CHEMICAL CONTROL

(ANSI Sugar Tech. First Year & DIIPA)

By

Dr. Jahar Singh

APST

N S I Kanpur

Brix

- **Brix** :-Brix is defined as the total solid matter present in the solution.

- That is to say if 20 gms of sugar is dissolved in 80 gms of water to get 100 gms sugar solution,the brix of the solution would be 20 deg.
- Again if we take 20 gms sugar and 5 gms common salt and 75 gms water to get a sugar salt solution of 100gms,brix of solution would be 25.
- In a sugar factory we always came across sugar solutions which are almost associated with some other substances in dissolved state which we called it as Non-sugar .
- If we evaporate such as solution to dryness some solid matter will result.

- **Definition.** The percentage by weight of solid matter is represented by the term ‘Brix’ or gravity solid.
- Brix can be measured by means of hydrometer which is know as ‘Brix hydrometer 'or brix spindle.
- In highly pure sugar solution which contains nothing else but only sugar ,the brix reading on the hydrometer will indicate the percentage of sugar itself, since brix is an entity and treated as a substance the terms ‘Total Brix.’, Tons brix and quintal brix are in use.

Pol or polarisation :-

- **Pol or polarisation :-** Pol is defined as the ‘Value determined by the direct polarization of normal or half normal solution in a polarimeter’.
- This requires little explanation, if we taste the substance and find it sweet we say that substance contains sugar.
- Another the property of sugar is that if “polarized light
is passed through a solution of sucrose the plane of polarization is turned towards right by certain no. of degrees. The number of degrees by which the plane gets rotated is directly proportional to the percentage of sugar (sucrose) present in solution .
- Here it fructose , lactose etc all are called as “sugars” but what we mean by a sugar is sucrose ,which we recover from sugarcane in crystalline form in a sugar factory.
- Therefore the term ‘pol’ derived from polarization denotes for all practical purposes only sucrose which we called it sugar.

- **Purity :-** The purity denotes the percentage by weight of sugar in solution or,
- Apparent Purity $= \frac{\text{Pol \%}}{\text{Brix\%}} \times 100$
- The term purity will indicate in a sugar factory , the proportion of sucrose present in total dissolved solids by weight.
- **True Purity :-** $\frac{\text{Pol \%} \times 100}{\text{Dry Substance}}$
- **Gravity Purity :-** $\frac{\text{Sucrose\%}}{\text{Brix\%}} \times 100$

- Suppose fresh cane juice sample is analyzed, it will be observed that it’s purity is 80. We allow the juice to stay over for some time during which bacterial action takes place and it ferments that is bacteria have extent some part of sucrose we again analyze it, when we observe that it’s purity is not 80 but only 75.
- This fall in the purity indicates loss of sugar. Conversely, if from the sugar solution some non sugars are removed the purity of sugar solution will increase. This is broadly the significance of the term purity.

- **Technical Difinations:-**
- **Cane:-**The raw material delivered to the cane carrier including clean cans, field trash, roots, tops, dirt etc.
- **Fibre:-** The insoluble matter in the cane or all material other than juice.
- **Bagasse:-**The fibrous residue after the extraction of juice obtained from crushing cane in one or more mills. This is known as 1st mill bag or final bag or simply bagasse.
- **Imbibition:-** The process in which water or juice is added or sprayed on bagasse to mix and dilute the juice contained in the bagasse.
- **Maceration:-** The process in which the bagasse is steeped in an excess of water or juice, generally at high temperature. The water added for this purpose is termed as maceration water or added water.

- **Bagacillo** :-A fraction of the fine particles separated from bagasse. This is added in mud to make a good admixture for the purpose of better filtration.
- **Primary Juice** :- All the juice express before dilution begins.
- **Secondary juice** :- The diluted juice expressed by the rest of the mills after the first mill.
- **Last mill juice** :- The juice expressed by the last mill of the milling tandem.
- **Mixed juice** :-The composite juice comprising P.J & S.J. which is sent from the milling plant to boiling house .

- **Last Expressed juice** :- The juice expressed by the last two rollers of the milling tandem.
- **First Expressed juice** :- The juice by the first the rollers of the milling tandem.
- **Absolute juice** :- All the dissolved solids in the cane plus total water of the cane.
- i.e. Absolute juice = cane – fibre
- **Undiluted juice** :- The juice expressed by the mills or retained in the bagasse corrected for imbibitions water. For the purposes of calculation, it has brix of the primary juice.
- **Residual juice** :- All the dissolved solids in the bagasse plus total water in bagasse i.e. bagasse – fibre.

- **Clarified juice** :- The whole juice which come out from the clarifiers and is fed to vapor cell or 1st body of evaporators for concentration.
- **Filter cake** :-The washed residue discharged either from the filter presses or vacuum filters. Used as manure as contains N,P & K.
- **Filterates** :- Liquid which has passed through the filtration process or the combined filtrates from the filters.
- **Suspended solids** :- Solids in juice or other liquid, removable by mechanical means.
- **Impurities (soluble)** :- A collective term for all substances other then sucrose present in the total soluble solids contained in a sample i.e.

- **Dilution water :-** The quantity of added water for maceration or imbibitions which is present in mixed juice.
- **Settlings :-** The material which collects in the bottom portion of clarifier.
- **Normal weight :-** The weight of pure sucrose which when dissolved in water to a total volume of 100 ml at 20 C gives a solution reaching of 100 C of scale when examined in a saccharimeter in a tube of 200 mm long at 20 C
- The normal weight according to the international sugar scale is 26.00 gms weighed in air with brass at 20C.
- **Brix spindle :-** A hydrometer which reads directly the % age by weight of sucrose in an aqueous solution of pure sucrose at the calibrated temperature.
- **Gravity solids :-** The weight of solids calculated from the brix determination. Numerically gravity solids and brix are the same. The solids in solution of cane sugar.

