Checking the fermentation process in beer production using DMA 35 from Anton Paar

Relevant for: Craft breweries & breweries

Continuously monitoring the fermentation process is essential for ensuring correct progression of the fermentation process for high-quality end products.

1 Introduction

To guarantee high quality in beer production, it is necessary to continuously monitor the fermentation process and the change in the extract. Checking the density or extract and temperature daily allows fast adjustment of the fermentation process if necessary and therefore ensures optimal fermentation.

In the fermenter, major changes are underway as the yeast converts sugar into alcohol and carbon dioxide and the so far alcohol-free liquid is turned into beer. Once yeast is added to the aerated cold wort and all the oxygen is metabolized by the yeast, fermentation starts. The conversion of carbohydrates to alcohol and carbon dioxide is arguably the most important part in the beer brewing process.

2 Traditional methods for checking the fermentation process

A hydrometer (also called areometer or „spindle“) is often used to check the fermentation process. A hydrometer is a self-contained graduated glass tube to be immersed into the sample. The sample has to be filled into a suitable container, e.g. a measuring cylinder. The deeper the hydrometer immerses into the liquid, the lower its density, or specific gravity, respectively. The density or concentration can be read off the scale on the hydrometer.

As the density is dependent on the temperature, the temperature must also be determined.

It is also important to ensure that no gas bubbles attach themselves to the hydrometer as this would cause additional buoyancy and therefore would falsify the results.

3 Checking the fermentation process with DMA 35

3.1 DMA 35 presents itself

DMA 35 (**Figure 1**) is a portable digital density meter using the oscillating U-tube principle. It has an accuracy in density of 0.001 g/cm³. Different concentration units can be calculated from the measured density using integrated functions. DMA 35 also determines the sample temperature so that the concentrations can be given as temperature-compensated values.

To check the fermentation process, integrated functions can be selected which calculate the desired density-dependent properties such as °Plato from the density value and display the results temperature-compensated to 20 °C.

Density measurements with DMA 35 require very little time thus allowing daily determinations. The main advantage of frequent measurements is the continuous information on the extract content and the temperature. Thus, it is possible to react right away if the extract content decreases too quickly or too slowly.

If the extract content decreases too quickly, the temperature in the tank can be lowered. If the extract content decreases too slowly it is possible to react immediately and increase the temperature. Continuously checking the fermentation process is essential for ensuring a good and constant beer quality.

Figure 1: The portable DMA 35 density meter

3.2 Adjustment

The instrument is delivered factory adjusted.

Readjustments of DMA 35 can be carried out quickly and easily with ultra-pure water or any other reference fluid. Experience has shown that readjustments are only required once every few weeks or months.

3.3 Sampling

The sample from the tank is filled into a glass as can be seen in **Figure 2**. The glass is rinsed with the sample and this sample is thrown away. The glass is filled again with sample. This sample is now measured by pressing the pump lever, immersing the sample tube into the glass, followed by slowly releasing the pump lever.

Figure 2: Sampling from a glass

3.4 Filling the measuring cell

DMA 35 is equipped with an integrated hand pump. By pressing and releasing the lever of the hand pump, approximately 2 mL of sample are aspirated into the measuring cell by means of the PTFE filling tube.

Tip: Before each measurement it is recommended to press the pump button 1 or 2 times to rinse the cell with sample. This prevents carry-over effects.

Tip: Samples containing dissolved CO_2 may create bubbles in the measuring cell leading to invalid measurement results.

Depending on the amount of dissolved gas, it may be necessary to degas the sample properly before measurement. This can be done by stirring it vigorously for 5 to 15 minutes until bubbling ceases, or putting it into an ultrasonic bath for approximately 5 to 10 minutes until bubbling ceases. Be aware that degassing should not change the alcohol or water content in your sample.

Tip: From experience we know that fermenting beer samples can often be measured without prior degassing. It is sufficient to put the instrument in a horizontal position on a table as shown in figure 1. In this position the sensitive measurement area of the U-tube oscillator is positioned lower than its inlet/outlet. Bubbles move to an area where they have lowest influence on the result and thus stable results can be achieved also with fermenting samples.

Tip: Most beer types do not need to be filtrated for the fermentation monitoring with DMA 35. Measurements can be performed directly with the sample. Only very turbid beer types reach more accurate measurement results with filtration prior to filling the sample.

3.5 Measuring

After filling, either hold the instrument in the adequate position or place it on a bench as shown in **Figure 1**. This position causes gas bubbles to collect at the ends of the U-tube and minimizes their influence on the measurement result. By having a look through the inspection window it can be observed whether the measuring cell is filled bubble-free or not.

A few seconds after filling, the result can be read off the large, digital display and stored in the internal memory.

Tip: Before measuring the next sample, it is advisable to rinse the measuring cell with the new sample. If the instrument is not used for long periods of time, rinsing with water is recommended.

Tip: To prevent condensation inside the instrument, the ambient temperature should not be higher than the temperature of the sample. Therefore, DMA 35 should be left in the same room where the measurements take place. Otherwise condensation could affect the measurement.

3.6 Single point measurement or fermentation curve measurement

It is possible to read the result from the instrument (and e.g. note it) without saving data on the instrument.

A second option is to use a certain method (e.g. “Extract” or “Sugar”) in combination with a certain measurement ID (e.g. “Tank 1”) and measure using the “Save” button so that the results are available on the instrument (**Figure 3**). It is common to export the measured data as .csv file to a PC and then plot the graph using the exported data on a PC.

A third possibility is to measure a fermentation curve directly on the instrument - this is the most comfortable way.

