A REVIEW OF CONTINUOUS PAN DEVELOPMENT IN THE SOUTHERN AFRICAN SUGAR INDUSTRY

P.W. Rein and M.P. Msimanga
Tongaat-Hulett Sugar Limited
South Africa

ABSTRACT

The widespread adoption of continuous pan boiling in the Southern African countries is reviewed. It is shown how the use of continuous pans forms the basis of cost-effective expansion and replacement strategies in preference to batch pans. An update of experience with control and operation of continuous pans is presented. Performance data on heat transfer rates and information on crystal quality is presented, showing how fewer compartments and lower heating surface/volume ratios can be utilised.

INTRODUCTION

The early stages of adoption of continuous pan boiling into the South African sugar industry were described in a paper to the South African Sugar Technologists in 1986 (Rein, 1986). This paper also reviewed the work involved in developing the Tongaat-Hulett continuous pan. Since that time, the adoption of continuous pan boiling has accelerated.

The purpose of this paper is to describe how continuous pans have been incorporated into sugar mills in the Southern African countries (South Africa, Swaziland, Zimbabwe, Zambia and Malawi). This region incorporates most of the lowest cost producers of sugar in the world. The incorporation of continuous pans has been accepted as a part of the route to low cost production, both from a capital and operating cost point of view.

CONTINUOUS PAN INSTALLATIONS

Continuous pans are now routinely introduced as part of an expansion or replacement program. Figure 1 shows the numbers of continuous pans installed over the years. As there are 23 factories in the region, this suggests that nearly all factories have shown acceptance of continuous pan boiling. At least three further continuous pans are expected to be installed in 1999.

Fig.1 : Number of continuous pans installed in Southern African countries since 1976
A step change in the number of continuous pans is shown in 1984, with the installation of continuous pans on all massecuite grades in the new Felixton mill. Then followed a period of relative inactivity with few new continuous pan installations. This was largely associated with a period of no expansion. The second new factory built in the region at Komati in 1994 also incorporated continuous pans on A, B and C massecuite boilings. Since that time a general expansion in the region has seen the number of new continuous pans increase considerably.

Economics clearly favour the installation of continuous pans when new factories are built, as shown by Rein (1992). In existing factories, no new batch pans have been installed on raw sugar massecuites in the region since the early 1980’s. Strategies for expansion or replacement of old unserviceable pans now consistently involve the installation of continuous pans.

This is a clear indication of the fact that problems initially experienced with continuous pan boiling have been overcome, and that expected benefits have, in fact, been realised.

**EXPANSION AND REPLACEMENT STRATEGIES**

A common philosophy employed when a marginal expansion is required, has been to install a continuous C pan, and cascade batch C pans on to B or A duty. This, for instance, was the policy adopted at Darnall mill. Subsequently, when some of the older and smaller batch pans became unserviceable, a continuous B pan was installed. This resulted in an increased capacity pan floor with 6 batch pans and 2 continuous pans, compared initially with 9 batch pans.

A more comprehensive expansion plan incorporating continuous pans for Triangle mill (Zimbabwe) involving more than doubling capacity is outlined in Table 1. Progressive installation of continuous pans allows older small batch pans to be taken out of service, ultimately ending up with fewer pans in the expanded case than the initial installation. Some batch pan capacity is maintained for seed production. Triangle are presently in the third phase of this expansion.

**Table 1 : Pan floor expansion strategy for Triangle Sugar Mill showing number and sizes (in m\(^3\)) of pans required**

<table>
<thead>
<tr>
<th>Crushing rate (tch)</th>
<th>350</th>
<th>430</th>
<th>550</th>
<th>640</th>
<th>740</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Batch pans</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- A</td>
<td>3 x 56</td>
<td>3 x 56</td>
<td>2 x 56</td>
<td>3 x 56</td>
<td>2 x 56</td>
</tr>
<tr>
<td>- B</td>
<td>1 x 85</td>
<td>1 x 85</td>
<td>1 x 85</td>
<td>1 x 85</td>
<td>1 x 85</td>
</tr>
<tr>
<td>- C</td>
<td>1 x 85</td>
<td>1 x 85</td>
<td>1 x 85</td>
<td>1 x 85</td>
<td>1 x 85</td>
</tr>
<tr>
<td><strong>Continuous pans</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- A</td>
<td>1 x 160</td>
<td>1 x 160</td>
<td>1 x 160</td>
<td>2 x 160</td>
<td></td>
</tr>
<tr>
<td>- B</td>
<td>1 x 120</td>
<td>1 x 120</td>
<td>1 x 120*</td>
<td>1 x 120*</td>
<td></td>
</tr>
<tr>
<td>- C</td>
<td>1 x 86</td>
<td>1 x 86</td>
<td>1 x 86</td>
<td>2 x 86</td>
<td>2 x 86</td>
</tr>
<tr>
<td><strong>Total number of pans</strong></td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>12</td>
<td>9</td>
</tr>
</tbody>
</table>

