final report

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Superheated Steam Blood Meal Dryer

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1. Introduction

MLA, Australian Tallow Pty Ltd and Keith Engineering (Aust) Pty Ltd have together initiated a project to explore the development of a Super Heated Steam Blood Meal Dryer.

As a first step towards exploring the use of Keith Engineering's super heated steam technology to dry blood meal, MLA have charged Keith Engineering with conducting small scale tests to collect initial data on the drying of the blood meal.

Milestone 1.3 of MLA project P.PSH.0308 on Super Heated Steam Blood Meal Dryer requires that coagulated and centrifuged blood be obtained from a blood supplier and then dried in small scale test set-ups using super heated steam.

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The first series of tests were undertaken by Keith Engineering, using a basket test set-up attached its own SHS pilot plant in June – September 2008. An interim report was presented to Australian Tallow in October 2008 on these tests.

The results of the basket tests in June – September 2008 were somewhat inconclusive from the blood quality point of view. And it was felt that this was largely due to some limitations of the basket test set-up. So another test set-up was specially designed and constructed to conduct further tests. These tests were done in February – March 2009.

This report presents findings of this latest study. The earlier interim report of October 2008 is also included here as an appendix for the sake of completeness.

This report now completes the milestone 1.3 of MLA project P.PSH.0308 on Super Heated Steam Blood Meal Dryer.

2. The Equipment

A steam oven was purchased and modified to conduct these tests. The steam oven is a Gaggenau steam oven model number ED 221. It has facility to supply both 100 % steam or 100 % air at a desired temperature. It also has a facility to measure the temperature of the sample, if that is required.

The oven was modified with a small hole at the top to allow suspension of a wire. This wire was connected to a load cell which measured the changes in weight as drying progressed.

Figure 1 below shows a schematic of this experimental set-up.

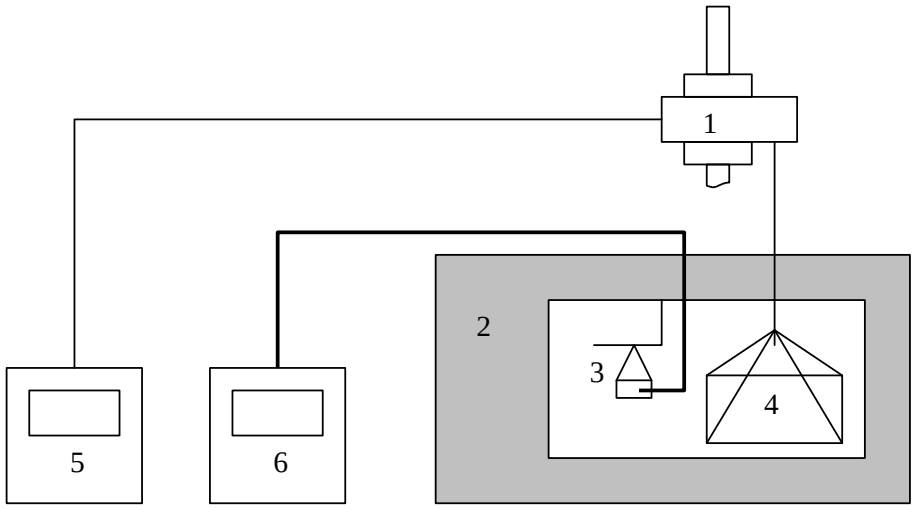

Figure 1:Schematic diagram of the steam oven system. (1) Load cell (2) Steam oven (3) Thermocouple (4) Cross shape sample holder (5) Weight display (6) Temperature display

As shown in the figure 1, a small baskets with blood sample in it was suspended from the load cell. One small basket with blood in it was independently suspended from a hook in the oven ceiling to measure the temperature of the blood. The temperature of the blood and the weight measured by the load-cell were shown on the digital displays. These measurements were also logged continuously into a computer.

The set-up shown in the figure 1 was used to measure drying rates for steam and air at different temperatures using small amount of blood samples (5 – 10 gms).

The oven also has facility to provide trays, which could dry larger amount of material (about 100 – 200 gms).

Figure 2 below shows a schematic of the oven set-up with such trays.

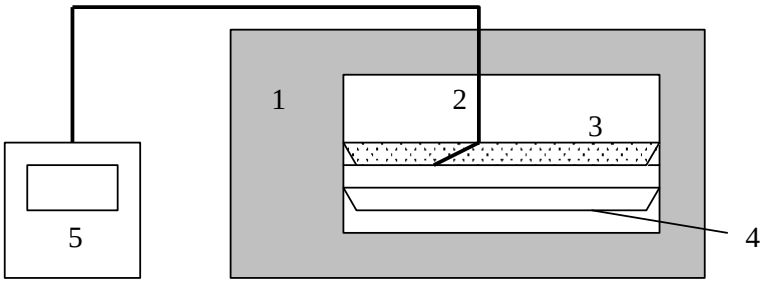

Figure 2: Schematic diagram of the steam oven system for bulk drying. (1) Steam oven (2) Thermocouple (3) Mesh on grill (4) Tray (5) Temperature display

However, as shown in the figure 2, the tray can not be hung from the load cell wire. But temperature of the blood could be measured with a thermocouple.

3. The Experimental Procedure

3.1 Materials

The coagulated blood used in this study consisted of a mixture of bovine, sheep and poultry blood. It was obtained from the project partner, Australian Tallow Pty Ltd. The blood was collected in a single batch of four kilograms and stored in a refrigerator. The particle size of the supplied blood varied widely, between 1 mm and greater than 5 mm.

Before the drying experiments, the blood was milled in a coffee grinder to an average particle size of about 2 mm. Then a representative amount of sample was dried in an oven at 105°C in order to determine the initial moisture content.

The average initial moisture content for the samples was found to be 60.12 % on wet basis.

