Dynamic Modelling of Meat Plant Energy Systems

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Rodger David Stephen Kallu,
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ABSTRACT

The objective of this study was to develop dynamic mathematical models of the major energy use and recovery operations within the New Zealand meat industry. Ordinary differential equation based models were developed for the five most common rendering systems, for hot water use, generation and storage, and for the refrigeration system. These cover about 90% of process heat use and about two-thirds of electricity demand. Each model was constructed so that ultimately it could be linked to the others to develop an integrated energy supply and demand model. Strong linkages to product flow were developed for the rendering models, but those for hot water and refrigeration are less developed, although there is no technological impediment.

In developing the models for rendering it was assumed that cookers and dryers are perfectly mixed vessels and that time delays in materials transport are negligible. Model predictions could be improved by removing these assumptions, but taking into account the possible extent of data uncertainties, the present accuracy may be adequate for the overall meat plant energy model.

A major consequence of the development of a hot water demand model was that areas of low efficiency were identified. By attention to equipment designs for hand tool sterilisers and cleanup systems substantial heat savings are possible. Although not tested, both the model for heat recovery and the model for hot water storage and supply are expected to be accurate as few major assumptions were required in their development.

The main novel feature of the refrigeration model is that it treats the refrigeration applications in abstract terms rather than performing a room by room analysis. As a consequence data demands are lower than for refrigeration models which use a room-based approach, and the actual data needed are more easily obtainable. In spite of the lower data requirements good accuracy was demonstrated.

The models developed will have major benefits to the NZ meat industry, initially as stand-alone entities, but later as an integrated package to help in reducing energy use.

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