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Water Saving In the Routine Cleaning of Carcase Chillers

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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 include technological solutions, equipment improvement or procedure changes.

This project demonstrated efficiencies in the usage of water, energy and cleaning chemicals through the application of customised dry manual cleaning procedures to beef carcase chillers as an alternative to cleaning regimes using the intensive application of cleaning chemicals and high volumes of hot water. These benefits are also reflected in reduced volumes in total water and residual cleaning chemical in waste discharge.

Executive summary

A trial was conducted to assess efficiencies across a range of input parameters from the introduction of an alternative dry manual cleaning program in beef chillers to the intensive cleaning procedures commonly used.

A way to reduce water consumption in the cleaning of 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. This concept was applied to the cleaning of beef chillers. The cleaning process was aided by the use of an electric powered mechanical floor scrubber.

The outcomes from the trial demonstrated efficiencies within chiller cleaning regimes, reflected through:

- 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 30°C water.
- Commensurate reductions of water and cleaning chemical in waste discharge.

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 this trial was conducted within beef chillers, the same principles apply to chillers for other abattoir species.

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Background

1.1 Introduction

The key environmental concerns associated with meat processing are the high consumption of water, the discharge of high-strength effluents and the consumption of energy.

Hygiene standards in abattoirs necessitate the use of large quantities of water. Water is used for the washing of livestock, the washing carcases and carcase products, and for the cleaning of yards, equipment and process areas. The rate of water usage varies substantially between abattoirs depending on factors such as the scale of operations, the age and type of operations and cleaning practices. Calculations for total water consumption indicate rates of useage in the range of 8 – 13 kL water/t HSCW.

The cost of water is increasing significantly as the true environmental value of its supply is determined. Accordingly, water is becoming an increasingly important issue in meat processing and its efficient use increasingly more important.

1.2 Cleaning

Cleaning is one of the most water-intensive activities at abattoirs, estimated to account for 20-25% of total water consumption.

Wastewater from cleaning procedures contains a high organic load from blood, fat and manures, as well as detergents and sanitisers. Detergents used in meat processing are usually strongly alkaline in their composition in order to remove proteins and fats from processing areas and equipment.

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.

In an overseas study, changes in cleaning practices at a pig abattoir are reported to have resulted in a 31% reduction in water consumption and a 67% reduction in the use of detergents impairing hygiene standards. This study also reported that undertaking dry cleaning to remove solid materials from floors and equipment prior to washing resulted in a 30% decrease in overall man-hours used in cleaning operations.

Water used in the cleaning of carcase chillers accounts for approximately 10% of total water consumption in cleaning, and accordingly amounts to around 2% of total water usage at abattoirs. Whilst water savings from alternative cleaning procedures of carcase chillers can only promise modest reductions in total water usage, such procedures can play an important role in the context of an overall strategy for water efficiency.

1.3 Carcase Chillers

Chillers are typically cleaned, sanitized and dried before carcasses are loaded. A usual cleaning procedure is described below:

1. Dry clean floor;
2. Cold water wash floor, walls and doors;

3. Detergent wash floor, walls and doors;
4. Scrub stains on floor, walls and doors;
5. Hot water wash floor, wall and doors;
6. Sanitise the room.

Doors, door handles, rail switches, brooms and squeegees are also cleaned daily. Evaporators and defrost drain trays are normally cleaned weekly. Rails are cleaned and re-oiled as necessary to prevent contamination of carcases.

1.4 Soils in Carcase Chillers

The type of soils in chillers is mainly on the floor of the chiller. The soli mostly relates to blood that has drained from carcases after entry into the chamber. It may also include any other extraneous matter that may have entered the chiller from boots or other sources during loading.

Other types of soil on floors, such as fat and other carcase tissues, usually arise from the handling of sides, such as scribing, following active chilling as a step in preparing the sides for boning.

1.5 Approved Arrangement for Carcase Chillers

The approved arrangement for the establishment conducting this trial provides for the cleaning of carcase chillers once they are emptied in compliance with the procedures described above in 1.3. The work instruction for the cleaning of carcase chillers sets down cleaning steps for cold water hosing to remove excess build up from floors and walls, the application of a detergent sanitiser, hot water rinsing and the application of a non-rinse sanitiser fog.

Some fixtures within the trial chillers, such as the point changers and carcase temperature probes, were already subject to manual cleaning and, accordingly, the existing arrangements for the cleaning of these fixtures remained unaltered by the trial.

