

# SOME COMMENTS ON THE ELONGATION RATIO OF CRYSTALS IN C-MASSECUITES

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## Abstract

Crystal size distribution (CSD) and elongation ratios for the crystals in South African C-masseccutes have been measured on a weekly basis for the past 20 seasons by the Sugar Milling Research Institute.

The degree of control available at the factory for these two parameters is different: the CSD and, more particularly, the average value of the crystal width, is controllable through such factors as the amount of slurry added and the number of masseccuite cuts. The elongation ratio is determined by the presence of specific impurities such as kestoses and, possibly, dextran, which are introduced into the factory mostly through cane deterioration. Thus, the elongation ratio and any processing effects associated with it are generally outside the control of process management.

Elongation ratios in the Tongaat-Hulett Sugar factories during the 2005 season are examined, and attempts made to identify parameters that may be associated with them. Some effects associated with elongation ratios and various unit operations in the FX C-station are discussed. It appears that higher elongation ratios may be associated with poor exhaustions in the C-station at this factory.

*Keywords:* CSD, elongation ratio, exhaustion, C-crystal, factory process

## Introduction

In 1982, the Sugar Milling Research Institute (SMRI) started investigating methods for determining the crystal size distribution (CSD) in C-masseccutes. A semi automatic system based on the Kontron IBAS-1 Video Image Analyser showed promise and was purchased in 1983. Surveys of crystal sizes in C-masseccutes were then conducted. The technique was also used to measure the crystal length-to-width ratio, referred to as an elongation ratio (ER). In the case of raw cane sugar products this gives an indication of the crystal habit, i.e. the ratio of the crystal length in the c-axis direction to that in the b-axis direction. Two pioneering papers, one on crystal size distribution in C-masseccutes (Jullienne) and the other on crystal habit (Morel du Boil) were published in 1985. Subsequently, reports on the role of oligosaccharides on crystal habit and processing (Morel du Boil, 1991; 1995) and the relationship between ER and viscosity (Jullienne, 1995) have been published. Regular surveys of CSD and ER for crystals in C-masseccutes have been recorded by the SMRI for more than 20 years, the weekly results being obtained from a catch sample of C-masseccuite taken at the centrifugals. Some relationships between these parameters and processing conditions are explored in this paper.

## CSD and ER

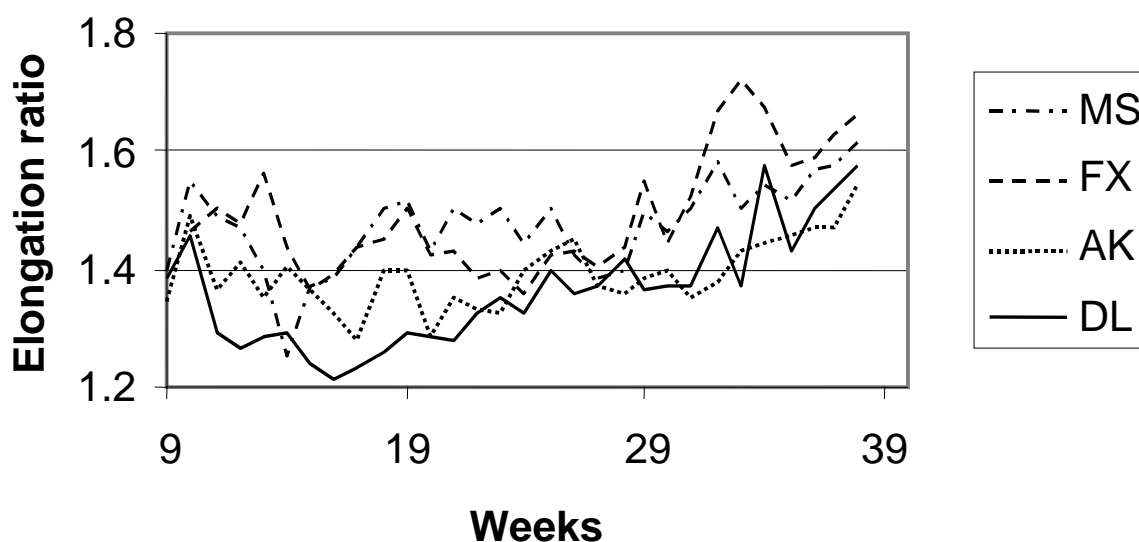
The degree of control available at the factory for these two parameters is different: the CSD and, more particularly, the average value of the crystal width, is controllable by means of such factors as the amount of slurry added, and the number of massecuite cuts. The elongation ratio is determined by the presence of specific impurities such as kestoses and, possibly, dextrans, which are introduced into the factory mostly through cane deterioration. Microbiological activity in the factory can, however, introduce smaller amounts of these impurities and, in that respect, good factory sanitation provides limited control. Thus, the ER and any processing effects associated with it are mostly outside the control of process management.

