****

**KNOWLEDGE COMPONENT: LEARNING RESOURCE:**

**BOOK 3: SUGAR PROCESSING FACTORY CONTROL CALCULATIONS**

**OCCUPATIONAL QUALIFICATION: SUGAR PROCESSING CONTROLLER**

**KNOWLEDGE COMPONENT:**

**LEARNING RESOURCE**

**BOOK 3: SUGAR PROCESSING FACTORY CONTROL CALCULATIONS**

**KNOWLEDGE COMPONENT:**

**LEARNING RESOURCE**

**BOOK 3: SUGAR PROCESS FACTORY CONTROL CALCULATIONS**



**OCCUPATIONAL QUALIFICATION:**

**SUGAR PROCESSING CONTROLLER**

**©Copyright AgriSETA**

**Telephone: +27 12 301 5600**

 ****

AgriSETA holds the copyright to its publications and Web pages. Proper citation is requested.

**TABLE OF CONTENTS**

[AN INTRODUCTION TO THIS LEARNING RESOURCE 8](#_Toc526490299)

[KNOWLEDGE MODULE 3 9](#_Toc526490300)

[SUGAR PROCESSING FACTORY CONTROL CALCULATIONS 9](#_Toc526490301)

[1.1 Knowledge Topic 1: Introduction to factory control concepts 10](#_Toc526490302)

[1.1.1 INTRODUCTION 10](#_Toc526490303)

[1.1.2 DAILY AVERAGING 10](#_Toc526490304)

[1.1.3 DAILY FIGURES 11](#_Toc526490305)

[1.1.4 WEEK AND TO-DATE FIGURES 12](#_Toc526490306)

[1.1.5 MONTHLY FIGURES 13](#_Toc526490307)

[1.1.6 ANNUAL FIGURES 13](#_Toc526490308)

[1.1.7 CANE PAYMENT 13](#_Toc526490309)

[1.1.7.1 Mill Balance 13](#_Toc526490310)

[1.1.7.2 Direct Analysis of cane (DAC) 13](#_Toc526490311)

[1.1.8 FORMULAE FOR FACTORY CONTROL CALCULATIONS 13](#_Toc526490312)

[1.1.8.1 Tons Water 13](#_Toc526490313)

[1.1.8.2 Tons brix in bagasse 14](#_Toc526490314)

[1.1.8.3 Tons moisture in bagasse 14](#_Toc526490315)

[1.1.8.4 Tons fibre in bagasse 14](#_Toc526490316)

[1.1.8.5 Tons pol in bagasse 15](#_Toc526490317)

[1.1.8.6 Tons pol in mixed juice 15](#_Toc526490318)

[1.1.8.7 Tons brix in mixed juice 15](#_Toc526490319)

[1.1.8.8 Tons suspended solids in mixed juice 15](#_Toc526490320)

[1.1.8.9 Tons corrected pol in mixed juice 15](#_Toc526490321)

[1.1.8.10 Tons corrected brix in mixed juice 17](#_Toc526490322)

[1.1.8.11 Tons pol in cane (Mass balance pol) 17](#_Toc526490323)

[1.1.8.12 Tons brix in cane (Mass balance brix) 17](#_Toc526490324)

[1.1.8.13 Tons DAC fibre in cane 18](#_Toc526490325)

[1.1.8.14 Tons DAC brix in cane 18](#_Toc526490326)

[1.1.8.15 Tons DAC pol in cane 18](#_Toc526490327)

[1.1.8.16 Tons cane per hour 18](#_Toc526490328)

[1.1.8.17 Tons fibre per hour 18](#_Toc526490329)

[1.1.8.18 Fibre % bagasse 18](#_Toc526490330)

[1.1.8.19 Pol % cane 19](#_Toc526490331)

[1.1.8.20 Fibre % cane 19](#_Toc526490332)

[1.1.8.21 Brix % cane 19](#_Toc526490333)

[1.1.8.22 Fibre in bagasse % cane (uncorrected) 19](#_Toc526490334)

[1.1.8.23 Imbibition % fibre 19](#_Toc526490335)

[1.1.8.24 Corrected brix % mixed juice 19](#_Toc526490336)

[1.1.8.25 Corrected pol % mixed juice 19](#_Toc526490337)

[1.1.8.26 Purity of mixed juice 19](#_Toc526490338)

[1.1.8.27 Mixed juice % cane 20](#_Toc526490339)

[1.1.8.28 Imbibition % cane 20](#_Toc526490340)

[1.1.8.29 Pol % cane by material balance (Pol % cane by mass balance) 20](#_Toc526490341)

[1.1.8.30 Brix % material balance (Brix % by mass balance) 20](#_Toc526490342)

[1.1.8.31 Pol Factor 20](#_Toc526490343)

[1.1.8.32 Brix factor 20](#_Toc526490344)

[1.1.8.33 Fibre factor 20](#_Toc526490345)

[1.1.8.34 Bagasse Purity 20](#_Toc526490346)

[1.1.8.35 Material balance cane purity 20](#_Toc526490347)

[1.1.8.36 DAC purity 21](#_Toc526490348)

[1.1.8.37 Extraction 21](#_Toc526490349)

[1.1.8.38 Corrected reduced extraction (CRE) 21](#_Toc526490350)

[1.1.8.39 Boiling house recovery 21](#_Toc526490351)

[1.2 Knowledge Topic 2: Daily Materials Balance 22](#_Toc526490352)

[1.2.1 THE DAILY MATERIALS BALANCE 22](#_Toc526490353)

[1.2.2 MASS OF BAGASSE 24](#_Toc526490354)

[1.2.3 THE MILL BALANCE 24](#_Toc526490355)

[1.2.4 WORKED EXAMPLE OF A DAILY MATERIAL BALANCE 26](#_Toc526490356)

[1.3 Knowledge Topic 3: Stock Taking of Factory Products 45](#_Toc526490357)

[1.3.1 INTRODUCTION 45](#_Toc526490358)

[1.3.2 DATA COLLECTION 45](#_Toc526490359)

[1.3.3 ERRORS 46](#_Toc526490360)

[1.3.4 TAKING STOCK OF PRODUCTS 46](#_Toc526490361)

[1.3.4.1 Clear juice 46](#_Toc526490362)

[1.3.4.2 Mud 46](#_Toc526490363)

[1.3.4.3 Syrup and molasses 46](#_Toc526490364)

[1.3.4.4 Massecuites 46](#_Toc526490365)

[1.3.4.5 Magma and seed 46](#_Toc526490366)

[1.3.4.6 Sugar 47](#_Toc526490367)

[1.3.5 WORKING OUT THE STOCK IN PROCESS 47](#_Toc526490368)

[1.3.6 ABBREVIATED EXAMPLE OF A STOCKTAKING EXERCISE 48](#_Toc526490369)

[1.3.7 DERIVING THE SJM FORMULA 49](#_Toc526490370)

[1.4 Knowledge Topic 4: Factory Performance Calculations 52](#_Toc526490371)

[1.4.1 CONSIDERING PRODUCTS STILL IN THE PROCESS 52](#_Toc526490372)

[1.4.2 NEED FOR FACTORY DATA 53](#_Toc526490373)

[1.4.3 FACTORY PERFORMANCE CALCULATIONS: INTRODUCTION 53](#_Toc526490374)

[1.4.4 FACTORY PERFORMANCE CALCULATION: EXAMPLE 55](#_Toc526490375)

AN INTRODUCTION TO THIS LEARNING RESOURCE

This Knowledge Component Learning Resource: Book 3: Sugar processing factory control calculations is intended to be used with the Knowledge Component Learner Workbook 3 (Formative Assessment Guide): Sugar processing factory control calculations: Sugar Processing Controller NQF 5. It can also be used as a stand-alone information resource (text book).

This Learning Resource provides detailed information on the following topics:

* KM-03-KT01: Introduction to factory control concepts (40%)
* KM-03-KT02: Materials balance (25%)
* KM-03-KT03: Stock taking (10%)
* KM-03-KT04: Calculations (25%)

(Note: KM = Knowledge Module, KT = Knowledge Topic)

KNOWLEDGE MODULE 3

SUGAR PROCESSING FACTORY CONTROL CALCULATIONS

Module number: 313908000-KM03: NQF Level 5: Credits 12

**BACKGROUND**

In our discussion on laboratory techniques we said that the laboratory is used as the instrument of control in a sugar factory and its four main purposes are:

* To control the process.
* To detect and indicate the extent of losses.
* To supply management with information for financial and administrative purposes.
* To make comparisons with mills of a similar nature

Figures are provided as a guide to process and engineering staff and also management to determine whether the factory is running efficiently. If the factory is running efficiently, profits are boosted and if figures are below those budgeted, profits are reduced.

* 1. Knowledge Topic 1: Introduction to factory control concepts

# INTRODUCTION

The following are the stages involved in factory control:

* Analysis of the product
* Daily averaging of analytical results
* Daily report using the daily average figures and tonnages
* Weekly report using the week’s daily figures, stock in process and the previous week’s figures. To date figures are calculated at the same time.
* Monthly figures using the previous month’s to date figures and the current month’s to date figures.

The last month’s to date figures are the season’s results.

