A REVIEW OF ENERGY MANAGEMENT AND IMPROVEMENTS AT NOODSBERG SUGAR MILL OVER THE PAST EIGHT YEARS

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Abstract

In common with all South African back-end refiners, Noodsberg has had to use supplementary fuel to meet its energy requirements since refining began in 1982. The import refining of Union Co-op raws since 1984 has imposed further energy demands which have had to be met. Measures taken over the past eight years to reduce the factory's dependence on coal burning are described and their effectiveness quantified in terms of coal burnt per week.

Introduction

Since 1983 a steady improvement in the overall thermal efficiency at Noodsberg has taken place and coal usage has dropped by about 90%. The absence of reliable steam % cane measurements and the continually changing energy loads and fibre levels over the years have made it difficult to assess positively the individual energy saving changes. For this reason, a theoretical approach has been adopted and a computer model of NB's process steam requirements has been developed. A theoretical base case has been derived which reflects the energy and supplementary fuel required to operate at the 90/91 season production levels, assuming no improvements had been made since the 1983 base year. Each subsequent improvement is then evaluated relative to the base case.

Computer model

The spreadsheet model used consists of a process steam balance built around the evaporators and linked to a factory mass balance with reconciliation of computed energy requirements against available fibrous fuel. The model uses an iterative method to adjust vapour pressures, enthalpy, flash, and syrup brix to equilibrium in response to any process change.

The model assesses the global effects of a process change, rather than a theoretical calculation focused on the unit operation concerned.

Base case

The production variables from the 1990/91 season were used in the base case:

Production variables from the 1990/91 season

TCH	300
Imbibition % fibre	300
Moisture % bagass	53,5
Refining rate (%)	138
Overall time efficiency	85

Performance data used from the 1983 season

A massecuite exhaustion	62
Refinery brix recovery	90
Melt brix refinery	65
Total movement water/ton sugar (kg)	550
Boiler efficiency	73

Base case energy requirements

Exhaust steam to process/hour (t/h)	210
Steam % cane	76,24
Steam % cane supported by bagasse	49,8
Coal burnt per week (tons)	1 174

Discussion

Plant installation

Step 1: Liquid/liquid heating of mixed juice

During the 1983 season, a shell and tube liquid/liquid heater was installed as a primary mixed juice heater.

Reject condensate at about 85°C was used to heat mixed juice from 32 to 50°C. This condensate was previously bled into the factory's condenser water system and served no useful purpose. In effect the use of the liquid/liquid heater reduced the amount of vapour 1 (V1) required for secondary juice heating with resulting steam savings.

Effect on energy requirement for process by introduction of liquid/liquid heating:

Exhaust steam to process/hour (tons)	204
Steam % cane	74,12
Coal burnt per week (tons)	1 080
Coal saved per week (tons)	94

Step 2: The application of mechanical vapour recompression

In 1984, a mechanical vapour recompressor was commissioned. The principle involved was to recompress vapour 2 (V2) from 20 to 100 kPa. An electrically driven compressor was used for the purpose, delivering 40 tons per hour to a dedicated Roberts first effect.

The saving was primarily made by using the energy previously lost in high pressure let-down steam to provide the power to upgrade the V2. To accommodate the extra 40 tons of V2 bleed, mixed juice heating duties had to be rearranged between V1 and V2 with the maximum possible on V2. This led to a substantial increase in syrup brix, and added to the overall savings made by this step.

Effect of MVR on energy requirements

Exhaust steam to process/hour (tons)	179
Steam % cane	65,06
Coal burnt per week (tons)	678
Coal saved per week (tons)	402

Step 3: Flash steam utilisation

During the 1981/82 expansion, all condensate flash was directed to the calandria of the evaporator's 4th vessel. The utilisation of flash in this manner had a depressing effect on syrup brix, which became more apparent as throughput increased. This was due to suppression of evaporation from the preceding vessels, a situation analogous to 'negative' vapour bleeding. Options considered to overcome the problem were installing a full cascade system or making use of the combined flash for juice heating. Although not the more thermally efficient, the second option was chosen as modifications needed were minimal, and the temperature and quantity of flash were ideally suited to a mixed juice heating stage in one of the existing heaters. The end result was that MJ could now be heated from 50 to 65°C by flash steam.

