External dry hopping: the solution for problems? (Part 3)

DRY HOPPING SYSTEM | In this final third part of the series of articles, the significance of the results from the second part for plant and process engineering in an industrial environment is highlighted and the advantages provided by such systems are presented based on sample projects already installed. Results are discussed and summarised at the end.

THIS RESEARCH PROJECT was aimed at finding out whether external dry hopping is feasible. Accordingly, a highly concentrated hop suspension was prepared and subsequently diluted while hop particles were removed immediately afterwards, without loss of valuable components.

The test results presented in part 2 confirmed the observations described in part 1 of this series of articles [1, 2]. Previous research projects relating to this question were also confirmed, i.e. that speed of aroma transfer goes down when large quantities of hop pellets are added during dry hopping.

Concentration of aroma substances thus does not rise linearly with hop dosage. In the tests carried out, the thiols, in particular 4-MMP and 3-MH, as well as the caryophyllenes and humulenes were exceptions. No drop in transfer of these aroma substances into beer was observed.

Beer analyses and sensory attributes

After dispersing and stirring for 120 minutes, the dry hopped beer was diluted with a mass concentration of 6.5 wt %. Transfer rates of substances – both of bitter substance and aroma substances – could be measured again to the full extent immediately after a very short contact at a mass concentration of 1.5 wt % after dilution. This goes to show that mass transfer of hop components can be restored very rapidly, once inhibiting conditions are set aside, i.e. by reducing concentration of hop components in the medium.

Results of sensory analyses from sensory tests reflect analytical data. No significant difference was found between undiluted and diluted beers in discriminatory and descriptive tests.

Rapid extraction – advantages

The above fact provides new possibilities for dry hopping techniques in breweries. The initial dispersion/suspension step dissolves the hop pellets in the beer and/or distributes hops. Hops can thus take up beer and swell. Though maximum efficiency of extraction is not achieved in this step, this can be compensated for by subsequent dilution of the suspension. The duration required for dilu-

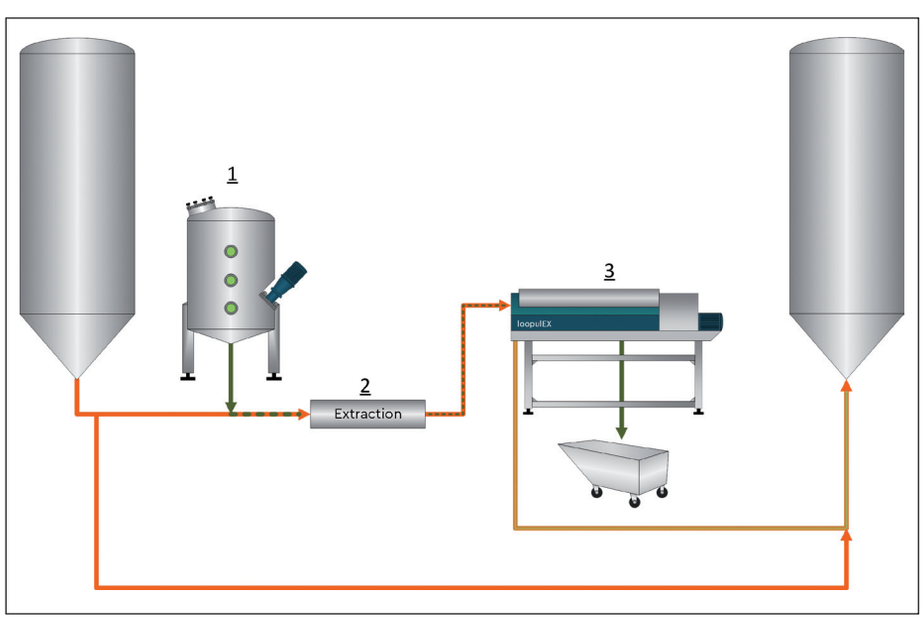

Fig. 1 Process diagram of the novel dry hopping system, using a two-tank process with a decanter as an example

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Fig. 2 Schematic overview of the dry hopping system

Fig. 3 Hop solids separated after extraction (35 % dry substance)

tion so that complete extraction is possible is about 60 s, and thus short.