*120m\(^3\) pan expanded to 168m\(^3\) by increasing from 10 to 14 compartments.*
The general strategy of replacement of small pans with larger ones is available for batch pan options as well. However, there is a limit to batch pan size. In the Southern African region, the largest batch pans are 85m³, and although larger sizes are in operation elsewhere in the world, they do not approach the size of large continuous pans now in operation. Because the effective capacity of a continuous pan is of the order of 40-50% higher than an equivalent batch pan, a 160m³ continuous pan equates in terms of capacity to a batch pan of about 230m³.

**OPERATIONAL ISSUES**

It is still necessary to produce seed massecuite for feeding to a continuous pan. Attempts have been made to produce seed on a continuous basis, but most of these have been unsuccessful (Broadfoot & Wright, 1992).

In some cases, seed production in batch pans has been eliminated. For instance, at Felixton mill, B seed boilings have been dispensed with, and a magma of C sugar is fed directly to the continuous B pan as seed.

At Eston mill, a similar approach is used on A massecuite. B sugar is cured in continuous centrifugals with large diameter casings to eliminate crystal damage. The B sugar is made into a magma with clear juice, and this is fed directly to a 90 m³ FCB pan followed in series by an 86m³ Tongaat-Hulett continuous pan.

Roughly a quarter of the pan installations are for A massecuite boiling. Thus, continuous systems for higher grade boiling are now well accepted. In general, continuous A pans are emptied and cleaned out on a regular cycle, of somewhere between 1 and 4 weeks. In sugar industries where weekly maintenance shut-down cannot be countenanced, various techniques are available to minimise or eliminate encrustation. These involve periodic water or condensed vapour washes, reduced internal surfaces, or the installation of some additional capacity to enable part of the pan capacity to be taken out of service on the run to minimise disruption to production. Some basic precautions can help to minimise encrustation (Rein, 1990).

C massecuite pans can run a whole season of 9 months without having to stop, empty and clean. In general, B massecuite pans are emptied once or twice during a season.

Typical pan control systems are described elsewhere (Rein, 1992). In general, the massecuite condition in each compartment is controlled by either conductivity (B and C massecuites) or RF probe signals (A massecuite). Overall production rate is set by setting evaporation rate, controlled by calandria pressure. Seed flow rate is controlled in a set ratio to syrup or molasses feed flow rate.

RF probes have developed to the point where they are reliable and successfully used on A massecuite pans. However, they are still prone to encrustation, and need to be removed and manually cleaned, generally once per day. They are the most cost-effective devices for control of high grade pans.

A method of tuning pan feed controls has been devised by Love & Chilvers (1986), which is successfully used to set up the tuning parameters. Tuning feed controls on continuous pans requires a somewhat different approach compared with most control loops. The system has no element of self-regulation, and the response to a step change is an on-going continuous ramp until the step is removed. An example of the step response is given in Figure 2. Love & Chilvers show how the measured time delay and the measured slope, related to the capacity of the compartment, and time can be used to set up optimum tuning parameters.
Initially, control of compartment feeds used modulating control. In general, it has been found easier to use time proportioning control. This has the advantage that simple on/off valves can be used, and the feed system is less prone to blocking.

CANE SUGAR REFINERY APPLICATIONS

Because of the very short cycle times in cane sugar product refinery boilings and the necessity still to produce seed in a batch pan, this is one application for which continuous operation has not found successful or widespread application.

