Enhanced Beer Filtration With STABISOL

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Silica sol (silicic-acid-hydrosol) has been used in the beverage industry since 1940. In 1983 Raible indicated the possibility of using silica sol for the improvement of the filtration properties of beer[1]. Since then it has been introduced in the brewing industry under the brand narre STABISOL.

Silica sol is a colloidal solution of silicic acid ($Si0_2$) in water: it appears bluish opalescent and consists of special unlinked particles of amorphous silicic acid, ranging in size between 5 and 140 nm. (1 nm = one millionth of a millimeter). The surface of the particles is hydroxylised: the particles possess no internal porosity and are negatively charged. For this reason, silica sol is protected against agglomeration and precipitation. If properly stored at above 0°C, it is stable for over 12 months. Below freezing point it converts to waterinsoluble silica gel[2].

The $Si0_2$ content of silica sol solutions, depending on its internal surface area, ranges between 15% and 50% by weight. STABISOL for example, has 30% at a density of 1.2 g/ml and an internal surface area of 300 m^2/g $Si0_2$.

Adding silica sol to wort or beer results in the crosslinkage of $Si0_2$ particles to form a hydrogel. Haze is formed, which then proceeds to flocculate and finally forms a sediment. In the course of this flocculation process, the silicic acid of the sol is quantitatively converted into insoluble silicic acid hydrogel. Since this hydrogel is removed completely from the beer, silica sol treatment of wort and beer fulfils the requirements stipulated by German Reinheitsgebot, provided that pure silica sol products are used[3].

The precipitating silica sol adsorbs matter from wort or beer and settles, together with matter, in the trub or tank bottoms. The precipitation process occurs relatively quickly, so that the sedimentation in beer amounts to 5-7 m daily, while normal trub substances usually amount to only 0.5 m.

The sediment resulting from STABISOL consists of very fine particles. Thus it is important to make sure that no large quantities of the sediment get into the beer directly prior to filtration, as this Gould result in the formation of a blockage in the filter. The amount of the essential substances which are adsorbed by STABIS0L[4] are shown below (in mg per gram of $Si0_2$):

- Organic substance = 39,8 mg (Protein contained therein approx. 86%)
- Glucose after hydrolysis = 0,75 mg
- Total quantity of carbohydrate = 1,7 mg

From these figures, it is clear that silica-sol-induced precipitation in beer has, in every case, an adsorbing effect on protein-like substances. This is to be expected, since silicic acid hydrogel, and the xerogel resulting from drying the latter, have been known as protein adsorptive beer stabilisation substances for almost 35 years now. Aside from the targeted effect of silica sol, another argument in favour of its use is the possible removal of the silica sol induced precipitate.

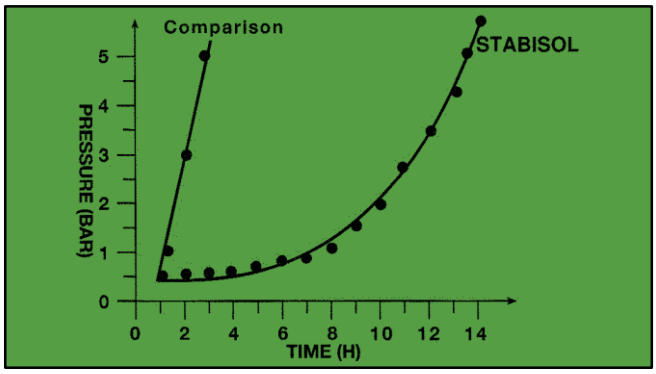

Fig 1. Pressure profile of a kieselguhr filter with and without STABISOL

Hot cast wort

The easiest way to use STABISOL, with no additional equipment needed, is in the treatment of the hot cast wort. The sol is applied in the copper after boiling or dosed into the wort stream before the whirlpool. In this case, the flocculated sol acts similarly like the hot break; merely a negligible increase of the hot break cone size is observed.

It is not advisable to boil the silica sol with the wort in Order to get a very intensive distribution. Otherwise, the silicic acid flocculation will be broken up, thereby complicating its separation. It is customary to add raten between 30 and 60 ml STABISOL per hectolitre cast wort. At a density of 1.2, this is equivalent to 36 and 76g/hl or 11 and 22 g $Si0_2$.

There is no problem in separating the precipitate: it occurs with the hot break. If a small amount of silica sol passes the whirlpool, it will be eliminated during the flotation process. Blending of the spent grains with the silicic acid containing hot break also occurs without difficulties, because the amount of SiO_2 is negligible in relation to the dry matter of the spent grains.

Raible et al have carried out intensive investigations of the influence of silica sol an the hot cast wort[5]. They found no differences in the fermentation, but a faster clarification and an obviously faster filterability of the soltreated beers.

Table 1 shows the results of plant trial filtration. The filtrate clarity of the sol-treated beer is obviously more brilliant than the untreated beer, and the pressure increase during the 2 h filtration time of both beers is also lower with the sol beer. Even the packaged beers are significantly brighter. The application of silica sol in the brewhouse is especially advisable also for topfermented beers.

