final report

Project code: A.ENV.0141

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Date submitted: August 2013

PUBLISHED BY
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Facilitation of Water Reuse Projects

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government and contributions from the Australian Meat Processor Corporation to support the research and development detailed in this publication.

Abstract

The high consumption of water associated with many activities in abattoir operations is a key environmental issue.

Water is used for the watering and washing of livestock, the washing of trucks, the washing of carcasses and by-products, and for cleaning and sanitising of equipment and processing areas. Strategies for reducing water consumption can involve technological solutions, equipment improvement or procedure changes.

Three projects have been commissioned to demonstrate the effectiveness of these water minimising strategies:

- Steam has been adopted for the continuous sanitation of moving viscera tables in lieu of hot water;
- A water reuse system has been designed for the processing of tripe; and
- A cleaning program based on manual procedures has been developed for chillers.

Whilst the trial programs for the application of steam and the water reuse system are continuing, the project on chiller cleaning has been completed. This project demonstrated savings in the usage of water, energy and cleaning chemicals through the application of targeted manual cleaning procedures to beef carcase chillers. These benefits are also reflected in reduced volumes in total water and residual chemical in waste water discharge.

Executive summary

The objective of this project has been to facilitate the conduct of three trials aimed at demonstrating mechanisms for reducing water consumption in meat processing facilities.

These three trials include:

- The adaptation of steam for the continuous sanitation of moving viscera tables in lieu of hot water;
- The design of a water reuse system for the processing of beef tripe and bibles; and
- The adoption of a cleaning program for carcase chillers built around physical manual procedures.

A protocol was developed for the performance of each of these trials in support of regulatory approval prior to commissioning the trials.

The steam and water reuse trials are within various stages of development at this point and have not been completed at the time of preparing this report.

The manual cleaning project has been finalised and is now fully operational at the trial establishment. This project recognises that water will continue to play an important role in the cleaning of meat plants for the foreseeable future. It also recognises that significant reductions in water consumption associated with cleaning are feasible.

Accordingly, a trial was conducted to assess efficiencies across a range of parameters from the introduction of an alternative manual cleaning program in beef chillers to more broadly based cleaning procedures reliant on generous hot water washing and the liberal application of cleaning chemicals.

The trial demonstrated:

- 74% reduction in total water consumption (mostly at 82°C or hotter);
- 93% reduction in detergent concentrate;
- 60% reduction in labour input;
- Replacement of all 82°C hot water with warm water.

Regulatory standards for hygiene, supported by microbiological verification, were met throughout the trial. An additional benefit relates to the durability of floor and wall surfaces within chillers whereby the erosive effect on these surfaces from the continual application of detergents and hot water will be reduced.

Whilst the water and energy savings from this chiller cleaning trial were modest in the context of overall plant consumption, this project does highlight that an integrated approach incorporating a range of technological improvements and procedural changes is necessary to achieving greater levels of efficiency in consumption outcomes.

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1 Background

Livestock are slaughtered at abattoirs to produce dressed whole carcases and carcase sides. It is common for abattoirs to also undertake the boning of carcasses to produce cuts of meat. Fresh meat products are highly perishable and refrigerated storage is required throughout their life to maintain eating appeal and prevent microbiological spoilage.

The high consumption of water associated with abattoir operations is a key environmental issue. Water is used throughout the meat production process for the washing of carcasses and by-products, and for cleaning and sanitising of equipment and processing areas. High levels of thermal energy in the form of steam and hot water is routinely used for cleaning and sanitising.

A factor that affects water consumption is cleaning practices. Slaughter, evisceration and casings and offal processing tend to account for a large proportion of total water use, where it is used principally for cleaning.

2 Project objectives

This project is jointly sponsored and managed by the Australian Meat Processor Corporation and Meat and Livestock Australia.

This project facilitates trials in water efficiency at abattoirs in three ways:

1. The application of recycled water in tripe and oakum processing (A.ENV.0136);
2. The utilisation of steam for sanitising large and small stock viscera tables instead of hot water (A.ENV.0137);
3. Customised cleaning practices for carcase chillers (A.ENV.0138).

In addition to water efficiency, this project touches upon efficiency in energy consumption; decreases in volumes in wastewater generated and labour savings.

Each of these three trials is a separate research initiative under the National Water Efficiency & Food Safety Program developed by the Australian Meat Processor Corporation.

3 Methodology

3.1 A.ENV.0136 - Tripe Wash Water Reuse

The purpose of this trial is to evaluate the effectiveness of water reuse in the processing of beef tripe (including bibles).