- **Dry substance :-** The solid matter as obtained on drying the matter to a constant weight. It gives the measure of total solids both soluble and insoluble, or in the absence of insoluble solids, the total soluble solids.
- **Refractometer Brix :-** Weight of solids in a solution indicated by the sugar refractometer or as derived from the refractive index.
- **Purity :-** Three classes of purities.
- **Apparent purity :-** $\frac{\text{Pol \%}}{\text{Brix \%}} \times 100$
- **Gravity purity :-** $\frac{\text{Sucrose \%}}{\text{Brix \%}} \times 100$
- **True purity :-** $\frac{\text{sucrose}}{\text{Dry substance}} \times 100$
- **Non pol :-** Brix – Pol
- **Non sucrose :-** Brix – Sucrose
- **Impurity :-** Brix – Pol

- **Fundamental formulae for cane , Added water, mixed juice & bagasse :**
- Milling control fundamentally depends upon the following.
- Determination of the amount of sugar entering in the factory ,in the form of cane i.e. sugar input.
- Portion of sugar extracted in mixed juice
- The quantity of water used in the process for the extraction of juice.
- Fundamental or Basic formula
- Input = Out put
- Cane + Added water = Mixed juice + Bagasse

  Where,
- Cane is weighed by weight bridge.
- Added water is know by it's volume and temperature or it can be weighed.
- Mixed juice is also weighed.

- **Mill Extraction** :- The quantity of sugar extracted in the mixed juice per 100 sugar in cane i.e. percentage of sugar extracted in the mixed juice out of total sugar in cane.
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- Mill Extraction = Sugar (Pol) in M.J. % cane x 100
- Sugar (Pol) % cane
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- Exam.(1) Cane = 9500 M.T. ;Mixed juice =9120 M.T.
- Added water = 2327.5
- Analysis of M.J.: – Bx. %juice - 15.5 , Pol %juice -13.02
- Pol % bagasse -2.5
- Calculate A.W. % cane, Pol % cane & Mill Extraction
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- **Solution** Cane + A.W. = M.J. + Bagasse
- 9500 + 2327.5 = 9120 + Bagasse
- Bagasse = 9500 + 2327.50 – 9120
- = 2707.50
-
- Bagasse % cane= Total bagasse x 100/ cane crushed
- = 2707.5 x10/ 9500
-
- = 28.50 %
-
- M.J. % cane = Total M.J. x 100/ cane crushed
- = 9120 x 100/ 9500
-
- = 96.00 %
-

A.W. % cane = Total Added water x 100/ cane crushed

= 2327.50 x 100/ 9500

= 24.50 %

Pol in M.J. % cane = Pol % M.J. % cane

Mill Extraction =Pol in M.J. % cane x 100/ Pol % cane

= 12.50 x 100/ 13.21

= 94.625

= 94.63

- **Fibre % cane**
- There are two methods for finding fibre % cane
- (A) Direct Method
- (B) Indirect Method
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- **Direct Method** :-(1) **Laboratory Method** :-
- In this method a few cane sticks are taken & some portion of cane is shredded or cut into fine pieces by means of a laboratory shredder.
- A sample of shredded cane is weighed and dried in air over to determine moisture % cane.
- The remaining cane sticks are crushed into laboratory mill or crusher and brix of the juice so extracted is determined.
- From these figs ,fibre ,cane is determined as follows.
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- **(2) <u>By Rapi – pol Extractor</u> – Method :-**
- The sugar cane sticks are cut into fine pieces.
- 250 gms of this sample along with 2000 ml water is transferred to rapi-pol vessel.
- Run the Rapi-pol extractor for 15 mints .
- Decant the whole liquid from vessel.
- Repeat the same above procedure for 2 or 3 times. Then take out the fibrous mass from vessel .
- fter well squeezing with hand & dry the fibrous mass completely in drier and weigh it. The fibre % cane will be calculated as,
- Fibre%cane= Weight of the fibrous massx100/250
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- **Indirect Method:-**
- **Laboratory Method:-** Crush the weighed cane in a laboratory mill. Determine the wt. of juice extracted and analyse the juice for Brix %, Pol % & Purity. Bagasse is also analyzed for Pol % & moisture % as usual.
- From there analytical results fibre % cane is calculated as under -

$$\text{Bagasse \% cane} = \frac{\text{wt.of cane} - \text{wt.of juice extracted}}{\text{Wt.of the cane}} \times 100$$

$$\text{Brix \% Bag.} = \frac{\text{Pol \% bag}}{\text{Pty of extracted juice}} \times 100$$

- Fibre % Bag = 100 – Moist. % Bag – Brix % Bag.
- Fibre % cane = Fibre in bag. % cane

$$\text{Fibre \% cane} = \frac{\text{fibre \% Bag. X Bag. \% cane}}{100}$$

- But ,in the factory ,fibre % cane is determined as follows
- Cane + A.W. = Mixed juice + Bagasse
- 100 + A.W. % cane = M.J. % cane + Bag. % cane
- Bag. % cane = 100+A.W.%cane – M.J.% cane
- Fibre % cane = 100 – moist. % Bag – Brix % Bag
- Brix % Bag = Pol % Bag.x100/Purity LMJ
- Fibre % cane = $\frac{\text{fibre \% Bag. x Bag. \% cane}}{100}$

Bagasse % cane :-

- Bagasse % cane , can be calculated by two methods.
- Cane + Added water = Mixed juice + Bagasse
- OR 100 + A.W. % cane = M.J. % cane + Bag. % cane
- Bag. % cane = 100 + A.W. % cane – M.J. % cane
- Here cane, Added water & mixed juice are directly weighed & the quantity of bagasse & bag % cane is calculated as,
- By determining fibre % cane & fibre % bagasse
- Bagasse % cane can be determined as,
- Bagasse % cane = $\frac{\text{Fibre \% cane}}{\text{Fibre \% bagasse}} \times 100$
- Here fibre % cane is determined by direct method and bagasse is analyzed for moisture % and Pol % & knowing the purity of L.M.J. fibre % bag. is calculated.

