HOW DO ODOUR PLUMES EXIT TUNNEL VENTILATED MEAT CHICKEN SHEDS-CONSIDERATIONS OF THERMAL BUOYANCY AND PLUME INTERCEPTION STRUCTURES

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Odour plumes from poultry sheds

Shape, movement, thermal buoyancy & interception structures

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What is interesting about the shape and movement of odour plumes?

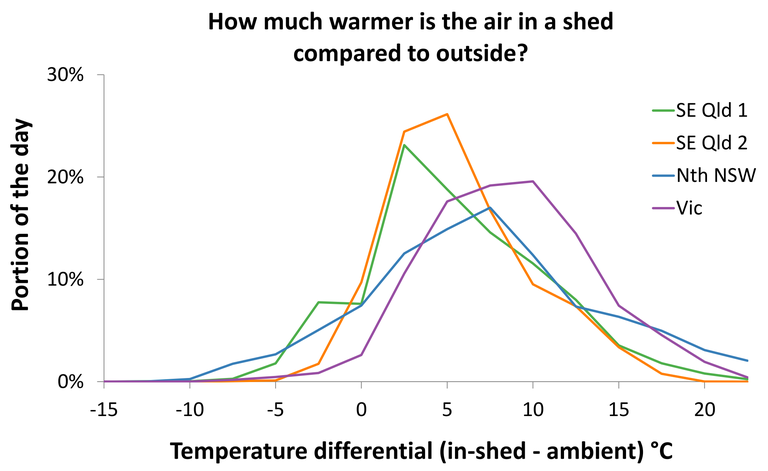
Shape and movement of an odour plume as it is exhausted from a meat chicken shed:

- Influences the initial dispersion of the plume and ultimately where it ends up.
- Needs to be understood for accurate odour modelling and developing farm specific odour/dust mitigation strategies.
- Is affected by:
  - the number and location of operating ventilation fans
  - temperature difference between in-shed and ambient air
  - the presence of interception structures such as short stacks, interception walls (otherwise referred to as windbreak walls) or vegetation screens.

We used smoke to observe plumes as they were exhausted from chicken sheds combined with computational fluid dynamics (CFD) modelling. With these methods, we were able to understand and quantify the effects of thermal buoyancy and interception structures.

Thermal buoyancy

The air exiting a meat chicken shed is often warmer than ambient air. Vertical movement of the plume will occur close to the shed (within 20–40 m). The height that it will ultimately rise to will be influenced by the temperature differential but also the atmospheric stability and other local phenomena such as inversion layers.



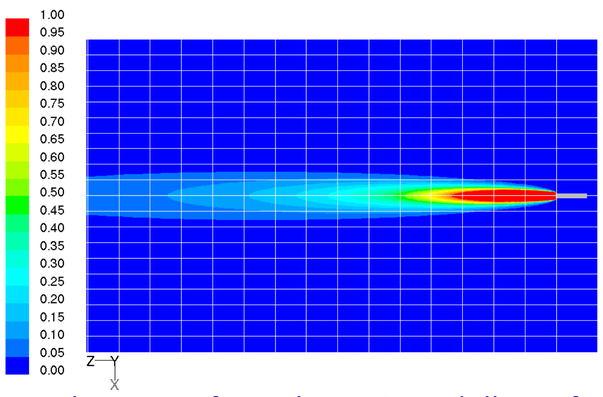
Temperature data collected at broiler sheds–air exiting the shed is nearly always warmer than outside

Using smoke to visualise plume movement. *Left:* Exhaust air 5°C warmer than ambient, 2 fans operating, photo taken at sunrise. *Right:* Exhaust air 1°C warmer than ambient, *7* fans operating , photo taken 2 hours after sunrise.

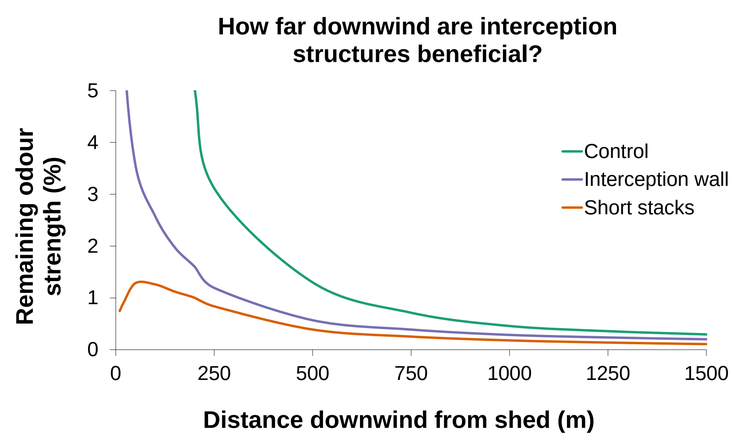
Interception structures

Interception structures (such as interception/windbreak walls) can be constructed close to the exhaust fans with the intention of enhancing dispersion. Normally occurring conditions such as wind, plume buoyancy and fan turbulence tended to make any potentially positive effect of the interception wall insignificant. CFD modelling confirmed this observation and quantified the overall effect downwind from the shed.

Example smoke release from a shed fitted with an interception wall —stable atmospheric conditions



Example output from the CFD modelling of an interception wall (ground level concentrations)



Average ground level concentration (GLC) data from the CFD model. Positive effect of interception structures diminishes as the plume travels further from the source.

Conclusions

- **The effect of the ventilation fans on odour plumes is limited** to within a short distance from the shed (40–50 m).
- **Atmospheric stability has a strong influence on odour plumes** close to the shed. Vertical dispersion is very limited under stable conditions.
- **Thorough understanding of the conditions under which impacts occur in a specific situation is required** before considering interception walls or short stacks. We suggest that this **'understanding' requires more analysis and ground-truthing than is possible by dispersion modelling alone**.
- **Plumes from meat chicken sheds are frequently warmer than ambient air and will therefore rise**.
- **Subtle changes in environmental conditions or shed operations can result in significant changes to odour plume shape, movement and dispersion** within very close distances to meat chicken shed exhaust fans—this may may affect the potential for odour impacts in the near-field but will diminish as the plume travels downwind.

More information

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Research reports:

http://www.agrifutures.com.au/publications/separation-distances-for-broiler-farms-verifying-methods-including-the-effects-of-thermal-buoyancy

https://agrifutures.infoservices.com.au/items/13-001

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