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A financial evaluation of high pressure processing of small goods

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A FINANCIAL EVALUATION OF HIGH PRESSURE PROCESSING OF SMALL GOODS

EXECUTIVE SUMMARY

This assessment is based on the USA manufactured, Avure Technologies QFP 35L-600, 35 Litre and QFP 215L-600, 215 Litre High Pressure Processing (HPP) units.

HPP of food is not a new technology, having been used since the 1890's to preserve milk and other products. HPP technology was commercially introduced in Japan in the mid 1990's for a few high acid and low water activity foods such as fruit juices and jams. It is now used to process a wide variety of foods, including meat, vegetables, fruit juices, pasta sauces, fresh fruit, fully cooked and packaged entrees, meats and shell fish. HPP is suitable for foods that have a high water content. This includes ready to eat meats.

Food items, usually in their final consumer packaging, are placed in a cylindrical pressure vessel. Water is added and the vessel is closed. The vessel contents are pressurized at levels up to 600 Mpa (87,000 psi). Once the maximum required pressure has been achieved, it is sustained for a specific time period.

HPP is not a complex process, however the components that comprise the HPP package are very specialised to cope with the extreme pressures involved. As a result of the specialised nature of the equipment, much of it developed specifically for HPP, HPP is not a low cost technology from the point of view of either capital or running costs.
On the basis of an average 12 minute cycle time, running a two shift operation 50 weeks per year or 20,000 cycles per year, the cost per cycle, including maintenance and labour is $25.01 or $0.05 per packaged unit.

For the small processor or start up operation, contract processing is available from AHPP, an Adelaide based company set up specifically to provide HPP services. AHPP have quoted a rate of $100.00 per cycle including handling, or a cost of $0.20 per package based on a 100mm x 130mm x 25mm, 300g package. AHPP have plans to set up similar processing facilities in other capital cities in the future, making the technology easily available to all producers.

The benefits of HPP are indirect. The process does not improve production rates or quality, however it will extend shelf life, with benefits in restocking frequencies production run sizes, stock levels and pallet utilisation improvements in the warehouses of major retail chains. Extended shelf life has particular benefits in servicing overseas markets and may allow sea freight to be used rather than airfreight with substantial cost savings. HPP may also give a product a premium edge in the market place, using the Avure Technologies patented "Fresher under Pressure" logo. HPP will eliminate any risk of microbiologically contaminated product entering the consumer stream, guaranteeing microbiological integrity. HPP may also enable the possible reduction in QA staff. The HPP treatment becomes the verifiable traceable HACCP step in the small goods manufacturing process, a step which may be lacking in the producer's current process.

Food Safety Australia figures indicate there have been 21 microbiological contamination based recalls since 1990. Industry sources have put the cost of a recall and subsequent loss of business of one large product line in the order of $5,000,000.00.

In summary, because of the high capital and running costs, it is difficult to justify the ownership of HPP equipment in all but the largest of manufacturers. Contract processing does however bring the process within the reach of all manufacturers, at a cost of twenty cents per pack or less. With the attendant benefits of guaranteed product integrity the process is highly recommended.

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INTRODUCTION

High pressure food processing (HPP) is not a new technology, having been used since the 1890's to preserve milk and other products. High pressure processing technology was commercially introduced in Japan in the mid 1990's for a few high acid and low water activity foods such as fruit juices and jams. It is now used to process a wide variety of foods, including meat, vegetables, fruit juices, pasta sauces, fresh fruit, fully cooked and packaged entrees and shell fish. HPP is ideally suited to foods that have a high water content, such as ready to eat meats and poultry, fish and shellfish, fruits vegetables salads and beverages.

Food items, usually in their final consumer packaging, are placed in a cylindrical pressure vessel. Water is added and the vessel is closed. The vessel contents are pressurized at levels up to 600 Mpa (87,000 psi). Once the maximum required pressure is achieved, it is sustained for a specific time period then released and the contents removed.

HPP is a suitable treatment for vacuum packaged small goods products and is already used for this purpose in the USA, where the USDA considers HPP an approved technology.

The purpose of this study is to evaluate the financial aspects of HPP technology. The financial evaluation uses quoted costs from Avure Technologies for their 35 and 215 Litre HPP units, including the cost of spare parts and maintenance. Transport, import duty, additional installation and site preparation costs and labour and services costs are included in the evaluation.