Experience at Malelane mill, however, has shown that a continuous pan can be used most successfully on refinery recovery boilings (Schorn & Meadows, 1998). When a continuous pan was used on this duty during off-crop refining, it showed some notable benefits. In particular, exhaustion of refinery molasses was significantly improved, resulting in a considerable increase in yield. The low hydrostatic head and good circulation characteristics are particularly significant in this application. Low calandria pressures could be used, with implications for improved steam economy. The pan had to be emptied and cleaned once during a 3-month refining period, handling massecuite purities from about 75 to over 90.

HEAT TRANSFER PERFORMANCE

With the exception of a BMA-VKT pan on B massecuite at Hippo Valley Estates, all continuous pans in the Southern African region rely on natural circulation. These are generally the most cost-effective units for raw cane sugar mills. The majority of these pans are of Tongaat Hulett design.

The Tongaat-Hulett continuous vacuum pans have a vertical tube calandria and rely on natural circulation. Good circulation is important in order to ensure good evaporation rates and effective heat transfer. Heat transfer performance is doubly significant since it determines not only the heat
transfer area required and the quality of the heating vapour which can be used, but also the degree of circulation and thence the uniformity of conditions in the pan. Homogeneous boiling conditions as a result of good circulation are a highly desirable feature of good continuous pans.

Heat transfer performance of the Tongaat-Hulett pans installed at Felixton, Maidstone and Triangle mills were revisited and compared with other pans in Southern Africa for which performance information was available. Rein (1986) observed that the heat transfer coefficient in A pans increased linearly with $\Delta T$ (temperature difference). However, the current data only shows this dependence clearly in the Tongaat-Hulett C pans.

The heat transfer rates of A continuous pans (all of Tongaat-Hulett design) are shown with corresponding evaporation rates in Table 2. These pans show an average heat transfer coefficient (HTC) of 413 W/m²°C, which is a relatively high heat transfer rate for a natural circulation system. A-pans are generally boiled out and cleaned on a 1 - 3 week cycle. Thus the effect of tube scaling is not clearly demonstrated by these HTC figures. However, the fact that heat transfer rates are maintained at a fairly high level over a period of 1 - 3 week is evidence of good pan circulation which reduces the calandria scaling rate.

Table 2 : Measured heat transfer data for Tongaat-Hulett continuous A pans

<table>
<thead>
<tr>
<th>Factory</th>
<th>Volume (m³)</th>
<th>Heat Transfer (m²)</th>
<th>Absolute Pressure (kPa,a)</th>
<th>Calandria Pressure (kPa,a)</th>
<th>Massecuite Temperature (°C)</th>
<th>Evaporation (kg/hm²)</th>
<th>HTC (W/m²°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX</td>
<td>120</td>
<td>1118</td>
<td>16</td>
<td>116.3</td>
<td>67</td>
<td>17.9</td>
<td>304</td>
</tr>
<tr>
<td>FX</td>
<td>120</td>
<td>1118</td>
<td>15</td>
<td>99.3</td>
<td>67.5</td>
<td>25.0</td>
<td>492</td>
</tr>
<tr>
<td>FX</td>
<td>120</td>
<td>1118</td>
<td>16</td>
<td>88.5</td>
<td>69</td>
<td>19.2</td>
<td>442</td>
</tr>
<tr>
<td>FX</td>
<td>120</td>
<td>1118</td>
<td>15.8</td>
<td>116.4</td>
<td>67.5</td>
<td>21.2</td>
<td>475</td>
</tr>
<tr>
<td>TR</td>
<td>160</td>
<td>1444</td>
<td>19</td>
<td>111.3</td>
<td>69</td>
<td>19.4</td>
<td>362</td>
</tr>
<tr>
<td>FX</td>
<td>120</td>
<td>1118</td>
<td>16.1</td>
<td>87.3</td>
<td>69</td>
<td>20.1</td>
<td>470</td>
</tr>
<tr>
<td>MS</td>
<td>110</td>
<td>1092</td>
<td>14</td>
<td>88.3</td>
<td>68</td>
<td>20.2</td>
<td>449</td>
</tr>
<tr>
<td>FX</td>
<td>120</td>
<td>1118</td>
<td>15.8</td>
<td>81.3</td>
<td>67.5</td>
<td>16.1</td>
<td>382</td>
</tr>
<tr>
<td>FX</td>
<td>120</td>
<td>1118</td>
<td>16</td>
<td>77.8</td>
<td>66</td>
<td>16.1</td>
<td>378</td>
</tr>
</tbody>
</table>

Tongaat Hulett B continuous pans show an average HTC of 212 W/m²°C (and a range of 173 to 254 W/m²°C) compared to an average of 87 W/m²°C obtained from an FCB B pan at Illovo Mill (Munsamy 1982). In general, B pans are boiled out and cleaned once or twice during the season except for Felixton mill where encrustation of pan internals results in lumps in the massecuite, so that a pan is boiled out once every four weeks. Good circulation with a vertical tube calandria accounts for good heat transfer rates which are not easily achievable in horizontal tube calandria pans.