- **Added Water % cane :-**
- Added water % cane is also determined by two methods.
- By actual measurement of water & knowing temperature and density of water or by weighment of water.
- From the fundamental formula
- Added water % cane = M.J. % cane + Bag. % cane – 100
- Where weight of M.J. is determined directly and bagasse % cane is calculated from fibre % cane & fibre % bagasse of which fibre % cane is determined by the direct method & fibre % cane is determined by the direct method & fible % bagasse is calculated from the analysis of bagasse & purity of L.M.J.

- **Added water % Mixed Juice :-**
-
- Let M.J.% cane = X
- A.W. % cane = Y
- i.e. for 100 cane ; Mixed juice is X & A.W. is Y.
- i.e. for X mixed juice - Added water is Y
- for 100 Mixed juice - Added water =
- = Y/X x 100
- = Added water % cane X100
- M.J. % cane
- i.e. Added water % mixed juice = Added water % cane x 100
- M.J. % cane
-

$$\text{Added water \% mixed juice} = \frac{\text{Added water \% cane}}{\text{M.J. \% cane}} \times 100$$

- **Added Water Extracted % cane :-**
- This is calculated from Brix % P.J and Brix % mixed juice by the following formula.
- Added water extracted % mixed juice = Bx. % P.J – Bx.% M.J.

  Bx.% P.J.

- Added water extracted in M.J.% cane =A.W.ext. in. % M.J. X 100

  M.J. % cane

- A.W.extracted in M.J. % cane =Bx. % P.J. – Bx. % M.J. x M.J. % cane
- Bx. % P.J. Add.W.%cane

- **Added water extracted in M.J. % Added water on cane**
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- Let A.W. extracted in M.J. % cane = X
- And Added water % cane = Y
- i.e. for 100 cane Added water is Y and A.W. extracted in M.J. is X.
- i.e. for (out of) Y, added water – Added water ext. in M.J. is X.
- : for 100, water – Added water ext. is X/Y x 100
-
- i.e. Added water extracted in .M.J. % added water by
-
- cane = X/Y x 100
- = A.W.extracted in M.J. % cane x 100
- A.W. % cane
- i.e. Added water extracted in M.J. % added water on cane
-
- = Bx. % P.J. – Bx. % M.J. x M.J. % cane 100
- Bx. % P.J. A.W. % cane
-

- **Undiluted juice lost % Bagasse :**
- **Assumption** :-undiluted juice lost in bagasse For the purpose of calculation, it is assumed that bagasse have the same brix as that of primary juice and purity as that of last expressed juice (last mill juice)
- Brix % primary juice = P
- Brix % bagasse = b
- Bx. % P.J. = P = Bx. % undiluted juice
- i.e. for P, brix, undiluted juice is b/p x 100
- but for 'b' brix, baggasse is 100

- i.e. In 100 bagasse undiluted juice is = b/p x 100
- This undiluted juice is lost in bagasse
- .: Undiluted juice lost % bag. = b/p x 100

  $= \frac{\text{Brix \% bag}}{\text{Brix \% P.J.}} \times 100$
- Undiluted lost % bag = $\frac{\text{Brix \% bag}}{\text{Brix \% P.J.}} \times 100$

- **Undiluted juice lost in bagasse % fibre :**
- This term was evolved by Java system of chen.
- **Advantages in calculating this term are as following.**

No weighment is necessary & this figure is unaffected by in accurate weighing.

- Factories,which do not weigh the cane or added water or mixed juice,can be taken for mutual comparison.
- Simplicity in calculation.
- The term undiluted juice lost in bag % fibre is accurate enough for practical purpose only.

- Let,
- Undiluted juice lost % bag = X
- and fibre % bagasse = Y
- i.e. In 100 bag – fibre is Y & undiluted juice lost in X
- .: for Y fibre -Undiluted juice lost is X
- for 100 fibre -Undiluted juice lost is X/Y x 100
- Undiluted juice Lost in bag % fibre =X/Y x 100

- = $\frac{\text{Undiluted juice lost \% bagasse}}{\text{Fibre \% bagasse}}$ X
-
- Undiluted juice lost in = $\frac{\text{Bx. \% bag}}{\text{Bx. \% P.J.}}$ x 100 x $\frac{100}{\text{fibre \% bagasse}}$
- Bagasse % fibre
-
- = $\frac{\text{Bx. \% bagasse}}{\text{Bx. \% pri.juice}}$ X $\frac{10000}{\text{fibre \% bagasse}}$

- **Recorded Mill Extraction**

- **Juice lost per Unit fibre** :- It is assumed that cane is an ideal cane i.e.it (cane) contains only fibre and juice.
- i.e. cane = fibre + juice
- Let, fibre per unit cane - f
- Then juice per unit cane - 1 – f ……….(1)
- .: 'f' fibre corresponds (1 – f) juice
- .: Unit fibre then juice = $\frac{(1 - f)}{f}$ …….(2)
- Let, fibre per unit bagasse = m
- Bagasse per unit cane = f/m
- Juice extracted per unit cane = 1 - f/m …….(3)
- Now from equ (1) & (3)
- Out of 1-f juice , juice extracted = 1 – f/m

- For unit juice in cane , juice extracted
- Will be = $\dfrac{1 - f/m}{1 - f}$
- i.e. juice extracted per unit juice in cane = $\dfrac{1 - f/m}{1-f}$ = extraction (e)
- Juice lost per unit juice in cane = 1 – juice extracted per unit juice in cane
- = 1 – e
- i.e. for unit juice (in cane), the juice lost is (1 – e)
- .: for $\dfrac{1 - f}{f}$ juice (in cane) juice lost is = $\dfrac{(1 - e)(1 - f)}{f}$
- = $\dfrac{(1 - e)(1 - f)}{f}$

