BarthHaas®

SPECTRUM

FULL FLAVOR DRY-HOPPING WITH SPECTRUM

HOW TO CREATE THE MOST NATURAL FULL HOP FLAVOR IN YOUR BEER AND GAIN EFFICIENCY USING SPECTRUM LIQUID HOPS.

WHITEPAPER

TABLE OF CONTENTS

INTRODUCTION

MANY BREWERS are looking for ways to be more efficient in their production processes, so that they can increase profitability for their businesses. Often when choosing more efficient liquid hop flavor product brewers will feel that they are moving away from the natural hop flavor that is achieved with pellets. This paper outlines why SPECTRUM offers the only solution that not only offers high brewing efficiency, but does so while delivering the full natural hop flavor that you get from a hop pellet.

WE KNOW that you will find the paper useful and if you have any further questions about how to best introduce SPECTRUM into your brewery, we encourage you to contact our Brewing Solutions Team. They will work with you to ensure that your SPECTRUM experience is the best it can be and that you gain the greatest flavor and efficiency for your brewery.

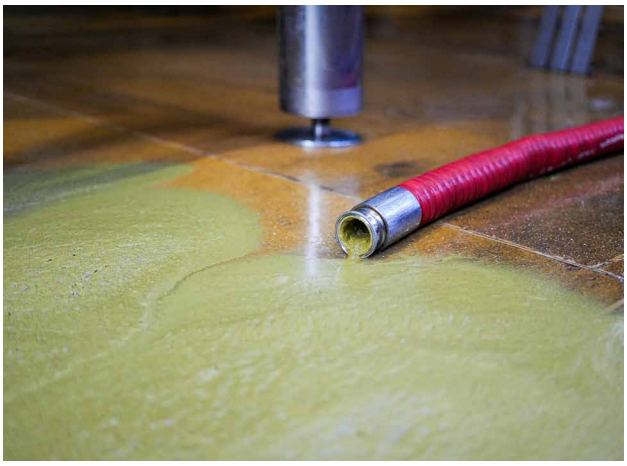
brewingsolutions@barthhaas.com

IT EXPLAINS:

- the challenges that brewers can face when dry-hopping with hop pellets,
- the unique nature of SPECTRUM that enables it to deliver a superior natural full hop flavor that is the closest you can get to a liquid version of a hop pellet,
- the benefits a brewer can expect from using SPECTRUM,
- best practice methods for introducing SPECTRUM into your brewery,
- real life use cases of successful introduction of SPECTRUM into established brewing processes

THE CHALLENGES OF DRY-HOPPING

BREWERS KNOW dry-hopping as an established and proven way to add a unique flavor to a beer. The technique can be used to extract complex and impactful flavors from hops, making beers more interesting and delicious for customers. However, it also comes with some challenges.



INEFFICIENT FLAVOR AND AROMA TRANSFER

INEFFICIENCY in flavor and aroma transfer associated with traditional Dry-hopping can:

- Reduce your hop flavor impact.
- Increase your production time.

Traditional Dry-hopping methods are inefficient when it comes to ensuring the transfer of flavor from the hops to the beer. In whole hop cones, lupulin glands remain completely intact which slows down the process of aroma transfer from the hop material into the beer. This can be overcome by the brewer by extending the contact time and/or through agitation to encourage contact with a greater volume of beer. Factors such as alcohol content and temperature can also have a significant effect on this process, with lower temperatures and alcohol content slowing the extraction further.

The introduction of hop pellets has improved the efficiency of dry-hopping compared to hop cones. Hop pellets remove a percentage of the vegetative material depending on the pellet type you are using. This, combined with the material being milled to create smaller particle sizes, increases the contact the beer has with the value-adding hop components. Even with this improved contact area, however, the process of flavor transfer still requires time no matter what pellet type or variety you are using.

ADDITIONAL COSTS

DRY-HOPPING with pellets means additional costs such as:

- Reduced production output.
- Increased cleaning and waste management.

As well as the direct costs of the additional hops required for dry-hopping, there are also other costs that the process adds. The biggest of these is the cost of the beer that is soaked up by the solid material used during the dry-hopping process. This varies depending on the product format that is used, the quantity used, and the equipment used. No matter how well a brewer uses pellets to dry hop however, they will lose beer that they would otherwise have been able to sell. Add to this the costs of removing the used dry-hop material from the beer, the additional cleaning time and the costs associated with the disposal of the waste material, and the total impact on the bottom line can be significant. All brewers that dry-hop must do what they can to strike the balance between beer flavor, product quality and the ability to work profitably.