# DAILY AVERAGING

There are two ways by which averages can be calculated.

The arithmetic average is the sum of the analytical results divided by the number of analyses.

The weighted average takes into consideration the quantity of material associated with the analysis.

Wherever possible the weighted average is used as it is a more accurate method.

Example:

Consider two quantities of molasses. The one quantity has a mass of 20 tons and a pol of 36%.

The other has a mass of 10 tons and a pol of 28%.

Arithmetic average: Pol = = 32%

Weighted average: Mass of pol (apparent sucrose) in 20 ton quantity

 = 36% of 20 tons

 = ×

 = 7.2 tons pol

 Mass of pol (apparent sucrose) in 10 ton quantity

 = 28 of 10 tons

 = ×

 = 2.8 tons pol

 Pol = × 100

 =

 = × 100

 = 33.33%

# DAILY FIGURES

The calculations necessary for the daily materials balance can be done once the averages are complete. The figures are carried forward daily to obtain a weekly to date figure at the end of the week or run.

The process starts again for the next week or run. Figures carried forward must be weighted average figures.

Example:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Mon | Tues | Wed | Thurs | Fri | Sat | Sun |
| Tons cane crushed | 7600 | 5800 | 6200 | 7100 | 6900 | 7000 | 6500 |

However, we want a running total of the amount of cane crushed.

This is accomplished as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Mon | Tues | Wed | Sun |
|  | D | P | TD | D | P | TD | D | P | TD | D | P | TD |
| Tons Cane Crushed | 7600 | 0 | 7600 | 5800 | 7600 | 13400 | 6200 | 13400 | 19600 | 6500 | 40600 | 47100 |

# WEEK AND TO-DATE FIGURES

The weekly to-date figures become the week figures at the end of the week. These figures are then combined with the previous week’s figures to give the new to-date figures.

Once again we want a running total of the tons of cane crushed.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Week 1 | Week 2 | Week 3 | Week 4-37 | Week 38 |
| Tons Cane Crushed | 47100 | 53300 | 49800 |  | 50100 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Week 1** | **Week 2** | **Week 3** | **Week 38** |
|  | **W** | **P** | **D** | **W** | **P** | **D** | **W** | **P** | **D** | **W** | **P** | **D** |
| Tons Cane Crushed | 47100 | 0 | 47100 | 53300 | 47100 | 100400 | 49800 | 100400 | 150200 |  |  |  |

To find the data for any particular week we use:

Week = (To-Date) – (Previous To-Date)

Thus:

Cane crushed during Week 3

= (Cane crushed To-Date for Week 3) – (Cane crushed To-Date for Week 2)

= 150 200 – 100 400

= 49 800

# MONTHLY FIGURES

These figures are produced at the end of each month. They are calculated in the same way:

Month = (Month To-Date) – (Previous Month To-Date)

# ANNUAL FIGURES

These are produced at the end of each season.

They are To-Date figures at that time.

# CANE PAYMENT

## Mill Balance

This entails the determination of the brix, pol and fibre of cane from the analysis of mixed juice and final bagasse.

## Direct Analysis of cane (DAC)

This entails the direct analysis of individual cane consignments for brix, pol and fibre.

Both of these analyses depend on the analysis of fibre by the direct analysis of cane.

# FORMULAE FOR FACTORY CONTROL CALCULATIONS

**TONNAGES**

## Tons Water



Mass of materials entering the process = Mass of products leaving the process

Tons cane + Tons water = Tons bagasse + tons mixed

**Tons water = tons bagasse + tons mixed juice – Tons cane**

## Tons brix in bagasse

 × Tons bagasse

## Tons moisture in bagasse

 × Tons bagasse

## Tons fibre in bagasse

The fibre that enters the extraction plant in the cane is split into two portions. Most of this fibre leaves the extraction plant as bagasse. while a small amount ends up in the juice and is referred to as suspended / insoluble solids.



Mass of fibre entering extraction plant = Mass of fibre leaving extraction plant

Mass of fibre in cane = Tons fibre in bagasse + Tons insoluble solids

The ton fibre in cane is found via the direct analysis of cane (DAC) and is hence referred to as the “Tons DAC fibre”.

Tons DAC fibre = Tons fibre in bagasse + Tons insoluble solids

**Tons fibre in bagasse = Tons DAC fibre in Cane + Tons insoluble solids**

## Tons pol in bagasse

 × Tons bagasse

## Tons pol in mixed juice

 × Tons mixed juice

## Tons brix in mixed juice

 × Tons mixed juice

## Tons suspended solids in mixed juice

 × Tons mixed juice

## Tons corrected pol in mixed juice

When the mixed juice coming from the diffuser / mills is massed by the mixed juice scale. the mixed juice and suspended solids is massed and the mass is recorded by the scale.

When we calculate the tons pol in mixed juice we must take into account the fact that not all the mixed juice consists of juice that contains pol. but a small amount of the juice of insoluble solids that does not contain pol.



Tons corrected pol

= Tons uncorr. pol in mixed juice – [ × Tons insoluble solids]

Tons corrected pol

= Tons uncorr. pol in mixed juice – [ × × Tons mixed juice ]

= Tons uncorr. pol in mixed juice – [ × Tons mixed juice × ]

= Tons uncorr. pol in mixed juice – [Tons uncorr. pol in mixed juice × ]

=

=

**Example:**

Consider 50 tons of mixed juice with a pol of 10% and 0.5% suspended solids.

**Methods 1:**

Mass of actual mixed juice = 99.5% of 50 tons

 = × 50

 = 49.75 tons

Mass of pol in the 49.75 tons = 10% of 49.75

 = × 49.75

 = 4.975 tons

**Method 2:**

Tons uncorrected pol in mixed juice (including suspended solids) = 10% of 50 tons

 = × 50

 = 5 tons

Tons corrected pol

=

=

= 4.975 tons

## Tons corrected brix in mixed juice

When we calculate the tons brix in mixed juice we must take into account the fact that not all the mixed juice consists of juice that contains brix, but a small amount of the juice consists of insoluble solids that does not contain brix.

Tons corrected brix =

## Tons pol in cane (Mass balance pol)



**Tons pol in cane = Tons pol in bagasse + tons corrected pol in mixed juice**

## Tons brix in cane (Mass balance brix)

Tons brix in bagasse + tons corrected brix in mixed juice

## Tons DAC fibre in cane

 tons cane

## Tons DAC brix in cane

 tons cane

## Tons DAC pol in cane

 tons cane

## Tons cane per hour

## Tons fibre per hour

**PERCENTAGES**

## Fibre % bagasse

Bagasse consists (like all other process streams) of three components:

* brix (dissolved substances)
* fibre (insoluble substances – including sand)
* moisture (water)

If we calculate the brix %, fibre% and moisture% of any process stream, these 3 parameters must add up to 100%.

**Thus for bagasse: brix% bagasse + fibre % bagasse + moisture % bagasse = 100**

**Fibre % bagasse = 100 – moisture bagasse – brix % bagasse**

## Pol % cane

 100

## Fibre % cane

 100

## Brix % cane

 100

## Fibre in bagasse % cane (uncorrected)

Here the mass of fibre in bagasse is expressed as a percentage of the mass of cane. The small amount of fibre that is present in the mixed juice as suspended solids is ignored.

Fibre in bagasse % cane = × 100

## Imbibition % fibre

 100

## Corrected brix % mixed juice

 100

## Corrected pol % mixed juice

 100

## Purity of mixed juice

 100

## Mixed juice % cane

 100

## Imbibition % cane

 100

## Pol % cane by material balance (Pol % cane by mass balance)

 100

## Brix % material balance (Brix % by mass balance)

 100

## Pol Factor

 100

## Brix factor

 100

## Fibre factor

 100

## Bagasse Purity

 100

## Material balance cane purity

 100

## DAC purity

 100

**PERFORMANCE FORMULAE**

## Extraction

 100

## Corrected reduced extraction (CRE)

The corrected extraction is used to correct for the influence of pol and fibre on extraction. It changes the extraction to the extraction that would have been obtained if cane of 15% fibre and 13% pol was processed.

CRE = 100 -

Where E = extraction

 Fc = fibre % cane

 FBC = fibre in bagasse % cane (uncorrected)

 PC0.6 = (pol % cane)0.6(see Table in Laboratory Manual)

## Boiling house recovery

 100

Overall recovery

 100

* 1. Knowledge Topic 2: Daily Materials Balance

# THE DAILY MATERIALS BALANCE

The Daily Materials Balance is used to monitor the performance of the extraction plant (front-end). The tons cane crushed and the tons mixed juice per day is known because the materials are massed. The following data must be known to complete the daily materials balance.