- lost is $\frac{(I - e)(I - f)}{f}$
- But from equation (2)
- Unit fibre corresponds to $\frac{I - f}{f}$ juice
- For unit fibre = f
- i.e. juice lost per unit fibre = $\frac{I - f}{f}$ juice = v
- This is indicated ‘v’ and this can be called as <u>‘juice Retention factor’</u>

- **Reduced Mill Extraction :**
- _It is evident that mill extraction will depend upon the juice lost in bagasse
- And quantity of juice lost in bagasse will depend on the fibre content.
- This explains that extraction is greatly influenced by the amount of fibre in cane.
- To eliminate the influence of variation in fibre, Noel Deerr proposed a formula to reduce the extraction to a common basis of 12.5 % fibre in cane so it has been agreed that fibre content of 12.5 % should standard or common fibre content to which values of “mill Extraction”,corresponding to different fibre contents should be reduced for comparison purposes

- This formula of Noel Deerr is called as R.M.E. (Red. Mill Extraction) & it enables to compare the results (milling performance) of different factories.
-
- Suppose the value ‘v’ remains constant irrespective of change in fibre content and recorded mill extraction.
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- Suppose in a particular factory ‘e’ & f is changed to f’& e’
- Then,
-
- $\frac{(I - e)(I - f)}{f} = v = \frac{(I - e')(I - f')}{f'}$
- as ‘v’ is constant

- Let $f' = 0.125$ ($f' = 12.5$)
- $v = \underline{(I - e')\ (I - f')}$
- f'
- $v = \underline{(I - e')\ (I - 0.125)}$
- 0.125
- $v = 7\,(I - e')$
- $(I - e') = v/7$
- $e' = I - v/7$
- $e' = \underline{7 - v}$
- 7

- Where e' = reduced Mill Extraction &
- $V = \frac{(I - e)(I - f)}{f}$ where e = Recorded mill extraction
- f = fibre per unit cane
-
- $R.M.E. = \frac{7 - v}{7} \times 100$
- Where $V = \frac{(I - e)(I - f)}{f}$

- The influence of the amount of fibre in cane on mill extraction is great for obvious reasons.
- NOEL DEERR proposed a formula to reduce the extraction to a common basis of 12.5% fibre in cane **.**
- This formula came to be known as 'Reduced Extraction'
- NOELDEERR'S formula for reduced extraction is as follows:

  where *em*,,.,= reduced extraction

  v = absolute juice in bagasse per cent fibre
- The value of v is calculated from the following equation:

$$v = \frac{(100 - \text{sucrose or pol extraction}) \times (100 - \text{fibre \% cane})}{\textbf{fibre \% cane}}$$

- Now, by the International Society of Sugar Cane Technologists (1SSCT)definition:
  IOO - sucrose or pol extraction = sucrose or pol in bagasse per cent sucrose or pol in cane;
  (100 - fibre % cane) = per cent of absolute juice in the cane.'
  The ISSCT definition of absolute juice is given as 'all the dissolved solids in the cane plus the total water of the cane; cane minus fibre'.
- This definition does not state that all the dissolved solids are uniformly dispersed in the water. It is a fact that solids in juice are not dispersed uniformly.
- This is also true for sucrose in juice, as made evident from the fact that there is a considerable drop in juice purity from mill to mill of the same tandem.
- Hence the extraction which is calculated on the basis of sucrose or pol, is not the same as the absolute juice extraction.

- I t is, therefore, wrong to presume that the expression (100 - sucrose or pol extraction) x (100 - fibre % cane) is thevalue of the lost absolute juice or the absolute juice in bagasse per cent cane. Hence the true value of the absolute juice in bagasse % fibre is anything but

  $$\frac{(100\text{- sucrose or pol extraction}) \times (100 - \text{fibre \% cane})}{\text{fibre \% cane}}$$

  NOEL DEERR'S formula for reduced extraction also fails in its main purpose to reduce the extraction to a common basis of 12.5% fibre in cane.
- In other words, the influence of variations in fibre % cane is not completely eliminated. This will be clear

RME By Mittal

- Let e = actual mill extraction on sucrose or pol basis
- *PC* = pol % cane
  f = fibre % cane and P b c = pol in bagasse % cane
- then pol in bagasse per cent pol in cane = 100 – e
- or pol in bagasse per cent cane = (100-e) x Pc/100
- pol lost in bagasse per cent fibre = (100-e)*xPc/f* = *M(say)* ----*(1)*

from Eq. (I) e = 100 – Mxf/Pc ------------(2)

let f = 1 2 . 5 ,then the extraction is reduced to e'

e'= 100- M x 12.5 / Pc ---------(3)

- Substituting the value of M from Eq. (I) in Eq. (3)
- *e'* = IOO --- 12.5 /f x (100 - e) ------ (4)
- But , 100 –e = Pbc /Pc x100

Hence e' = 100-(12.5/f xPbc /Pc x 100)

- or e'= 100 (1- 12.5/f x Pbc / Pc)
- Where e' = reduced extraction

REDUCED EXTRACTION BY NOEL DEERR'S FORMULA FOR DIFFERENT VALUES OF FIBRE % CANE WHEN POL % CANE, POL % BAGASSE AND FIBRE % BAGASSE REMAIN CONSTANT