THE CHALLENGES OF DRY-HOPPING

INCONSISTENCY

POTENTIAL INCONSISTENCY during dry hopping is due to:

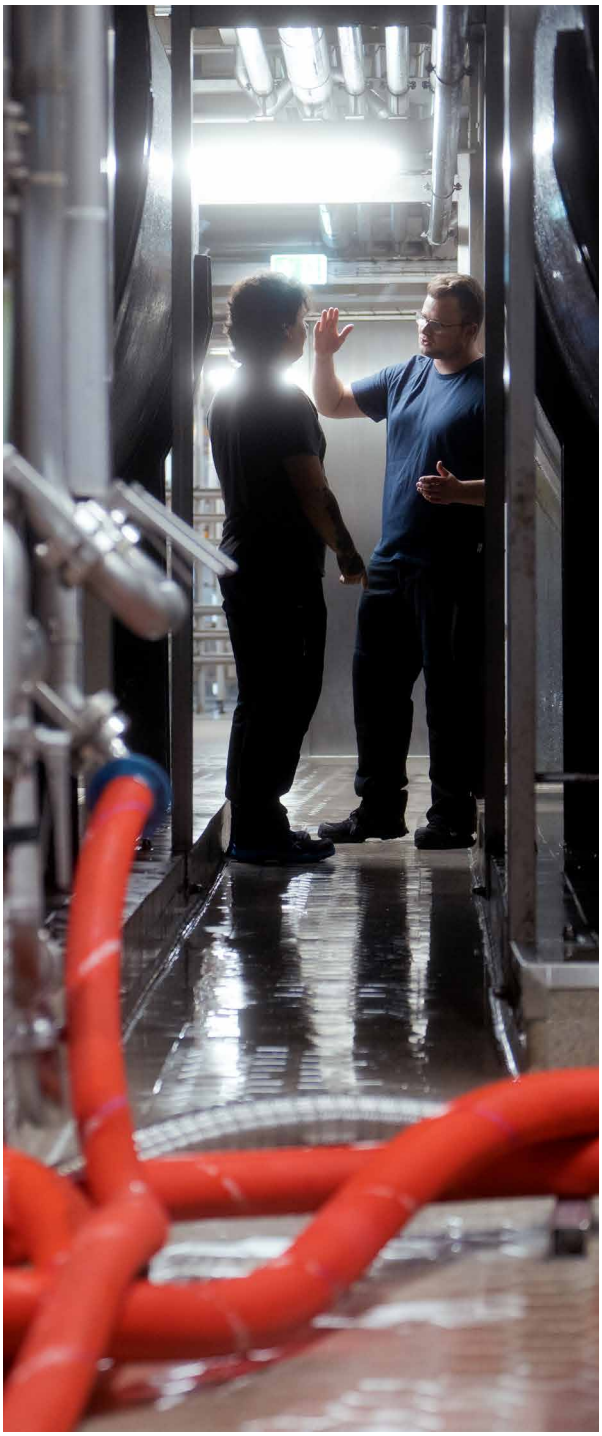
- The natural variation in hop plants.
- Introduction of oxygen to the brewing process when using hop pellets or cones.

There are a number of factors that brewers have to contend with when it comes to creating consistent flavors in their beer. The biggest of these is the natural fluctuation in the raw hops. Hops are grown over large areas with countless environmental variables involved.

This means that from field to field, farm to farm and year to year there will be variance in the hop itself, even within one variety. This can be somewhat offset by production techniques such as Sensory Plus™ used in Lupomax® pellets, but most pellet types will be subject to inconsistency. The variance in oil content is particularly important in dry-hopping. The more oil a variety contains, the bigger its impact during dry-hopping tends to be. The brewer has to manage the varying oil content that they may find in different varieties, as well as a noticeable variation within the varieties themselves. With other variables such as oxygen ingress and yeast performance also playing their part, consistency when dry-hopping is a constant challenge.

CHALLENGES WITH THE ADOPTION OF LIQUID HOP PRODUCTS

WITH EFFICIENCY being a clear driving force within the brewing industry, there are an increasing number of liquid hop products coming to the market. The majority of these products are offering efficiency gains, but they are almost invariably based on simple CO_2 extract technology that cannot deliver a full range of hop flavor compounds. CO_2 extract and hop oils are not easily soluble, especially in cold liquids. This is often overcome by the use of non-hop derived emulsifiers that help them to dissolve more easily.