Effect of flash juice heating on energy requirements

Exhaust steam to process/hour	174
Steam % cane	63,14
Coal burnt per week (tons)	593
Coal saved per week (tons)	85

Process performance improvements

Step 4: Improving A-massecuite exhaustion

Singh (1989) documented the steady improvement in A-massecuite exhaustion and the reasons for the improvement. In summary, the exhaustion has improved from 62 to 70% and the energy savings came about through reduced volumes of A and B-massecuites having to be boiled.

Effect of A-massecuite exhaustion improvement of energy requirement

Exhaust steam to process/hour (tons)	169
Steam % cane	61,16
Coal burnt per week (tons)	525
Coal saved per week (tons)	68

Step 5: Improved refinery recovery

An active programme to improve refinery recovery has been used since 1983 when brix recoveries of 90% were common. Now the recovery stands at about 94% and the reasons for this improvement are:

- Application of improved pan boiling techniques and procedures
- Liquor wash of centrifugal massecuites as a partial substitute for wash water
- A strictly enforced policy of not allowing blending of 1st, 2nd, or 3rd runoff
- The introduction of a secondary scums dewatering stage to the phosphatation plant
- Longer secondary filter cycles due to the introduction of Tate & Lyle deep bed filtration.

The effect of this is reflected below.

Effect of refinery recovery improvement on energy requirements

Exhaust steam to process/hour (tons)	165
Steam % cane	60,12
Coal burnt per week (tons)	459
Coal saved per week (tons)	66

Step 6: An increase in refinery melt brix

It was previously believed that 65°C brix was optimum for operating a Talo phosphotation clarifier. By raising melt temperature to 90 from 85°C, it was possible to operate the clarifier with equal efficiency at 70°C brix and this became routine. The filters were easily able to cope with the additional brix load.

Effect of increasing refinery melt brix to 70C on energy requirements

Exhaust steam to process/hour (tons)	164
Steam % cane required	58,38
Coal required per hour (tons)	382
Coal saved per week (tons)	77

Process innovation

Step 7: Reduction of pan movement water by graining technique

Both rawhouse and refinery pans when fitted with stirrers were able to reduce movement water requirements by allowing the stirrer to bring in the grain. The technique involved shutting off the steam and condenser water once the graining point was reached, then injecting slurry and allowing the grain to develop while the stirrer ran continuously. Movement water usage was reduced from 550 kg/ton sugar to 370 kg/ton sugar.

Effect of reduction of pan movement on energy requirement

Exhaust steam to process/hour (tons)	154
Steam % cane required	56,11
Coal required per week (tons)	281
Coal saved per week (tons)	101

Step 8: Substitution of A, B & C pan movement water with clarified juice

As from August 1990, this system was commissioned and found to have little effect on massecuite purities. In addition to a saving in pan evaporation (work due to the substitution of juice for water), a major gain occurred by slip streaming juice around the evaporator, thereby raising the syrup brix by ±2 units. The net result was a further reduction in Vapour 1 used on the A pans.

Effect of clarified juice as movement water on steam requirement

Exhaust steam to process/hour (tons)	146,5
Steam % cane required	53,3
Coal required per week (tons)	157
Coal saved per week (tons)	124

Step 9: Flocculant preparation with clear juice

By substituting clarified juice for water, a reduction of 1,5 tons of water per hour into the evaporator was achieved. No loss in performance of the flocculant was experienced.

Effect of flocculant preparation with clear juice

Exhaust steam to process/hour (tons)	146,5
Steam % cane required	53,03
Coal required per week (tons)	145
Coal saved per week (tons)	12

Summary and Conclusions

Tons of coal saved	
Equipment installation	581
Process performance improvement	211
Process innovation	237
Total	1 029

- With an average season length of 30 weeks and a landed price of R100 per ton, coal savings per season would amount to R3 087 000.
- Equipment installations effected by far the biggest savings. However, when grouped together the process performance improvements also greatly reduced the overall energy requirements.
- The need for innovative and creative thinking should not be overlooked, as often large savings can be made from a small investment.
- Room for further improvement is also obvious. Achieving a moisture % bagasse of 50 and the introduction of B sugar affination are two areas which can be mentioned. It is believed quite possible that Noodsberg could become energy self sufficient in the near future with a continuation of the approach of the last few years.

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REFERENCE

Singh, I (1989). Improvements in A-Massecuite Exhaustion at Noodsberg. *Proc S Afr Sug Technol Ass* 63: 85-89.