* Tons corrected brix in mixed juice, which can be calculated from the brix% mixed juice (from laboratory analysis) and the tons of mixed juice.
* Tons corrected pol in mixed juice, which can be calculated from the pol% mixed juice (from laboratory analysis) and the tons of mixed juice.
* DAC Pol % cane
* DAC Brix % cane
* DAC Fibre % cane

Obtained via laboratory results

* Brix % bagasse
* Pol % bagasse
* Suspended solids % mixed juice

**EXAMPLE OF A DAILY MATERIALS BALANCE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | DAY | PREVIOUS | WK TO DATE |
| SUMMARY | TONS CANE CRUSHED | GIVEN |  |  |
| TONS MIXED JUICE | GIVEN |  |  |
| TONS WATER |  |  |  |
| TONS BAGASSE |  |  |  |
|  |  |  |  |  |
| BAGASSE | TONS Bx IN BAG (BRIX% GIVEN) |  |  |  |
| TONS MOIST IN BAG (MOISTURE % GIVEN) |  |  |  |
| TONS FIBRE IN BAG |  |  |  |
| TONS POL IN BAG (POL % GIVEN) |  |  |  |
| Fib % BAG |  |  |  |
|  |  |  |  |  |
| CANE | TONS POL IN CANE |  |  |  |
| TONS BRIX IN CANE |  |  |  |
| TONS FIBRE IN CANE |  |  |  |
| POL % CANE |  |  |  |
| Fib % CANE |  |  |  |
| Bx 5 CANE |  |  |  |
| FIBRE IN BAG % CANE (UNCORR) |  |  |  |
| TONS D.A.C. BRIX IN CANE |  |  |  |
| TONS D.A.C. pol in cane |  |  |  |
| IMBIBITION % FIBRE |  |  |  |
| IMBIBITION % CANE |  |  |  |
|  |  |  |  |  |
| EXTRACTION |  |  |  |
| C.R.E. |  |  |  |
|  |  |  |  |
| M.J. | % SUSP. SOLIDS | GIVEN |  |  |
| TONS SUSP. SOLIDS |  |  |  |
| TONS CORR. BRIX IN M.J. | GIVEN |  |  |
| TONS CORR. POL IN M.J. | GIVEN |  |  |
| CORR. Bx.% M.J. |  |  |  |
| CORR. Pol% IN M.J. |  |  |  |
| PURITY M.J. |  |  |  |
| M.J. % CANE |  |  |  |
|  |  |  |  |  |
| HOURS AVAILABLE |  |  |  |
| STOPS: MECHANICAL |  |  |  |
| OPERATIONAL |  |  |  |
| NO CANE |  |  |  |
| SCHEDULED |  |  |  |
| TOTAL STOPS |  |  |  |
| HOURS CRUSHING |  |  |  |
| TONS CANE PER HOUR |  |  |  |
| TONS FIBRE PER HOUR |  |  |  |
|  | **MAT BAL** | **D.A.C.** |  | **DAY** | **PREVIOUS** | **WK- TO-DATE** |
|  | POL | BRIX | FIB | POL | BRIX | TIB | POL FACTOR |  |  |  |
| DAY |  |  |  | GIVEN | GIVEN | GIVEN | BRIX FACTOR |  |  |  |
| PREVIOUS |  |  |  |  |  |  | FIBRE FACTOR |  |  |  |
| WK-TO-DATE |  |  |  |  |  |  |  |  |  |  |

MILL: DAY: DATE: DAY NO:

# MASS OF BAGASSE

Bagasse is not routinely massed like cane and mixed juice. However the amount of bagasse produced is an important parameter and it must be quantified. The mass of bagasse is calculated by indirect method.

**The method is as follows:**

* Tons of DAC fibre in cane: × Tons cane
* Tons suspended solids in mixed juice
	+ × Tons mixed juice
* Tons fibre in bagasse Tons DAC fibre in cane – tons insoluble solids
* Fibre % bagasse 100 – moisture % bagasse – brix % bagasse
* Tons bagasse × Tons fibre in bagasse

# THE MILL BALANCE

The Mill balance states that the mass of materials entering the extraction plant must equal the mass of materials leaving the extraction plant.

**Cane + Imbibition = Mixed juice + bagasse**

The following are typical figures:



The tons imbibition water is calculated via mill balance.

Most of the data on the daily material balance is calculated using the mill balance.

To be able to calculate the mill balance we need to know the DAC fibre % cane so that the tons bagasse can be calculated.

|  |  |  |  |
| --- | --- | --- | --- |
| **CANE** | **IMBIBITION** | **MIXED JUICE** | **BAGASSE** |
| Known:DAC Pol % Cane DAC Brix % Cane DAC fibre % Cane \*Tons Crushed  |  | Known:\*% Susp. Solids \*Tons Mixed juiceTons Corr. Pol in M.J.Tons Corr. Brix in M.J.  | Known:\*PoL % Bagasse\*Brix % Bagasse\*Moisture % Bagasse |
| 1. Tons fibre in Cane
2. Tons Pol in Cane
3. Tons Bx. in cane
4. Pol % Cane
5. Fibre % Cane
6. Bx % Cane
7. Ton DAC Brix in cane
8. Ton DAC Pol in cane
 | 1. Tons Imbibition
2. Imb. % Fibre
3. Imb. % Cane
 | 1. Tons Susp. Solids
2. Corr. Bx 5 MJ
3. Corr. Pol 5 MJ
4. Purity MJ
5. MJ % Cane
 | 1. Tons fibre in Bagasse
2. Fibre % Bagasse
3. Tons Bagasse
4. Tons Bx. in Bagasse
5. Tons Moist. in Bagasse
6. Tons Pol in Bagasse
7. Fibre in Bag % Cane
 |
| 1. Extraction
2. C.R.E.
 |  |  |  |

# WORKED EXAMPLE OF A DAILY MATERIAL BALANCE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | DAY | PREVIOUS | WK TO DATE |
| SUMMARY | TONS CANE CRUSHED | 5580.968` | 34593.136` | 40174.104 |
| TONS MIXED JUICE | 6739.943 | 41519.415 | 48259.358 |
| TONS WATER | 2980.465 | 18544.759 | 21525.224 |
| TONS BAGASSE | 1821.490 | 11618.480 | 13439.97 |
|  |  |  |  |  |
| BAGASSE | TONS Bx IN BAG (Bx % Bag = 2.68) | 48.816 | 301.33 | 350.146 |
| TONS MOIST IN BAG (Moist % Bag = 51.21) | 932.785 | 5965.766 | 6898.551 |
| TONS FIBRE IN BAG | 839.889 | 5351.395 | 6191.284 |
| TONS POL IN BAG (POL % Bag = 1.53) | 27.869 | 147.934 | 175.803 |
| Fib % BAG | 46.11 | 46.06 | 46.07 |
|  |  |  |  |  |
| CANE | TONS POL IN CANE | 731.122 | 4435.499 | 5166.521 |
| TONS BRIX IN CANE | 860.183 | 5262.133 | 6122.316 |
| TONS FIBRE IN CANE | 882.351 | 5604.587 | 6486.938 |
| POL % CANE | 13.10 | 12.82 | 12.86 |
| Fib % CANE | 15.81 | 18.20 | 16.15 |
| Bx 5 CANE | 15.41 | 15.21 | 15.24 |
| FIBRE IN BAG % CANE (UNCORR) | 15.05 | 15.47 | 15.41 |
| TONS D.A.C. BRIX IN CANE | 843.842 | 5257.984 | 6101.826 |
| TONS D.A.C. pol in cane | 723.293 | 4466.249 | 5189.542 |
| IMBIBITION % FIBRE | 355 | 347 | 348 |
| IMBIBITION % CANE | 53.40 | 53.61 | 53.58 |
|  |  |  |  |  |
| EXTRACTION | 96.19 | 96.66 | 96.60 |
| C.R.E. | 96.07 | 96.71 | 96.63 |
|  |  |  |  |
| M.J. | % SUSP. SOLIDS | 0.63 | 0.61 | 0.61 |
| TONS SUSP. SOLIDS | 42.462 | 253.202 | 295.664 |
| TONS CORR. BRIX IN M.J. | 811.367 | 4960.813 | 5772.180 |
| TONS CORR. POL IN M.J. | 703.253 | 4287.566 | 4990.819 |
| CORR. Bx.% M.J. | 12.04 | 11.95 | 11.96 |
| CORR. Pol% IN M.J. | 10.43 | 10.33 | 10.34 |
| PURITY M.J. | 86.68 | 86.43 | 86.46 |
| M.J. % CANE | 121 | 120 | 120 |
|  |  |  |  |  |
| HOURS AVAILABLE | 24 | 153.24 | 177.24 |
| STOPS: MECHANICAL | NIL | 4.65 | 4.65 |
| OPERATIONAL | NIL | 0.95 | 0.95 |
| NO CANE | NIL | NIL | NIL |
| SCHEDULED | - | - | - |
| TOTAL STOPS | NIL | 5.60 | 5.60 |
| HOURS CRUSHING | 24 | 147.64 | 171.64 |
| TONS CANE PER HOUR | 232.540 | 234.307 | 234.06 |
| TONS FIBRE PER HOUR | 35.00 | 36.25 | 36.07 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **MATERIAL BALANCE** | **D.A.C.** |  | **DAY** | **PREVIOUS** | **WK- TO – DATE** |
|  | POL | BRIX | FIB | POL | BRIX | TIB | POL FACTOR | 101.08 | 99.31 | 99.56 |
| DAY | 13.10 | 15.41 | 15.81 | 12.96 | 15.12 | 15.81 | BRIX FACTOR | 101.94 | 100.08 | 100.34 |
| PREVIOUS | 12.82 | 15.21 | 16.20 | 12.91 | 15.20 | 16.20 | FIBRE FACTOR | 100.00 | 100.00 | 100.00 |
| WK-TO-DATE | 12.86 | 15.24 | 16.15 | 12.87 | 15.19 | 16.15 |  |  |  |  |