The Tongaat-Hulett C pans display a linear dependence of HTC on $\Delta T$, as shown in Figure 3. In the $\Delta T$ range covered, HTC (in W/m²°C) can be predicted (at 98 % confidence) from the following correlation:

$$\text{HTC} = 5.82\Delta T - 82.7$$

(1)
Fig. 3: Heat transfer coefficients measured in continuous C pans in South African factories.

Tongaat-Hulett C pans show an average HTC of 107 W/m²°C compared to an average of 64 W/m²°C measured on FCB pans at Sezela and Gledhow mills (Munsamy 1982, 1988). An SRI pan on C massecuite at Sezela mill gave an average HTC of 61 W/m²°C (Munsamy, 1988). Heat transfer performance of an FCB (CCTW) pan at Cruz Alta in Brazil, as reported by Journet (1998), was considered but has not been included in Figure 3 since it falls outside Southern Africa. However, it is worth noting though that the Cruz Alta pan gave an average HTC of 68 W/m²°C at a ΔT of 31.2 °C at a higher massecuite purity (62.9) than Southern African C - massecuites.

Rein (1986) noted that heat transfer rates and pan circulation are closely linked. The faster the heat transfer rate, the more vapour is generated resulting in better circulation. Figures 4 - 6 show plots of specific evaporation in continuous pans (kg/h.m²) as a function of ΔT (difference in temperature between calandria steam and massecuite leaving the pan) for A, B and C massecuites. Specific evaporation rate (kg/h.m²) in Tongaat Hulett pans for cane sugar massecuites is linearly dependent on ΔT and can be predicted by the following correlations:

A - massecuite:
\[ \text{Evaporation} = 0.28 \Delta T + 11.3 \]  

B - massecuite:
\[ \text{Evaporation} = 0.16 \Delta T + 5.6 \]  

C - massecuite:
\[ \text{Evaporation} = 0.48 \Delta T - 10.1 \]
Fig. 4: Specific evaporation rates as a function of temperature difference (between condensing vapour and massecuite) for Tongaat-Hulett A massecuite continuous pans.

Fig. 5: Specific evaporation rates measured in South African B massecuite continuous pans.

HEATING SURFACE / VOLUME RATIOS

The first continuous pans installed were conservative in that more heating surface than was actually necessary was incorporated. These pans had heating surface/volume ratios of about 10 m⁻¹ (i.e., 10 m² of heating surface per m³ of pan capacity). As a result, most of the early Tongaat-Hulett continuous pans run with calandria pressures at or below atmospheric pressure on average.

In subsequent installations, this has been reduced to 9 m⁻¹, and, more recently, two pans have been installed with a ratio of 8 m⁻¹.
Based on the average heat transfer coefficients for Tongaat-Hulett A pans and the values for C pans shown in Figure 3 and Table 2, it can be shown that lower heating surface areas can be utilised with higher calandria pressures. The results of calculations are shown in Table 3, for A and for C massecuites.

**Table 3 : Heat transfer areas required in Tongaat-Hulett continuous pans as a function of calandria steam conditions (Assumptions: feed brix of 67 and massecuite / seed ratios of 3.0 and 2.0 for A and C massecuite pans respectively.)**

<table>
<thead>
<tr>
<th>Calandria pressure (k Pa)</th>
<th>143</th>
<th>121</th>
<th>101</th>
<th>85</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam Temperature (°C)</td>
<td>110</td>
<td>105</td>
<td>100</td>
<td>95</td>
<td>90</td>
</tr>
<tr>
<td>Heating surface/volume ratio A massecuites (m⁻¹)</td>
<td>6.0</td>
<td>6.4</td>
<td>7.4</td>
<td>8.8</td>
<td>10.7</td>
</tr>
<tr>
<td>Heating surface/volume ratio C Massecuites (m⁻¹)</td>
<td>3.7</td>
<td>4.9</td>
<td>7.0</td>
<td>10.7</td>
<td>18.8</td>
</tr>
</tbody>
</table>

These results show clearly that the use of higher calandria pressures enables significant savings to be made in terms of reduced heating surface. If heating steam of over 105°C is utilised, heating surface/volume ratios of 6 m⁻¹, similar to those used in batch pans, can be utilised.

