Short Note
No 210/2015

Your Evaporation Guide – Evaporating flask size

Achieve higher distillation efficiency when using a rotary evaporator – Impact of flask size

Summary

Generally, the larger the evaporating flask the greater is the evaporation rate. This is due to the greater turbulence inside a larger flask, enlarging the active surface and leading to a higher evaporation output. On the other hand, smaller flasks are advantageous when the residue needs to be collected for further quantitative analyses. Moreover, larger flasks generally allow easier handling.

Introduction

After decades of building rotary evaporators, there is still potential to optimize the evaporation process. The choice of the adequate glass accessories is therefore an important aspect in increasing the evaporation output. For that reason it is interesting to examine the influence of the evaporating flask size on the evaporation output.

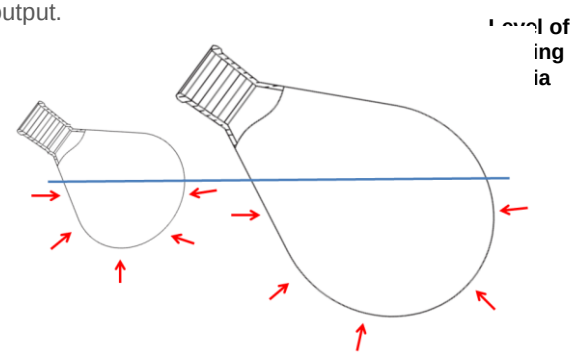


Figure 1: *Schematic representation of two different sized evaporating flasks immersed in the heating medium. There is more heat transfer within a larger flask due to a larger surface area (right picture).*

The main impacts of the flask's size are:

- Due to increased velocity at the perimeter of larger flasks, the solvent inside the flask is more agitated, enlarging the active surface area of the solvent.
- Due to a larger glass wall surface, more heat energy transfers from the heating bath, through the evaporation flask, to the solvent.
- Larger flasks are more likely to prevent foaming over and the negative consequences of boiling delays and bumping.
- Smaller flask are more suitable for quantitative collection, for example, if the user is interested in the residue that remains after the evaporation
- Smaller flasks offer more flexibility when handling the rotary evaporator in the vertical axis.

Apart from this, larger conventional evaporating flasks automatically have thicker glass walls which, in turn, lowers the efficiency of the evaporation performance as there is obviously less heat transfer through thicker glass walls [1].

Experiment

The flask size certainly affects the evaporation process. For that reason it is interesting to examine the influence of the evaporating flask size on the evaporation output.

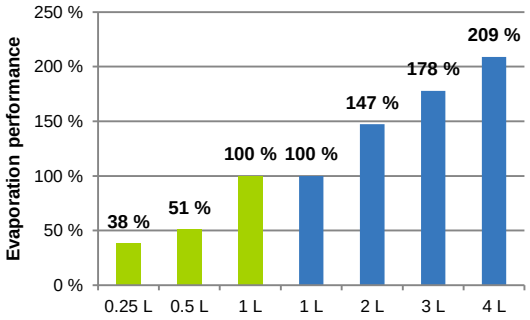
The aim of the following experiment was to analyze the influence of the size of the evaporating flask on the evaporation rate of a solvent single-stage distillation. The experiment was executed with a BUCHI Rotavapor®.

For the realization of the experiment, the evaporation process was performed using different sized evaporating flasks (from 250 mL up to 4 L). 200 mL solvent were used for the flasks up to 1 L, 750 mL for the flasks of 1 L and larger.

Parameter	
Solvent	acetone
Heating bath temperature	60 °C
Cooling temperature	10 °C
Pressure	556 mbar
Flask size	250 mL - 4 L
Content	200 mL, 750 mL
Immersion depth	fill level

Results

To evaluate the outcomes of the evaporation performance, the evaporation outputs of the two 1 L flasks were set to 100 % and the outcomes were divided into two groups, according to the amount of the solvent, and put in relation to the 1 L flasks.



Graphic 1: *Illustration of the influence of the flask size on the evaporation output.*

As illustrated in the graphic above, the evaporation rate increases with larger flask size. If the evaporation output of the 1 L evaporating flask is put at 100 %, the 2 L flask achieved 147 % and the 4 L flask 209 % output. The 250 mL flask obtained only 38 % of the output compared to the 1 L flask.

Interpretation

As seen from the experiment, the larger the evaporating flask, the higher the evaporation output. For instance, the evaporation rate using a 4 L flask is significantly higher compared to a 1 L flask.

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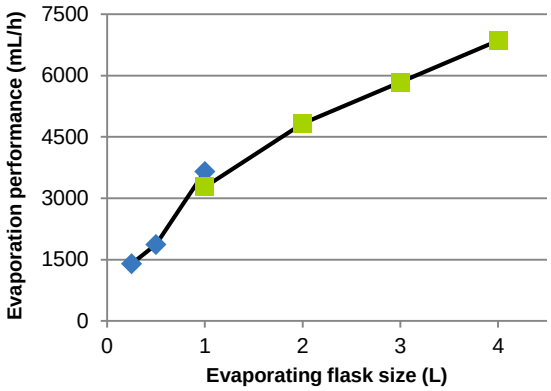

Graphic 2: *Illustration that with an increased evaporating flask size, the evaporation output increases.*

This is due to the correlation between the surface area inside the evaporating flask with the flask's volume. Therefore, with increasing flask volume, the active surface area is increased, raising the evaporation output.

Recommendation

The evaporating flask size should be selected to be as large as possible while still being suitable for the application. Basically, a larger evaporating flask provides sufficient greater interior surface area for increased evaporation performance. However, in the case the residual needs to be quantitatively collect for further analyses, the flask should be small enough not to risk losing the sample, as it will be more difficult to transfer the residue out of a larger evaporating flask. Therefore, the optimum flask size has to be adjusted to the respective sample and application. In general, it is appropriate to select a flask that accommodates at least twice the starting sample volume.

Figure 2: *Optimum filling quantity is 1/3 to 1/2 of the evaporating flask' volume.*

BUCHI's high quality glassware assortment offers evaporating flask sizes from 50 mL up to 5 L and a broad variety of accessories and glass assemblies which allow optimized operation. Moreover, the lift of the Rotavapor® R-300 is movable 220 mm in the vertical axis and the heating bath can be moved horizontally. [2] This enables evaporating flasks up to 5 L (Heating Bath B-305) to be deeply inserted into the heating bath and adjusted to each individual distillation situation. Nevertheless, BUCHI also offers customized glassware to meet special customer requirements.

References

[1] Your Evaporation Guide, Operation – Impact on glass thickness
[2] Technical Datasheet, Rotavapor® R-300