**Day Column:**

The available data is used to complete the column marked “Day”

1. Tons fibre in cane = ×Tons cane

= ×

= 882.351 tons

1. Tons suspended solids= × Tons of mixed juice

= × 6 739.943

= 42.462 tons

1. Tons fibre in Bagasse

= Tons DAC fibre in cane – Tons insoluble solids in mixed juice

= 882.351 – 42.462

= 839.889 tons

1. Fibre % Bagasse = 100 – Moisture % Bagasse – Brix % Bagasse

= 100 – 51.21 – 2.68

= 46.11%

1. Tons Bagasse = × Tons fibre in bagasse

= × 839.889

= 1 821.490 tons

1. Tons imbibition water

= Tons bagasse + Tons mixed juice – tons cane

= 1 821.490 + 6739.943 – 5 580.968

= 2 980.465 tons

1. Tons Brix in bagasse = ×

= × 1 821.490

= 48.816 tons

1. Tons Moisture in Bagasse = ×

= × 1 821.490

= 932.785 tons

1. Tons pol in bagasse = ×

= × 1 821.490

= 27.869 tons

1. Tons pol in cane

= Tons pol in bagasse + tons corrected pol in mixed juice

= 27.869 + 703.253

= 731.122 tons

1. Tons brix in cane

= tons brix in bagasse + tons corrected brix in mixed juice

= 48.816 + 811.367

= 860.183 tons

1. Pol % cane = × 100

= × 100

= 13.10%

1. Fibre % cane = × 100

=

1. Brix % cane =

= × 100

= 15.41%

1. Fibre in Bagasse % cane = × 100

= × 100

= 15.05%

1. Tons DAC brix in cane = × 100

= × 5580.968

= 843.842 tons

1. Tons DAC pol in cane = × Tons cane

= × 5580.968

= 723.293 tons

1. Imbibition % fibre = × 100

= × 100

= 354.864% = 355%

1. Imbibition % cane = × 100

= × 100

= 53.404

1. Corrected brix % mixed juice = × 100

= × 100

= 12.045

1. Corrected pol % mixed juice = × 100

= × 100

= 10.43%

1. Purity of mixed juice = × 100

= × 100

= 86.68%

1. Mixed juice % cane = × 100

= × 100

= 120.77% = 121%

1. Extraction = × 100

= × 100

= 96.19%

1. Corrected reduced extraction

= 100 -

= 100 -

= 100 – 3.93 = 96.07%

Further calculations:

Tons cane per hour =

 =

 = 232.540 tons / hour

Tons fibre per hour =

 =

 = 35 tons / hour

**Previous column**

The data from the previous “Week to date” column is transcribed into the columns headed “Previous”

**Week to date column**

The masses of materials in the “Day” column are added to the masses of materials in the “Previous” column and the total recorded in the “Week to date” column.

Percentages must be recalculated using the totals in the “Week to date” column.

Tons crushed (week to date) = Tons cane (Day) + Tons cane (Previous)

 = 5580.968 + 34593.136

 = 40 174.104 tons

Tons mixed juice (week to date)

= Tons mixed juice (Day) + Tons mixed juice (Previous)

 = 6 739.943 + 41 519.415

 = 48 259.358 tons

Tons imbibition water (week to date)

= Tons water (Day) + tons water (previous)

 = 2 980.465 + 18 544.759

 = 21 525.224 tons

Tons bagasse (week to date)

= Tons bagasse (Day) + Tons bagasse (Previous)

 = 1 821.490 + 11 618.480

 = 13 439.97 tons

Tons Brix in bagasse (Week to date)

= Tons Bx in bagasse (Day) + Tons Bx in bag (Previous)

 = 48.816 + 301.33

 = 350.146 tons

Tons Moisture in bagasse

= Tons moisture in bagasse (Day) + Tons Moisture in bagasse (Week to date) (Previous)

 = 932.785 + 5 965.766

 = 6898.551 tons

Tons fibre in bagasse

= Tons fibre in bagasse (Day) + Tons fibre in bagasse (Week to date)(Previous)

 = 839.889 + 5 351.395

 = 6 191.284 tons

Tons pol in bagasse (Week to date)

= Tons pol in bagasse (Day) +Tons pol in bagasse (Previous)

 = 27.869 + 147.934

 = 175.803 tons

Fibre % bagasse (Week to date) = × 100

 = × 100

 = 46.07%

Tons pol in cane (week to date)

= Tons pol in cane (Day) + Tons pol in cane (Previous)

 = 731.122 + 4435.499

 = 5166.621 tons

Tons brix in cane (Week to date)

= Tons brix in cane (Day) + Tons brix in cane (Previous)

 = 860.183 + 5 262.133

 = 6 122.316 tons

Tons fibre in cane (Week to date)

= Tons fibre in cane (Day) + Tons fibre in cane (Previous)

 = 882.3511 + 5604.587

 = 64 86.938 tons

Pol % cane (Week to date) = × 100

 = × 100

 = 12.86%

Fibre % cane (Week to date) = × 100

 = × 100

 = 16.15%

Brix % cane (Week to date) = × 100

 = × 100

 = 15.24%

Fibre in bagasse % cane (Week to date)

 = × 100

 = × 100

 = 15.41%

Tons DAC brix in cane (Week to date)

= Tons DAC brix in cane (Day) + Tons DAC brix in cane (Previous)

= 843.842 + 5357.984

= 6101.826 tons

Tons DAC pol in cane (Week to date)

= Tons DAC pol in cane (Day) + Tons DAC pol in cane (Previous)

= 723.293 + 4466.249

= 5189.542 tons

Imbibition % fibre (Week to date)= × 100

= × 100

= 53.58%

Tons suspended solids (Week to date)

= Tons suspended solids (Day) + Tons suspended solids (Previous)

= 42.462 + 253.202

= 295.664 tons

Suspended solids % mixed juice (Week to date)

= × 100

= × 100

= 0.61%

Tons corrected brix in mixed juice (Week to date)

= Tons corrected brix in mixed juice (Day) + Tons corrected brix in mixed juice (Previous)

= 811.367 + 4 960.813

= 5772.180 tons

Tons corrected pol in mixed juice (Week to date)

= Tons corrected pol in mixed juice (Day) + Tons corrected brix in mixed juice (Previous)

= 703.253 + 4287.566

= 4 990.819 tons

Extraction (Week to date) = × 100

 = × 100 = 96.60%

Corrected brix % mixed juice (Week to date)

= × 100

= × 100

= 11.96%

Corrected pol % mixed juice (Week to date)

= × 100

= × 100

= 10.34%

Purity of mixed juice (Week to date)

= × 100

= × 100

= 86.46%

Mixed juice % cane (Week to date)

= × 100

= ×100

= 120.125%

= 120%

Corrected reduced extraction (Week to date)

= 100 -

= 100 -

= 100 – 3.371

= 96.53%

Hours available (Week to date)

= Hours available (Day) + Hours available (Previous)

= 24 + 153.24

= 177.24 hours

Mechanical stops (Week to date)

= Mechanical stops (Day) + Mechanical stops (Previous)

= 0 + 4.65

= 4.65 hours

Operational stops (Week to date)

= Operational stops (Day) + Operational stops (Previous)

= 0 + 0.95

= 0.95 hours

Total stops (Week to date)

= Mechanical stops + operational stops + Scheduled stops + No cane stops

= 4.65 + 0.95 + 0 + 0

= 5.6 hours

Hours crushing (Week to date)

= Total hours available (Week to date) – Total stops (Week to date)

= 177.24 – 5.60

= 171.64

Tons cane per hour (Week to date) =

=

= 234.06 tons / hour

Tons fibre per hour (Week to date) =

=

=36.07 tons / hour

**DAC Data**

* The DAC pol % brix % and fibre % cane for the day is unknown.
* The DAC pol %, brix % and fibre % for the previous day is unknown since it was calculated as part of the Week-to-date figures for the day before.
* The pol % cane, brix % cane and fibre % cane for the week-to-date must be calculated.

Tons DAC pol in cane = × Tons cane

Therefore

DAC pol % cane = × 100

 = × 100

 = 12.92%

Tons DAC brix in cane = × Tons cane

Therefore

DAC brix % cane = × 100

 = × 100

 = 15.19%

The DAC fibre % cane = fibre % cane via mill balance

 = 16.15%

Reason: The DAC fibre % cane is used to determine the tons fibre in cane, which is used to find the fibre % using the mill balance.

**Material Balance / Mill balance**

* The pol % cane, brix % cane and fibre % cane via mill balance for the day has been calculated and needs only to be transcribed.
* The pol % cane, brix % cane and fibre 5 cane mill balance for the previous column is known since it was calculated as part of the Week-to-date figures for the day before.
* The pol % cane, brix % cane and fibre % cane for the Week-to-date must be calculated.