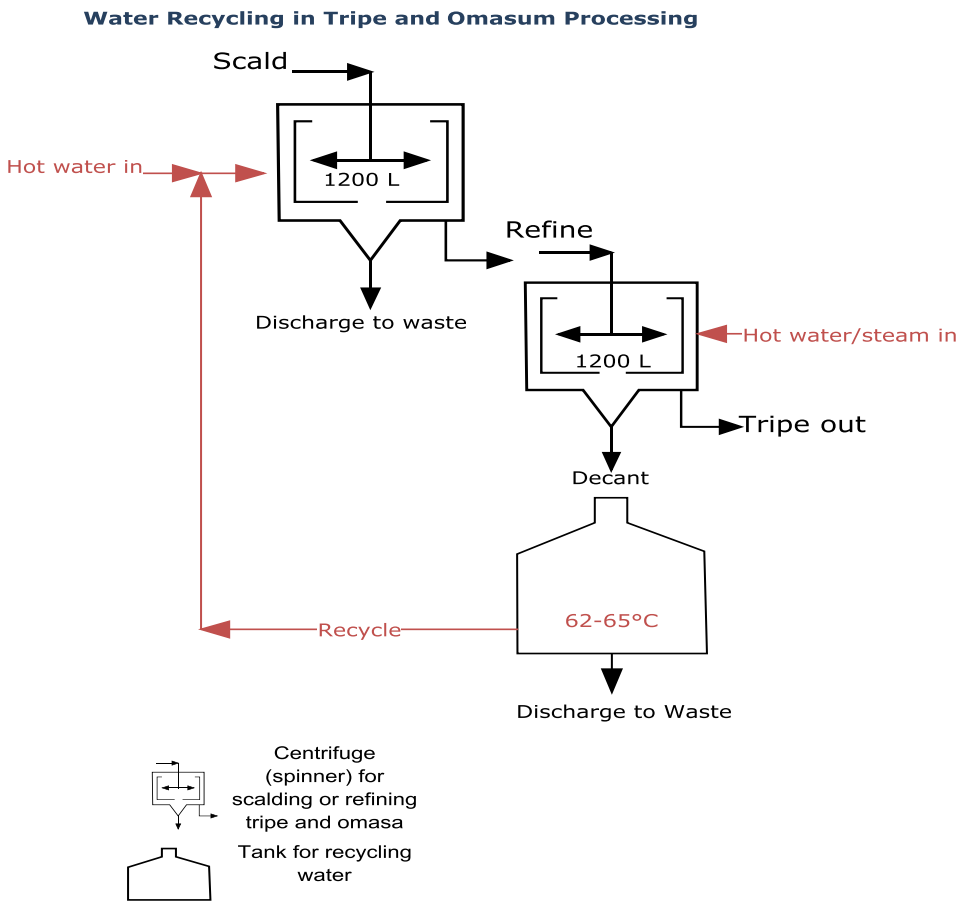
After opening and emptying the contents, tripe processing is generally a two-step process using commercial centrifuges wherein:

1. The tripe is scalded and blanched with hot water to wash the tripe and remove the inner linings; and

2. Then refined by hot water and steam to degrease and polish the tripe.

In this project, a trial is to be undertaken over a two week period at an export abattoir with a custom fit recycling unit returning thermostatically controlled hot water from the refining process to the scalding process in a single recycle operation.

A schematic describing the process is included below.



Microbiological content in the tripe is to be assessed prior to and during the trial for comparative purposes. Microbiological testing of the reuse water will also be conducted during the trial.

3.2 A.ENV.0137 - Steam Sterilisation of Viscera Trays

The purpose of this trial is to evaluate the use of steam as a replacement for hot water (≥ 82°C) for the continuous sanitation of large and small stock viscera tables during routine slaughter operations.

When cattle and sheep are eviscerated following slaughter, the internal organs and intestines are dropped onto stainless steel pans or conveyors. The pans must be cleaned and sanitised between each set of viscera to minimise cross contamination from one set to another.

In general, this procedure is:

- Pans (or slats) are flushed with cold water sprays at the far end of the table to remove tissues, blood and other fluids;

- Pans (or slats) are sanitised with ≥ 82°C hot water at the near end of the table to reduce the microbial load on the surface of the pans (or slats) and then rinsed with cold water to cool the pans (or slats) prior to accepting the internal organs and intestines.

Steam may directly or indirectly come into contact with meat.

Historically, the most common way this may have occurred within the Australian meat industry is where steam injection is used for heating potable water. Over the past decade, direct product contact with steam has been widely used in carcase decontamination procedures, such as steam vacuuming and steam pasteurisation, in response to microbiological concerns relating to pathogenic Escherichia coli (E. coli).

Steam has been used as a cleaning agent in the meat industry for over fifty years. Cleaning equipment with pressurised steam enables impact temperatures of 100°C to be achieved. The disadvantage of steam is the intense fog and aerosol formation that may affect installations and equipment through high humidity and condensation.