The advantage that continuous pans have over batch pans is that lower pressure calandria vapour can be used if required, but at the expense of additional heating area, while still relying on natural circulation. This allows steam economy to be significantly improved where this is of advantage. It is evident from Figures 3 to 6 that continuous pans generally operate with ΔT values of 25° to 40°C. Generally, batch pans without stirrers have to operate with ΔT values of over 40°C to achieve reasonable boiling times, particularly as the pan fills up.

**Fig.6 : Specific evaporation rates measured in South African C massecuite continuous pans**
CRYSTAL QUALITY

It has previously been shown that quality of sugar produced in a continuous pan is better than that achieved under the same conditions in batch pans (Rein, 1986). In particular, sugar colour is lower, and quality improvements are generally ascribed to more uniform boiling conditions within a continuous pan.

Inspection of data for A massecuites and C massecuites from South African factories shows no discernible differences in CV (coefficient of variation) of sugar for factories with batch or continuous pans.

Figure 7 shows the relationship between CV and MA (mean aperture) for A-sugar delivered by South African sugar factories to the South African Sugar Terminal between 1996 and July 1998. It is evident from this relationship that in general, there is no noticeable difference between batch and continuous pan factories, indicating that the crystal size distribution of sugar from continuous pans is no different from that achieved in batch pans. The exception in Figure 7 is sugar from Eston mill (continuous pans) which records high CV values. As outlined earlier, at Eston B magma is used as seed for the A pans. Although the B magma centrifugal has a big monitor casing, it used to operate at 2100 rpm resulting in excessive crystal breakage. The centrifugal speed has since been reduced to 1800 rpm resulting in less crystal breakage and hence an improvement in CV (from 59 in 1996 to 47 in 1998). Nevertheless, a method of improving B magma crystals size distribution prior to entry into A continuous pans is being investigated at Eston, in order to improve the A sugar CV.
In evaluating crystal size variation in continuous pan massecuite it should be borne in mind that the crystal size distribution in the seed has a large influence on size variation in the massecuite, as shown by Rein et al (1985).

In general, it is evident that if properly designed, continuous pans can be operated to approximate plug flow conditions closely. The consequence is a fairly uniform crystal retention time resulting in a crystal size distribution that is not significantly different to that of batch pans. It is noted however, that there is a considerable distribution in crystal size in both batch and continuous pans but this is due to other crystal growth mechanisms applicable to both batch and continuous pan operations which have been investigated in detail by Wright and White (1969). In general however, in A massecuites as crystals grow, the CV improves, as Figure 7 shows.

Investigations into C massecuite crystal size and size distribution variations were conducted by Jullienne (1985) for South African sugar factories in the 1984/5 season. The objective of the investigation was to encourage South African factories to produce C massecuite of not less than 150 micron mean crystal width in order to reduce physical losses at the centrifugals. He analysed C massecuite crystal size using the Kontron MOP Video Plan and expressed the dispersion of the crystal population size as a relative standard deviation. The results of these tests are shown in Figure 8. In general, the standard deviation appears to depend linearly on the mean crystal width with no discernible difference between batch and continuous pans.

![Fig. 8: Dispersion of C crystal width values as a function of the mean (data from Julienne, 1985)](image)

In C massecuites (low purity), uniform crystal growth is inhibited by the presence of impurities, so that as crystal size increases, the crystal size spread also increases. This is different from A massecuites. In their investigations into causes of crystal size distribution in high purity massecuites, Wright and White (1969) made a similar observation and proposed that the size spread, as measured by the variance, varies linearly with increasing mean size. In high purity A massecuites, the coefficient of variation (CV) decreases with increasing crystal mean width. This can be explained by the crystal growth mechanisms, as proposed by Wright and White (1969). At
low crystal growth rates the supersaturation is low and crystals tend to grow preferentially where there are surface imperfections or dislocations on the crystal surface. On the other hand, at high growth rates the supersaturation is higher and is able to enhance new growth centres which are evenly distributed over the crystal surfaces, giving a more uniform growth of crystals.