Averaged values of the elongation ratio for the past three seasons at the Tongaat-Hulett Sugar (THS) factories are shown in Table 1. Although the range is not large, Darnall generally shows the lowest ratio.

**Table 1. Elongation ratio for C-crystals: seasonal values.**

Season	2003	2004	2005
Maidstone	1.37	1.57	1.47
Entumeni	1.47	–	–
Felixton	1.39	1.50	1.49
Amatikulu	1.36	1.47	1.39
Darnall	1.37	1.41	1.36

The 2005 seasonal trend for ER is shown in Figure 1, with FX giving the highest ratio.



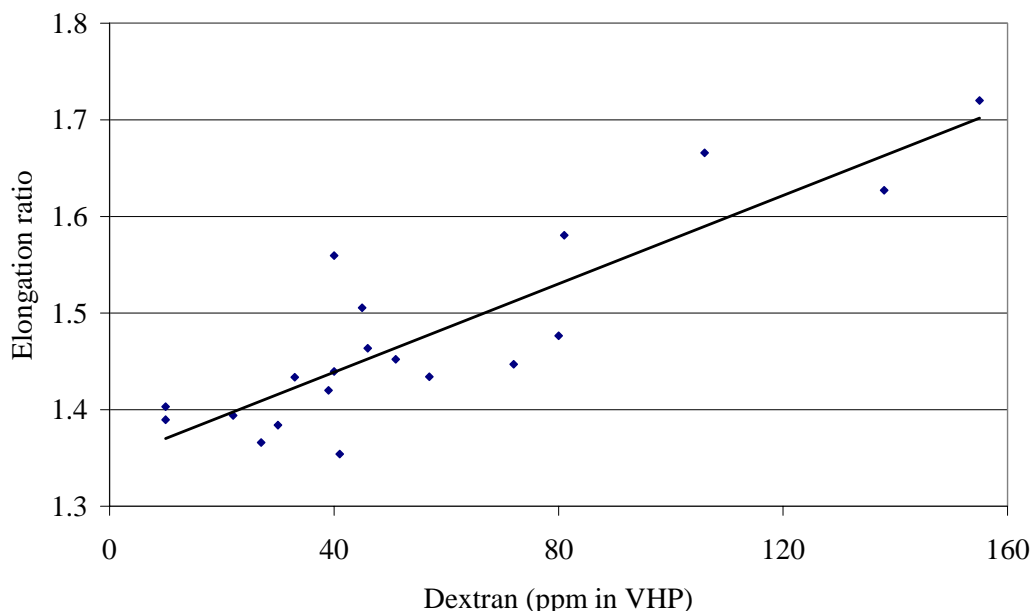
**Figure 1. Weekly elongation ratios for C-crystals during the 2005 season (Maidstone = MS, Felixton = FX, Amatikulu = AK and Darnall = DL).**