3.2 Procedure

3.2.1 Drying Rate Determination

Drying rate determination of the milled blood is important from the point of view of drying on a larger scale, both in the steam oven and in the larger dryers. The experimental set-up shown in figure 1 was used for this set of experiments.

The oven has the facility to use either 100 % steam or 100 % air as drying medium.

Y **Start-up procedure**

1. The blood sample from the company was milled through a coffee grinder to make uniform consistency.
2. The motor pump was turned on.
3. The thermocouple device was switched on.
4. The timer was set to zero.
5. The oven was switched on.

Y **During the experiment**

1. The steam percentage (100 % steam for steam drying and 0 % steam for air drying) and the temperature in the oven were set.
2. In the basket, a layer of blood was placed and pressed in to remove voids among the blood particles.
3. The cross-shaped metal rig was taken out and the blood sample tray was hung onto the rig using the suspended spokes.
4. The Excel worksheet was prepared to record the data for the experiment.
5. After checking the temperature is close to the set point, the oven door was opened and the metal rig with the blood sample tray was placed onto the wire connecting to the load cell.
6. One more sample tray was fitted with the thermocouple wire inside the oven.
7. The oven door was closed and the timer was activated.
8. The data from the load cell and temperature of the sample were recorded into the Excel worksheet on a computer.
9. When the moisture content reaches below 8%, the sample was taken out, collected, labelled and placed into storage.
10. The above procedures were repeated for following steam and air temperatures:
    1. 230 °C, 100 % steam
    2. 200 °C, 100 % steam
    3. 150 °C, 100 % steam
    4. 150 °C, 100 % air (0 % steam)
    5. 120 °C, 100 % air

3..2.2 Drying in the tray

The experiments of drying rate mentioned in above section are done with only 5 – 10 gms of samples. That amount of sample is not enough for the quality assessment of the dried blood. Hence, experiments were also done in the trays with blood samples of 50 – 100 gms. These samples were dried for an amount of time indicated by the drying rate curve results so as to obtain 8 % of moisture in the dried product. However, this was not very easy, and sometimes led to a little bit of under drying or over drying.

The similar procedure as mentioned in above section 3.2.1. was also employed in this section, except that a tray was used with larger blood sample and that the tray was not suspended from the load cell. As a result, only blood temperature was logged into the computer.

The blood was dried in the tray over time estimated from the drying rate curve. Samples were collected in air tight containers and sent for analysis.

4. Results and Discussion

4.1 Coagulated Blood Combustion

One of the important findings of this study has been that temperatures higher than 155 °C cannot be safely used to dry blood by hot air in trays. In our experiments hot air at 190 C caused smouldering of the blood which gave out foul burning type of smell. (This finding was also reported in the last interim report on this project given in October 2008. It was re-confirmed in this further trials as well)

This finding explains the superior fire-safety performance of SHS dryers over hot air dryers. The occurrence of fire incidents in hot air dryer is frequent.

On the other hand, we found that we could quite safely dry blood by steam even at 230 °C.

Also, as will be shown in the next section, drying at higher temperature produces higher drying rates, which is an advantage that results in smaller drying equipments.

Thus, steam drying which lets us use higher temperatures will lead to fire-safe and smaller dryers compared to hot air dryers.

4.1 Drying Rate Curve

The drying rate curves are useful in obtaining a starting initial estimate of the drying rate for the design of the larger equipment.

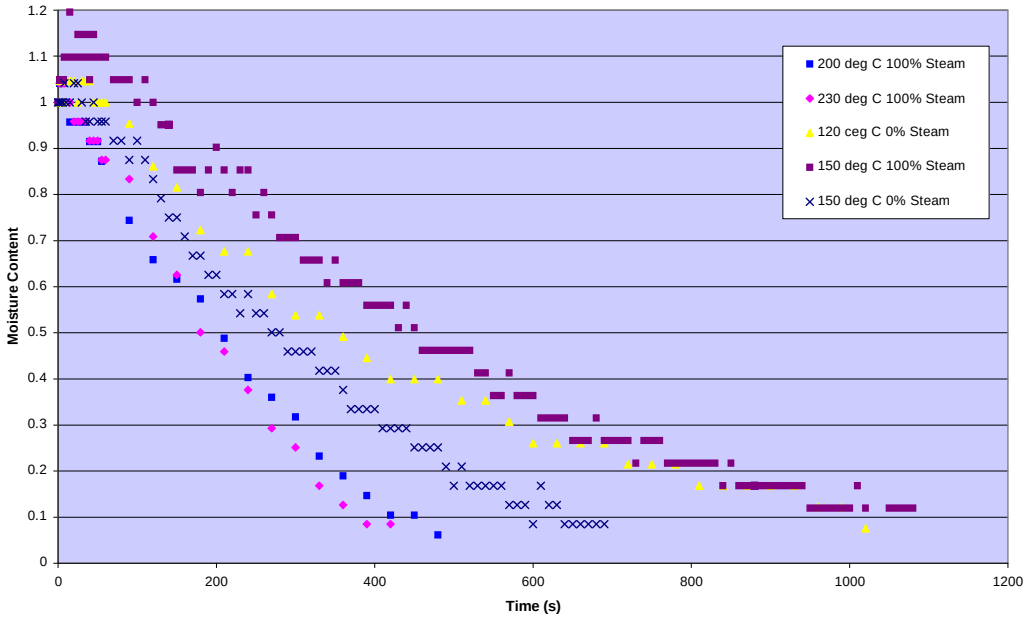

Figure 3: Moisture content (dry basis) over time for blood samples at different temperatures and steam percentages in the steam oven

Figure 3 presents the drying rate curves obtained for the following conditions.

1. 230 °C, 100 % steam
2. 200 °C, 100 % steam
3. 150 °C, 100 % steam
4. 150 °C, 100 % air (i.e. 0 % steam)
5. 120 °C, 100 % air

The relative moisture content is present presented by x-axis and time in seconds is presented on y-axis. Relative moisture content of 1.0 stands for 60.12 % moisture on wet basis.