It has previously been shown (Rein et al, 1985) how crystal size and size distribution (or CV) can be calculated for a tanks-in-series model (assuming that the pan is equivalent to a number of perfectly mixed tanks connected in series), based on the assumption of a log normal crystal size distribution. The equation for the variance $\sigma^2$ of the size distribution (on a number basis) is given by:

$$\sigma^2 = \sigma^2_i + \frac{w^2 t^2}{n} + p w t$$

where $\sigma^2_i$ is the variance of the seed crystal distribution
$w$ is the average growth rate (mm/hr)
$n$ is the number of tanks in series
$t$ is time (hr)
$p$ is a proportionality constant (mm), expressing the degree of crystal dispersion for a given increase in crystal size (Wright & White, 1969).

Based on the assumption that there is no nucleation, crystal break-up or agglomeration occurring, this equation can be used to compute the effect of number of compartments (or tanks-in-series) on product crystal CV. By fitting data for A massecuite to this equation, it was found that typical values of $w$ and $p$ are 0.05mm/hr and 0.05mm respectively. Using these values, predicted CV values for typical A massecuite pan conditions were calculated, as shown in Figure 9.

![Figure 9: Calculated A sugar CV values for A continuous pans](image)

It is clear that there is little benefit to be gained (in terms of CV) in increasing the number of
tanks-in-series above 12. Since it has been found that a 12-compartment Tongaat-Hulett pan can generally be represented by about 18 tanks-in-series (Rein et al., 1985), 12 tanks-in-series is roughly equivalent to 8 compartments. It appears that it should be possible to reduce the number of compartments without sacrificing crystal size distribution. Some of the more recent installations in South Africa have 10 compartments, and there is scope to reduce this still further.

CONCLUSIONS

Continuous pan technology has been developed to the extent that it is internationally accepted and plays a big role in cost effective pan floor expansions and new pan installations. Continuous pans enhance fuel economy as low grade vapours can be used and have the advantage of maintaining steady operating conditions.

Continuous pans have been widely applied in Southern African mills. Development of continuous seed production technology is still logging behind and hinders the upgrading of pan floor operations to fully continuous systems.

Heat transfer and evaporation rates in continuous pans have been evaluated under natural circulation, with vertical tube calandria pans showing superior massecuite circulation.

There is no noticeable difference in the crystal size distribution of sugar from continuous pan massecuite compared to that of a batch pan, provided that the pan is fed with reasonable quality seed and the massecuite flow in the pan approximates to reasonable plug flow conditions.

REFERENCES


**UNA REVISION DEL DESARROLLO DE TACHO CONTINUO EN LA INDUSTRIA AZUCARERA DE AFRICA MERIDIONAL**

P.W. Rein y M.P. Msimanga  
Azucar Limite Tongaat-Hulett  
Africa del Sur

**RESUMEN**

La amplia adopción de cocción entacho continuo en los países África meridional va a ser revisada. Aquí se muestra cómo el uso de tachos continuos forma la base de la efectividad del costo de expansión y estrategias de reemplazo en preferencia a tachos discontinuos. Se presentará lo último en experiencia con control y operación de tachos continuos. Datos del comportamiento de la velocidad en transferencia de calor y información sobre la calidad del cristal son presentados, mostrando cómo pueden ser utilizados menos compartimentos y radios más pequeños de la superficie de calentamiento/volumen.

**LE DEVELOPMENT DES CUITES CONTINUES DANS LES INDUSTRIES SUCRIERES DU SUD DE L'AFRIQUE**

P.W. Rein et M.P. Msimanga

**RÉSUMÉ**

On discute l'emploi des cuites continues dans la région Sud Africaine. Ces appareils permettent une expansion de capacité ou le remplacement des cuites discontinues, pour un cout raisonnable. On présente des données de performance et on montre l'avantage d'un nombre réduit de compartiment et d'un rapport surface de chauffe/volume plus petit. Finalement les méthodes de contrôle et l'opération des cuites sont présentés.