The Economy 7 Electric Storage Boiler for Creep Heating

Introduction

The Economy 7 electricity tariff provides electricity at less than 40% of the normal day rate for a period of 7 hours from about 12.30 am to 7.30 am GMT.

Reduced running costs are achieved when conventional direct acting electric creep heating systems are used on this tariff as 30% of their consumption takes place during the cheap night period. However, 70% of their total energy consumption is still consumed in the more expensive day period.

With an indirect method of creep heating using water as a heat transfer medium it is possible to carry out all heating during the cheap 7 hour night period and store the heated water in an insulated tank until it is required for use.

How the System Works

Water is heated overnight in an insulated tank to a temperature of 90°C. This water is then fed through a mixing valve to maintain a circulating water temperature of 40-50°C in creep radiators and/or pipework set in the floor (underfloor heating).

NAC Pig Unit Installation

A scheme is installed at the NAC Pig Unit. It consists of a 773 litre (170 gallon) tank fitted with 9kW of night-time operating immersion heaters and a 3kW day-time "back-up" immersion heater.

The tank supplies 12 farrowing creeps in two rooms (Fig 1). The creeps in the first room are fitted with plastic underfloor pipework to provide underfloor heating. The creeps in the adjacent room are fitted with small steel central heating radiators.

The temperatures in each group of three creeps are controlled by thermostatic valves.

In the underfloor heated room, two room heating radiators are also fitted. The operation of these radiators is interlocked with the fan ventilation controller via a motorised valve.

The Tank

The water storage tank is made of mild steel and built to BS 799. Appropriate inlets, outlets and immersion heater entry bosses are shown in Fig 2. The tank should be insulated with a minimum 150 mm of glass fibre (or equivalent).

The tank capacity should be 77 litre (17 gal) per creep to be heated.

Immersion Heaters and Controls

Because of the trial nature of the installation at the NAC Pig Unit, a top entry day operating immersion heater was included as an insurance against the system being undersized. Ideally this immersion heater should not be required, and therefore, it is recommended that this feature is not included in any new design.

The night-time operating immersion heating elements should be installed at the bottom of the tank. It is recommended that incaloy or titanium sheathed elements are used, as these are more reliable than standard types at high water temperatures.

Standard rod thermostats are not recommended for use with this system as they can be very inaccurate. An electronic thermostat with a remote sensor positioned

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in the thermostat pocket of the immersion heaters should be used. It is normal for the thermostat to operate a contactor to switch on the immersion heaters. The setting of this thermostat should be 90°C.

It is important that the operation of the immersion heaters is correctly synchronised with the cheap-rate times of the E7 tariff. The best way of achieving this is to have a switched supply from the timeswitch which controls the Electricity Company's meters. Permission from your local Electricity Company is required to do this. Where this is not practical, a separate timeswitch adjacent to the tank should be used. To help prevent the timeswitch getting out of step with the E7 cheap-rate (as would happen in a power failure) a spring or battery reserve timeswitch is recommended.

Rule of Thumb

The immersion heaters should be sized at 1kW per creep to be heated.

The Mixing Valve and Pump

The mixing valve should be set to give a return temperature of about 45°C. A standard domestic central heating circulation pump is quite suitable for this application and should be sized at about 22 litres/hour/creep. This should result in a 5-10°C differential between the flow and return pipes of the system.

Creep Heating

Underfloor

For underfloor heating plastic pipework is most suitable. The pipe should be set at 100 mm centres to obtain adequate heat transfer to the floor. The plastic hot water pipe available for general use is not entirely suitable for this application as it is extremely difficult to bend to the radii required. There is, however, a corrugated pipe available which bends much more easily and has the added advantage that the corrugated walls of the pipe provide a greater surface area for heat transfer to the floor.

Radiators

Pressed steel domestic type radiators can be used for creep heating. A radiator of the dimensions 305 mm x 610 mm (12 in x 24 in) will provide sufficient heat output. To prevent the pigs burning themselves on the radiators, a barrier of some kind should be used, a piece of suitably placed slotted metal flooring material is suggested. Our experience has shown that the underfloor heating technique is more successful than radiators.

