FH Maschinen und Braumanufaktur Werk II GmbH
Walburger Str. 35 37247 Großalmerode
☎ +49(0)5604 9369915 ✆ +49(0)171 7436619
✉ info@werk-2.eu 💻 www.werk-2.eu

Maximizing the filling speed

Background

The speed at which the beer can be filled depends mainly on two different factors: the pressure and the temperature.
CO_2 is produced during the fermentation process that can be absorbed by the beer up to a certain amount. Once the maximum absorption quantity has been reached, it becomes - figuratively speaking - tight in the fermentation tank. The excess CO_2 cannot escape, and the pressure in the tank rises. Conversely, this means that the beer is forced to absorb even more CO_2 if additional CO_2 pressure is applied from outside.
The maximum intake quantity is largely determined by the temperature.
Assuming that the CO_2 level should have a fixed value, temperature and pressure are related as follows:

temperature [°C]	pressure [bar]
5	0,9
10	1,2
15	1,6
20	2
25	2,5

Table 1: Bunging table for a CO_2 level of 5g/l

It can be clearly seen that the required pressure for a constant CO_2 level also increases with increasing temperature.

$$P = \frac{C}{10e^{-10{,}73797+\frac{2617{,}25}{T+273{,}15}}} - 1{,}013$$

P = bung pressure *[bar]*
C = CO_2 level *[g/l]*
T = temperature *[°C]*

Formula 1: Calculation of the bung pressure

The filling

During filling, the beer foams either in the hose or in the bottle - a sign that CO_2 is escaping. Here, too, the factors of pressure and temperature play an important role, but also the distance the beer has to travel in the hose and the dimensions of the hose.
As for the hose, you can basically remember: the shorter and thicker, the better.
As the beer travels from the tank to the filler, a little pressure is constantly lost; the CO_2 is no longer bound, it dissolves and foam is formed. To prevent this foaming, it is necessary to increase the pressure in the tank during the bottling process. Werk II recommends a pressure difference of +1bar to the bung pressure.
At this point, the temperature comes into play again: If the beer has a relatively high temperature, you need a correspondingly high pressure to bind the desired amount of CO_2. If you want to add CO_2 with a gas bottle, you can only do this up to a certain value specified by the pressure reducer; furthermore, fermentation tanks have a pressure relief valve that opens when the pressure is too high and allows CO_2 to escape.

An example: A CO_2 level of 5g/l is desired, the temperature is 20°C and the overpressure valve on the fermentation tank reads 2.2bar (see fermentation tank Werk II). According to Table 1, this would require a bung pressure of 2bar, and for bottling this pressure must be increased by 1bar. A pressure of 3bar would therefore have to prevail in the tank to compensate for the pressure loss during filling, but this cannot be realized because the pressure relief valve already opens at 2.2bar.
This problem can be solved very easily by lowering the temperature. At 5°C, for example, the required bung pressure would only be 0.9bar, and the filling pressure would therefore be 1.9bar.

FH Maschinen und Braumanufaktur Werk II GmbH
Walburger Str. 35 37247 Großalmerode
☎ +49(0)5604 9369915 ✆ +49(0)171 7436619
✉ info@werk-2.eu 💻 www.werk-2.eu

Maximizing the filling speed

- Ensure a low temperature in the fermentation tank or KEG
  - This allows a low bung pressure and thus a greater margin for pressurization for filling
  - Bung tables provide a good basis
- Select beer hoses as thick as possible and ensure the shortest possible distances
  - Recommendation Werk II: Diameter approx. 10mm
- Drain solids from the bottom of the fermentation tank
  - Impurities in the hose lead to clogging and premature foaming
- Increase pressure for filling
  - Werk II recommends approx. 1bar above the bung pressure, however, the filling pressure should be adjusted individually
- Adjust filling speed until foam formation stops
  - Due to the intrinsic temperature of the various machine parts, foam may still form on the first bottles until these have also cooled down as a result of the beer flowing through them.

➡ This results in the maximum filling speed, which, however, always depends on the external conditions and the beer to be bottled.

Sources:
http://braukaiser.com/wiki/index.php/Carbonation_Tables
https://braureka.de/berechnungen/spundung/
http://braukaiser.com/documents/CO2_content_metric.pdf