The fermentation curve can be selected in the menu “Edit Method”. When using the fermentation curve, it is important to always use the same sample from the same tank, so that the correct curve is drawn for one sample. This can be done by assigning a certain sample ID (e.g. “Tank 3”) to each sample and using it every day for the measurement of this sample.

The result screen of a measurement with fermentation curve shows a graphical representation of the monitored process (**Figure 4**). The horizontal axis represents the time between measurements [days]. The vertical axis shows the decrease of extract in the selected tank.

For example, to monitor the fermentation process of a sample, start the first measurement with a method with fermentation curve activated. This will enter the first measurement result in the graph as the initial value between day 0 and 1, depending on the time.

Subsequent measurements of the same sample using the same method and sample ID, e.g. one measurement per day, will automatically add points to the graph, thus representing the progress of the fermentation process over a period, e.g. one week.

The fermentation curve helps you to immediately detect if the fermentation of each tank is working properly. Each datapoint is marked and after exporting the curve can be drawn easily on a PC.

3.7 Cleaning

After completing the daily measurements, DMA 35 must be cleaned with ultra-pure water so that no sample residues remain in the measuring cell. Fill DMA 35 with ultra-pure water using the hand pump and release the water into the waste vessel by pressing the lever of the hand pump again. Repeat this procedure 2 to 3 times. Additionally, we recommend to clean with enzymatic lab cleaner and deionized water on a regular basis. To ensure a completely thorough cleaning of the hand pump, the whole pump can be removed from the instrument.

3.8 Accessories

The integrated Bluetooth interface allows wireless data transfer to a printer or a PC. A compatible portable printer is available.

3.9 Measuring results – an example

Figure 3 shows a typical single point measurement.

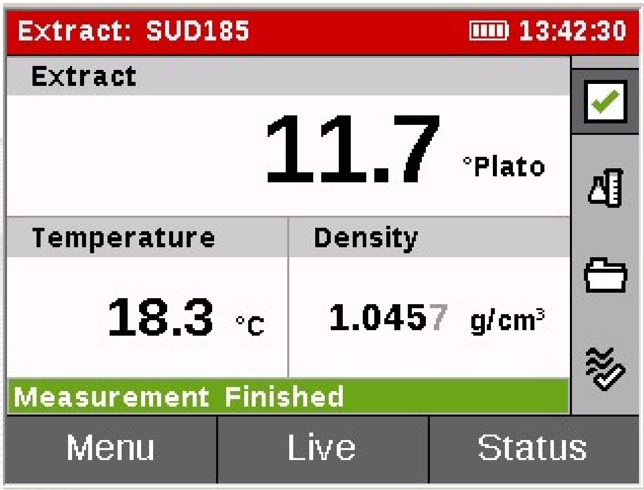

Figure 3: Single point measurement result on DMA 35 display

Figure 4 shows a typical fermentation curve.

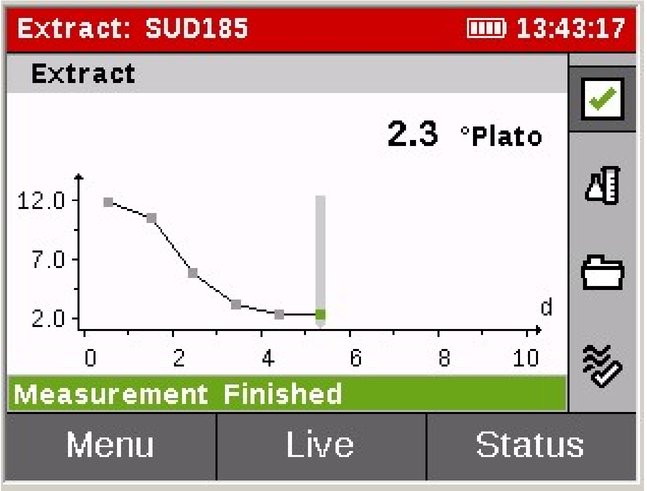

Figure 4: Fermentation curve result on DMA 35 display

4 Features and benefits of DMA 35

- Result is already shown in the unit you prefer
- Automatic temperature correction: it displays the extract or density at reference temperature – no chance for errors compared to manual corrections
- Short measuring times for daily measurements enable optimization of the fermentation process
- A measurement is finished in a few seconds
- Better measuring accuracy than hydrometers
- Portable, compact, lightweight instrument
- Integrated fermentation curve for quick decisions directly at the fermentation tank
- Accuracy in density of 0.001 g/cm³
- One instrument covers a wide measuring range
- Easy operation
- Large, easy-to-read digital display (**Figure 3 and 4**)
- Small sample volume of approximately 2 mL
- Memory for 1200 results
- Memory for up to 30 measuring methods and up to 250 sample IDs
- Bluetooth interface for wireless data transfer to PC or printer
- Robust design
- RFID interface allowing to read RFID tags for easy sample identification and change of measuring method

5 Instrument specifications

The **Tables 1, 2** and **3** inform about accuracy, repeatability and measuring ranges.

Table 1: Accuracy

Parameter	Accuracy
Density	0.001 g/cm³
Temperature	0.2 °C
°Plato	0.25 °Plato

Table 2: Repeatability

Parameter	Repeatability
Density	0.0005 g/cm³
Temperature	0.1 °C
°Plato	0.10 °Plato

Table 3: Measuring ranges

Parameter	Measuring ranges
Density	0 g/cm³ - 3 g/cm³
Temperature	0 °C – 40 °C
°Plato	-10 °Plato - 85 °Plato

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