Sample no.	Fibre % cane (f)	Fibre % bagasse (m)	Bagasse % cane $\left(B = \frac{f \times 100}{m}\right)$	Pol % bagasse (P)	Pol in bagasse % cane $\left(Pbc = \frac{P \times B}{100}\right)$	Pol % cane (Pc)	$100\text{-}e = \frac{Pbc \times 100}{Pc}$	$100\text{-}f$	$V = \frac{(100\text{-}e)(100\text{-}f)}{f}$	Reduced extraction $\left(100 - \frac{v}{7}\right)$
1	11.0	48.0	22.92	2.5	0.573	13.0	4.41	89.0	35.68	94.90
2	11.5	48.0	23.96	2.5	0.599	13.0	4.61	88.5	35.47	94.93
3	12.0	48.0	25.00	2.5	0.625	13.0	4.81	88.0	35.27	94.96
4	12.5	48.0	26.04	2.5	0.651	13.0	5.01	87.5	35.06	94.99
5	13.0	48.0	27.08	2.5	0.677	13.0	5.21	87.0	34.86	95.02
6	13.5	48.0	28.13	2.5	0.703	13.0	5.41	86.5	34.66	95.05
7	14.0	48.0	29.17	2.5	0.729	13.0	5.61	86.0	34.46	95.08
8	14.5	48.0	30.21	2.5	0.755	13.0	5.81	85.5	34.26	95.11
9	15.0	48.0	31.25	2.5	0.781	13.0	6.01	85.0	34.06	95.13
10	15.5	48.0	32.29	2.5	0.807	13.0	6.21	84.5	33.86	95.16
11	16.0	48.0	33.34	2.5	0.833	13.0	6.41	84.0	33.66	95.19
12	16.5	48.0	34.38	2.5	0.859	13.0	6.61	83.5	33.45	95.21
13	17.0	48.0	35.42	2.5	0.885	13.0	6.81	83.0	33.25	95.25

REDUCED EXTRACTION BY MITTAL'S FORMULA FOR DIFFERENT VALUES OF FIBRE % CANE WHEN POL % CANE, POL % BAGASSE AND FIBRE % BAGASSE REMAIN CONSTANT

Sample no.	*Fibre % cane (f)*	$\frac{Pbc}{Pc} \times 100$	*Reduced extraction* $100\left(1 - \frac{12.5}{f} \times \frac{Pbc}{Pc}\right)$
1	11.0	4.41	94.99
2	11.5	4.61	94.99
3	12.0	4.81	94.99
4	12.5	5.01	94.99
5	13.0	5.21	94.99
6	13.5	5.41	94.99
7	14.0	5.61	94.99
8	14.5	5.81	94.99
9	15.0	6.01	94.99
10	15.5	6.21	94.99
11	16.0	6.41	94.99
12	16.5	6.61	94.99
13	17.0	6.81	94.99

- Pol % cane = 14.25 M.J. % cane = 96.75
- 2) Fibre % cane = 12.00 Pol % M.J = 13.25
- Calculate Reduced Mill Extraction
- Solu : i) Pol in M.J. % cane =Pol % M.J. x M.J. %cane
- 100
- =13.25 x 96.75
- 100
- =12.82
- ii) Mill Extraction = Pol in M.J. % cane x 100
- Pol in cane
- = 12.82 x 100
- 14.25
- = 89.96

- iii)Juice retention factor V = $\frac{(I - e)(I - f)}{f}$
- = $\frac{(I - .8996)(I - .12)}{0.12}$
- = 0.73626
- iv) R.M.E = $\frac{7 - V}{7} \times 100$ = $\frac{7 - 0.73626}{7} \times 100$
- = 89.48

- **Brix free cane water** :
- Brix free cane water is the moisture which is chemically associated with fible & cannot be separated from it mechanically.
- B.F.C.W. Refers to portion of water which does not contain sugar & solids. It is sometimes called as colloidal water.
- It is closely associated with (1) Protoplasmic constituents of living cell & (2) fibre in cane.
- The general value of B.F.C.W. % fibre veries between 16 to 30. It helps in checking the chemical control figures.

- With applying pressures on mills the fluids i.e.Bx. free cane water & protoplasm (semifluid cand) are extracted in small quantities and sugar sap extraction is more ; but under heavy pressure, the quantity of sap i.e. Bx free cane water & protoplasm extracted is more.
- **Assume,**
- Cane = fibre + Undiluted juice + Brix free cane water
- .: B.F.C.W. = Cane - Undiluted juice – fibre
- If fibre = 100 then,
- B.F.C.W % fibre =cane % fibre – Undiluted juice % fibre – 100

- **(A) To find out cane % fibre**
- Let, fibre % cane = (f)
- i.e. for (fibre f) = cane is 100
- .: for 100 fibre = cane is = $\frac{100 \times 100}{(f)}$
- i.e. cane % fibre = $\frac{100 \times 100}{(f)}$
- = $\frac{100 \times 100}{\text{fibre \% cane}}$ .... (2)

- (B) To find out undiluted juice % fibre :-
- we know ,
- Undiluted juice % bag = $\frac{\text{Brix \% Bag}}{\text{Bx. \% P.J.}} \times 100$
- Similarly
- Undiluted juice % cane = $\frac{\text{Bx. \% cane}}{\text{Bx. \% P.J.}} \times 100$ ……………………..(3)

- Now let undiluted juice % cane = X
- & fibre % cane = Y
- .: In 100 cane - fibre is Y & undiluted juice is X
- i.e. In Y fibre - Undiluted juice is X
- .: for 100 fibre - Undiluted juice = X/Y x 100
- .: Undiluted juice % fibre = X / Y x 100
- = Undiluted juice % cane x 100
- Fibre % cane
- = Undiluted juice % cane x 100
- Fibre % cane (4)

- Putting equation (3) in equation (4)
- Undiluted juice % fibre = Bx. % cane x 100 x 100
- Bx. % P.J. fibre % cane
- = Bx. % cane x 100 x 100
- Bx. % P.J. x fibre % cane (5)
- Now putting equation No. (2) & (5) in equation No. (1) we get,
- B.F.C.W. % fibre = 100 x 100 - Bx. % cane x 100 x 100 – 100
- Fibre % cane Bx. % P.J. x fibre % cane
-
- = 100 x 100 (1 – Bx % cane) – 100
- Fibre % cane Bx % P.J.
-
- B.F.C.W. % fibre = 10,000 (1- Bx % cane) - 100
- Fibre % cane Bx % P.J.