All curves have been adjusted to begin at the same initial moisture content to enable comparison.

As can be seen from the figures 3 all steam drying curves and air drying curves exhibit similar qualitative nature. However, their quantitative behaviour is quite different.

As can be seen from the figure, the highest drying rate is exhibited by steam at 230 °C, which takes about 400 seconds to reach the desired moisture of content less than 8 %. This is followed by steam at 200 °C, which takes about 450 seconds to reach the desired moisture content. This is followed by 150 °C air, which takes about 700 seconds. Next is 120 °C air and 150 °C steam, both of which take about 1000 seconds to reach the desired moisture. Though air drying at 120 °C is faster at the beginning, it slows down later and the final time for 120 °C air and 150 °C stem is about the same.

Thus it is evident that, while air drying is faster than that of steam at temperatures lower than 160 °C, it is much slower than the steam drying rate at 200 °C and 230 °C. And the drying time required for steam at 200 °C is about 33 % less than that of air at 150 °C.

It should again be noted that it is not possible to use air hotter than 150 °C, for fire-safety reasons. Whereas, the steam drying rate could be further increased by using the steam temperature higher than 230 °C.

4.2 Blood Quality

Table 1 below compares the quality of the dried blood obtained with steam drying to the quality of the blood obtained with air drying under different conditions.

The table reports the values of the blood quality parameters as obtained from the laboratory analysis of the dried blood samples obtained under different experimental conditions. The following blood quality parameters have been determined :

1. % moisture
2. % protein
3. % protein digestibility
4. % crude fibre
5. % ash

All values are reported in percentages and represent the mass percentage per total mass.

The table also compares the blood quality values obtained by experiments with the prevailing guidelines in industry in Australia and USA.

Number	Blood Quality Parameter	Blood - Steam dried at 230 °C	Blood – Steam dried at 200 °C		Blood - Steam dried at 150 °C			Blood - Air dried at 150 °C			Industry guideline	
		1 -1	2 - 1	2 - 2	3 –1	3 - 2	3 - 3	4 - 1	4 - 2	4–3	Aus	US
1	% Moisture	9.48	4.22	9.90	4.11	12.1 *	5.55	6.19	14.1 *	4.6	<8	<10
2	% Protein	90.2	97.0	88.1	95.4	87.1	96.6	93.4	84.8	98.2	>85	>85
3	% Pepsin digestible protein	94.5	98.7	99.0	98.6	98.7	98.8	98.7	98.8	86.5 *	>95	>90
4	% Crude fibre	1.2	<0.1	< 0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<2.0	<2.0
5	% Ash	1.7	1.8	1.8	1.8	1.7	1.8	1.8	1.7	1.8	<5.0	<5.0
6	Drying time (min)	10.5	18	14	38.5	33.5	44	21.5	19	23		

* value away from industry guideline

TABLE 1 : Comparison of steam and air dried blood quality

The table also shows the drying time allowed to the samples. This is not a quality parameter, but included here to show the difference in drying times required to achieve the desirable % moisture, under different experimental conditions.

It is evident form the table that the quality parameter values obtained under steam drying are as good as those obtained under the air drying; and that they easily meet the quality guidelines of the industry.

Thus, drying with superheated steam drying at temperatures between 200 C and 230 C, we have produced dried blood with the quality parameter values which exceeded the guidelines as suggested by the industry. The industry guidelines are –

1. % moisture : < 8 %
2. % protein : > 85 %
3. % pepsin digestible protein : > 95 %
4. % Crude fibre : < 2 %
5. % Ash : < 5%

And at the same time we availed of the high drying rates provided by the super heated steam drying.

From the point of drying time required, the steam drying at a temperature between 200 °C and 230 °C requires much less time than the air drying. As a result the steam dryer will be smaller than the air dryer.

4.3 Other Advantages of Superheated Steam Drying

Apart from the faster drying rate, better fire safety aspects and good dried blood quality proven in this study, there are also other advantages of super heated steam drying which are relevant to blood drying which need to be considered here and also should be kept in mind in the next stage of the project. These are –

1. Odour minimisation and environmental emissions :

   As shown in the figure 1 in the Appendix, the drying loop of Keith dryer is separate from the combustion loop of the dryer. This allows most odorous compounds to be captured by the steam and then condensed and taken out with the condensate. The small amount of non-condensable odours could also be put through the dryer's combustor and destroyed.

   Thus, the odour emanating from the plant into the atmosphere will be eliminated.

2. Smaller dryer

As proven in the earlier section, in the temperature range of 200 °C to 230 °C, the drying rates are much faster for the steam drying. This would lead to smaller dryer and less capital expense.

3. Possible better thermal efficiency.

The higher drying rates of steam could also lead to higher thermal efficiency.

4. Possible uses of the surplus steam :

The other advantage of the Keith dryer is that the steam generated by the dryer can be easily captured. It may be possible to use this steam partly or fully in the other parts of the rendering plant. For instance, in the blood coagulator. This will further add to the efficiency gain of the dryer.

5. Conclusions

This study has led us to conclude that

1. Steam drying rate for milled coagulated blood at 150 °C is slower than the air drying at 150 °C.
2. Air drying could not be conducted at temperatures greater than 150 °C for the risk of fire and safety.
3. Steam drying has been conducted at temperatures up to 230 °C, without any incidence of smouldering or fire.
4. Steam drying rate at temperatures between 200 °C and 230 °C are much higher than air drying rate at 150 °C. This reduced the drying time for achieving 8 % moisture (from 60 % moisture) in the blood by 33 %.
5. Blood drying with super heated steam at temperatures between 200 °C and 230 °C produced the dried blood which exceeded the following quality requirements of the industry guidelines -
    a. % moisture : < 8 %
    b. % protein : > 90 %
    c. % pepsin digestible protein : > 95 %
    d. % Crude fibre : < 2 %
    e. % Ash : < 5%
6. This study demonstrates, by small scale experiments that super heated steam drying is quite suitable to dry coagulated blood, and offers unique advantages over air drying.
7. These unique advantages are –
    a. Super heated steam drying of blood will lead to smaller dryers and more fire-safe dryers compared to air drying.
    b. The odour emissions from the dryer will also be much less compared to other dryers
    c. There is also possibility of efficiency gains and re-use of dryer steam in the other parts of the plants.