THIS LEAVES BREWERS WITH TWO POTENTIAL ISSUES

FLAVOR. The use of these liquid products means that they are not getting a natural hop flavor as the CO_2 extracts don't extract the full range of flavor compounds that you will find in hop pellets. This often means that brewers often limit the use of these liquid products with the replacement ratio having to remain lower, to avoid the absence of a fully rounded and natural hop flavors becoming evident in the beer. Some products attempt to disguise this by adding additional hop oils which can help but does not ultimately get around the fact that the full range of flavor compounds are simply not present.

SOLUBILITY. Getting a highly efficient flavor and aroma transfer from your liquid hop product into your beer is key to what it can deliver for you. Classic CO_2 extracts and hop oils are not naturally soluble in water, especially at cold temperatures. This means that a liquid product needs to be able to offer effective dispersal of the flavor and aroma molecules, and ensure that they stay dispersed to allow them to be carried over into the final beer. If a liquid product does not properly disperse carriers, solvents or expensive engineering equipment is needed to ensure an efficient hoppy flavor or aroma.

INTRODUCING SPECTRUM

SPECTRUM IS FOR ALL BREWERS who need greater efficiency when creating natural hop flavor that matches the flavor created when using hop pellets. SPECTRUM is created from 100% hop material and offers large efficiency gains, while delivering a full natural hop flavor in an easy-to-use, highly flowable, liquid hop product.

KEY BENEFITS OF SPECTRUM

- A full natural hop aroma and flavor.
- Easy to use, highly flowable, 100% soluble liquid hop product.
- Increased Profits
- Reduced Costs

NATURAL HOP FLAVOR AND AROMA

A unique combination of extraction processes that delivers highly efficient transfer of the most natural hop flavor

UNLIKE OTHER liquid hop products SPECTRUM uses a unique combination of hop extract technologies, allowing for greater retention of hop flavor, aroma and many other valuable components found in hops (e.g. terpenes, thiols, bitter acids, polyphenols,...)the hop flavor, aroma and other valuable components including the polyphenols, proteins and aroma precursors that are lost in standard extraction processes. SPECTRUM then goes a step further in that it is able to fully disperse these molecules and cause them to remain dispersed within beer to ensure a fuller transfer of flavor. The patented technology leads to greater extraction efficiency, imparting more key hop aroma compounds than pellets and other hop products. The result is a natural liquid product that is made from 100% hops and is 100%fully dispersible, delivering the full SPECTRUM of hop flavor attributes that are as close as possible to a liquid hop pellet.

FLAVOR COMPONENT AVAILABILITY

	Hop pellets	SPECTRUM	Other liquid hop products
Full range of hop flavor, aroma and other valuable components found in hops (e.g. terpenes, thiols, bitter acids, polyphenols...)	✓	✓	✗
Full and fast dispersion without the need of added carriers/solvents or expensive dry hopping equipment	✗	✓	✗
Absence of enzymes identified for causing hop creep	✗	✓	✓
No leaf material meaning no beer losses or spent material to remove	✗	✓	✓

INCREASED PROFITS

Beer production volume gains

THE VOLUME GAINS with SPECTRUM will vary depending on what beer you are brewing and what volume of solid hop material you are replacing. All breweries will see increases in yields when replacing solid hop products with SPECTRUM. This is especially true for breweries that run a more basic brewery set-up and don't have sophisticated separation technology such as a centrifuge.

Calculating the exact savings is difficult due to the high number of variables. However, in our experience with customers so far it is possible to achieve yield increases in excess of 10% relatively easily, with even bigger gains possible for fine-tuned production. We have added some useful case-studies in the appendix of this paper to give some real life examples of how breweries have benefited from yield increases (among other benefits).

REDUCED COSTS

Reduced production time

THE FACT that SPECTRUM facilitates a highly efficient transfer of a full natural hop flavor means a significant reduction of contact time is required during your production. Pellets and whole hops by their nature need long contact times with beer to impart their full flavor and aroma. By fully dispersing into beer, SPECTRUM makes the full range of hop flavor and aroma compounds available, speeding up the transfer of these into your beer. Depending on the beer and production method, a reduction in production times of 25% is a realistic outcome when SPECTRUM is well integrated into your processes.

The outcome of this is clear. By reducing your production time you produce more beer, more quickly, while reducing your energy usage and resource use associated with extended production time.

ADDITIONAL BENEFITS OF SPECTRUM

QUICKER AND SIMPLER DOSING

FOLLOWING recent improvements in SPECTRUM it is very quick and easy to dose, remaining highly flowable at room temperatures. It does not need any preparation steps and can be dosed directly with no specialist equipment required for a fast and clean addition.