- <u>Inferential Methods</u>
-     In the sugar factory,cane added water and mixed juice are weighed directly. These weights may give wrong results if weighing equipments are not in proper order or due to manual errors. In order to check these weighments whether they are right or wrong, the method employed or used called or known as inferential method.
- (1)<u>Bagasse % cane</u> :-
- It is found as ,
-     Bagasse % cane = <u>Fibre % cane</u> x 100
-     Fibre % Bagasse
-
- Here fibre % cane is determined by direct method & fibre % bag is determined by the analysis of bagasse for pol % moisture % & knowing purity of L.E.J
- Fibre % Bag = 100 – Moist. % Bag – Bx. % Bag.

- Mixed juice % cane :-
- (a) **Brix % cane :-**
- We know, cane = Absolute juice + fibre
- Absolute juice is not found out but primary juice & mixed juice are obtained by crashing cane. There is relationship established between absolute juice and primary juice i.e.
- Bx. % absolute juice = 0.975 x Bx.% P.J. (1)
- But cane = Absolute juice + fibre
- Absolute juice = cane – fibre
- If cane = 100 then,
- Absolute juice % cane = 100 – fibre % cane (2)
-
- But Bx. % cane = Bx. % Ab. Juice x Ab. Juice % cane (3)
- 100
-
- Thus putting equ (1) & (2) in equ (3), Bx. % cane can be calculated.

- **Mixed juice % cane** :-
- Like Pol % cane = Pol in M.J. % cane + Pol in Bag % cane
- Bx. % cane = Bx. In M.J. % cane + Bx in Bag. % cane
- Bx in M.J. % cane + Bx. % cane – Bx in Bag % cane.
-
- = Bx. % cane – Bx. % Bag x Bag % cane
- 100
-
- Putting equ (3) in equ (4), Bx. In M.J. % cane can be calculated,
- Now,
- Bx in M.J. % cane = Bx. % In M.J. x M.J. % cane
- 100
- M.J. % cane = Bx. In M.J. % cane x 100
- Bx. % M.J. (5)
- Thus knowing Bx. % M.J. from analysis and Bx. in M.J. % cane, M.J. % cane can be calculated.

- <u>Added water % cane</u> :-
-
- Cane + A.W. = M.J. + Bag OR
- 100 + A.W. % cane = M.J. % cane + Bag % cane
- Where cane = 100
- .: A.W. % cane = M.J. % cane + Bag % cane – 100
- Since M.J. % cane & Bag % cane , found out as above, A.W. % cane can be calculated.
- **Mathematical Formula for** :
- 1) Bagasse per Unit cane
- 2) Mixed juice per Unit cane
- 3) Added water per Unit cane

- (1) **Bagasse per Unit cane** :-
- Let , fibre per Unit cane = f
- & fibre per Unit = m
- Bagasse per Unit cane = fibre per Unit cane
- fibre per Unit bagasse
- Bagasse per Unit cane = f/m ………. (1)
-

Mixed Juice per Unit cane :-

- a) Absolute juice per Unit cane :- = I – fibre per unit cane
- = I – f
- Let, Bp = Bx per Unit Primary juice
- Bm = Bx per Unit mixed juice
- Bb = Bx per Unit bagasse
- And s = Mixed juice per Unit cane.
- b) Bx per Unit ab. Juice = 0.975 x Bx. per Unit P.J.
- = 0.975 x Bp
- c) Bx per Unit cane = Bx per Unit Ab. Juice x
- Ab. Juice per unit cane
- = 0.975 x Bp (I – f)

- d) Bx in bag Unit cane = Bx per Unit Bag x Bag per Unit cane
- = Bb x f/m
-
- e) Bx in M.J. per Unit cane = Bx per Unit M.J. x M.J. per Unit cane
- = Bm x s
-
- f) Bx per Unit cane = Bx inM.J. per Unit cane + Bx in Bag per Unit cane
-
- 0.975 x Bp x (I – f) = Bm x $ + Bp xf/m
- .: Bm x $ = 0.975 x Bp (I – f) – Bb x (f/m)
- $ = 0.975 x Bp (I – f) – Bb (f/m)
- Bm
- i.e. M.J. per Unit cane = 0.975 Bp (I – f) – Bb (f/m)
- Bm

- **Added water per Unit cane :-**
- Cane +Added water=Mixed juice + Bagasse +Bag per Unit cane
- A.W. per unit cane =M.J. per Unit cane + Bag per unit cane – I.
- A.W. per unit cane= $\frac{0.975\ Bp\ (I - f) - Bp}{Bm} + f/m - I$

- **Java Control :-**
-
- If sometime the weight of cane crushed is to be cheeked indirectly, following method should be used or adopted.
-
- Cane=Total Dirt + Total Undiluted juice in M.J.
- + Total Undiluted bagasse in bagasse … (1)
-
- (A) **Total Dirt** :- It is determined by dirt apparatus knowing the total gross weight of M.J.
-
-

- (B) Total Undiluted juice in M.J.
- = Total Net M.J. x $\frac{\text{Bx \% M.J.}}{\text{Bx \% P.J.}}$

(C) Total Undiluted bagasse in bagasse

- = Total qty of bag. x $\frac{\text{Undiluted bag \% bag}}{100}$

In equ (c) we have, Undiluted bag.= undiluted juice in bag.+BFCWin bag.+fibre in bag.