2 Project objectives

2.1 Water Efficiency

This project aims to evaluate the effectiveness of a customised dry manual cleaning procedure for beef carcase chillers. It is envisaged this process will utilising less water than in the more usual chiller cleaning procedures described above in 1.3 that are typical of conventional chill – bone operations within the Australian meat industry.

This method of dry manual cleaning of carcase chillers has been applied over many years in meat processing establishments where chillers are in constant use and may only be fully emptied once weekly for cleaning purposes.

2.2 Additional Benefits

In addition to water efficiency, this project identifies opportunities for efficiency in energy consumption. Thermal energy in the form of steam and hot water is widely used for cleaning and sanitising purposes. Approximately 80% of total energy consumed by abattoirs is provided by thermal energy.

Furthermore, this project examined savings from the use of cleaning chemicals through the application of customised cleaning practices and the impact on labour input from these customised practices.

3 Methodology

3.1 Trial

A trial was conducted at an export registered beef only establishment for a seven week period from 14 May to 29 June 2012 using a custom cleaning program based upon dry 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 are of modern design and materials. The chillers are free from points of incidental contact between carcases and the 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, pipe-work and housing, are outside the product chamber. The chillers have been maintained in scrupulous condition.

Water flow meters were installed to the supply line for 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 meat establishments. Other types of equipment such as industrial vacuum cleaners have been used successfully for dry cleaning operations at abattoirs.

Image 1: Floor scrubber

3.2 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 is cleaned daily following the discharge of sides and prior to commencing reloading.

    The cleaning procedure employs a combination of dry and manual cleaning processes. These processes aim to minimise both washing and rinsing with cold and hot water, as well as the application of cleaning chemicals.

    The cleaning procedure must ensure the effective cleaning of floor, walls and doors of each chiller. The existing procedure of manually cleaning point changers and carcase temperature probes remains unchanged throughout the trial.

    The evaporators remain operational throughout the cleaning process. The trial chillers are available for reloading immediately upon completion of the cleaning.

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

3. The cleaning of overhead structures, including evaporators and drains, is maintained in accordance with the approved standard operating procedure.

The trial chillers continue to be fogged with a non-rinse sanitiser after each cleaning.

3.2 Approved Arrangement for Trial

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 establishment to accommodate this alternative approach to chiller cleaning.

The trial chillers were subject to the full set of cleaning 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 carcases into and from the chillers were unaltered during the trial.

3.4 Trial Assessment

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

Microbiological verification (aerobic plate 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 establishment's approved arrangement for the microbiological testing of contact surfaces. An additional data set of 45 samples was collected in the front end period of the trial 16 – 31 May 2012.

All microbiological testing for this project was undertaken on-site within the establishment's laboratory. Petrifilm was incubated at 35°C for 48hrs in accordance with AOAC 990.12 - "Aerobic Plate Count in Foods, Dry Rehydratable Film (Petrifilm Aerobic Plate Count) Method".

This method is approved by DAFF for the testing of meat and meat products. However, there are no specific analytical methods approved for the microbiological testing of contact surfaces.

The microbiological verification results were assessed against the benchmark value of 5cfu/cm² that is used by the Department of Agriculture, Fisheries and Forestry (DAFF) for reporting the results from contact surface testing within the monthly Product Hygiene Index (PHI). This same value is applied by the trial establishment within the Approved Arrangement for assessing the effectiveness of cleaning as the trigger point for corrective action.

Surfaces in chillers are not product contacting points (except for carcase temperature probes) and are strictly not required to be assessed under a microbiological verification program. The trial establishment, however, collects random samples weekly for the testing of a range of surfaces from across all carcase chillers.

3.5 Background Microbial Levels

Prior to the commencement of the trial, 20cm press plate samples were collected from various surfaces from a chiller prior to cleaning and then compared with the results from the same surfaces of a similar chiller following cleaning with the existing procedures at the establishment. The "unclean" chiller had been emptied some hours earlier prior to the sampling and the evaporators turned off.

These results are presented below in table1.

Table 1: Background counts (APC) of Chiller Surfaces Before and After Cleaning

Sampling Site	Door	Wall	Point Changer
Before Clean Count (cfu)	0	23	1
Post Clean Count (cfu)	130	0	36

When expressed as cfu/cm², the only result exceeding the 5cfu/cm² benchmark is the door sample from the cleaned chiller. These results are not intended to be definitive, only indicative. They do, however, illustrate that background microbial levels on various surfaces in carcase chillers can be low.

4 Results and discussion

The results from the trial indicate reductions in water, chemical usage, energy and labour were achieved using the customised dry manual procedures for the cleaning of beef chillers, whilst maintaining strict hygiene standards. Each of these input parameters is expanded upon below.