Microbiological and visual cleanliness of beef and mutton moving viscera tables were evaluated using hot water and steam sanitation. In addition, the amount of water and energy used for each method was calculated. Other factors impacting upon the processing environment, such as fog, were also evaluated.

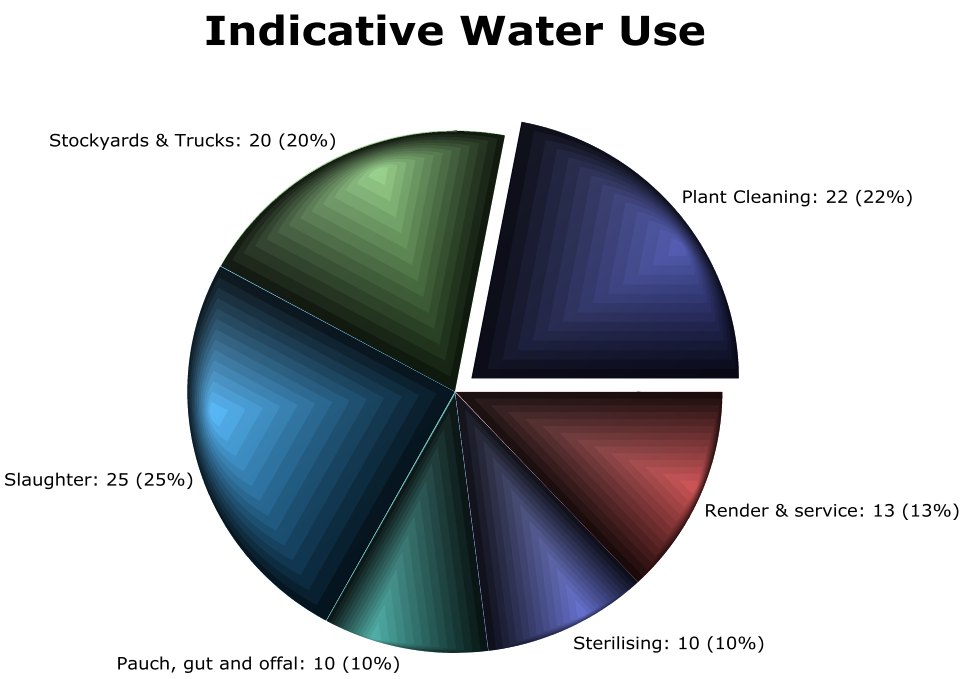
Each sanitising method is to be evaluated microbiologically over five (5) separate days for each of the two tables using 20cm press plates. Two (2) samples from different pans or slates are to be collected three times a day (morning, post smoko and post lunch). In total thirty (30) samples from each table for each method are to be collected for assessment by total viable count, total coliform and E. coli.

Each sanitising method was evaluated visually over five (5) separate days for each of the two tables. On the beef table, ten (10) slates were examined three times daily and the number and type of soil recorded. On the mutton table, ten (10) small pans and ten (10) large pans were examined three times daily and the number and type of soil recorded. The types of soil were categorised as stains, blood, tissue and fat.

3.3 A.ENV.0138 - Dry Cleaning of Chillers

This aim of this trial was to evaluate the effectiveness of a manual cleaning program for beef carcase chillers utilising less water than in the more intensive chiller cleaning procedures typical of conventional chill – bone operations within the Australian meat industry.

Cleaning is one of the most water-intensive activities at abattoirs, estimated to account for 20-25% of total water consumption. An illustrative breakdown of water usage is presented in the following graphic:



A way to reduce water consumption in cleaning any part of an abattoir is to undertake an effective dry clean before washing with water. Solid materials are scraped and removed from all surfaces, including floors.

A trial was conducted at an export registered beef only abattoir for seven week period using a custom cleaning program based upon manual cleaning methods.

The carcase chillers for the trial consisted of five (5) separate cold water spray chillers each of similar design and holding capacity. The trial chillers were of modern design and materials. The chillers were well designed and free from any points of incidental contact between carcases and surfaces within the chillers

Each of the five chillers has a side plenum for evaporators thereby ensuring any risks from condensation sources, such as evaporator drains, pipework and housing, are outside the product chamber. The chillers were maintained in scrupulous condition.

Water flow meters were installed to the supply line of the chillers prior to commencing the trial in order to provide data on prior consumption as well as consumption throughout the trial.

An electric powered mechanical floor scrubber, similar to that depicted in Image 1 was commissioned for the duration of the trial to assist in the manual cleaning of the floors both within the trial chillers and along conveyor passageways. Mechanical floor scrubbers of this type are successfully used in various settings, such as loading docks, at export establishments.