Pol % cane (Week-to-date) = × 100

= × 100

= 12.86%

Brix % cane (Week-to-date) = × 100

= × 100

= 15.24%

Fibre % cane (Week-to-date) = × 100

= × 100

= 16.15%

Notice that the fibre % cane via mill balance (material balance) equals the DAC fibre % cane. This will be the case because the DAC fibre % cane was used to determine the tons fibre in cane, which is used to find the fibre % cane using the mill balance.

**Factors**

**Day:**

Pol factor = × 100

 =

 = 101.08%

Brix factor = × 100

 = × 100

 = 101.94%

Fibre factor = × 100

 = × 100

 = 100.00%

Notice: that the fibre factor must equal 100.00 since the DAC fibre % (used to calculate the tons DAC fibre in cane) was also used to find the mass balance tons of fibre in cane.

**Previous**

Pol factor =

 = × 100

 = 99.31%

Brix factor =

 = × 100

 = 100.08%

Fibre factor = × 100

 = × 100

 = 100.00%

**Week-to-date**

Pol factor = × 100

 = × 100

 = 99.56%

Brix factor = × 100

 = × 100

 = 100.34%

Fibre factor = × 100

 = × 100

 = 100.00%

* 1. Knowledge Topic 3: Stock Taking of Factory Products

# INTRODUCTION

Quantitative measurements of the products entering and leaving the factory are required for the purpose of factory control as well as a basis for the cane payment. Under present legislation the SICB (Sugar Industry Central Board) is responsible for the analytical data relating to the cane, final bagasse and mixed juice so that, apart from checks on the SICB work, the factory personnel need obtain data only on other products of the factory.

# DATA COLLECTION

The data collected is used to prepare reports as well as to calculate material balances which in South African factories are made on a weekly and monthly basis as well as seasonally.

The stock in process in the factory must be taken into account and this can be done most accurately during a scheduled stop. However, some factories rarely come to a complete stop during the season so it is necessary to assess the stock with an adequate degree of accuracy while the factory is running.

Individual vessels must be calibrated in cubic metres and tables which give the capacity corresponding to the wantage (shortage) measured in “cm out” must be prepared for each vessel. Where a running stock is taken, the quantities of product in heaters, evaporators, piping etc. must be estimated and the data recorded for inclusion with that measured in tanks, etc. where levels are variable.

It should be appreciated that errors made in the quantity of sugar or the quantity of a massecuite, will have a relatively large effect on the stock data compared with similar errors in more dilute or lower purity products, like clarified juice.

Where it is necessary to take a running stock, it is recommended that curing especially of “A” massecuite should be stopped for a short time so that centrifugals, conveyors and driers are empty at the time of taking stock.

The data for the quantities of the different materials is taken in conjunction with their analyses to calculate the tonnages of brix and pol. It is not necessary to analyse the actual stock and for most products the last daily average analysis should be used. If true or gravity purity data on final molasses is required the last available weekly analysis may be used.

# ERRORS

Gas in massecuite can cause an error in the mass per m3. To compensate for this error a known volume of massecuite is massed every week and from this the mass per m3 can be calculated.

# TAKING STOCK OF PRODUCTS

## Clear juice

Clarifiers are always filled to the same level and can be considered to contain a constant volume of juice.

## Mud

It is usual in most factories to keep the filters going after the mill stops until all mud is liquidated. If mud is left no appreciable error is introduced if it is not taken into account in view of the very low pol.

## Syrup and molasses

When measuring centimetres out the scum layer on the tanks should be broken first before the liquid level is measured. If the factory is running the volume of products in the factory must be estimated.

## Massecuites

Batch crystallizers – the best method is to take the volume when the pan is struck. This volume is then logged in a book.

Continuous crystallizers – here each crystallizer must be measured. The connecting boxes should also be taken into account.

## Magma and seed

The volumes of these products must be measured because, being high purity products, they will introduce a big error if not taken into account.

## Sugar

The mass of sugar should be accurately known but this is one product which is very difficult to estimate. Sugar bins should be calibrated accurately and if possible the sugar in the bin should be levelled before estimating the volume. The bulk density for VHP sugar can be taken at 900 kg/m3.

# WORKING OUT THE STOCK IN PROCESS

1. The centimetres out is converted to m3 of product using prepared tables for each vessel (called “wantage tables”). The total volume of product is the sum of each individual vessel containing that product.
2. From the brix of the product and using Table 11 in the Laboratory Manual the tons brix per m3 of product can be found
3. The product of tons brix per m3 and the volume of the product gives the tons brix of the product.
4. The product of the ton brix and the purity divided by 100 will give the tons pol of the product.
5. The total mass of tons brix and tons pol in process is the sum of the individual products.
6. From the total tons pol and brix the average purity of the stock in process can be calculated.
7. The % pol recoverable in sugar is now calculated using the SJM formula.

 **× 100**

Where:S = sugar purity

 J = stock purity

 M = molasses purity

Sugar purity = × 100

Molasses purity = × 100

1. The estimated tons pol recoverable in sugar is the product of the total tons pol in stock and the % pol recoverable in sugar.
2. The estimated tons sugar recoverable is now calculated.

 × Estimated tons pol recoverable

(To this figure is added the tons sugar in the bins to give the total tons sugar recoverable)

1. The estimated tons pol in molasses is the difference between the total tons pol in stock and the estimated tons pol recoverable in sugar.
2. The estimated tons molasses can now be calculated.

 **× Estimated tons pol in molasses**

# ABBREVIATED EXAMPLE OF A STOCKTAKING EXERCISE

Using the following figures calculate the stock in process

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Wantage(“cm out”) | Volume | Brix % | Purity % |
| Clarifier  | - | 439.6 | 12.00 | 83.50 |
| Syrup Tank  | 152 | 53.3 | 68.40 | 84.90 |
| A-crystalliser  | 96 | 62.4 | 93.00 | 85.20 |
| B-crystalliser  | 46 | 110.9 | 93.40 | 68.50 |
| C-crystalliser  | 32 | 134.4 | 96.30 | 53.60 |
| A-molasses tank | 186 | 34.2 | 70.80 | 68.70 |
| B-molasses tank | 366 | 32.2 | 71.50 | 45.40 |
| Magma tank  | 98 | 32.6 | 91.00 | 69.20 |

**Given**

|  |  |
| --- | --- |
| Pol % sugar  | 99.35% |
| Moisture % sugar  | 0.15% |
| Pol % molasses | 27.52% |
| Brix % molasses | 87.72% |

**Solution**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Wantage (cm out) | Vol | Brix % | Purity % | Tons Bx/m3 | Ton Brix | Ton pol |
| Clarifier |  | 439.60 | 12.00 | 83.50 | 0.124 | 54.510 | 45.516 |
| Syrup tank | 152 | 53.3 | 68.40 | 84.90 | 0.913 | 48.663 | 41.315 |
| A-crystalliser | 96 | 62.4 | 93.00 | 85.20 | 1.395 | 87.048 | 74.165 |
| B-crystalliser | 46 | 110.9 | 93.40 | 68.50 | 1.403 | 155.593 | 106.581 |
| C-crystalliser | 32 | 134.4 | 96.30 | 53.60 | 1.467 | 197.165 | 105.680 |
| A-molasses tank | 186 | 34.2 | 70.80 | 68.70 | 0.956 | 32.695 | 22.462 |
| B-molasses tank | 366 | 32.2 | 71.50 | 45.40 | 0.969 | 31.202 | 14.166 |
| Magma tank | 98 | 32.6 | 91.00 | 69.20 | 1.352 | 44.075 | 30.500 |
|  | 650.951 | 440.385 |

Average Stock Purity = × 100 = 67.653%

% pol in stock to sugar estimated = × 100 = × 100 = 78.325%

Sugar Purity = × 100= 99.50%

Molasses Purity = × 100= 31.37%

Estimated Tons pol recoverable in sugar = × 440.385 = 344.932 tons

Estimated tons pol recoverable in molasses = 440.385 – 344.932 = 95.453 tons

Estimated tons recoverable sugar = × 344.932 = 347.189 tons

Estimated tons recoverable molasses = × 95.453 = 346.850 tons

**FOR INTEREST**

# DERIVING THE SJM FORMULA

The derivation of this formula gives an insight into the use of balances in factory control.

**Consider the Boiling house as follows:**



MJ = Mass of Juice MS = Mass of sugar MM = Mass of molasses

BPJ = Brix % Juice BPS = Brix % Sugar BPM = Brix % Molasses

PPJ = Purity % Juice PPS = Purity % Sugar PPM = Purity % Molasses

**First we construct a Brix balance:**

Brix in = Brix out

Brix in Juice = Brix in Sugar + Brix in Molasses

 × MJ = × MS+ × MM

BPJ × MJ = BPS × MS + BPM × MM

 = MM

**Secondly we construct a sucrose balance:**

Sucrose in = Sucrose out

Sucrose in Juice = Sucrose in Sugar + Sucrose in Molasses

 × (Tons Brix in Juice) = × (Tons Brix in Sugar) + × (Tons Brix in Molasses)

 × × MJ = × × MS + × × MM

PPJ × BPJ × MJ = PPS × BPS × MS + PPM × BPM × MM

Substituting for MM

PPJ × BPJ × MJ = PPS × BPS × MS + PPM × BPM

PPJ × BPJ × MJ = PPS × BPS × MS + PPM × BPJ × MJ – PPM × BPS × MS

PPJ × BPJ × MJ – PPM × BPJ × MJ = PPS × BPS × MS – PPM × BPS × MS

BPJ × MJ (PPJ – PPM) = BPS × MS (PPS –PPM)

BPS × MS (PPS – PPM) = BPJ × MJ (PPJ – PPM)

 =

Multiplying both sides by:

 × =

 =

 ×100 = × 100

% Sucrose recovered in sugar = × 100\

% Sucrose recovered in sugar = × 100

* 1. Knowledge Topic 4: Factory Performance Calculations

# CONSIDERING PRODUCTS STILL IN THE PROCESS

The factory holds considerable stock in process that has come from the cane crushed. If this stock can be processed without more cane input, it would be converted into sugar and molasses.