## Elongation ratio and exhaustion parameters

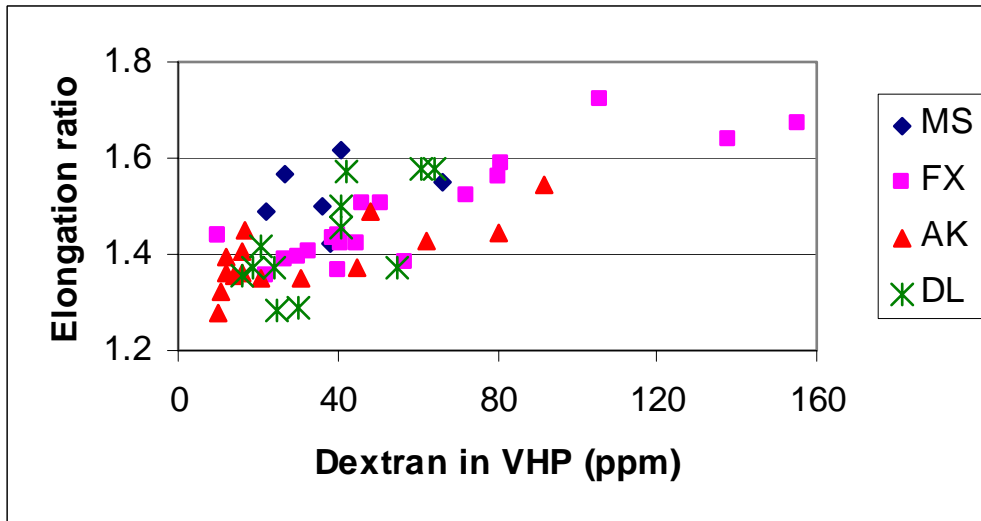
An attempt is now made to identify parameters that are associated with the elongation ratio in the THS factories. It has been widely reported (Smythe, 1967; Bruijn and Morel du Boil, 1986; Morel du Boil 1985, 1991, 1995, 1998; Ravnö and Purchase, 2005) that a number of specific impurities can slow down or stop the crystallisation rate of particular faces of the sucrose crystal, and it is expected that the concentration of these impurities will be associated with the elongation ratio. Unfortunately, these concentrations are not readily available.

Since differences in factory equipment and operator efficiency will influence any comparisons between the C-stations, the following comments are restricted to a single factory, namely Felixton (FX). Weekly data from the 2005 season at FX are used to explore further trends.

Figure 2 is a plot of the FX C-crystal elongation ratio against the dextran concentration (Haze method) in FX VHP sugar received by the Terminal; clearly, there is a positive relationship between the two parameters. Ravnö and Purchase (2005) state that about 20% of the total dextran in juice is occluded in the VHP sugar (measured as high molecular weight dextran). As a rough approximation, this indicates that about 80% of the dextran entering the factory would exit in final molasses and thus affect the C-station operation. The trend between ER and dextran in VHP for all the THS factories can be seen in Figure 3. It must be stressed that this association is not one of cause and effect. It has been clearly shown by Bruijn and Morel du Boil (1986) and by Mantovani *et al* (1991) that the contribution of high molecular weight components (including dextran) to crystal elongation is minimal under South African conditions. The major causative influence in cane sugar is from the presence of certain oligosaccharides formed during cane deterioration (Morel du Boil, 1998). Furthermore, several workers have been unable to correlate dextran and crystal elongation in C-masseccuite (Tilbury, 1971; Hidi and Staker, 1975; Morel du Boil, 1998).