In view of such short extraction times, brewers can efficiently extract hops outside of the maturation tank and reduce contact time between hops and beer – usually taking several days – to just a few hours, while achieving full aroma transfer at the same time. When using this technique, residence times in the brewery tanks can also be significantly reduced.

Concept dry hopping system

Based on the findings of research work, banke GmbH from Taufkirchen, Germany, developed an industrial dry hopping system called loopulEX that was commissioned successfully in several breweries in 2021.

In this system the dry hopping process is subdivided into three elementary steps taking place successively (see fig. 1):

1. Dispersion and/or dissolution of hop pellets in beer;
2. Transfer of hop aromas into beer and/or extraction of aromas;
3. Separation of hop particles.

Dispersion and dissolution of hop pellets

The first step is aimed at reversing the pelleting process and allowing the primary particles of hops to swell in beer to make aroma substances completely accessible and available for extraction. In this step, extraction efficiency does not play any role yet. Hop mass concentration of such suspensions can be maximum, the plant size can thus be compact. From a process point of view, hop solids concentrations from 6.5 to 8.5 wt % are advantageous in practice. In order to accelerate the dispersion process, a stirring unit is used which protects the yeast but simultaneously size reduces the hop pellets into primary particles. This first step thus takes only 30–120 minutes, depending on hop variety and pellet processing.

Transfer of hop aromas

In the second step, the hop-beer suspension is added to a stream of beer. This significantly reduces hop mass concentration locally. This dilution and/or the resulting higher concentration gradient make it possible that hop aromas are completely transferred into the surrounding beer that is either unhopped or weakly hopped. When selecting suitable process parameters, substance concentration, contact time and, if necessary, extraction temperature can be influenced locally, so that transfer of hop aroma is finished in less than one minute. The particles are subsequently separated from this beer stream loaded with hops before the beer returns into the beer tank.

Separation of hop particles

For this final third step, process parameters were selected to allow the maximum possible separation of hop particles, the maximum possible volume throughput and the highest possible dewatering of particles swollen with beer. Depending on focus, the curved screen technique [3] and the decanter centrifuge process have proven their worth in practice. Using the latter, beer losses can be reduced to a minimum in view of high separation rates of up to 99 percent and a dry substance content of 32–38 percent in the hop solids separated (fig. 3).

Hands-on experience

When following these three highly efficient inline process steps outside of the beer tank, hop quantities of up to 1000 kg per cycle can be processed in the loopulEX system, with process times of less than 8 hours, under ideal dry hopping conditions (fig. 4). In 2021, several projects were implemented with total batch sizes ranging from 100 kg to 3500 kg of hop pellets. For example, beer losses could be reduced from more than

400 hl per tank to less than 14 hl corresponding to savings of 96 percent compared to the beer quantity previously lost.

In all breweries, duration of the dry hopping process of two to four days could be reduced to less than 8 h in some instances.

In view of the high extraction efficiency, the system could also reduce hop addition while maintaining an identical aroma profile. In all instances, the aroma profile of the beer desired could be completely obtained by adaptation of all process conditions. In sensory analyses, no differences between the new and the old production method were noted.

It was also observed that, as a result of rapid hop particle separation, the well-known hop creep effect was considerably reduced or even non-detectable.

Summary

Using this dry hopping system based on a hop-beer suspension with a high concentration of solids and prompt re-dilution with beer, the problems of dry hopping such as e.g. beer losses presented in part 1 of this series of articles [2] are solved. Based on results [1] of laboratory tests described in part 2, it was possible to develop the novel loopulEX dry hopping system as an inline process. With this inline process system, the whole dry hopping process can take place at a central location in a brewery. Analogous to the cleaning-in-place principle, one could call the process dry hopping-in-place.

Fig. 4 Dispersion and dosage system unit for batch sizes of up to 1000 kg

This three-part series of articles is based on the contribution "An approach to develop an external dry hopping method by restoring the aroma transfer through dilution" published in BrewingScience, Nov/Dec 2021, vol. 74, pp. 151–159. ■

References

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