Parameter	Comparison	STABISOL-wort
Pressure difference after Filtration of 600 hl beer (bar)	0.7	0.5
Clarity of filtrate	0.3	0.2
Clarity of bottled beer at 0°C/EBC	0.45	0.3

Table 1

Storage cellar

Another procedure, already used routinely in several breweries, is the application of silica sol in fermented beer. Sommer[4] reported about his experiences and method. He adds 50 ml of sol per hectolitre to beer of final attentation which has been chilled to 0° C at the transfer process. A fast clarification during the storage is achieved and, what is even more important, an optimisation of filterability (Fig.1).

The use of STABISOL at the transfer process is of greatest effect if the fermentation is finished and the temperature is close to the freezing-point[6,7]. In this case the bulk of haze-forming components is already insoluble. Together with other filtration-impeding substances, they are adsorbed by the silica sol and settle in the tank bottoms.

If, after the transfer process, the beer needs maturation at higher temperatures it is advisable to apply the silica sol at the chilling phase. The best way of doing this is to transfer the beer for a second time, because this guarantees intensive mixing. Another way, if this is not possible, is to pump silica sol, diluted with water (1:1 or 1:3) via the CIP into the tank and then to inject CO_2 from the tank cone. In general, a careful mixture of the beer with the silica sol is of greatest importance. Therefore, it is not advisable to put the sol into the tank before filling.

References
1. K. Raible et al, Mschr. Brauwiss., 1983,36,76.
2. "Ullmanns Enzyklopädie der Technischen Chemie", 4. Auflage Bd. 21, p 456
3. K. Raible, Brauwelt, 1985,125, 855.
4. G. Sommer and F. Boback, ibid, 1988, 128, 177.
5. K. Raible et al, ibid, 1985,125, 540.
6. H. Pfenninger et al, Brauerei-Rundschau, 1983, 94, 236.
7. H. Pfenninger et al, Proc London EBC, 1983, 361.

Preliminary test methods

It is still not possible to give exact advice on the use of STABISOL in an actual case of filtration difficulties in a brewery, without preliminary tests. At 0°C, increasing quantities of STABISOL from 20, 35 to 50 ml should be added to the beer to be filtered; after subsequent precipitation and removal of the precipitate, the beer should be tested for filterability. If the result indicates that the STABISOL has not been sufficiently effective, it is advisable to try using sol in the hot cast wort.

Here, the wort treatment can also be tested in a laboratory. The obvious evaluation criteria are the appearance of the hot wort and the wort during the chilling period after separation of the hot trub, together with the STABISOL precipitate. In such a case, however, industrial-scale tests are the only means of obtaining definitive results, since this is the only way to properly record the other production conditions and their influence on the filterability of a beer.

STABISOL in practice

The following two examples demonstrate the effect of STABISOL.

Example 1.

Optimisation of the filtration properties of beer by using STABISOL in the storage cellar.

Table 2 indicates the results of a comparison. The control beers (i.e. no STABISOL added) are filtered with 50 and 100 g/hl of fine guhr. The specific filtrate-volume was determined at 6.1 and 5.9 hl/m^2.h respectively and clarity was 0.7 and 0.95 EBC. The beers with 50 ml STABISOL added with 100 or 50 g/hl of fine guhr show a better filterability by a margin of 0.4 hl/m^2.h. However, the significantly brighter clarity is more important here. The sol samples have a turbidity of only 0.3 EBC units. Also, the mixtures of the fine kieselguhr and a medium fine one result in a much brighter filtrate.

As a result of the beer treatment with STABISOL - and considering the better filterability - the control beer with 100 g/hl fine guhr can be compared with the sol beer, filtered with 50 g/hl kieselguhr mixture. For the same clarity of the filtrate, 100 g/hl fine guhr are needed for the control beer. But for the sol beer, only a mixture of 25 g/hl fine guhr and 25 g/hl medium fine kieselguhr is needed. In addition to the considerable reduction of kieselguhr, by the use of STABISOL, an increase of the specific filtrate volume, from 6.1 to 10.0 hl/m^2.h is achieved. The silica sol, in this case, achieves about a 70% increase in filter capacity, in addition to a 25% lower body feed.

Body feed	Specific filtrate Volume (hl/m^2.h)	Clarity of filtrate (EBC units)
WITHOUT STABISOL:		
100g/hl fine guhr	6.1	0.7
50g/hl fine guhr	5,9	0.95
WITH 50ml/hl STABISOL ADDED:		
100g/hl fine guhr	6.5	0.3
50 g/hl fine guhr	6.1	0.3
50 g/hl fine guhr plus 50 g/hl Medium fine guhr	9.9	0.4
50 g/hl fine guhr plus 25 g/hl Medium fine guhr	10.0	0.5

Table 2

Example 2.

Optimisation of brilliance.

It is often observed that beer cannot be filtered brilliantly, even with the finest kieselguhrs. Without any pressure increase the filtrate does not become clearer than 1-2, often 3-4, EBC units. In these Gases an application of 5-10 ml/hl STABISOL at the kieselguhr dosing unit helps. The fine haze of the silica gel formed in this manner, causes a tighter kieselguhr filter bed. Consequently, the clarity amounts to 0.3-0.5 EBC and pressure increases 0.2-0.4 bar/h. The new method demonstrates this optimisation well as shown in Table 3.

STABISOL additions to 200 g/hl Filtercel E	Specific filtrate volume (hl/m^2.h)	Clarity (EBC units)
No STABISOL added	8.2	1.1
2 ml/hl STABISOL	7.4	0.8
5 ml/hl STABISOL	6.8	0.6
15 ml/hl STABISOL	4.6	0.4

Table 3