4.1 Water, Energy and Labour Efficiency

The data from the trial indicates that improvements in water efficiency and energy can be anticipated from the dry manual cleaning operations across carcase chillers at the trial establishment.

The results from the trial indicate a 74% reduction in water consumption from the cleaning of carcase chillers using the dry manual cleaning compared with usual cleaning procedures. trail. Whilst this number is significant in reducing water consumption in the cleaning of chillers, it represents around 1% of total water useage for the establishment.

Energy savings accrued from replacing hot water applied to chiller walls and floors at 82°C with water at 30°C. In terms of overall energy, this represents less than 0.25% of thermal energy requirements for the establishment.

The trial indicates that labour savings of around 60% in man-hours were achieved in the cleaning of chillers through this customised dry manual process.

4.2 Chemical Savings

A 93% reduction in the volume of detergent concentrate used for the cleaning of carcase chillers was realised during the trial. This is a significant reduction in the amount of detergent that would otherwise be entering the discharge waste and in the direct cost of the detergent from the chemical supplier.

Under the usual chiller cleaning program, foaming detergent is applied to the walls and floor of each chiller during a single cleaning cycle. During the trial, 93% less detergent was applied in same single cleaning cycle under dry manual method of cleaning each chiller when compared with the more usual regime.

4.3 Microbiological Verification

The results from the additional data set of microbiological testing (aerobic plate count) from common sites used in chillers within the establishment's approved arrangement to assess the effectiveness of cleaning procedures are presented in table 2 below. All results expressed as cfu/cm².

The full data set is included at Appendix 1.

Table 2: Results from Additional Microbiological Data from Trial

Sampling Site	Door	Wall	Wall jamb
Av count (cfu/cm²)	0.2	0.45	0.25
Highest count (cfu/cm²)	0.8	1.65	1.25

The results reflect a high level of regulatory compliance. All results from the data set from the doors and walls comply with the DAFF benchmark value of 5cfu/cm².

The single highest result was 1.65cfu/cm² from a wall count. 37% of all results from the data set have returned a zero reading.

A test of the chiller floor following mechanical scrubbing returned a microbiological count of 4 cfu/cm².

Within the regular microbiological testing program conducted throughout the trial period, the average microbiological count across the common sampling sites was 0.24 cfu/cm². The highest count recorded was 4 cfu/cm² on a door jamb.

These average counts are reflected in the results from weekly microbiological verification since commencement of CY 2012.

4.4 Sensory Inspection

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 unclean surfaces or fixtures within the trial chillers.

5 Conclusions and recommendations

This trial has demonstrated that efficiencies can be achieved in water and energy consumption, cleaning chemicals and labour from the adoption of customised dry cleaning procedures for carcase chillers. At the same time, regulatory standards for hygiene can be maintained as assessed through sensory evaluation and microbiological verification.

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

The adjustments required to the approved arrangement at the trial establishment to accommodate this alternate approach to chiller cleaning were relatively minor and were achieved with assistance from DAFF officers.

An additional benefit from this trial was that reductions in chemical usage and hot water in the daily cleaning regime should reduce the erosive effect and the overall wear and tear on wall surfaces and floors from the continuous application of cleaning chemicals and hot water.

6 Reference list

AQIS Meat Notice 2008/01 Protocol for Alternative Procedures and New Technology Approvals

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7 Appendices

7.1 Appendix 1:

Additional microbiological testing undertaken during trial

MANUAL CHILLER CLEANING TRIAL							
CARCASE CHILLERS SURFACE TESTING RESULTS							
TVC RESULTS PER 20 square cm SAMPLED AFTER UNLOADING AND FLOOR SCRUBBED							
LOCATION	DATE	POINT CHANGER	DOOR JAMB	WALL	TEMP PROBE	WALL JAMB	FLOOR
CHILLER C	16/5/2012	49	0	0	0	4	80
CHILLER E	18/5/2012	150	5	16	62	2	
CHILLER A	22/5/2012	150	12	33	37	25	
CHILLER B	23/5/2012	0	0	0	0	1	
CHILLER D	24/5/2012	4	0	0	300	0	
CHILLER E	28/5/2012	6	2	10	1	2	
CHILLER C	29/5/2012	50	0	15	0	2	
CHILLER B	30/5/2012	1	16	5	22	8	
CHILLER A	31/5/2012	14	2	0	0	0	
	AVERAGE	**47**	**4**	**9**	**47**	**5**	

Note: The point changers and temperature probes were cleaned with the same procedure undertaken prior to this trial.