Control

Control of temperature in the creeps can be by thermostatic valves with capillary sensors. In the case of the underfloor heating, the capillary sensors should be positioned in a copper tube in the floor and the valve should have an operating range of 20-40°C.

The capillary sensors for the creep areas with the radiators should be clipped to the inside wall of the creep box so that creep air temperature is sensed. A similar operating temperature range is required.

Creep Design

An enclosed creep design is recommended especially in the case of the radiator system and plastic strip curtains should be used over the pop-holes of the creeps to conserve heat.

Typical Sizing Calculations

For a 10 creep room:

Tank volume = 10 x 77 litres = 770 litres (170 gal)

Immersion heater loading = 10 x 1kW = 10kW

Pump capacity = 10 x 22 litre/hour = 220 litres (48 gal) per hour

The Economics of Storage Boiler Heating

The economic appraisal of a storage boiler versus conventional system is largely dependent on the efficiency of the conventional system being used in comparison. Monitoring studies show that there can be large differences in electricity consumptions between different systems and that the type of control and how it is managed is critical. For the purposes of the following calculations, however, an average consumption of 8kWh per pig has been used as the consumption of a typical conventional system. The storage boiler figure has been taken as 20% greater than

this to allow for system losses. The energy consumed by attraction lights has been ignored in these figures. The storage boiler system together with many of the conventional creep heating systems need attraction lighting, but it should be borne in mind that this extra running cost is not incurred by the bright emitter infra-red lamp. The replacement costs of these lamps has also been ignored.

Considering a 10 place farrowing room and assuming 12 batches of sows/annum producing 10 pigs/litter the approximate energy consumption per piglet produced would be 8kWh giving a total consumption of 9,600 kWh/annum for creep heating.

A conventional creep heating system would use approximately 30% of total energy during the cheap night period and 70% during the day period. Assuming the same heat input costs would be:

9,600 x 0.3 x 2.62p* = £75.46 * E7 night-time rate
9,600 x 0.7 x 8.28p^ = £556.42 ^ Daytime rate
TOTAL = £631.88

Assuming a 20% system loss with storage boiler heating and the same net heat requirement, the cost of running a storage system would be:

$$9{,}600 \times \frac{120}{100} \times 2.62\text{p} = £301.82/\text{annum}$$

The annual running cost saving of the storage boiler system would therefore be about £330.06.

Capital Costs and Paybacks

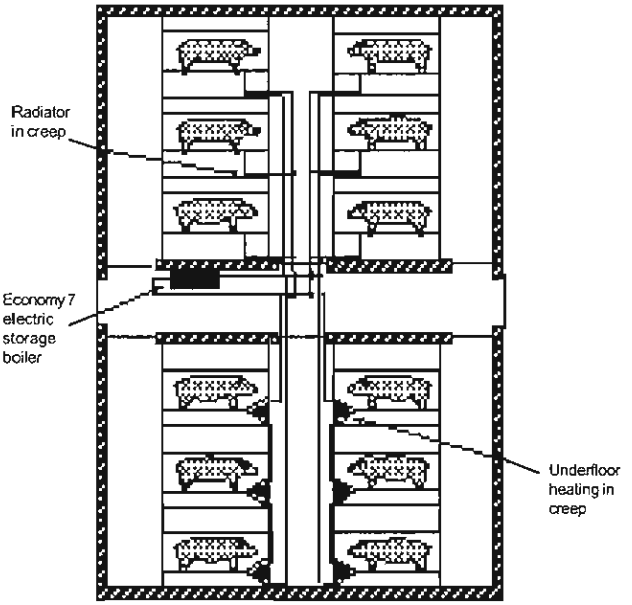
The approximate capital cost of a number of systems including thermostatic controls, wiring and attraction lights where applicable, are as follows:

Infra-red lamps ... ... £ 35/creep
Underfloor heating (mains voltage) ... £ 35/creep
Radiant panel heating ... ... £ 70/creep
Floor pads ... ... £ 80/creep
Storage boiler £102/creep

The payback period based on these capital costs will be between one and three years.

The labour costs involved in the installation of these systems will vary considerably and those associated with the storage boiler are likely to be on the high side.

Schematic layout for the Economy 7 electric boiler and pipework



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