THE HIGH PRESSURE PROCESS

Food items, usually in their final consumer packaging, are placed in a vertical cylindrical pressure vessel. Water is added and the vessel is closed. The vessel contents are pressurised at levels up to 600 Mpa (87,000 psi). Once the maximum required pressure is achieved, it is sustained for a specific time period. Process times and pressures are easily set on a controller in the control panel, with the processing cycle commenced by pressing a single start button. Product to be treated is loaded into a basket, approximately 190mm diameter and 1220mm long for the 35 Litre unit and 390mm diameter and 1800mm long for the 215 Litre unit. The basket is constructed of food grade plastic or stainless steel, to suit the particular application. In the case of packaged small goods the plastic basket would be the chosen material. At least two baskets would be required for process continuity with one basket being filled while the other is in process and another spare in case of damage. The basket should be manoeuvred into the HPP pressure vessel by use of an overhead motorised crane. Once in the vessel and with the initial water levels established for the particular product, the automatic pressurising cycle is commenced.

The frame containing the upper and lower closures moves automatically over the vessel, sealing the top of the vessel and clamping it from underneath. Two additional pressure plugs are then transferred onto the top and bottom of the vessel and hydraulically locked into position. The vessel is then automatically topped up with water, or emptied as required to a set level and the pressure increased to the preset level of 600 Mpa and held for the preset time of 180 seconds for small goods. Should the pressure drop by more than 1% during the process, the control system automatically boosts the pressure back to the set point. The system will boost the pressure only twice then will fault, assuming a leak or other equipment problem has developed. At the end of the preset time, the vessel is decompressed, the top and bottom pressure plugs are released then the sealing lid and base are released and slid back, opening the pressure vessel for access to remove the product basket. The cycle time varies with pressure and holding time, however for small goods is anticipated to be 10.5 minutes for the 35 Litre unit and 12 minutes for the 215 Litre unit.

The HPP units are fully protected with various feed back devices to ensure the total safety of product and operators.

Data logging is available to record pressures holding times and cycle duration for HACCP requirements.

The basket contents could be stacked to increase the product density, increasing the units in the basket and therefore lowering the unit processing cost. Costs in this assessment have been based on the lower density obtained from randomly filling by simply tipping product into the basket. The trade off in filling regimes is possible increased labour costs to stack verses lower labour costs for random filling.

Some water is removed with the product when the basket is removed from the HPP unit. The water remaining on the product must be removed prior to further packaging in a shipping carton. For the purposes of this comparison it has been assumed that the packaged product will be spread on racks in a high air velocity 4 C chiller, to evaporate the water. It has also been assumed that the second, basket fill/empty operator would perform this function as well as placing the dried packages into containers for further processing. The drying chiller has been allowed in the capital cost of the system, with size based on a drying time of 24 hours and a two shift operation.

Water for use in the process is heated within the supplied water-processing module to a constant temperature of 30C. The jacketed pressure vessel is also held at the same temperature.

THE EQUIPMENT

The HPP units comprise an upright pressure vessel, wire wound with a safety liner. One hydraulically operated intensifier pump is installed on the 35 Litre unit and four intensifier pumps on the 215 Litre unit, operating to pressures of 600 Mpa or 87,000 psi. Systems also include, automatic pressure control, cycle parameter recording, vessel temperature control module and on the 215 litre unit two level installation for safety and product loading accessibility.

The ASME approved pressure vessel consists of a forged, wire wound pre stressed cylinder with end closures that slide axially. This design ensures that the inner surface is always subject to compressive stress. The pre stressing achieved by the wire winding gives a conservative service life of 200,000 cycles. All connections for media, as well as sensors for pressure and temperature control, are located in the end closures. The pressure vessel has a safety liner that provides a leak before failure mode for the vessel, therefore damage to the cylinder's inner surface will not be a safety hazard. Any failure of a component would see the force directed down due to the systems design.

