "zoned" basis - that is, a number of heat pads are connected to a single (controlled) mains power circuit, and regulated based on temperature measured at one or two pads in the zone.

To handle this (varying) power load, Dicam uses external power handling modules. To increase the power handling, simply add more modules. This also allows multi-circuit switching - controlling several mains circuits with individual breakers - as a single zone.

Dicam controls can also be set up for multi-phase operation (control spread across all mains phases).

Control Type and Setup

Improved control and reduced pig stress is achieved with proportional control - as shown previously. Using the special "Simmer" feature, Dicam achieves proportional control without electrically noisy dimming, by setting the control type.

As well as heat pads, Dicam creep control can regulate almost any other type of creep (or other heating) - lamps, hot water, and so on - simply according to choice of driver and controller set up. So if the heating type is changed, the control can be adjusted, without needing a new controller.

Noise Free Switching

For heat pads, we recommend triac driver drivers with "Simmer" control. This removes "mains switching spikes" which can otherwise occur with mechanical contacts or dimming control, relieving stress on (often weak or heavily loaded) rural electricity supplies.

Multi-Zone Control

Dicam heat pad controllers can control from one to eight heating zones, according to circumstances and choice of program. (Heat zones don't all have to be the sametype - some may be heat pads, others lamps, and so on.)

This reduces costs by "sharing" a Dicam processor master unit, but each zone has its own sensor(s) settings and so on.

Integrated Control Choices

Dicam heat pad control is available as stand alone control (regulating heat pads only) or "integrated" with ventilation or other control. This shares the controller, but each control function is independent - or temperature interlocked - according to requirements.

Safe Low Voltage Operation and Circuit Isolation

The master unit and peripherals operate at isolated low voltage, reducing risk of damage and maximising both user and animal safety.

If, say, sensor cables get damaged by animals or attack by vermin, there is no risk of fire, damage to health and potential equipment damage is minimised. (Thermostats and low cost controllers, by contrast, are not usually mains isolated, and may operate at full mains voltage.)

Only the parts which must - necessarily - carry mains do so, and these use optical or galvanic isolation to minimise damage and reduce risk of consequent failure.

Reliability

Operating conditions are often poor on pig farms and similar situations - variable and often weak mains supplies, dirty and dusty conditions. But high reliability is essential for efficient production.

The integrated approach to design, and robust low cost power modules means high reliability even under these harsh conditions. The master unit is housed in a dirt and dust resistant, enclosure, and power module design means they can be installed for efficient and reliable operation.

The system is about ten times as reliable as other (comparable) systems, withstands much greater overloads, and is cheaper to repair (if the worst happens).

Expandable and Upgradeable

Many pig buildings are changed from time to time, for example as the size of the herd changes. Dicam controllers can be improved, altered, upgraded at will, as the needs change. For example, further rooms or zones can be added, or heating or ventilation method changed.

Alarm (option)

Controllers automatically detect faults such as failed sensor readings or excessive interference (otherwise causing malfunction).

Temperature alarms can be added to detect faults due to factors such as circuit trip-outs or power module damage.

Networking and Logging (option)

With increasing regulatory and other pressure on farms, there is an increasing need to get higher efficiency, lower production costs, and meet monitoring requirements.

By connecting units on an alarm and logging network, not only can faults or problems be signaled centrally, but also operating data - temperatures, heating levels, and so on can be recorded, displayed and analysed using the unique Barn Report data system. (The data shown on an earlier page is from just such a system.)

This gives valuable insight in both detecting problems and optimising heater use to help meet both present and future needs for minimising electrical use, without sacrificing animal performance.

Example System

Building

Three 10-crate farrowing rooms with a 450mm fan and 150 watt heat pads

Equipment suggested

FSC3.F/3Autocreep/Alarm : Dicam master unit with 3 room/3 creeo control
3 TS4-1 : Temperature sensors (armoured) for room temperature
3 TS4-0-3 : Temperature sensors (unarmoured) for heat pad temperature
3 FSS1 : Fan speed control driver modules
3 FSS3 : Driver modules for heat pads (noise free)
PSU-A-UP : Backup power supply
NP112 : backup battery
SM107 : Siren

General description

The master unit is connected to its low voltage external power, sensors in each room and zone, and power modules. Power modules situated next to mains distribution board/circuit breakers in or at each room.