YIELD CALCULATION ON
MOLASSES-BASED SPIRITS

Best Practices Series #4

Targets

In the distilleries, **getting the optimum yield during the process of spirits production** is a daily target.

Features of yield on molasses

- Yield calculation is the key to understanding how efficient a distillery is and to target areas for improvement.
- There are four different yield calculations you can use in your distillery which will give you different information.
- **Overall yield:** it gives you the cost of the molasses to produce your spirit. This is a quantity of pure ethanol that you can sell per ton of molasses.
- **Theoretical yield** is theoretical amount of ethanol that can be produced from certain amount of fermentable sugars. (see calculation for converting sucrose into fermentable sugars in conversion factors).

$$Theoretical\ yield\ (L\ of\ ethanol\ per\ kg\ of\ sugar) = \frac{Amount\ of\ Fermentable\ sugars(kg) \times 0.511}{0.789}$$

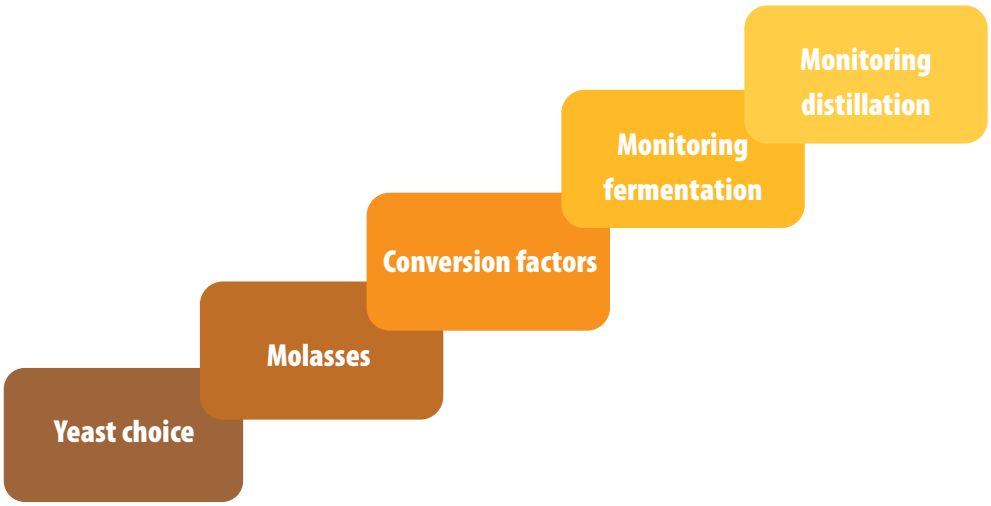
- **Fermentation Yield** is the amount of ethanol produced in your fermentation from certain amount of sugar.

$$Fermentation\ yield\ \% = \frac{V_{Fermenter}(L) \times \%abv_{Fermenter}}{Theoritical\ yield} * 100$$

The aim for the producers is to reach 82-90 % of theoretical yield.

- **Distillation yield:** final litres of your distillate produced divided by litres of ethanol into distillation.
- **Why can we never get 100 % of the theoretical yield?** The diverse reasons are the production of daughter yeasts, some losses in factory production, the contamination by bacteria and wild yeast and the production of glycerol, organic acids, higher alcohols, esters, etc. There will be losses in distillation.

Key points to consider for yield



www.lallemanddistilling.com
@Company/Lallemand-Biofuels-&-Distilled-Spirits
distilledspirits@lallemand.com
LallemandDistilling

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Lallemand Distilling recommendations

Yeast choice

Molasses is a very diverse feedstock since it is a co-product of the production of sugars and the quantity of non-fermentable compounds is significant. In molasses the fermentable sugars are glucose, fructose; there is sucrose also that yeast will convert in fermentable sugars. It is important to ferment with a yeast dedicated to this type of sugar to make sure that we get a complete fermentation with no residual sugars. Lallemand Distilling recommends looking at the characteristics of the **DistilaMax®** range to choose the yeast strain according to your process.

Molasses

Successive crystallizations during the sugar production process tend to degrade molasses sugars into unfermentable compounds. According to the process, the molasses will be of grade A, or grade B or blackstrap. The main characteristics of the molasses are the °Brix, the % of invert sugars (reducing sugars) and the % of sucrose. The invert sugars are Glucose + Fructose + about 6 % of non-fermentable sugars; the sucrose is converted by the yeast into glucose + fructose. (see calculation for Sucrose below). The addition of the various sugars will give the real quantity of fermentable sugars and so will allow a relevant calculation of the theoretical yield.

Conversion factors

During the fermentation process, the yeast thanks to the natural invertase will convert sucrose into glucose + fructose. The conversion factor for sucrose to glucose is 1.05; that means that for 100 parts by weight of sucrose you get 105 parts of glucose.
If you have 1000 kg of molasses with a % of invert sugars of 34,5 % and a % of sucrose of 35,1 % the total amount of fermentable sugars will be ((1000*(94 %*34,5 %)) + ((1000*35,1 %)*1,05)= 693kg.
The theoretical ethanol content in litres is 693*0,511 (glucose to ethanol theory factor)/0,789 (density ethanol) = 449 litres.

Monitoring fermentation

It is recommended to get an analysis of the molasses you work with to do the relevant calculation of the yields. In fermentation, Lallemand Distilling recommends recording temperatures and °Brix and/or Specific Gravity (SG) to make sure that the fermentation is working well. Unlike the fermentations of grains, fruit, sugar it is not possible to reach a very low final SG or °Brix; a final °Brix about 10 (SG 1040) is quite usual.

Monitoring distillation

Along all the process, consistency is the key to success, so always working the same way and recording data are important.
At the end of distillation, the final ethanol content is measured by distillation taking care of the accurate volumes of sample and distillate. The distillate temperature must be adjusted to 20 °C before final measurement.

Summary

To get the highest yield:

- Use a dedicated yeast strain to the sugar present in your feedstock,
- Ask for the analysis of the molasse you work with,
- Tailor your process according to the quality of the molasses taking in account the invert sugars and the sucrose amounts,
- Do the calculation of the theoretical yield and compare with what you get,
- Monitor your fermentation and distillation to get consistency.

Regarding the usage and dosage of products, Lallemand Distilling recommends consulting local regulations to ensure you comply with your product category approved processing aids.
Lallemand Biofuels & Distilled Spirits (LBDS) is proud to supply distillers with a "one stop shop" format.
Visit our website www.lallemanddistilling.com to find out more about our products or contact your local LBDS representative.

www.lallemanddistilling.com
@Company/Lallemand-Biofuels-&-Distilled-Spirits
distilledspirits@lallemand.com
LallemandDistilling

240724

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