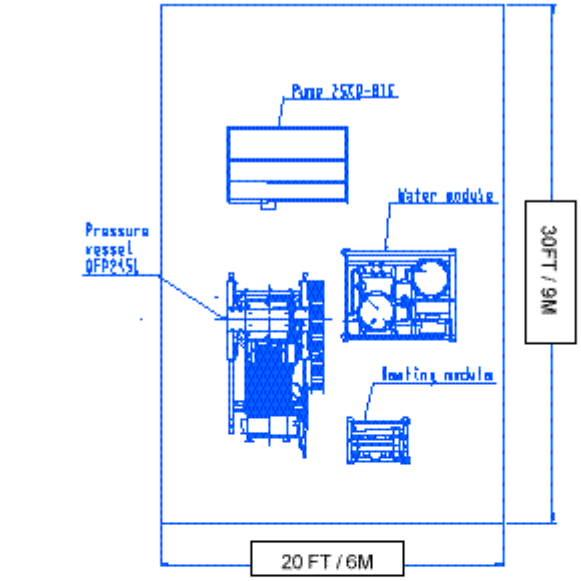
The wire wound pre stressed frame that is designed to take the axial force of the end closures. The frame consists of two semi cylindrical yokes separated by two columns made from high strength steel. The whole assembly is held together by pre stressed high strength steel wire. A dedicated hydraulic actuator moves the frame to the open or closed position.

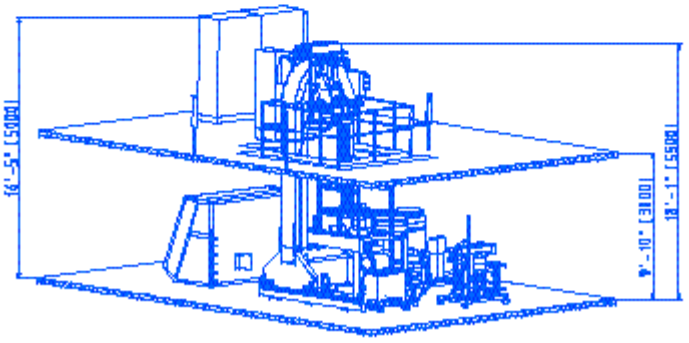
The upper manipulator has hydraulic actuators installed. These actuators move the upper closure to an open or closed position. The manipulator is attached to the frame, thus it moves with the frame during the opening and closing operations.

A large closed loop hydraulic system powers the movements of the press frame, the upper manipulator of the pressure vessel and the intensifiers. The equipment comprises a pump, tank, valves and safety devices.

The pressure intensifier provides the ultra high pressure through a pipe to the lower closure of the pressure vessel.

TYPICAL LAYOUT OF AVURE TECHNOLOGIES 215 LITRE HPP PLANT

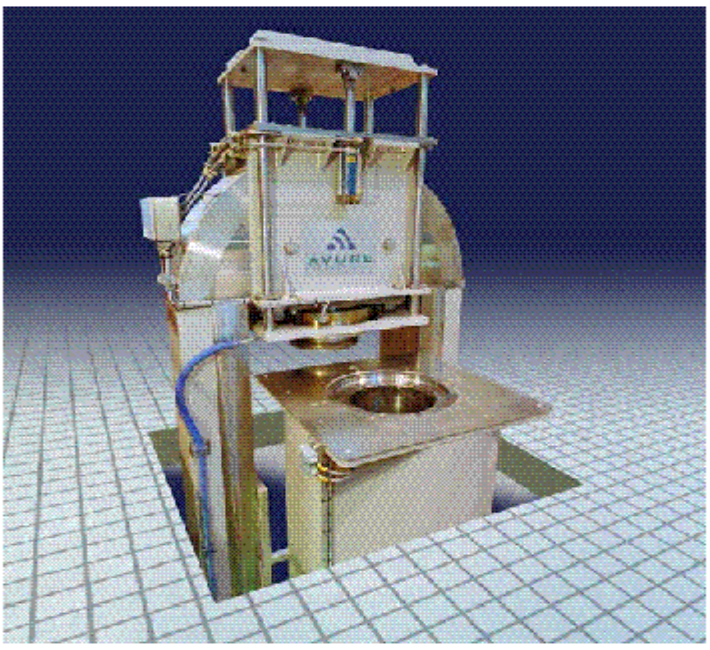




OPERATIONAL COSTS

COSTING ASSUMPTIONS

Funds costs	7%
Depreciation period	15 years
Exchange rate	A$0.65
Labour costs	$22.00 per hour including on costs
Power cost	$0.05 per kw hour
Water cost	$0.75 per KL
Installation costs	See schedule
Loading of basket format.	Random fill
Maintenance costs including parts	US$2.50 per cycle - 35 Litre unit US$5.00 per cycle - 215 Litre unit
Floor space	Floor space is available, 54 sq m
Building height	Height is available, 7m