- Then,
- Undiluted bag . % bag .= Undiluted juice % bag. + B.F.C.W. % bag
- + fibre % bagasse
- Where,
- (i) Undiluted juice % bag. = Bx. % Bag. x 100
- Bx. % P.J.
- (ii) B.F.C.W. % bag = B.F.C.W. % fibre x fibre % bag.
- 100
- But B.F.C.W. % fibre= 10,000 (1- Bx. % cane) – 100
- Fibre % cane x Bx. % P.J.
- (iii) Fibre % bag = 100 – moisture % Bag – Bx. % Bag.
-

- Now, Bagaees= Undiluted bagasse + A.W. in bagasse
- .: A.W. in bag = Bag. – Undiluted bagasse
- If bag. = 100
- A.W. in Bag. % Bag. + 100 – Undiluted bag. % bag. ………………… (4)
-
- But from (B)
- Total Undiluted juice in M.J.
- = Total Net M.J. – Total
- Undiluted juice in M.J.
- And,
- Total A.W. in bagasse = Total A.W. on cane
- = Total A.W. in M.J. ……………………….. (5)

- Total Added water in bag. = Total A.W.in bag. X A.W. in bag. % bag.
- 100
- From equ (4) & (5) we have
- Total quantity of bag = Total A.W. in bag x 100
- A.W. in bag. % bag.
- Thus putting values of equ No. (3) & (6) in equ No. (2)
- Total undiluted bag .in bag. can be calculated.
- and thus putting the values of (A), (B) & (C) in equation No. (1), weight of cane can be found out.
- i.e.
- Cane = Total dirt + Total Undiluted in M.J.
- + Total Undiluted bagasse in bag.
-

Equivalent Ratio quotient value

- The purity drop during milling occurs as a result of extraction of non sugar,
- Due to varying degree of pressure, which is being exerted by different mills.
- But some time this drop is also affected on account of poor mill sanitation.
- This drop in purity adversely affects recovery % cane.
- The ratios of purities of mixed juice to that of primary juice & last mill juice are denoted by E.R.Q.V.
- Which provides an indication of extent of sanitation at the mills.

- Higher the ratio, better is the sanitation and more will be recovery % cane.
- Generally E.R.Q.V. for M.J./P.J. should be more then 95 or LMJ/P.J. , it should be more then 85.
- $$\text{E.R.Q.V.} \ \frac{\text{(M.J.)}}{\text{P.J.}} = \frac{1.4 \times \text{pty. M.J.} - 40}{1.4 \times \text{pty. P.J.} - 40} \times 100$$
- $$.\!: \ \text{E.R.Q.V.} \ \frac{\text{(L.M.J.)}}{\text{P.J.}} = \frac{1.4 \times \text{pty.L.M.J.} - 40}{1.4 \times \text{pty. P.J.} - 40} \times 100$$

PRIMARY EXTRACTION

PRIMARY EXTRACTION :- Primary extraction is the quantity of the sugar (Brix) in the primary juice extracted by the primary mill per 100 sugar in cane i.e. percentage of sugar extracted in the primary juice out of total sugar in cane.

- (1) There are two distinct methods for calculation of Primary Extraction
-
- (1) **First method** :-
- P.E. = Sugar (Pol) in primary juice % cane x 100
- Sugar (Pol) % cane
-
- Calculation of pol in primary juice % cane :
- Following analysis is to be carried out.
- (a) Primary mill bagasse for pol % & moisture %
- (b) Primary juice (discharge juice) for Bx, Pol, pty,
- (c) Fibre % cane can be found out by Rapi pol
- Extractor i.e. by direct method OR pol % cane & fibre % cane figures can be taken from the day figures for calculation purpose.

- **Primary bagasse analysis for pol % & moist. %**
- (1)Fibre % primary bag = 100 – moist. % P.Bag – Bx. % P.Bag
- = 100 – moist. % P.Bag – Pol % P.Bag
- Pty of Dis.P.J.
-
- (2)Primary bagasse % cane = fibre % cane x 100
- Fibre % P.Bag.
-
- (3)Pol in primary bag. % cane = Pol % P.Bag. x P.Bag. % cane
- 100
-
- (4)Pol in Primary juice % cane = Pol % cane – Pol in p. bagasse % cane
-
- (5)Primary Extraction = Pol in Primary juice % cane x 100
- Pol in cane
-

- **Primary Extraction** – (by solids method)
-
- 1) Primary Extraction = Bx.(Solid) in Prim.juice % cane x 100
- Bx (Solid) % cane
- (A) To find Brix (Solid) % cane
- Bx.% cane = Bx. in M.J. % cane + Bx. in bag % cane
- = Bx. % M.J. x M.J. % cane + Bx. % Bag. x Bag. % cane
- 100 100
-
- (B) To find Brix (Solids) in Primary juice % cane.
- Bx. In P.J. % cane = Bx. % P.J. xPJ % cane
- 100
-
- To calculate primary juice % cane

- The two components of mixed juice viz. primary juice & secondry juice must be sampled automatically and continuously.
-
- The Brix concentrations of the two types of juice (Samples) are determined. If the weights of mixed juice, primary juice and secondary juice are denoted by Wm ,Wp and Ws respectively and their brix concentrations are bm ,bp & bs respectively. The following equations are applied.
-
- 1) $W_m = W_p + W_s$ (weight equation) $W_s = W_m - W_p$ ……………. (1)
- 2) $W_m \times \frac{b_m}{100} = W_p \times \frac{b_p}{100} + W_s \times \frac{b_s}{100}$ (Bx. equation) ……………..(2)
-

- Equation (2) will become,
- $Wm.bm = Wp.Bp + Ws.bs.$
- Substituting Ws in equation No.2 we get, i.e.(1) in (2)
- $Wm.Bm = Wp.Bp + bs(Wm - Wp)$
- $Wm.bm = Wp.bp + Wm.bs - Wp\,bs$
-
- $Wm.bm. - Wmbs = Wpbp - Wpbs$
- $Wm(bm - bs) = Wp(bp - bs)$
-
- $Wp = \frac{wm(bm - bs)}{(bp - bs)}$
- $= Wm \frac{(bm - bs)}{(Bp - bs)}$
-
- Hence if Wm is total weight of M.J., the Wp will be the total weight of P.J. If Wn is M.J. % cane then Wp will be P.J. % cane.
- .: $P.J.\ \%\ cane = M.J.\ \%\ cane \times \frac{bm - bs}{Bp - bs}$
- $= M.J.\ \%\ cane \times \frac{Bx.\ \%\ M.J. - Bx.\ \%\ S.J.}{Bx.\ \%\ P.J. - Bx.\ \%\ S.J.}$
-

