The important principles of the design are as follows:

1. The cover plate overlaps the opening below it.
2. The cover plate lies below the top of the upstands.
3. The air passage width is maintained.
4. The upstands are laid with the flat side to the roof so that drainage is very rapid.

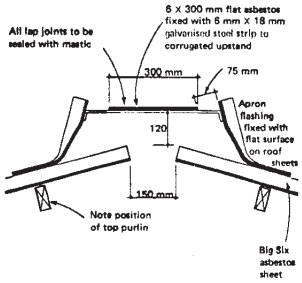


FIGURE 1:
Ridge detail (roof pitch 15°)

It was pointed out that the amount of moisture entering the building in this way was very small compared to the amount produced by the stock and from the dung. But not to be outdone Jim designed a ridge cap to exclude rain, see diagram. A 1:5 model of the ridge was tested in a water table and by injecting a thin stream of ink into the water, the wind pattern around the model ridge could be seen in the ink trail in the water see diagram. It demonstrated

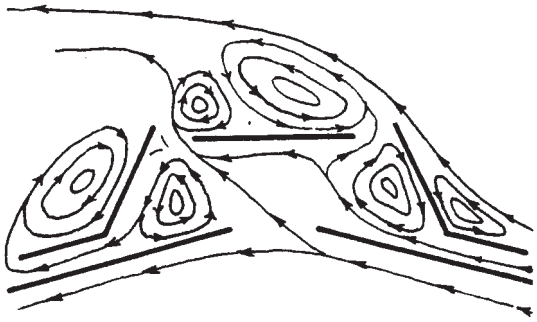


Figure 2 *Flow pattern as shown in water table*

conclusively that this design of ridge would prevent rain carried by the wind entering the building and full-scale ridge caps were used with complete success to replace part of the traditional type ridge on the roof of a cattle shed that was being used to store cereal grain and where moisture must be excluded.

Fan assisted ventilation

A full-scale cross-section or transverse slice of a typical pig or poultry house was built at The National Institute of Agricultural Engineering, now Silsoe Research Institute. It was enclosed in an outer shell so that its external ambient air conditions could be varied, and the air inlets, outlets, and the fans of the section could be changed or altered. Air in the building section was made visible by injecting bubbles of a special detergent through a specially designed nozzle. As the air carrying the bubbles passed through the darkened building section, a beam of light was thrown across it. The light was reflected from the bubbles so illuminating the direction and flow of the "ventilating" air and, because the air was visible, it could be photographed and compared with the patterns derived from different ventilation systems. See photograph.

Using the building section Dr John Randall found that most air-flow patterns were rotary in form but could be unstable. The determining factor was either the speed of the inlet jet of air or the

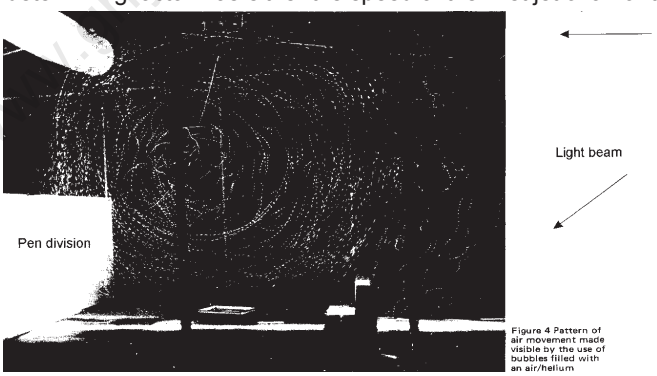


Figure 4 Pattern of air movement made visible by the use of bubbles filled with an air/helium

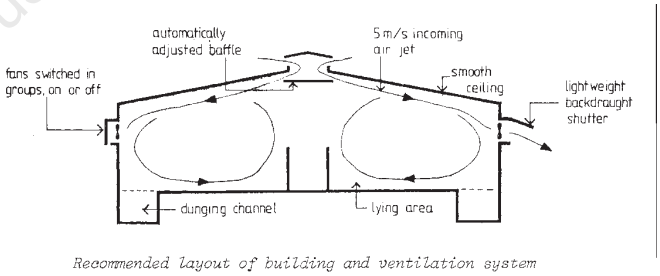
convective heat from the stock that in the experiments were replaced with heaters. For a stable air-flow pattern one or other must dominate and as the convection heat can vary as stock grow in size or the external ambient temperature varies, either high or ultra low, but unvarying, inlet air speeds must be used to keep the direction of the air flow and house temperature constant. If an intermediate air speed is used, 0.5 to1.5 m/s, the patterns reverse themselves as most night temperatures are colder than the day time ones, and the cold air drops downwards at or near the point of entry because the energy in the air is too low. An air flow rate of 5m/swas considered optimal.