8. This study now completes the milestone 1.3 of MLA project P.PSH.0308 on Super Heated Steam Blood Meal Dryer and

6. Recommendation

The MLA project P.PSH.0308 – Superheated Steam Blood Meal Dryer – should now proceed to the next phase of the project which is preparation for a large scale industrial dryer.

APPENDIX

Superheated Steam Drying of Blood in Keith Engineering's Basket Test Set-up

[Interim Report for milestone 1.3 of MLA project P.PSH.0308 : Super Heated Steam Blood Meal Dryer]

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1. Introduction

MLA, Australian Tallow Ltd and Keith Enginerring (Aust) Pty Ltd have together initiated a project to explore the development of a Super Heated Steam Blood Meal Dryer.

As a first step towards exploring the use of KE's super heated steam technology to dry blood meal, MLA have charged KE with conducting small scale basket tests to collect initial data on the drying of the blood meal.

Milestone 1.3 of MLA project P.PSH.0308 on Super Heated Steam Blood Meal Dryer requires that coagulated and centrifuged blood be obtained from a blood supplier and then dried in a basket test Set-up using super heated steam.

Keith Engineering undertook these tests in June – September 2008. This report presents the initial findings of this study.

2. The Equipment :

Figure 1 shows a schematic of KE's existing superheated steam drying pilot plant

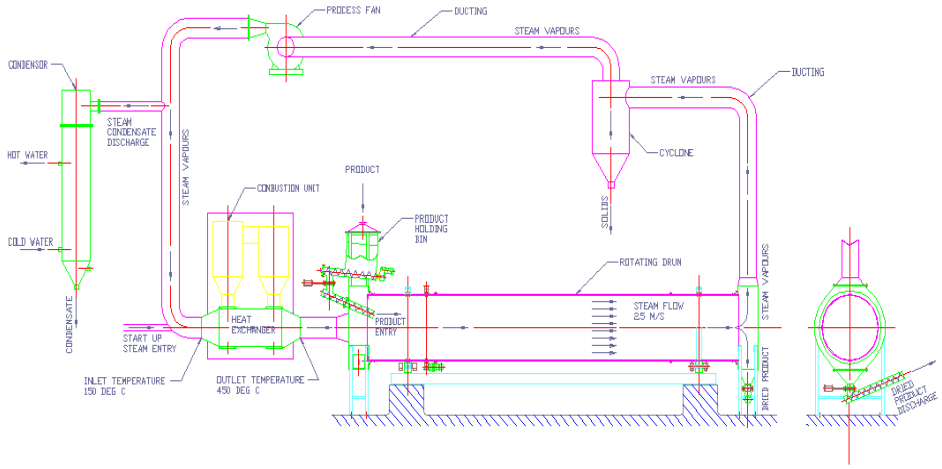

Figure 1 : Schematic of the Keith Engineering's Superheated Steam Dryer

As shown in figure 1, the pilot plant consists of a loop comprising of i) a rotating drum, ii) a cyclone, iii) a process fan, iv) a heat exchanger, v) a condenser, vi) a feed auger and vii) a product auger. Superheated steam is circulated continuously around the loop. The feed enters the drum via feed auger and dried product leaves the drum via exit auger. Fines generated during drying are separated out by the cyclone and withdrawn from the bottom of the cyclone. Excess steam generated due to the drying of the feed is withdrawn from the loop via condenser. The energy for the drying is supplied by the heater - heat exchanger assembly. In the pilot plant used for this trial, the heater employs electrical elements to supply heat.

This existing pilot plant was modified to accommodate the basket test experiments. The pilot plant's feed auger was removed and discharged auger was sealed. The condenser was disconnected and the steam withdrawal line was modified so as to supply steam for the basket tests

A special purpose experimental set-up was constructed for the basket test. Figure 2 shows the sketch of this experimental set-up.

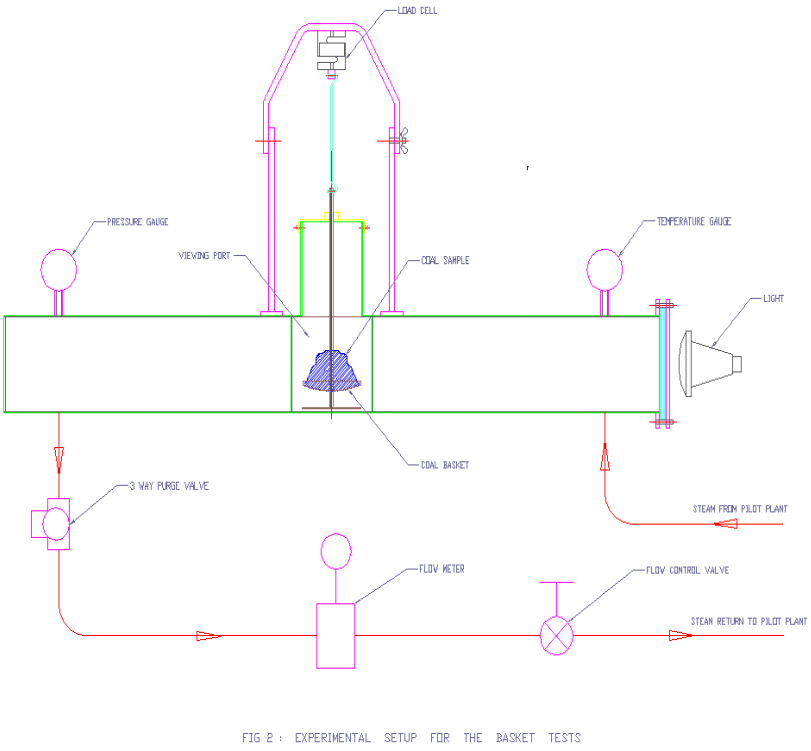

Figure 2 : Schematic of the Basket Test Experimental Set – up.