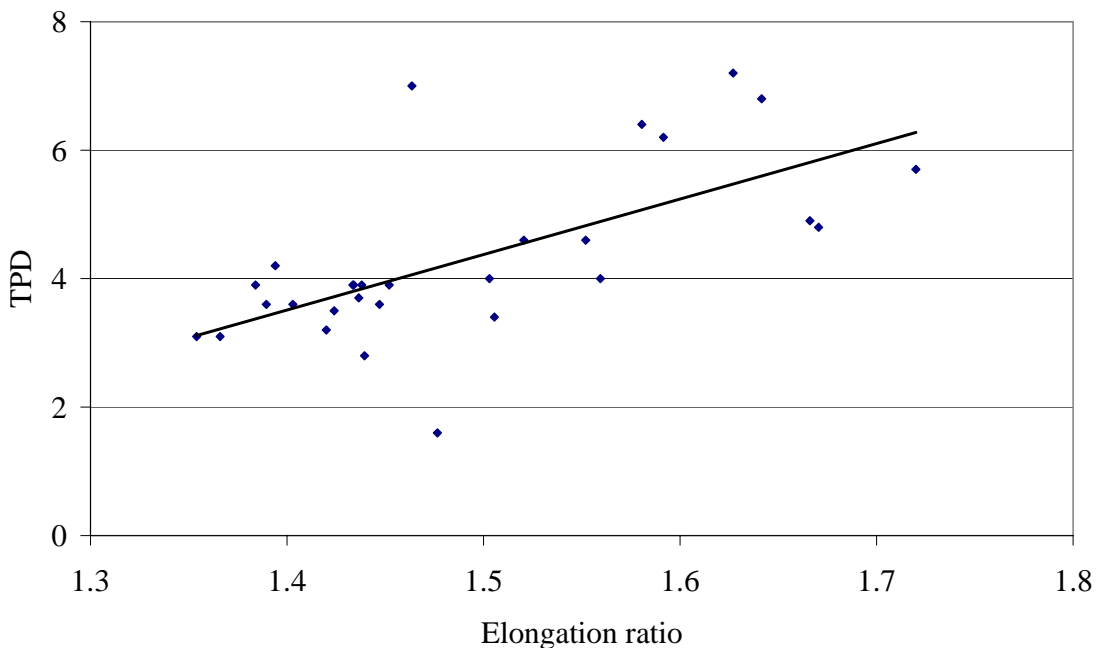


**Figure 2. Elongation ratio of for Felixton sugar factory (FX) C-crystals plotted against the concentration of dextran in FX very high pol (VHP) sent to the Terminal, 2005 season.**



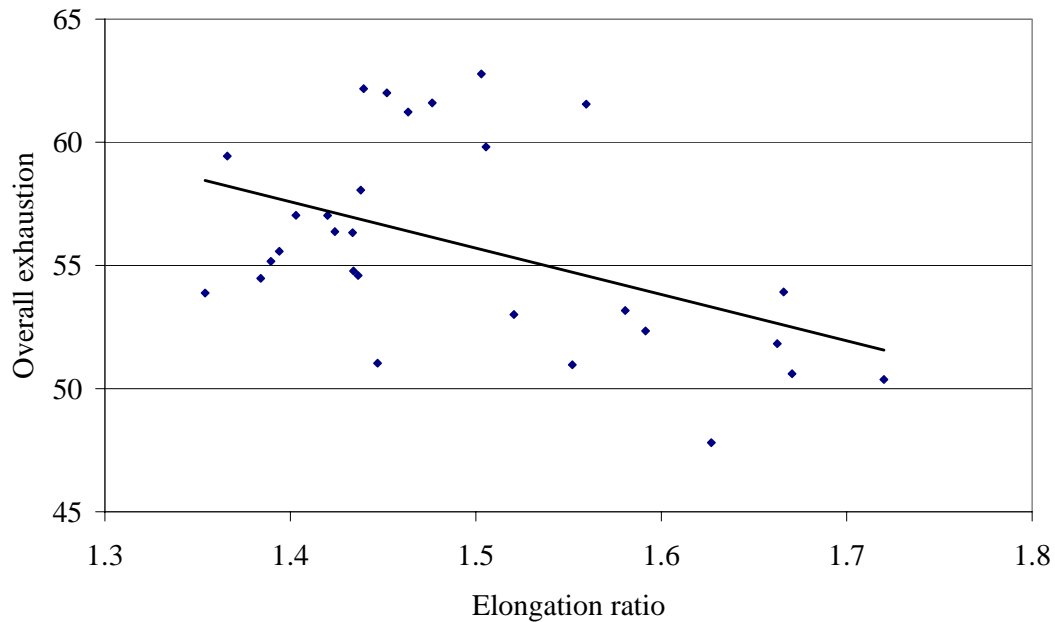
**Figure 3. Elongation ratio for C-crystals plotted against the concentration of dextran in very high pol (VHP) sent to the Terminal by the Tongaat-Hulett Sugar factories, 2005 season. (Maidstone = MS, Felixton = FX, Amatikulu = AK and Darnall = DL)**

Ravnö and Purchase (2005) also present a relationship between dextran in VHP (Haze method) and target purity difference (TPD) at Pongola, a factory with very high levels (up to 1200 ppm in VHP) of dextran; a similar relationship at FX is not evident, probably because the levels of dextran are much lower (up to 160 ppm). There is, however, a positive trend between TPD at FX and the C-crystal elongation ratio, as shown in Figure 4. As an approximate estimate, a 0.1 unit increase in elongation ratio is associated with a 0.8 unit increase in TPD at this factory, with both these values being close to the experimental error.