AVURE TECHNOLOGIES 215 LITRE HPP UNIT

HPP OWNERSHIP COSTS – 215 LITRE

Capital Cost (exchange rate $A1 = $US 0.65)	**US $**	**A $**
Recommended spares	1,700,000	2,615,384
Recommended consumable parts for pump	4,100	6,307
Recommended consumable parts for vessel	11,115	17,100
Duty at 5%	13,732	21,126
Freight		132,995
SUB TOTAL		15,000
INSTALLATION COSTS		**2,807,912.00**
Mezzanine floor, handrails, stairs etc		
Panel enclosure around pump vessel etc (Workcover safety requirement)		40,000
Connection to power, water and air (assumes support available above)		15,000
Installation (cranage, forks only, all other costs Avure)		5,000
		3,000
TOTAL COST		
FUNDING COSTS		**2,930,912**
Based on a 15 year lease at the rate of 7% per annum		
RUNNING COSTS		314,293
Maintenance and parts costs, 12 min cycle $US5.00 / cycle $A 7.70 cycle		
Manning 2 men at $22 per hour gross (approximate)		$ 38.50 per hour
Electricity 55 kw @ $0.05 per kwhr		$ 44.00 per hour
Water 1,200 litre per hr @ $0.75 per kl		$ 7.50 per hour
Two shift operation 8 hrs per shift		$ 6.80 per hour
Cycles are expected to be 5 per hour, 16 hours per day (two shifts), 50 weeks per year		22,800 Cycles

HPP OWNERSHIP COSTS - 215 LITRE

Cost Per Cycle	**$ 25 .01**
Units per cycle	500
COST PER UNIT	**5 cents**

PRODUCTION CASE STUDY

Net Capacity of basket 360mm diameter x 1775mm height	180 Litres
Assumed yearly volume	1500 tonne
Quantity per basket of 300g units 110x 100 x 30mm	500
Weight per cycle	150 kg
Weight per hour	750 kg
Weight per shift of 8 hours at 5 cycles per hour	6,000 kg
Shifts per year for volume	250

HPP 215 LITRE- UNIT PROCESSING COST

DOUBLE SHIFT TWO MEN REQUIRED

				Annual	Per Hour	Per Cycle	Per Unit
Running Costs					Based on 4,000 Hours	Based on 20,000 Cycles	Based on 500 units per Cycle
		Per Hour	**Hours**	**$A**	**$A**	**$A**	**$A**
Lease Cost	7%		4,000	314,293	78.57	15.71	0.0314
Maintenance and Parts		$ 38.50	4,160	160,160	40.04	8.01	0.0160
Manning Costs		$ 44.00	4,160	183,040	45.76	9.15	0.0183
Electricity		$ 7.50	4,000	30,000	7.50	1.50	0.0030
Water		$ 6.80	4,000	27,200	6.80	1.36	0.0027
Pre Tax Running Costs				714,693	178.67	35.73	0.0715
Income Tax Benefit	30%			(214,408)	(53.60)	(10.72)	(0.0214)
After Tax Running Costs				**500,285**	**125.07**	**25.01**	**0.0500**
				Kilograms	Kilograms	Kilograms	Kilograms
Weight of Product Processed				3,000,000	750	150	0.300

AVURE TECHNOLOGIES 35 LITRE HPP UNIT

HPP OWNERSHIP COSTS – 35 LITRE

	US$	Error! No index entries found.A$
Capital Cost (exchange rate $A1 = $US 0.65)	650,000	1,000,000
Recommended spares	400	615
Recommended consumable parts for pump	5,000	7,692
Recommended consumable parts for vessel	10,500	16,153
Duty at 5%		50,000
Freight		5,000
SUB TOTAL		**1,079,460**
INSTALLATION COSTS		
Platform, handrails etc (protective shroud included)		5,000
Connection to power, water and air (assumes all services available at site)		3,000
Hoist and fixings (assumes support available above)		5,000
Drying room and racks		15,000
Installation (Cranage, forks only, all other costs to Avure)		1,000
TOTAL COST		**1,103,460**
FUNDING COSTS		
Based on a 15 year lease at the rate of 7% per annum		**118,328**
RUNNING COSTS		
Maintenance and parts costs, 10.5 min cycle US $2.50 / cycle A $3.85 / cycle		$ 22.00 per hour
Manning 2 men at $22 per hour gross (approximate)		$ 44.00 per hour
Electricity 55 kw @ $0.05 per kwhr		$ 2.75 per hour
Water 1,200 litre per hr @ $0.75 per kl		$ 0.90 per hour
Two shift operation 8 hrs per shift		4,000 cycles per year
Cycles are expected to be 5.7 per hour, 16 hours per day (two shifts), 50 weeks per year. ,		