The basket test rig mainly consists of a specially constructed chamber. A basket filled with coagulated blood is suspended by a thin steel rod in the middle of this chamber. The thin steel rod is connected to a load cell which continuously measures the weight of the basket. The superheated steam from the pilot plant is fed into the chamber in a controlled manner. Two temperature gauges measure the temperature of the steam into and out of the chamber respectively. The steam exiting the chamber is supplied to a flowmeter which measures the velocity of the steam in the chamber. After the flow meter the steam is returned to the pilot plant loop where it is continuously heated and maintained at a desired temperature. The pressure in the basket test rig is very nearly atmospheric.

Figure 3 shows a photograph of the basket test set-up attached on to the pilot plant.

Figure 3 : A Photograph of the Basket Test Rig

The intake to the basket test rig is located just after the pilot plant's process heater as shown in the figure 4.

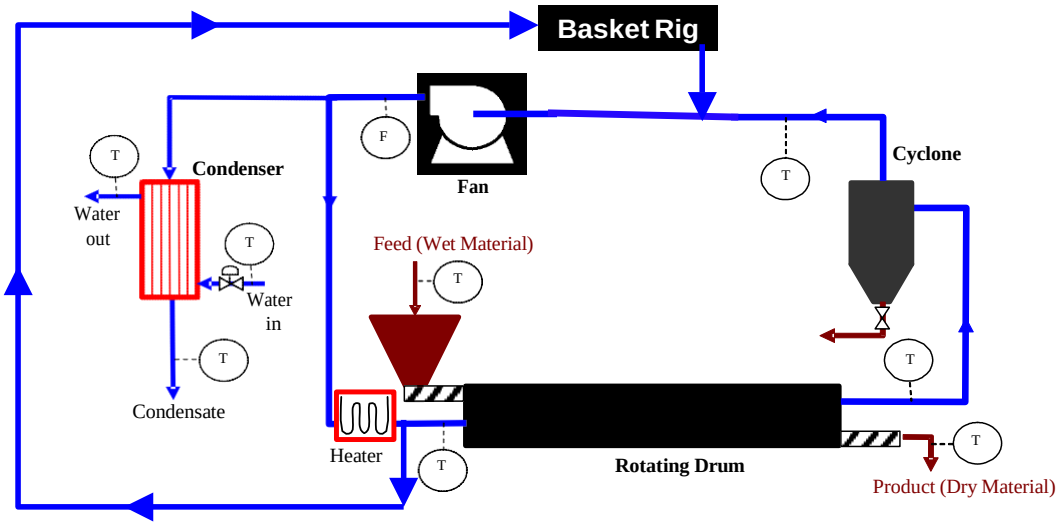

Figure 4. Schematic of the pilot-plant with the basket test rig.

The moisture content of the initial and final coagulated blood sample is determined using an oven and lab weight measurement balances.

3. The Experimental :

3.1 Materials

The coagulated blood used in this study consisted of a mixture of bovine, sheep and poultry blood. It was obtained from the project partner, Australian Tallow Ltd. The blood was collected in three batches, each of four kilograms and stored in a refrigerator. Before each drying experiment a representative amount of sample was dried in an oven at 105°C in order to determine the initial moisture content. The average initial moisture content for each batch was derived from these values and is presented in Table 1.

Table 1. Average initial moisture content for the three sample batches.

	Batch 1	Batch 2	Batch 3
Initial Moisture Content (% wet basis)	68.6	57.5	63.9

3.2 Procedure

The pilot plant is started up with air and heated up to a desired temperature above 100 °C. Water is then continuously sprinkled in the drum to generate steam. The 2-way valve of the basket test rig is now left open for at least 5 minutes. This purges the air in the pilot plant and the basket test rig and replaces it with the superheated steam. The heater continuously heats the circulating steam to maintain the desired temperature of the superheated steam in the basket test rig. The speed of the steam circulating fan and the valve after the flow meter are adjusted get the desired steam velocity through the basket test chamber. The amount of heat supplied to the heater and amount of water sprinkled in the drum are finely adjusted to obtain the desired steam temperature.

Coagulated blood is next filled in the basket and the test is commenced. The necessary adjustment to fan speed and the sprayed water are continuously done to maintain the required temperature, pressure and velocity of the steam in the basket chamber. As the test progresses, the coagulated blood loses moisture and its weight loss is measured by the load cell. And from the sample's change in weight over time the drying rate curve can be obtained.

The experiment is continued till the weight loss equals a desired value or till further weight loss becomes negligible.

Three sets of experiments were conducted using three different batches of blood. For the first two sets the drying was done using only super heated steam. For the third batch, both super heated steam and hot air were used, and the results of air drying and steam drying were compared.

Two different sample baskets were used in the drying experiments, these are illustrated in Figure 4 below. The bowl-shaped basket, to the right in Figure 4, was found to have a capacity of only 50 grams of wet sample per experiment and was therefore replaced by the upright basket, larger basket, to the left in Figure 4, with a capacity of 200 grams per sample. The larger basket also has an improved design replacing the bowl like construction of the smaller basket with two upright containers of steel mesh, providing a larger contact area between the steam and the blood sample.

