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WORLD BREWING CONGRESS 2016

World Brewing Congress
August 13-17, 2016
Sheraton Downtown Denver
Denver, CO 80202, U.S.A.

Gushing prediction based on the headspace pressure growth

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Introduction

Background of the solution
Gushing is associated with sudden CO_2 escape. The sensitivity of gushing prediction can be increased by measurement of CO_2 amount escaping from bottle. Amount of escaped CO_2 can be repeatedly measured by the pressure increase in the headspace of the bottle after bottle piercing and closing and repetitive opening of the piercing.

Problem definition
The finished beer rarely exhibits gushing early after bottling. To evaluate gushing it is necessary to combine motion and rest before the bottle opening. The volume or weight of the overflowed beer can be measured, which is easy, but not sufficiently sensitive for early prediction of gushing.

Instruments and procedures

Instruments
Headspace pressure growth recorder (1 CUBE, Czech Republic, fig. 1), laboratory shaker (Kühner, Germany, fig. 2) for horizontally loaded bottles in beer crates with 50 mm amplitude and a frequency of 100 min^{-1} , two angle (haze at 90 and 12º) turbidimeter (MZN-2009 , Czech Republic)

Determination of the CO_2 pressure growth
The bottle was shortly shaken for 10 min and left at rest for 1 h to reach equilibrium pressure in the headspace (*PE*). The pressure value 1 min after pressure releasing (PG_1) was chosen to characterize the tendency to gushing. As an example the headspace pressure growth was measured in subsequently for three different samples (fig. 1).

Determination of the overflowing volume (*OV*)
Beer bottle was quickly opened with beer opener and overflowed volume was recorded after overflowing stopped.

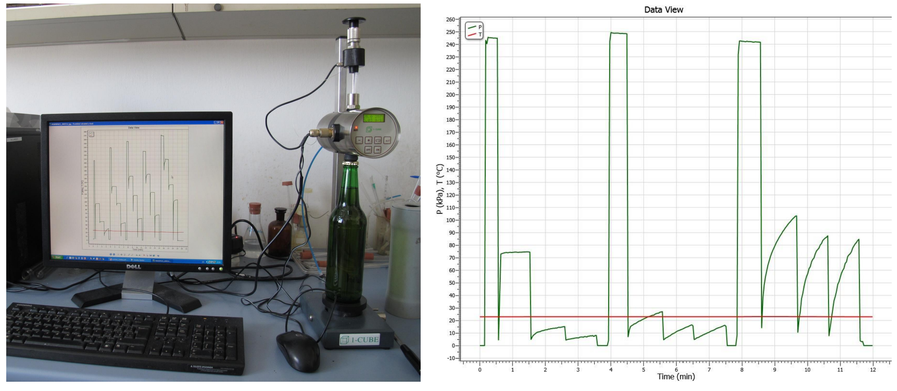

Fig. 1. Headspace pressure growth recorder with screen copy. From left: sample 1 (0-4 min, PG_1 = 75 kPa, sample 2 (4-8 min, PG_1 = 28 kPa), sample 3 (8 to 12 min, PG_1 = 102 kPa). CO_2 average content of beers was 5.1 g / l (*PE* = 242 and 245 kPa).

Fig. 2 Beer bottle shaker for two crates filled with bottles or cans.

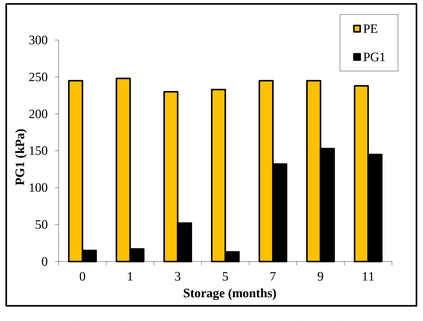

Fig. 3 Effect of beer storage time on the induction of gushing after 14-day shaking followed by 1 h rest.

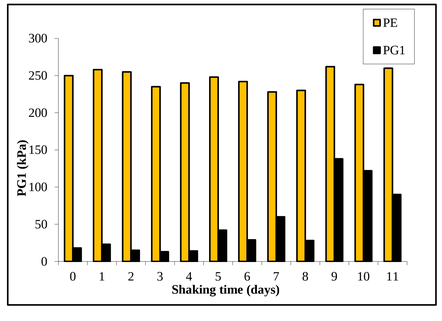

Fig. 4 The effect of shaking time, followed by 1 h rest on the induction of gushing in beer stored 11 months according to pressure growth value PG_1.

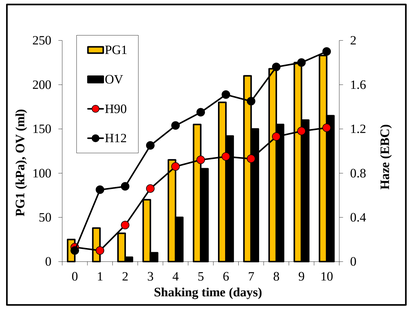

Fig. 5 The effect of shaking on the pressure growth (PG_1), overflowed volume (*OV*) and haze values (H90, H12).

Case examples

The effect of storage time of bottled beer on the pressure growth
Bottles with pasteurized beer were stored for 1 year at 20 ° C in the dark and at rest. Beer, which after long periods of storage showed neither rapid pressure growth nor overfoaming, could obtain this ability by shaking. The tendency to gushing increased with previous time of beer storage at rest (fig. 3). This effect can be associated with the formation of colloidal haze particles, change of their structure or electrical charge which could facilitate the formation of microbubbles.

The effect of shaking regime on the pressure growth
Bottles with pasteurized beer were stored for 1 year at 20 ° C in the dark and at rest. Randomly taken bottles with storage time longer then 10 months were shaken for different times to induce gushing. After 1 hour rest the equilibrium pressure *PE* and PG_1 values were determined (Fig. 4). Tendency to gushing noticeably increased with shanking time.

Development of haze in beer with tendency to gushing
In the group of regularly monitored bottled samples the beer with increased tendency to gushing was found. The haze of this beer was repeatedly measured every day using shaking/rest test (Fig. 5). The values of the pressure growth, the overflowed volume in this case grew with haze measured at 90 and 12º during the time of shaking.

Conclusion

For gushing prediction the headspace pressure growth recording after piercing and closing the piercing again can be used to determine the tendency to gushing. The important parameter is the pressure value reached after 1 min after crown piercing resealing called PG_1. Increasing storage and shaking time increased the probability of overfoaming. Therefore, we assume that gushing may also arise from compounds, naturally occurring in beer, such as proteins and polyphenols haze.