From this work it became possible to design a ventilation system with a stable air flow system, using several fans controlled by thermostats that switch a fan or group of fans either full on or off to maintain the pre-set temperature. To maintain an air flow rate of 5m/s the area of the area of the inlets have to be adjusted and this was done by using a system of cables, winches and electric motors linked to the volume of air produced by the fans.

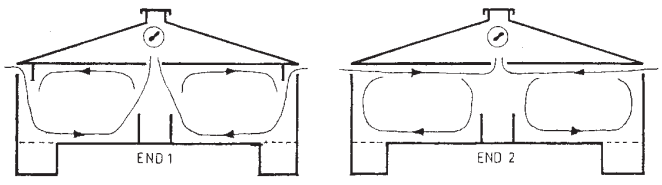
Thus air brought in at the ridge could be deflected along the ceiling towards the external wall, down the wall and across the floor and so be deflected upwards when meeting the air from the other side of the house, so forming a rotary pattern, see diagram of recommended layout or perforated polythene ducts slung beneath the ridge could be used to bring the air in from one end of, and along the length of, the building.

Alternatively air could be extracted at the ridge with the inlets, hinged at the bottom, deflecting the air along the underside of the ceiling or downwards to the floor where on contact with the air entering from the opposite side of the building it formed a rotary pattern, see diagram end 1 and 2 . All the time air is extracted by the fans.

A similar building section was built at the Institute of Animal Physiology near Cambridge where the experimental results were



Recommended layout of building and ventilation system



The two airflow patterns for the first experiment
END 1: air deflected down
END 2: air deflected horizontally

confirmed using live pigs and the building section was used to study the effect of different temperature regimes on pig behaviour. It is interesting to note that this ventilation system has a welfare connotation. Because pigs dung in the coolest part of the pen the stable air flow pattern keeps one part of the pen cooler than the rest of it, unlike ventilation systems with unstable or reversible patterns, and as a result the pigs dung in one part of their pen and are very much cleaner.

The principles of the system were incorporated in an experimental pig fattening house at the ADAS Experimental Husbandry Farm at Terrington in Norfolk where it was found to be satisfactory. However an experimental water scrubber designed to remove dust and smell from the exhaust air proved troublesome as the high air velocity through it carried the contaminated water droplets some considerable distance into the surrounding area, to the distress of

the local inhabitants including, it is said, the vicar when walking to his church and dressed ready to take a Sunday service.
At an Association Conference in 1980 J Skipper described two 117 by 36 ft pig fattening houses that had manually operated ventilation systems with variable speed fans. They had variable air flow patterns, dirty pigs, and stalling fans. Mr Skipper installed the NIAE system and said it had "the ability to maintain incredible constant house temperature and the provision of a really good atmosphere - good for pigs and good for the stockman." (Note pigs were given priority over stockman). He went on to say that the high speed jet system is certainly one of the biggest advances in fattening house ventilation for many years and that BST Builders who made the alterations had built 18 new houses fitted with it.

There are 40 to 50 articles on ventilation in the Journals reviewed. This article has tried to summarise what is considered the most important papers in the Journals and has left out many of interest. However it is dealing with the past and the practice of ventilation has moved on.
Countryside Buildings will bring you up to date. Read the Articles in it by Dr Mike Kelly. But with all this research why does he head one article "Good Ventilation for Livestock Housing - Why does it remain elusive?"

All the quotations were taken from the article by Jim Bruce and a full report of his and John Randall's work can be found in the publications of the Scottish Farm Building Investigation Unit and The Journal of Agricultural Research.

ENVIROBED

By Liz Russell of Envirobed

Next time you take your old newspapers to the recycling bank there is a good chance that they will eventually end up under a cow. Lancashire based company EnviroSystems has pioneered a novel product which utilises waste from paper recycling mills to create a healthy and cost effective alternative bedding for cubicles.