**Method:**

In practice, we estimate the stock in process and add it to the products already made To-date. The result we call product Made and Estimated (M & E) To-Date.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Week 1** | **Week 2** | **Week 3** |
|  | **W** | **P** | **TD** | **W** | **P** | **TD** | **W** | **P** | **TD** |
| **VHP Sugar Made (Week)** | 9819 | 0 | **9819** | 170262 | 9819 | **26881** | 22737 | 26881 | **49618** |
| **VHP Sugar Estimated (in stock)** | 4284 |  |  | 9473 |  |  | 8649 |  |  |
| **VHP Sugar Made & Estimated To-Date** |  |  | **14103** |  |  | **36354** |  |  | **58267** |
| **Sugar M & E (Week)** | **14 103** | **22 251** | **21 913** |

Therefore:

Sugar M & E (Week 2)

= Sugar TD M & E (Week 2) – Sugar TD M & E (Week 1)

= 36 354 – 14 103

= 22 251 tons

Sugar M & E (Week 3)

= Sugar M & E (Week 3) – Sugar M & E (Week 2)

= 58 267 – 36 354

= 21 913 tons

How can the sugar made for week 3 be 22 737 tons but the sugar made and estimated for week 3 be 21 913?

Note: the sugar in stock estimated decreased from 9 473 to 8 649 tons.

Therefore:

 TONS M (TO-DATE) + E(TO-DATE)

 - (Tons M(PREVIOUS)+ E(PREVIOUS))

 Tons M(WEEK) + E(WEEK)

Since E(TO-DATE) < E(PREVIOUS), E(WEEK) is negative and reduced the value of the tons sugar made & estimated for the week.

# NEED FOR FACTORY DATA

For proper factory control we need to keep track of all the input materials (i.e. cane) and all the output products (i.e. sugar. molasses. filter cake) taking into account those materials held in the process as intermediate materials.

# FACTORY PERFORMANCE CALCULATIONS: INTRODUCTION

The following table lists the parameters that need to be recorded. The figures that are available are listed as “Known”. The rest of the data must be found via calculation.

**FACTORY WEEKLY AND TO-DATE PERFORMANCE CALCULATIONS**

|  |  |  |  |
| --- | --- | --- | --- |
| **WEEK NUMBER**  |  | **1** | **2** |
| **WEEK SUGAR & FINAL MOLASSES ANALYSES** |
| 1 | POL % SUGAR  | KNOWN  | KNOWN  |
| 2 | MOISTURE % SUGAR  | KNOWN  | Known  |
| 3 | PURITY SUGAR |  |  |
| 4 | POL % FINAL MOLASSES | KNOWN  | KNOWN  |
| 5 | BRIX % FINAL MOLASSES | KNOWN  | KNOWN  |
| 6 | PURITY FINAL MOLASSES |  |  |
| **SHOCK. SUGAR & FINAL MOLASSES ESTIMATED** |
| 7 | TONS SUGAR IN BINS | KNOWN  | KNOWN  |
| 8 | TONS POL IN STOCK  | KNOWN  | KNOWN  |
| 9 | TONS BRIX IN STOCK  | KNOWN  | KNOWN  |
| 10 | STOCK PURITY  |  |  |
| 11 | SJM RECOVERY  |  |  |
| 12 | TONS POL IN SUGAR EST. |  |  |
| 13 | TONS SUGAR EST. |  |  |
| 14 | TONS POL IN FIN. MOL. EST. |  |  |
| 15 | TONS FIN. MOL. EST. |  |  |
| **V.H.P. SUGAR**  |
| 16 | TONS MADE WEEK  | KNOWN  | KNOWN  |
| 17 | TONS MADE PREVIOUS  | 0.000 |  |
| 18 | TONS MADE TO-DATE  |  |  |
| 19 | TONS EST. IN STOCK & BINS  |  |  |
| 20 | TONS M & EST. TO-DATE  |  |  |
| 21 | TONS M & EST. PREVIOUS  | 0.000 |  |
| 22 | TONS M & EST. WEEK |  |  |
| 23 | TONS POL M & EST. WEEK  |  |  |
| 24 | TONS POL M & EST. PREVIOUS | 0.000 |  |
| 25 | TONS POL M & EST. TO-DATE |  |  |
| **FINAL MOLASSES** |
| 26 | TONS MADE WEEK  | KNOWN  | KNOWN  |
| 27 | TONS MADE PREVIOUS  | 0.000 |  |
| 28 | TONS MADE TO-DATE  |  |  |
| 29 | TONS EST. IN STOCK  |  |  |
| 30 | TONS M & EST. TO-DATE |  |  |
| 31 | TONS M & E PREVIOUS  | 0.000 |  |
| 32 | TONS M &E WEEK  |  |  |
| 33 | TONS POL M & E WEEK |  |  |
| 34 | TONS POL M & E PREVIOUS  | 0.000 |  |
| 35 | TONS POL M 7 E TO-DATE |  |  |
| **FILTER CAKE**  |
| 36 | TONS MADE WEEK  | KNOWN  | KNOWN  |
| 37 | TONS PREVIOUS  | 0.000 |  |
| 38 | TONS TO-DATE  |  |  |
| 39 | TONS POL WEEK  | KNOWN  | KNOWN  |
| 40 | TONS POL PREVIOUS  | 0.000 |  |
| 41 | TONS POL TO-DATE  |  |  |
| **BAGASSE** |
| 42 | TONS MADE WEEK  | KNOWN  | KNOWN  |
| 43 | TONS PREVIOUS  | 0.000 |  |
| 44 | TONS TO-DATE  |  |  |
| 45 | TONS POL WEEK  | KNOWN  | KNOWN  |
| 46 | TONS POL PREVIOUS  | 0.000 |  |
| 47 | TONS POL TO-DATE  |  |  |
| **MIXED JUICE**  |
| 48 | TONS MADE WEEK  | KNOWN  | KNOWN  |
| 49 | TONS PREVIOUS  | 0.000 |  |
| 50 | TONS TO-DATE  |  |  |
| 51 | TONS CORRECTED POL WEEK  | KNOWN  | KNOWN  |
| 52 | TONS CORRECTED POL PREVIOUS  | 0.000 |  |
| 53 | TONS CORRECTED POL TO-DATE  |  |  |
| **CANE**  |
| 54 | TONS CRUSHED WEEK  | KNOWN  | KNOWN  |
| 55 | TONS CRUSHED PREVIOUS  | 0.000 |  |
| 56 | TONS CRUSHED TO-DATE  |  |  |
| 57 | TONS POL WEEK  |  |  |
| 58 | TONS POL PREVIOUS  | 0.000 |  |
| 59 | TONS POL TO-DATE  |  |  |
| **POL UNDETERMINED ON POL IN MIXED JUIC E** |
| 60 | TONS LOST WEEK  |  |  |
| 61 | TONS PREVIOUS  |  |  |
| 62 | TONS TO-DATE |  |  |
| **POL BALANCE % POL IN CANE**  |
| 63 | TONS POL IN BAGASSE WEEK  |  |  |
| 64 | TONS POL IN BAGASSE TO-DATE  |  |  |
| 65 | TONS POL IN F. CAKE WEEK  |  |  |
| 66 | TONS POL IN F.CAKE TO-DATE  |  |  |
| 67 | TONS POL F. MOL. M & E WEEK  |  |  |
| 68 | TONS POL F. MOL. M & E TO-DATE  |  |  |
| 69 | TONS POL UNDETERMINED WEEK  |  |  |
| 70 | TONS POL UNDETERMINED TO-DATE  |  |  |
| 71 | TONS POL IN SUGAR M & E WEEK  |  |  |
| 72 | TONS POL IN SUGAR M & E TO-DATE  |  |  |
| 73 | EXTRACTION FOR WEEK  |  |  |
| 74 | EXTRACTION TO-DATE  |  |  |
| 75 | B.H.R. WEEK  |  |  |
| 76 | B.H.R. TO-DATE  |  |  |
| 77 | OVERALL REC. WEEK  |  |  |
| 78 | OVERALL REC. TO-DATE  |  |  |
| **QUALITY CONTROL** |
| 79 | POL % CANE WEEK  |  |  |
| 80 | POL % CANE TO-DATE  |  |  |
| 81 | POL % SUGAR M & E WEEK  |  |  |
| 82 | POL % SUGAR M & E TO-DATE  |  |  |
| 83 | POL % F.MOL. M & E WEEK  |  |  |
| 84 | POL % F.MOL. M & E TO-DATE  |  |  |
| 85 | POL % BAGASSE WEEK  |  |  |
| 86 | POL % BAGASSE TO-DATE  |  |  |
| 87 | POL % F. CAKE  |  |  |
| 88 | POL % F. CAKE |  |  |
| 89 | CANE TO SUG RATIO WEEK |  |  |
| 90 | CANE TO SUG RATIO TO-DATE |  |  |