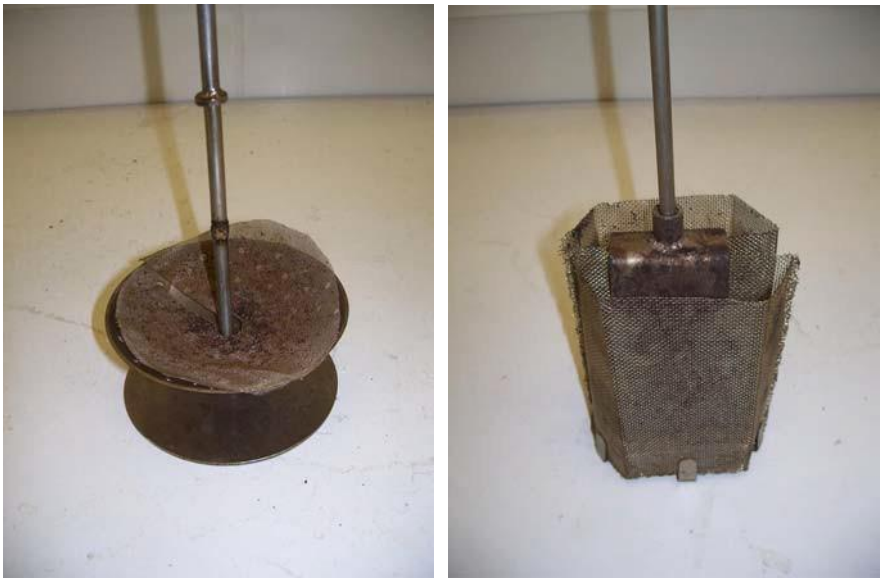

Figure 5. The two different baskets used in the basket rig.
To the left the initial bowl-shaped basket and to the right the larger upright basket.

Initially two sets of experiments at two different drying temperatures, 190°C and 155°C, were conducted using the small sample basket with steam. Another set of experiments at 190°C was then completed using the large sample basket. Finally a series of three samples dried in air using the big basket was completed. The drying temperature for the air experiments was 155°C in order to prevent burning of the sample. The steam velocity through the basket loop was kept at 1.2 m/s for all experiments. The final moisture content was attempted to be maintained at the industrially desired 8-10 % of moisture on wet basis.

4. Results and Discussion

4.1 Coagulated Blood Combustion

One of the important findings of this study has been that temperatures higher than 155 C cannot be safely used to dry blood by hot air in basket. In our experiments hot air at 190 C caused smouldering of the blood which gave out foul burning type of smell.

On the other hand, we could quite safely dry blood by steam at 190 C.

As will be shown in the next section, drying at higher temperature produces higher drying rates, which is an advantage that results in smaller drying equipments.

Thus, steam drying which lets us use higher temperatures will lead to smaller equipments compared to air drying.

4.1 Drying Rate Curve

The drying rate curves are useful in obtaining a starting initial estimate of the drying rate for the design of the larger equipment.

Figures 5, 6 and 7 present the drying curves for three sets of experiments performed in this study. Figures 5 and 6 display the resulting drying curves at steam temperatures 155°C and 190°C using the small sample basket. Figure 7 illustrates the curves generated for drying in the big basket at set temperature 190°C and Figure 8 illustrates the curves obtained from air drying at 155° C air temperature in the big basket. All curves have been adjusted to begin at the same initial moisture content to enable comparison. Each point of the legend, eg 1a, 2b, 3c, etc, represent a different experiment.

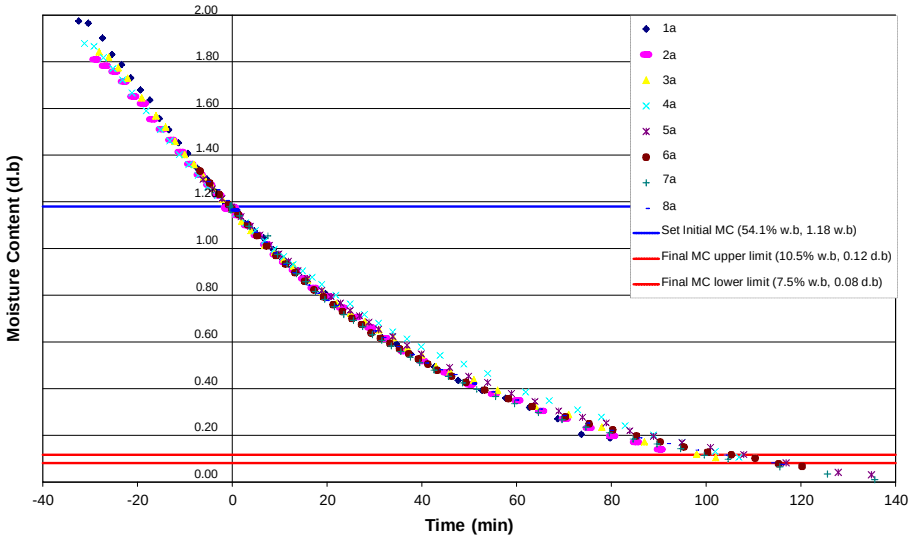

Figure 5. Drying curves for blood drying in the small basket with steam155°C

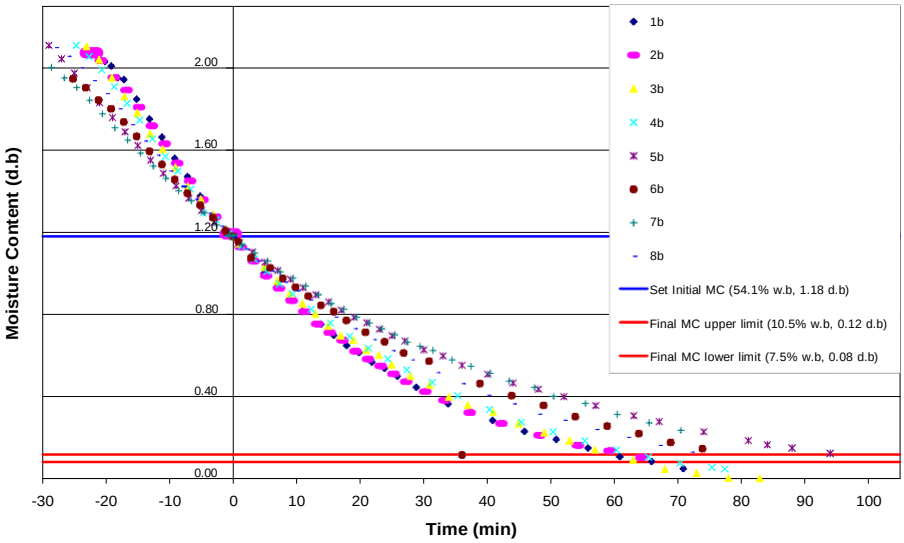

Figure 6. Drying curves for blood drying in the small basket with steam at 190°C.