"The idea behind the product was to recreate outdoor lying conditions on a dry day in summer inside a cubicle house in winter," says company director Liz Russell. Marketed as EnviroBed, the product is essentially the dried short fibre waste that is no longer suitable for making paper. The waste leaves the paper mill in a semi-dry form at 55-60% dry matter and is then dried down to 90% dry matter.

"Unlike straw and wood shavings which rot when soiled and wet, the EnviroBed dries out and remains stable which discourages the mould and bacteria which can cause problems with environmental mastitis," claims Mrs Russell. In addition to its ability to wick away moisture form the lying surface, the EnviroBed also reduces smell and ammonia levels by locking up nitrogen from the urine and muck.

Although EnviroBed can be used in conventional concrete cubicles or with mats, Mrs Russell and co- director John Singleton have developed a CowBed system for cubicles which utilises two types of paper waste. The system works best in cubicles designed for sand although a heelstone can be added to existing cubicles to retain the paper waste. The semi- dry waste is packed into the bed to the level of the heelstone and banked up at the front to create an incline, as cows prefer to lie uphill. Once this base is laid, a layer of dried paper waste is put on top and replenished every few days as required. On average it will take 0.25 - 0.5kg/cubicle/day to keep the beds well stocked. The dried product can be spread from a loader bucket or spread automatically through a conventional sawdust dispenser.

"We recommend that the dry paper waste is raked regularly to fill in any small holes or depressions that might form," comments Mrs Russell. "Every six months the beds can then be topped up and repaired if necessary using a load of the semi- dry waste."

Mrs Russell advises that to create the beds each cubicle will need about 200kg of EnviroBed SemiDri available in bulk tipped loads. Depending on the type of cubicle there may be an additional cost in creating a heel stone to retain the paper waste. The EnviroBed HiDri used to dress the beds costs around £48 a tonne before haulage which means maintenance over a 200 day winter will be about £5 a cubicle.

"This compares with sand beds which require around 0.5t to create and a further 1.5-2t a cubicle to maintain," says John Singleton. "With sand at £15 a tonne this works out at £30-£40 a year."

"Mats and mattresses can range in price from £25 to £100 a cubicle and will also require some bedding on top which makes them a more expensive alternative to the EnviroBed system," he adds.

The company also supplies an inoculant product called Bed Bugs which can be used once a month to keep the beds fresh and dry. The bacillus- based inoculant was developed in the US for use in multi-cropping broiler houses to keep the deep litter dry. Used once a month the inoculant works out at just over 2p a cow a day if the recommended 100g/cubicle is applied.

The EnviroBed HiDri can also be used as an absorbent underlay for young calves but it must be covered with a layer of straw as the product is relatively high in copper. The product can be used on its own for youngstock over six months of age.

Around 200 dairy units are now using EnviroBed bedding in their cubicle sheds. Producer processor Bill Pawson from Goosnargh near Preston was one of the first to switch to this relatively new form of bedding. His 220 Holstein Friesian cows at Kidsnape Farm are almost at the end of their second winter on this deep bed system.

"Over the years we have tried various types of cubicle bedding and most recently had been using box muck beds for a large part of the herd because they were more comfortable than mats or concrete," explains Mr Pawson. "Although this type of bedding is great for cow comfort it is high maintenance in terms of bedding and liming to keep the cows clean and bacteria at bay."

The EnviroBed product appealed because it was clean and sterile and could still maintain a high level of cow comfort with less labour input.

Around two thirds of the herd are now on the CowBed system and Mr Pawson is delighted with the results. The beds are cleaned off and topped up with HiDri every day and are levelled about once a month to take out any lumps and fill holes that the cows have made in the base.

Although unable to report a major drop in cell count as the herd consistently runs at 60-90,000cells /ml, Mr Pawson feels it is now much easier to keep cows clean and comfortable on this system. "It is noticeable that the cows on the EnviroBed lie for much longer than the one group of heifers still on mats," he comments

One further improvement has been the ease of handling the slurry. "With straw bedding we had to treat some of the muck as semi solid but now we can push it all into the lagoon without having to worry about clogging up channels and reception pit grids."