HPP OWNERSHIP COSTS – 35 LITRE

Cost per Cycle	**$14.24**
Units per cycle	80
Cost per Unit	**15.62 cents**

PRODUCTION CASE STUDY

Capacity of basket 190mm diameter x 1220mm high	28 Litres
Assumed yearly production	300 Tonne
Quantity per basket of 300g Units 110 x 100 x 30mm	80 items
Weight per cycle	24 kg
Weight per shift of 8 hours at 5.7 cycles per hour	1094 kg
Shifts per year for volume	274

HPP 35 LITRE- UNIT PROCESSING COSTS

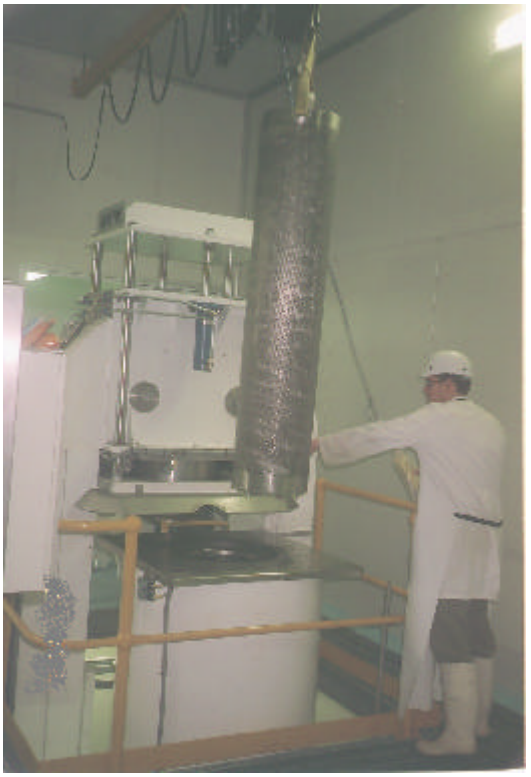
DOUBLE SHIFT AND TWO MEN

Running Costs				**Annual**	**Per Hour** Based on 4,000 Hours	**Per Cycle** Based on 22,800 Cycles	**Per Unit** Based on 80 per Cycle
		Per Hour	**Hours**	**$A**	**$A**	**$A**	**$A**
Lease Cost at 7%			4,000	118,328	29.58	5.19	0.0649
Maintenance and Parts		$ 22.00	4,160	91,520	22.88	4.01	0.0502
Manning Costs		$ 44.00	4,160	183,040	45.76	8.03	0.1004
Electricity		$ 2.75	4,000	11,000	2.75	0.48	0.0060
Water		$ 0.75	4,000	3,000	0.75	0.13	0.0016
Pre Tax Running Costs				406,888	101.72	17.85	0.2231
Income Tax Benefit	30%			(122,066)	(30.52)	(5.35)	(0.0669)
After Tax Running Costs				**284,822**	**71.21**	**12.49**	**0.1562**
				Kilograms	Kilograms	Kilograms	Kilograms
Weight of Product Processed				547,200	137	24	0.300

HPP 35 LITRE- UNIT PROCESSING COSTS

DOUBLE SHIFT AND
ONE MAN

Running Costs				**Annual**	**Per Hour** Based on 4,000 Hours	**Per Cycle** Based on 22,800 Cycles	**Per Unit** Based on 80 per Cycle
		Per Hour	**Hours**	**$A**	**$A**	**$A**	**$A**
Lease Cost	7%		4,000	118,328	29.58	5.19	0.0649
Maintenance and Parts		$ 22.00	4,160	91,520	22.88	4.01	0.0502
Manning Costs		$ 22.00	4,160	91,520	22.88	4.01	0.0502
Electricity		$ 2.75	4,000	11,000	2.75	0.48	0.0060
Water		$ 0.75	4,000	3,000	0.75	0.13	0.0016
Pre Tax Running Costs				315,368	78.84	13.83	0.1729
Income Tax Benefit	30%			(94,610)	(23.65)	(4.15)	(0.0519)
After Tax Running Costs				**220,758**	**55.19**	**9.68**	**0.1210**
				Kilogram	Kilograms	Kilograms	Kilogram
Weight of Product Processed				547,200	137	24.0	0.300