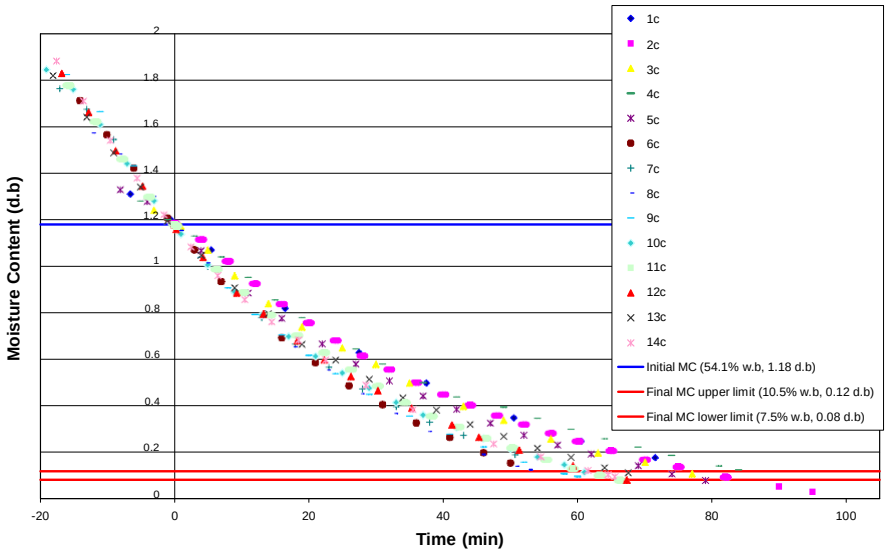

Figure 7. Drying curves for blood drying in the big basket with steam at 190°C.

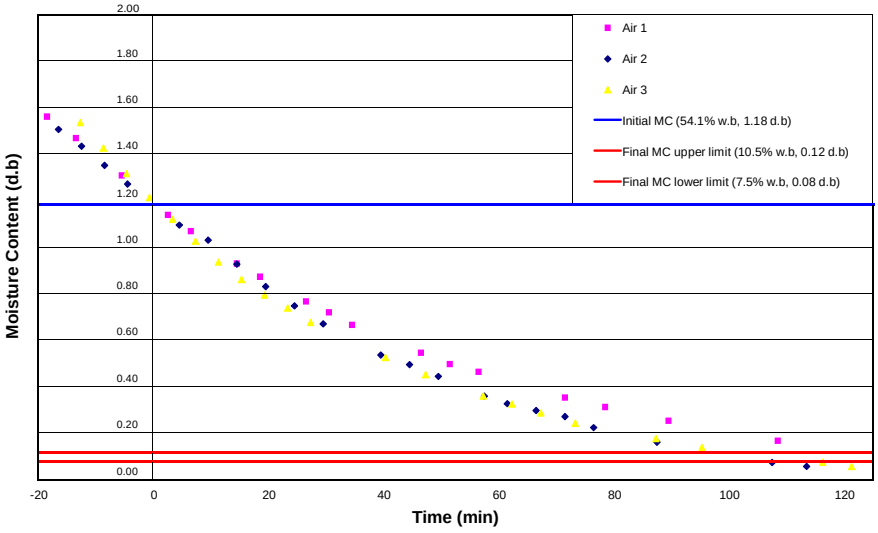

Figure 8. Drying curves for air drying of blood in the big basket with air at 155°C

As can be seen in Figures 5-8 all steam drying curves and air drying curves exhibit similar nature.

Further, form figure 6 & 7, it is evident that the initial drying rates (which are constant for first 50 minutes) are about the same in the bigger basket and the smaller basket. This initial constant rate for steam drying is about 1.8 gm of water removed /gm of dry solid/ hr at 190 C temperature.

Figure 5 & 6 together show the effect of temperature on the drying rate. Higher temperature leads to higher rates. The initial constant steam drying rate at 155 C is about 1.44 gm of water removed / gm of dry solid /hr. Whereas, at 190 C that value is 1.8.

The difference between air drying and steam drying can be estimated from the comparison of figures 5 and 8. From figure 8, the initial constant rate for air drying is 1.0 gm of water removed / gm of dry solids / hr at 155 C. From figure 5, the rate for steam drying is 1.44 gm of *water removed / gm of dry solid .hr at 155 C. Thus for the same temperature (in this case 155 C) the steam drying is 44 % faster.*

Also, the rate of steam drying could be increased further by increasing the temperature. However, air drying could not be conducted safely at temperatures higher than 155 C in basket drying, because of the dangers of smouldering and fire.

4.2 Blood Quality

Table 4.1 below compares the quality of the dried blood obtained with steam drying at 155 C to the quality of the blood obtained with air drying at 155 C.

TABLE 1 : Comparison of steam and air dried blood quality

Quality Parameter	***Steam dried blood***	***Air dried blood***
Moisture (%)	*8.5*	*3.7*
Protein (%)	*91.0*	*86.1*
Ash (%)	*2.2*	*2.4*
Pepsin Digestible Protein (%)	*82.0*	*93.4*
Crude Fibre (%)	*14.3*	*2.1*

It was found that controlling the final moisture content to desired value of 8 % was more difficult for air drying than steamdrying.

It is not clear why the digestible protein is less and crude fibre more for the steam dried sample. Theoretically, there is no reason for such an outcome. This is still being investigated. It is possible that there have been some mistake and these results are treated as inconclusive.