# FACTORY PERFORMANCE CALCULATION: EXAMPLE

The table below lists some fictitious factory figures. The factory performance calculations for week 1 have been performed as example for the method / procedure required.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **WEEK NUMBER**  | **1** | **2** | **3** | **4** | **5** | **35** |
|  |
| **WEEK SUGAR & FINAL MOLASSES ANALYSES** |
| 1 | POL & SUGAR  | 99.52 | 99.48 | 99.31 | 99.37 | 99.28 | 99.25 |
| 2 | MOISTURE % SUGAR  | 0.08 | 0.09 | 0.12 | 0.11 | 0.13 | 0.15 |
| 3 | PURITY SUGAR  | 99.60 |  |  |  |  |  |
| 4 | POL % FINAL MOLASSES | 29.98 | 31.58 | 32.85 | 33.05 | 32.46 | 24.79 |
| 5 | BRIX % FINAL MOLASSES | 82.50 | 83.56 | 83.98 | 84.41 | 84.02 | 85.28 |
| 6 | PURITY FINAL MOLASSES | 36.34 |  |  |  |  |  |
| **STOCK SUGAR & FINAL MOLASSES ESTIMATED**  |
| 7 | TONS SUGAR IN BINS  | 2.819 | 0.850 | 0.000 | 1.223 | 2.789 | 0 |
| 8 | TONS POL IN STOCK  | 7.770 | 6.623 | 7.585 | 8.003 | 8.413 | 0 |
| 9 | TONS BRIX IN STOCK  | 11.227 | 9.461 | 11.154 | 11.599 | 11.525 | 0 |
| 10 | STOCK PURITY  | 69.208 |  |  |  |  | 0 |
| 11 | SJM RECOVERY  | 74.773 |  |  |  |  | 0 |
| 12 | TONS POL IN SUGAR EST | 5.810 |  |  |  |  | 0 |
| 13 | TONS SUGAR EST | 5.838 |  |  |  |  | 0 |
| 14 | TONS POL IN FIN. MOL EST. | 1.960 |  |  |  |  | 0 |
| 15 | TONS FIN. MOL. EST. | 6.538 |  |  |  |  | 0 |
| **V.H.P. SUGAR**  |
| 16 | TONS MADE WEEK  | 9.838 | 10.372 | 18.753 | 22.300 | 20.369 | 14.179 |
| 17 | TONS MADE PREVIOUS  | 0.000 |  |  |  |  | 952.566 |
| 18 | TONS MADE TO-DATE | 9.838 |  |  |  |  |  |
| 19 | TONS EST IN STOCK & BINS  | 8.657 |  |  |  |  | 0.000 |
| 20 | TONS M & E TO-DATE  | 18.495 |  |  |  |  |  |
| 21 | TONS M & E PREVIOUS  | 0.000 |  |  |  |  | 953.657 |
| 22 | TONS M & E WEEK  | 18.495 |  |  |  |  |  |
| 23 | TONS POL M & E WEEK  | 18.406 |  |  |  |  |  |
| 24 | TONS POL M & E PREVIOUS  | 0.000 |  |  |  |  | 948.535 |
| 25 | TONS POL M & E TO-DATE | 18.406 |  |  |  |  |  |
| **FINAL MOLASSES** |
| 26 | TONS MADE WEEK  | 8.311 | 1.778 | 6.252 | 9.355 | 8.102 | 17.375 |
| 27 | TONS MADE PREVIOUS  | 0.000 |  |  |  |  | 273.802 |
| 28 | TONS MADE TO-DATE  | 8.311 |  |  |  |  |  |
| 29 | TONS EST. IN STOCK  | 6.538 |  |  |  |  | 0.000 |
| 30 | TONS M & E TO-DATE  | 14.849 |  |  |  |  |  |
| 31 | TONS M & E PREVIOUS  | 0.000 |  |  |  |  | 286.601 |
| 32 | TONS M & E WEEK  | 14.849 |  |  |  |  |  |
| 33 | TONS POL M & E WEEK  | 4.452 |  |  |  |  |  |
| 34 | TONS POL M & E PREVIOUS  | 0.000 |  |  |  |  | 83.004 |
| 35 | TONS POL M & E TO-DATE  | 4.452 |  |  |  |  |  |
| **FILTER CAKE**  |
| 36 | TONS MADE WEEK  | 7.825 | 8.502 | 8.998 | 9.033 | 8.473 | 4.080 |
| 37 | TONS PREVIOUS | 0.000 |  |  |  |  | 367.915 |
| 38 | TONS TO-DATE | 7.825 |  |  |  |  |  |
| 39 | TONS POL WEEK  | 0.257 | 0.303 | 0.324 | 0.35 | 0.333 | 0.090 |
| 40 | TONS POL PREVIOUS  | 0.000 |  |  |  |  | 10.609 |
| 41 | TONS POL TO-DATE  | 0.257 |  |  |  |  |  |
| **BAGASSE** |
| 42 | TONS MADE WEEK  | 58.516 | 60.603 | 55.752 | 58.369 | 57.456 | 30.613 |
| 43 | TONS PREVIOUS  | 0.000 |  |  |  |  | 2799.290 |
| 44 | TONS TO-DATE |  |  |  |  |  |  |
| 45 | TONS POL WEEK  | 0.738 | 0.748 | 0.653 | 0.728 | 0.698 | 0.614 |
| 46 | TONS POL PREVIOUS  | 0.000 |  |  |  |  |  |
| 47 | TONS POL TO-DATE |  |  |  |  |  |  |
| **MIXED JUICE** |
| 48 | TONS MADE WEEK  | 238.293 | 240.357 | 230.246 | 243.842 | 238.159 | 155.313 |
| 49 | TONS PREVIOUS  | 0.000 |  |  |  |  |  |
| 50 | TONS TO-DATE  | 238.923 |  |  |  |  |  |
| 51 | TONS CORRECTED POL WEEK | 24.699 | 25.123 | 22.752 | 26.021 | 24.996 | 15.143 |
| 52 | TONS CORR. POL PREVIOUS  | 0.000 |  |  |  |  | 1039.000 |
| 53 | TONS CORR. POL TO-DATE  | 24.699 |  |  |  |  |  |
| **CANE**  |
| 54 | TONS CRUSHED WEEK  | 205.968 | 208.751 | 202.421 | 210.635 | 205.562 | 129.684 |
| 55 | TONS CRUSHED PREVIOUS  | 0.000 |  |  |  |  | 8482.120 |
| 56 | TONS CRUSHED TO-DATE  | 205.968 |  |  |  |  |  |
| 57 | TONS POL WEEK  | 25.437 |  |  |  |  |  |
| 58 | TONS POL PREVIOUS  | 0.000 |  |  |  |  | 1065.154 |
| 59 | TONS POL TO-DATE  | 26.437 |  |  |  |  |  |
| **POL UNDETERMINED ON POL IN MIXED JUICE**  |
| 60 | TONS LOST WEEK  | 1.584 |  |  |  |  |  |
| 61 | TONS PREVIOUS  | 0.000 |  |  |  |  |  |
| 62 | TONS TO-DATE  | 1.584 |  |  |  |  |  |
| **POL BALANCE % POL IN CANE**  |
| 63 | POL IN BAGASSE WEEK  | 2.901 |  |  |  |  |  |
| 64 | POL IN BAGASSE TO-DATE | 2.901 |  |  |  |  |  |
| 65 | POL IN F. CAKE WEEK  | 1.010 |  |  |  |  |  |
| 66 | POL IN F.CAKE TO-DATE  | 1.010 |  |  |  |  |  |
| 67 | POL F. MOL. M & E WEEK  | 17.502 |  |  |  |  |  |
| 68 | POL F. MOL M & E TO-DATE | 17.502 |  |  |  |  |  |
| 69 | POL UNDETERMINED WEEK  | 6.227 |  |  |  |  |  |
| 70 | POL UNDETERMINEDTO-DATE  | 6.227 |  |  |  |  |  |
| 71 | TONS POL IN SUGAR M & E WK | 72.359 |  |  |  |  |  |
| 72 | TONS POL IN SUGAR M & E TD | 72.359 |  |  |  |  |  |
| 73 | EXTRACTION FOR WEEK  | 97.10 |  |  |  |  |  |
| 74 | EXTRACTION TO-DATE | 97.10 |  |  |  |  |  |
| 75 | B.H.R. WEEK  | 74.52 |  |  |  |  |  |
| 76 | B.H.R. PREVIOUS  | 74.52 |  |  |  |  |  |
| 77 | OVERALL REC. WEEK  | 72.36 |  |  |  |  |  |
| 78 | OVERALL REC. TO-DATE | 72.36 |  |  |  |  |  |
| **QUALITY CONTROL**  |
| 79 | POL % CANE WEEK  | 12.35 |  |  |  |  |  |
| 80 | POL % CANE TO-DATE  | 12.35 |  |  |  |  |  |
| 81 | POL % SUGAR M & E WEEK  | 99.52 |  |  |  |  |  |
| 82 | POL % SUGAR M & E TO-DATE  | 99.52 |  |  |  |  |  |
| 83 | POL % MOL. M & E WEEK  | 29.98 |  |  |  |  |  |
| 84 | POL % MOL. M & E TO-DATE  | 29.98 |  |  |  |  |  |
| 85 | POL % BAGASSE WEEK  | 1.26 |  |  |  |  |  |
| 86 | POL % BAGASSE TO-DATE  | 1.26 |  |  |  |  |  |
| 87 | POL FILTER CAKE WEEK  | 3.28 |  |  |  |  |  |
| 88 | POL FILTER CAKE TO-DATE  | 3.28 |  |  |  |  |  |
| 89 | CANE TO SUGAR RATIO WEEK  | 11.14 |  |  |  |  |  |
| 90 | CANE TO SUGAR RATIO TD | 11.14 |  |  |  |  |  |