LOADING THE AHPP AVURE TECHNOLOGIES 215 LITRE HPP UNIT

AHPP 215 LITRE HPP UNIT CHARGING AND DISCHARGING VESSELS UNDER MEZZANNE FLOOR

CONTRACT HIGH PRESSURE PROCESSING

THE FACILITIES

The first in a number of High Pressure Processing contracting operations has been set up by AHPP in the industrial suburb of Burton, North of Adelaide. AHPP have a 215 Litre Avure HPP system in operation, processing a range of products. The facility is new and well organised, with easy truck access. The Avure system is operating in a separate controlled environment area of the building, which includes personnel changing, hand wash stations and footbaths, storage chiller and high velocity chilled drying facilities.

BENEFITS

Contract HPP offers the process advantages of HPP without the direct capital, running, labour and maintenance costs of ownership. AHPP offer a professional service using trained personnel and include HACCP procedures. Turnaround time for a nominal 1000kg batch of packaged small goods is estimated by AHPP to be 48 hours including drying time.

DISADVANTAGES

Should HPP processing volumes rise, contract processing would eventually be displaced by ownership as the cost effective HPP processing solution. This point will be reached when processing volume exceeds 5,000 cycles per year on the 215 Litre unit.

COSTS

AHPP have calculated a rate of $100.00 per HPP cycle. This cost includes, unloading from transport, storage in a chiller, processing through the HPP system, chiller drying, re packing into shipping containers and re loading on to transport. AHPP will also pack finished product into the customers finished shipping cartons as required. The unit cost based on 500 units per cycle is $0.20.

HPP BENEFITS

HPP will guarantee the microbiological quality of product and the virtual elimination of pathogens, offering the following benefits:

LONGER SHELF LIFE

HPP offers a longer shelf life for treated products. The HPP process will reduce the levels of micro organisms by five log or 100,000 fold. Typical shelf life of vacuum packed product is 60 days. HPP has been proven to extend shelf life to at least 90 days. Longer shelf life enables the producer to undertake longer production runs of product as product can be stocked for longer periods and more product has the same use by date. Pallet utilisation is improved with less part pallets. At the retail outlet longer use by dates means less stock rotation and a reduction in short code allocation stock during promotions. Transport costs may also be reduced with better utilisation of trucking capacity.

Product that is shipped over seas can also benefit from longer shelf life. Longer shelf life allows larger shipments, longer time in retail outlets at the overseas location and the possibility of shipping use rather than air transport.

REDUCTION IN RECALLS

HPP will lower or eliminate the risk of product recall due to microbiological contamination. Over the past 13 years, Food Standards Australia New Zealand have recorded 21 microbiologically based recalls of small goods. Some of these recalls have had catastrophic results including deaths in the consuming population and the total loss of the company. Industry sources put the cost of a product recall at between $20,000.00 for a low end recall and $350,000.00 to recall stock in every state. This significant risk and cost can be eliminated with the use of HPP.

Recalls have a further cost beyond the direct cost of recall and dumping product, it is the loss of reputation of the product and organisation. Damage to reputation can range from thousands of dollars to millions of dollars to the total loss of business and the company.

REDUCTION IN QA STAFF

The use of HPP and the elimination of the risk of microbiological contamination may also result in a lower requirement for QA staff. The HPP HACCP step is verifiable, on record and a foolproof method of eliminating the risk of microbiological contamination without constant checks being made up and down stream in the production chain.

MARKETING ADVANTAGES

The use of HPP allows the user to display the Avure Technologies “Fresher Under Pressure” logo. With public recognition, associating this logo with quality and product security may come a premium small goods market without the concerns of contamination that may exist with untreated product.

CONCLUSION

Due to high capital and running costs, it is difficult to justify the ownership of a 215 Litre HPP equipment in all but the largest of manufacturers, although it has the lowest processing cost at $0.05 per pack. The 35 Litre unit is a cost effective alternative for smaller manufacturers with a lower capital cost, space efficient design and a processing cost of $0.12 per pack. Contract processing does however bring the process within the reach of all manufacturers, at a cost as low as $0.20 per pack. With the attendant benefits of guaranteed product integrity and processing costs as low as $0.05 per pack, the HPP process is highly recommended.