Alcoholic Strength in Beers

Reference: **COMMISSION REGULATION (EC)N° 2870/2000**

Tested with **VELP Scientifica UDK 129 Automatic Kjeldahl Distillation Unit** (Code F30200120)

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ALCOHOLIC STRENGTH IN BEER

Introduction

Beer is one of the oldest and most consumed alcoholic drinks in the world. It is also the third most popular drink after water and tea. The alcohol content of modern beer is usually around 4-6% alcohol by volume (ABV), although it can vary between 0.5% and 20%.

Alcoholic Determination in Beer

The alcohol level of a beer may affect the taste of a beer, and has an effect on the overall body and mouthfeel. Alcohol is the result of the fermentation of a by-product of yeasts that metabolize some derived cereals, fermentable sugars in alcohol and CO2. The final level of alcohol in a given beer depends on the yeast used, the amount of digested sugar and the fermentation method.
The ethylic alcohol can be measured as "the number of litres of ethanol contained in 100 litres of beer, both volumes are measured at a temperature of 20°C". It is expressed by the symbol %vol'.
Steam distillation is a method to determine the alcoholic strength in Beer: the distillate obtained is an ethanol-water mixture and, using a measurement of density by a pycnometer and expressing the results through the official tables, the alcoholic strength can be calculated.

Sample

Italian Lager Beer Alcohol strength by volume (labeled value): 4.6 % vol
Danish Lager Imperial Beer Alcohol strength by volume (labeled value): 7.7 % vol

To remove the carbon dioxide, stir gently the sample (1000 ml in a 2000 ml flask) with a VELP magnetic stirrer.

Chemicals and Equipment

- Alcoholic strength kit **(code A00000285)** composed by:
  - -Tweezer for closing the NaOH tube
  - -Kjeldahl balloon 500 ml for the distillation of sample **(code A00000082)**
- Pycnometer (volume 100 ml or 50 ml)
- 200 ml volumetric flasks with stopper
- KjTabs VS Antifoam - 1000 pcs/box **(code. A00000283)**
- Analytical balance (0.1 mg sensibility)
- Cooled Incubator (VELP Scientifica FOC Series i.e. **code F10400325**)

Procedure

1) Measure out 200 ml of the beer using a graduated flask and thermostat it at 20°C. Let the sample adjust to temperature, this will take about 15 minutes.
2) Bring down the volume of the sample exactly to 200 ml by taking away excess sample by a small pipette.
3) Transfer the liquids to the 500 ml test tube adding one KjTabs VS Antifoam.
4) Rinse the volumetric flask with distilled water (3 x 10ml) in order to collect all the mixture residues and transfer it into the 500ml test tube.
5) Add 10 ml of distilled water as receiving solution in the same volumetric flask and place it in a beaker filled with cold water and ice.
6) Insert the distillate outlet tube (it must be put in contact with the receiving solution) and fix it well using Parafilm.

Distillation

Collect the distillate in the 200 ml graduated flask used to measure the sample quantity.
Preheat the UDK 129 performing a wash down (about 7 minutes).

Start the distillation according to the parameters below:

· NaOH: 0 ml**
· Sample volume: 200 ml

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· Sample tube: 500 ml
· Distillation time : 7-9 minutes

** Close the NaOH tube using the tweezer received inside the Alcoholic strength kit.
In UDK 129 settings, set a distillation time to obtain a maximum of 200 ml of distillate. After the distillation, position the receiving flask in the thermostat for about 15 min and finally bring up to volume (200 ml) using distilled water at 20 °C.

Density of the Distillate

Measure the density of the distillate by a pycnometer:
1) Weigh the empty pycnometer, clean and dry, with all parts in place (M_{pyc} in g)
2) Weigh the pycnometer filled with the distillate at 20 °C (M_{dist} in g)
3) Calculate the density of the distillate at 20 °C ($D_{dist\ 20°C}$) following the formula:

$$D_{dist}\ 20°C = (M_{dist} - M_{pyc}) / (V_{pyc} \times 1000)$$

V_{pyc} (m^3) is the volume of the empty pycnometer and is calculated as follows:

$$V_{pyc} = (M_{pyc,\ H2O} - M_{pyc}) / (\rho_{H2O,20°C} \times 1000)$$

Where:
$M_{pyc\ ,\ H2O}$ = pycnometer weight filled with water at 20 °C (g) $\rho_{H2O,20°C}$ = density of the water at 20 °C (0.99823 g/ml)

4) Use the density table to express the results
5) Among measurements rinse the pycnometer with the next alcoholic solution.
6) During the entire procedure take care to avoid fat from fingertips, temperature changes when holding the pycnometer and air bubbles in it.

Typical Results on different type of Beers

Italian Lager Beer

Sample quantity (ml)	Alcohol strength (% vol) **
200	4,64
200	4,60
200	4,65
200	4,56
Average ± SD%	**4.61 ± 0.04**
RSD% *	**0.8**

Danish Lager Imperial Beer

Sample quantity (ml)	Alcohol strength (% vol) **
200	7,81
200	7,76
200	7,83
200	7,76
Average ± SD%	**7.79 ± 0.04**
RSD% *	**0.5**

* RSD% = (Standard Deviation x 100) / Average

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** The tables in the official standard method (Recommendation n°22 of the International Legal Metrology Organization suggested by Reg. EC 2870/2000) have been used

For the verification of the distillation apparatus, the Reg. EC 2870/2000 specifies that, distilling 200 ml of an ethanol water mixture with an alcoholic strength of 50% vol., the loss of alcohol must be smaller than 0,1% vol.

The UDK 129 satisfies completely the Reg. EC 2870/2000.

Conclusions

The alcoholic strength in beer is a fundamental data for consumers. A well-made **steam distillation** can make the difference. Here, results are reliable and reproducible in accordance with the expected values, with a low relative standard deviation (RSD < 1%). It means high repeatability of the results.

The **UDK 129** together with all the other **VELP Distillation Units** are the ideal solution for your lab providing:

- High level of precision and reproducibility
- High productivity
- Worldwide official method adherence
- Reliability and ease-of-use
- Time saving
- Moderate running costs

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