Image 1: Floor scrubber

3.3.1 Trial Design

A set of three key principles were developed to underpin the conduct of the trial. These principles were described within an operational protocol prepared for the trial and are described below:

1. Each trial chiller was cleaned daily following the discharge of sides and prior to commencing reloading. The cleaning procedure involve a combination of dry and manual cleaning processes aimed to minimise both washing and rinsing with cold and hot water, as well as the application of cleaning chemicals. At the same time, the cleaning procedure needed to ensure the effective cleaning of floor, walls and doors of the chiller. The existing procedure of manually cleaning point changers and carcase temperature probes remained unchanged during the trial. The evaporators remained operational throughout the cleaning process. The trial chillers were available for reloading upon completion of the cleaning.

2. Each trial chiller was subject to a hygiene inspection following cleaning in accordance with the trial abattoir's existing approved standard operating procedure. Any corrective action that was required as a result of findings from the hygiene inspection was instigated also in accordance with the trial abattoir's existing approved standard operating procedure.

3. The cleaning of overhead structures, including evaporators and drains, was maintained in accordance with the standard operating procedure. The trial chillers continued to be fogged with non-rinse sanitiser after each cleaning.

The operational protocol prepared to describe the trial cleaning procedures acted as a temporary amendment to the existing work instruction for chiller cleaning. The protocol represented a relatively simple step in adjusting the approved arrangement at the trial abattoir to accommodate this alternative approach to chiller cleaning.

The trial chillers were subject to the full set of procedures presently described within the work instruction when the chillers were cyclically decommissioned and evaporators turned off. Typically this occurred on one day during a seven (7) day operating cycle.

Procedures for the loading and unloading of the chillers were unaltered during the trial.

3.3.2 Trial Assessment

The cleanliness of each chiller was monitored by sensory assessment on each day of operation throughout the trial period.

Microbiological verification (total aerobic count) was undertaken after cleaning throughout the trial period. This was accomplished by the application of standard 20cm press plates on surfaces of structures and fittings and equipment within the trial chillers accordance with the methodology contained within the abattoir's approved arrangement.

4 Results and discussion

4.1 A.ENV.0138 – Dry Cleaning of Chillers

The data from the trial indicates substantial improvements in water efficiency and energy can be anticipated from manual cleaning operations across the chillers at the trial abattoir. Results indicate a 74% reduction in daily water use in the cleaning of each chiller during the trail.

Energy savings accrued by replacing all water applied to chiller surfaces at 80°C with water at 30°C.

The trial indicates that labour savings of 60% were achieved in the cleaning of chillers through this manual process by comparing labour inputs for the cleaning of chiller chambers prior to commencing the trial with those chambers during the trial.

A 93% reduction in the volume of detergent concentrate for the cleaning of a chiller was realised during the trial.

Under the present chiller cleaning program, foaming detergent is applied to each chiller during a single cleaning cycle. During the trial, 93% less detergent was applied in the manual cleaning of each chiller in a single cleaning cycle when compared with the intensive cleaning regime.

The testing results were assessed against the benchmark value of 5 colony forming units (CFU) / cm² that is used both by the Department of Agriculture, Fisheries and Forestry (DAFF) for reporting within the Product Hygiene Index (PHI). This same value is applied by the trial abattoir within the Approved Arrangement for assessing the effectiveness of cleaning as the trigger point for corrective action.

All results from the data set from doors and walls comply with this benchmark value with the single highest result being 1.65CFU/cm². 37% of all results from the data set have returned a zero reading. A test of the floor following mechanical scrubbing returned a microbiological count of 4 CFU/cm².

The daily monitoring records for chillers during the trial identified that all chillers were clean when assessed by sensory means (sight, feel, smell). No corrective action was recorded arising from any unclean surfaces or fixtures within the trial chillers.

5 Conclusions and recommendations

5.1 A.ENV.0138 – Dry Cleaning of Chillers

This trial has demonstrated that significant savings in water, energy, cleaning chemicals and labour accrue from the implementation of a more focussed cleaning regime in carcase chillers. At the same time, regulatory standards for hygiene and cleanliness can be maintained both by sensory evaluation and microbiological verification.

The quantum of savings however needs to be viewed within the context of the overall consumption of water and energy at abattoirs. The cleaning of chillers accounts for around 10% of total water consumed in the overall cleaning process. Accordingly, the water savings achieved from this trial represents less than 1.5% of total daily water use. The energy savings from the replacement of hot water with warm water represents less than 0.5% of total energy consumption.

Whilst this trial was conducted within active beef chillers, the same principles apply in holding chillers and chillers for abattoirs processing other species.

Only minor adjustments to the approved arrangement at export abattoirs are required to accommodate this alternate approach to chiller cleaning.

In broader terms, this trial has demonstrated the effectiveness of dry cleaning as a water saving measure that can be similarly employed across many cleaning applications. The trial also highlights that a range of measures, including technological advancement and procedural adjustments, are necessary in delivering significant reductions in consumption patterns across the operations at abattoirs.

6 Reference list

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