Conclusions

This study has led us to conclude that –

1. Steam drying rates, at temperatures of 155 C and above, are 44 % or more higher than the air drying rates.
2. Air drying can not be safely conducted, in a basket, at temperature above 160 C, because of dangers of smouldering and fire.
3. Whereas, steam drying can be conducted at much higher temperatures
4. Higher drying rates are obtained at higher temperatures
5. Controlling the final moisture content to 8% is more difficult in air drying than in steam drying.
6. Acceptable protein levels are obtained by both the steam drying and the air drying.
7. The results on digestible protein and crude fibre in the dried blood obtained by steam drying are currently regarded as inconclusive.

Recommendations

1. Another set of tests be conducted using a dynamic rotating drum or some other device instead of a static basket with a small sample size.

Next Phase

The drying rates obtained in a rotating drum are higher than those of the basket drying. This makes it easy to reduce the contact time between coagulated blood particles and steam or hot air to achieve the desired degree of drying. It also makes it easy to increase the drying temperature without having adverse effect on the dried blood quality, especially for steam drying.

Keith Engineering is currently exploring the best ways of conducting steam and hot air drying on a small lab scale using rotating drum or some other device for coagulated blood as next phase of this project.

BUSINESS PLAN ELEMENTS - SHS BLOOD DRYER

MLA, Australian Tallow Pty Ltd and Keith Engineering (Aust) Pty Ltd have together initiated a project to explore the development of a Super Heated Steam (SHS) Blood Meal Dryer.

As a first step towards exploring the use of Keith Engineering's super heated steam technology to dry blood meal, MLA have charged Keith Engineering with –
i) conducting small scale tests to collect initial data on the drying of the blood meal, and
ii) developing a business plan that will assist in the market uptake of SHS blood meal dryer.

Keith Engineering has already completed the milestone for small scale tests on SHS drying of the blood meal.

This note describes some elements of a business plan that will help in the overall project.

Business Plan Elements :

1. Product Sterility: The Keith SHS dryer offers superior and consistent sterility of the dried blood meal. This could be useful to firm up the existing clients and to access established and new markets.

It is often felt that the blood meal produced by some of the currently used drying technologies (hot air ring and spray dryers) produce blood meal that often suffers from salmonella and other bacterial contaminations. This is because these drying technologies do not ensure that meal particles would have been subjected to high temperatures for sufficiently long time to achieve sterility. Some New Zealand customers require blood to be dried for 30 minutes at 95 °C. International rendering association recommends this time to be greater than 3 minutes at temperatures greater than 120 °C. In fact, because of presence of oxygen, hot air dryers run risk of fire if they expose the blood meal for long time at high temperatures.

However this limitation is overcome by Keith SHS dryer. In Keith SHS dryer, the meal particles spend far greater than 3 minutes (up to 30 minutes) in the dryer at steam temperatures higher than 150 °C, which ensures complete sterility.

The established Australian blood meal market is about 31, 000 tons / yr, worth A$23 million. And overseas market will be at least 50 times that.

With its superior sterility, the SHS dried blood meal product could access at least a small fraction of this sizable market.

2. SWOT analysis: A preliminary SWOT analysis is presented below. The strengths and opportunities out of this analysis could guide us to break into new markets.

2a Strengths of Keith SHS technology: The SHS technology has the following strengths over the conventional hot air based drying technology.

1. It eliminates fire danger for the dryer, as there is virtually no oxygen present in the dryer. The conventional hot air ring, spray and rotary dryers are highly prone to fires. This could directly translate into financial advantage, as it significantly reduces production losses and also may reduce the insurance premiums for the dryer.
2. It eliminates / minimizes the odors and other noxious emissions emanating from the blood meal dryer. This is because most of the odorous and noxious compounds are contained within a closed SHS vapor loop. They are condensed with the excess steam and are present in the condensate. The treatment / disposal cost of this liquid condensate is much less than the treatment cost of the gaseous emissions as found with hot air dryers.
3. The Keith SHS dryer has a closed SHS vapor loop which carries out the drying of the solids. This gives it a much superior control system than other dryers. It corrects for the input variations in seconds rather than tens of minutes taken by other dryers. This also has a cost advantage, as it produces much less 'reject product material' than other dryers.
4. The Keith SHS dryer will also provide higher thermal efficiency, if the excess steam produced during the drying can be re-used elsewhere on the plant.
5. The Keith dryer operates at atmospheric pressure. Thus it has less explosion risk than pressurized disk dryers. Also, the complications of pressure vessel code compliance are avoided.
6. Also, as mentioned earlier, Keith dryer produces a higher degree sterile blood product, which will be a better marketing advantage.

2b Weaknesses of the Keith SHS Technology: There are not many weaknesses. But possible ones are –

1. It is likely that initial capital cost of SHS dryer is higher compared to hot air dryer. However, when we compare the capital costs of the total plants, including exhaust gas treatment units that go with the hot air dryer, hot air plant is likely to come out as more expensive. This is because the odor and noxious emissions from the SHS dryer are minimum. Most of the odorous and noxious elements are captured by the condensate, which is much smaller in volume and the treatment cost of which is also much smaller.

2. No existing operating blood drying plant as a precedent. Though, a commercial plant to dry meat and bone meal has been operating in NZ for past 7 years.

2c Opportunities for Keith SHS Technology: The existing hot air based drying of blood has many shortcomings. This gives the SHS technology following opportunities –

1. Capture new Australian blood drying market.
2. Capture new international blood drying market.
3. Increase the sterility of the dried blood product sold in the market.
4. Further understand and develop cost, product quality and other advantages of SHS drying, on a commercial scale SHS blood dryer.

2d Threats to Keith SHS Technology: The possible threats to the SHS Technology are –

1. Collapse of the dried blood market due to BSE or similar diseases scare.
2. World financial crisis.
3. Development of a superior technology. Though no better one seems to be on the horizon.