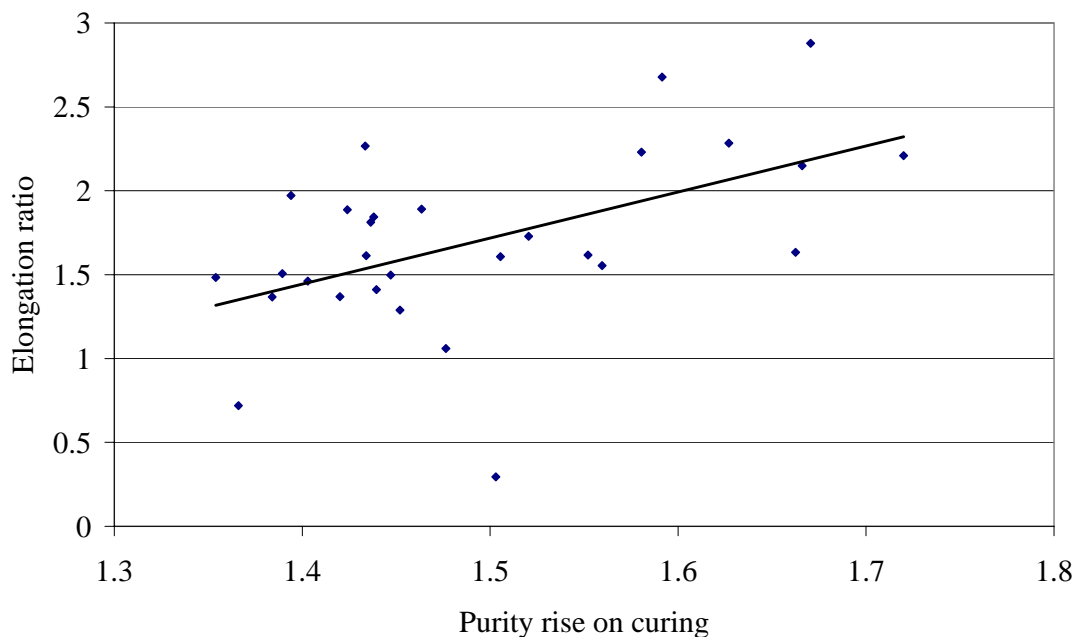


**Figure 4. Weekly target purity difference (TPD) plotted against the elongation ratio of the C-crystals at Felixton sugar factory, 2005 season.**

An attempt has also been made to associate the ER with the various unit operations used in the FX C-station. Weekly C-massecuite Brix and purities, nutsch purities at strike, after the crystallisers, after reheating, and final molasses purities, for the 2005 season, were obtained from the laboratory information management system (LIMS) at THS. These data were used to calculate weekly purity drops, exhaustions and purity rises over curing. Only two of the parameters, namely the overall exhaustion (C-massecuite to final molasses) and the purity rise over curing, showed reasonably clear trends with the ER, as shown in Figures 5 and 6.



**Figure 5. Weekly overall exhaustion plotted against the elongation ratio for C-crystals at Felixton sugar factory, 2005 season.**



**Figure 6. Weekly purity rise over curing plotted against the elongation ratio of the C-crystals at Felixton sugar factory, 2005 season.**

The results in Figures 5 and 6 are in line with observations reported by Ravnö and Purchase (2005), namely that the elongated crystals are fragile and tend to break during centrifugation, and that they hinder purging, resulting in a need for additional wash water. Also, since elongation is caused by blocked or retarded crystallisation on specific crystal faces, the crystallisation process will be incomplete within the time available, thus decreasing exhaustion. The generally smaller crystals associated with high ER will also tend to pass through the centrifuge screens, further contributing to the molasses purity rise and increased TPD (Jullienne, 1985).

### Conclusions

This brief investigation of the C-crystal elongation ratio at Felixton indicates that this parameter can be associated with the performance of the C-station; more particularly, higher than usual ratios are associated with reduced C-masseccuite exhaustions, a higher purity rise over curing, and thus higher TPD values at a particular factory. The positive association of ER and dextran and the trends presented here imply that deterioration products have a negative effect on back-end operations.

### Acknowledgements

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