1. Pol % Sugar – given (99.52)
2. Moisture % Sugar – given (0.08)

**Sugar and final molasses made for the week**

1. Purity of sugar = × 100 = × 100 = 99.60%

(Note: Brix % = 100 – Moisture %)

1. Pol % of final molasses – given (29.98)
2. Brix % of final molasses – given (82.50)
3. Purity of final molasses = × 100 = × 100 = 36.34%

**Stock: Sugar and Final Molasses Estimated**

1. Tons sugar in Bins – given (2.819)
2. Tons Pol in stock – given (7.770)
3. Tons Brix in stock – given (11.227)
4. Stock Purity = × = × = 69.208
5. S.J.M. Recovery = × = × 100 = 74.773%
6. Tons Pol in sugar estimated

= S.J.M. Recovery % of the Tons Pol in Stock

= × 7.77 = 5.810 tons

1. Tons sugar estimated = ×

= ×

= 5.838 tons

1. Tons Pol in final molasses estimated

= Tons Pol in stock estimated – Tons Pol in sugar estimated

= 7.77 – 5.810 = 1.960 tons

1. Tons final molasses estimated

= ×

= ×

= 6.538 tons

**V.H.P. Sugar**

1. Tons made for week – given (9.838)
2. Tons made previously – given (0.000)
3. Tons made to date

= Tons made for the week + previously

= 9.838 + 0.000

= 9.838 tons

1. Tons estimated in stock and bins

= Tons estimated in stock + Tons in Bins

= 5.838 + 2.819 = 8.657 tons

1. Tons made and estimated to date

= Tons made to date + Tons estimated in stock (and bins)

= 9.838 + 8.657

= 18.495 tons

1. Tons made and estimated previously – given (0.000)
2. Tons made and estimated for the week

= (Tons made and estimated to date) – (Tons made and estimated previously)

= 18.495 – 0

= 18.495 tons

1. Tons Pol made and estimated for the week

= Pol% × Tons of sugar made and estimated for the week

= ×

= 18.495 tons

1. Tons Pol made and estimated previously is given 0.000 tons
2. Tons Pol made and estimated to date

= (Tons made and estimated for the week) + (Tons made and estimated previously)

= 18.406 + 0

= 18.406 tons

**Final molasses**

1. Tons made for the week – given (8.311)
2. Tons made previously – given (0.000)
3. Tons made to date

= Tons made for the week + Tons made previously

= 8.311 + 0.00

= 8.311 tons

1. Tons estimated in stock = 6.538 – see step 15
2. Tons made and estimated to date

= Tons made to date + Tons estimated in stock

= 8.311 + 6.538

= 14.849 tons

1. Tons made and estimated previously – given (0.000)
2. Tons made and estimated for the week

= (Tons made and estimated to date) – (Tons made and estimated previously)

= 14. 849 tons

1. Tons Pol made and estimated for week

= Pol % of molasses × Tons of final molasses made and estimated for week

= × 14.849

= 4.452 tons

1. Tons Pol made and estimated previously – given (0.000)
2. Tons Pol made and estimated to date

= (Tons made and estimated for the week) + (Tons Pol made and estimated previously)

= 4.452 + 0

= 4.452 tons

**Filter Cake**

1. Tons made for the week – given (7.825)
2. Tons made previously – given (0.000)
3. Tons made to date

= Tons made for the week + Tons made previously

= 7.825 + 0.000

= 7.825 tons

1. Tons Pol made for the week – given (0.257)
2. Tons Pol made previously – given (0.000)
3. Tons Pol made to date

= Tons made for the week + Tons made previously

= 0.257 + 0.000

= 0.257 tons

**Bagasse**

1. Tons made for the week – given (58.516)
2. Tons made previously – given (0.000)
3. Tons made to date

= Tons made for the week + Tons made previously

= 58.516 + 0.000

= 58.516 tons

1. Tons Pol made for the week – given (0.738)
2. Tons Pol made previously – given (0.000)
3. Tons Pol made to date

= Tons made for the week + Tons made previously

= 0.738 + 0.000

= 0.738 tons

**Mixed juice**

1. Tons made for the week – given (238.923)
2. Tons made previously – given (0.000)
3. Tons made to date

= Tons made for the week + Tons made previously

= 238.932 + 0.000

= 238.923 tons

1. Tons corrected pol made for the week – given (24.699)
2. Tons corrected pol made previously – given (0.000)
3. Tons corrected pol made to date

= Tons made for the week + Tons made previously

= 24.699 + 0.000

= 24.699 tons

**Cane**

1. Tons crushed for the week – given (205.968)
2. Tons crushed previously – given (0.000)
3. Tons crushed to date

= Tons crushed for the week + Tons crushed previously

= 205.968 + 0.000

= 205.968 tons

1. Tons Pol made for the week

= Tons Pol in Mixed juice (week) + Tons Pol in Bagasse (week)

= 24.699 + 0.738

= 25.437 tons

1. Tons Pol made previously – given (0.000)
2. Tons Pol made to date

= Tons of corrected pol in mixed juice + Tons Pol in bagasse

= 24.699 + 0.738

= 25.437 tons

**Pol Undetermined**

1. Tons Pol lost for week

= Tons Pol coming in – Tons Pol leaving

= Tons Pol in cane for week – (Tons Pol in sugar for week + Tons Pol in molasses for week + Tons Pol in filter cake for week + Tons Pol in bagasse for week)

= 25.437 – (18.406 + 4.452 + 0.257 + 0.738) = 25.437 – 23.853

= 1.584 tons

1. Tons Pol lost previously – given (0.000)
2. Tons Pol lost to date

= Tons lost to date + Tons Pol lost previously

= 1.584 + 0.000

= 1.584 tons

**Pol Balance**

1. Pol in Bagasse % pol in cane (week)

= ×

= ×

= 2.901%

1. Pol in bagasse % pol in cane (To date)

= ×

= ×

= 2.901%

1. Pol in Filter Cake % pol in Cane (week)

= ×

= ×

= 1.010%

1. Pol in Filter Cake % pol in cane (To date)

= ×

= ×

= 1.010%

1. Pol in Final Molasses (Made & Estimated) % pol in cane (week)

= ×

= ×

= 17.502%

1. Pol in Final Molasses (Made & Estimated) % pol in cane (To date)

= ×

= ×

= 17.502%

1. Pol Undetermined loss % Pol in cane (week)

= ×

= ×

= 6.227 %

1. Pol Undetermined loss % Pol in cane (to date)

= ×

= ×

= 6.227 %

1. Pol in Sugar (Made & Estimated) % Pol in cane (week)

= ×

= ×

= 72.359 %

1. Pol in Sugar (Made & Estimated) % Pol in cane (To date)

= ×

= ×

= 72.359

1. Extraction (week)

= ×

= ×

= 97.10 %

1. Extraction (To date)

= ×

= ×

= 97.10 %

1. Boiling House Recovery (Week)

= ×

= ×

= 74.52 %

1. Boiling House Recovery (To date)

= ×

= ×

= 74.52 %

1. Overall Recovery (Week)

= ×

= ×

= 72.36

1. Overall Recovery (To date)

= ×

= ×

= 72.36 %

**Quality Control**

1. Pol % cane (week)

= ×

= ×

= 12.35 %

1. Pol % cane (to date)

= ×

= ×

= 12.35 %

1. Pol % sugar made and estimated (week)

= ×

= ×

= 99.52 %

1. Pol % sugar made and estimated (to date)

= ×

= ×

= 99.52 %

1. Pol % final molasses made and estimated (week)

= ×

= ×

= 29.98 %

1. Pol % final molasses made and estimated (to date)

= ×

= ×

= 29.98 %

1. Pol % bagasse (week)

= ×

= ×

= 1.26 %

1. Pol % bagasse (to date)

= ×

= ×

= 1.26 %

1. Pol % Filter Cake (week)

= ×

= ×

= 3.28 %

1. Pol % Filter Cake (to date)

= ×

= ×

= 3.28 %

1. Cane to sugar ratio (week)

=

=

= 11.14

1. Cane to sugar ratio (to date)

=

=

= 11.14