- **II B) <u>Primary Extraction</u>**
- Primary Extraction = <u>Brix (solids) in Prj. Juice % cane</u>
- Brix (solids) % cane
-
- (A) To find out Brix (solids) % cane
- Brix % Ab. Juice = 0.975 x Bx. % Pri, juice
- Absolute juice = 100 – fibre % cane
-
- Brix (solids) % cane = <u>Brix % Ab. Juice x Ab. Juice % cane</u>
- 100
- (B) To find out Brix (solids) in Primary juice % cane
- Brix in P.J. % cane = <u>Bx. % P.J. x P.J. % cane</u>
- 100

- **To calculate Primary juice % cane**
-
- The two components of mixed juice viz primary juice & secondary juice must be sampled automatically & continuously.
-
- The brix concentrations of the two types of juice are then determind. If the weights of mixed juice,primary juice & secondary juice are called as Wm,W1 & W2 respectively and their Brix concentration are bm,b1 & b2 then two equ mill exist.
-
- 1) $Wm = W_1 + W_2$ (weight equ)
- 2) $\frac{Wm\ bm}{100} = \frac{W1b1 + B2b2}{100}$ (Bx equ)
- Now substitute W2 from equ No.1 in equ No.2
- $W_2 = Wm - W_1$

- $\underline{Wmbm} = \underline{W1b1 + (Wm - w1)\, b2}$
- 100 100
- $Wm\, bm = W1b1 + Wmb2 - W1b2$
- $Wm.bm - Wm\, b2 = Wb_1 - W1b2$
- $Wm\, (bm - b2) = W1\, (b_1 - b_2)$
- $W1 = Wm\, (\underline{bm - b_2})$
- $(b_1 - b_2)$
-
- Here Wm is total M.J. then W1 mill be total P.J. & if Wm is M.J. % cane then W1 will be P.J. % cane.
-
- Primary juice % cane = M.J. % cane x $\underline{bm - b_2}$
- $B_1 - b_2$
-

Derivation of Primary

- Following assumptions are made for derivation of PE
- Cane is an ideal cane & consist of fibre & juice in uniform composition.
- There is 100% admixture of AW & bag.
- Fibre per unit bag. Remains constant irrespective all the mill.
- In an imbibition system juice extracted is equal tothe water or juice added.
- Let Fibre per unit cane = f
- Fibre per unit Bag. = m
- Fibre per unit P. Bag. = mp

- P. Bag. Per unit cane = f/mp
- P. Juice extracted per unit cane = 1 - f/mp
- Juice per unit cane = 1- f
- For 1-f juice, P. Juice extr. Is = 1-f/mp
- For unit juice, P. Juice extr. Is = 1-f/mp/ 1-f
- But according to assumption 3 mp = m
- P. Extraction $= \frac{1-f/m}{1-f}$ = m-f/(1-f)m
- **ep = m-f/(1-f)m**
-

Secondary Extraction using simple imbi.

- We know that ep = m-f/(1-f)m
- Consider 1st mill of secondary unit
- Juice leaving the pr. Unit per unit cane = 1st unit of seco. Unit
- Undiluted juice entering the 2nd unit/unit juice in cane=1-ep
- = 1- m-f/(1-f)m
- = f(1-m)/m(1-f)
- For 1-f juice entering = f(1-m)/m(1-f) x 1-f
- = f(1-m)/m
- Let w be the quantity of water per unit cane added after pr. Unit, then the total juice entering the secondary unit

- $= f(1-m)/m + w$
- $= \frac{f(1-m)/m + wm}{m}$
- As per the assumption no. 4
- Juice extracted = water or juice added
- $\frac{f(1-m)/m + wm}{m}$ = juice extracted will be w
- From unit juice , juice extracted = $\frac{f(1-m)/m + wm}{m}$

- Quantiry of juice extracted per unit juice present

$$= \frac{\frac{w}{f(1-m) + wm}}{m} \quad \text{or} \quad \frac{Wm}{f(1-m) + wm} = r$$

Mill Sanitation

- A certain drop of pty. of the mill juice occurs during milling as a result of extraction of NS.
- But there is another factor which contribute towards this drop in pty due to bad sanitation.
- If mills are not cleaned , cush 2 accumulate on the mill bads, the chains of intermediate carrier, funnels of the mills, juice tanks etc. ,the sugar gradually start decomposing.
- The decomposing of sugar is due to certain bacteria which become alive.
- There bacteria are ;-

- 1) Leuconostoc mesenteroides
- 2) Bacillus– Levonifarmneous
- 2) Yeast
- 1) Leuconostoc mesenteroides :- This spreads where juice is stagnate.
- The loss of sugar is marked by rapid drop in pty & increases acidity.
- This organism produces gelatinous substance called dextron.
- Gelatinous substance is insoluble in water & soluble in alkaline.

- It is also form gummy substances which is insoluble in nature and choke the pipe lines.
- Its growth is slow in acidic or neutral juices.
- Bacillus : - This organism also produces gummy substances called levos.
- Which on hydrolysis with acids yields levlose or fructose.
- Yeast :- It acts in acidic or take warm juice .
- It decomposes sucrose in glucose and fructose and further in to alcohol and co2.

prevention

- Regularly clean the mill house, mill juice tanks etc.
- The method of cleaning which is usually adopted :-
- Washing :- The mill should be stopped for about one hr. Daily or an alternate day particularly in hot weather and give a thourgh wash with hot water.
- Steaming :- For this purpose live steam is used under pressure nozzles fitted arrangement.
- Use of disinfectants :- Electrolytic chlorine with a dilution of 1/200 is used on the mill juice gutters.
- Fresh bleaching powder can also be used. Carbonic acid or sodium bisulphite is also used as 1% soln.