REDUCTION IN HOP CREEP WHEN DRY-HOPPING WITH SPECTRUM

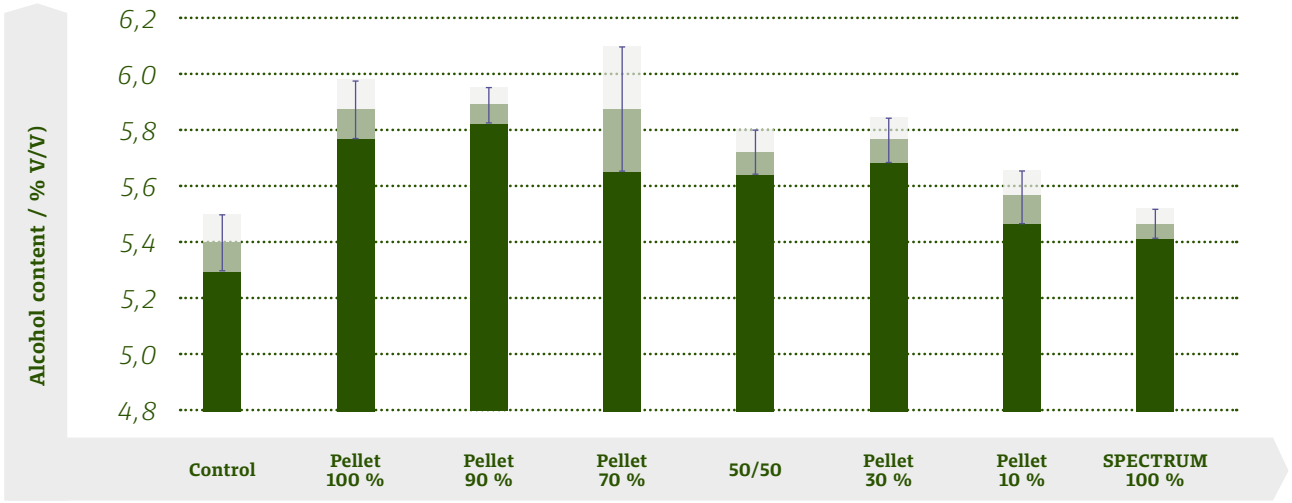
SPECTRUM itself does not contain any of the enzymes that can re-start the fermentation process, so depending on the percentage of the dry-hop bill you have replaced, SPECTRUM can completely eliminate hop-creep. For those brewers that actively use hop creep to reach the final ABV of a beer, this then needs to be accounted for. The following shows the impact of hop creep on a beer brewed in a controlled experiment.

A pale ale brewed in-house was dosed with yeast at a concentration of 25 million cells/ ml and split into 8 flasks with fermentation airlocks. They were dry-hopped with varying proportions of Citra® T90 pellets and SPECTRUM using a replacement rate of 1:2 w/w for SPECTRUM (to amplify any hop creep effects).
The beers were left to re-ferment for 7 days at 23 °C.
All beers were analysed in triplicate using the AntonPaar Alcolyser.

Results showed that although SPECTRUM increases the apparent extract of the beers, it does not exacerbate overattenuation through hop creep.

The increase in alcohol content was roughly proportional to the addition rate of T90 pellets and the beer treated exclusively with SPECTRUM was very close to the control beer.

REDUCTION IN HOP CREEP WITH SPECTRUM



REDUCED WASTE

USING SPECTRUM reduces the amount of waste and effluent material produced during the dry-hopping process. The result is that a brewery can significantly reduce the amount of time and money spent on removing these waste products from the brewing kit and the brewing site, helping you to run a cleaner and more sustainable production operation.

INTRODUCING SPECTRUM INTO YOUR BREWING PRODUCTION

TAKE A DELIBERATE AND ITERATIVE APPROACH

SPECTRUM is extremely versatile and can, with the correct application, be used in many ways to create full and intense natural hop flavors, while saving money and time. Through our trials we have found that for best results, it is important to take the time to understand the product and how it works before using it to push any boundaries.

We have found that experimenting with high dosing and replacement rates too soon, can lead to brewers having difficulty in achieving the best from SPECTRUM. Introducing SPECTRUM successfully works best by taking an iterative approach. The most successful introductions of SPECTRUM have begun with lower replacements and dosing rates, with brewers then working towards the "sweet spot" where they are able to replace all or a large percentage of solid hop material by dosing SPECTRUM at the right point and dose rate for their beer.

DOSING SPECTRUM

SPECTRUM is ideally dosed during secondary fermentation when 1-2 degrees Plato off terminal gravity. SPECTRUM can be pre-dispersed and then dosed into your fermenter with no specialist equipment required. SPECTRUM can also be used easily with any dynamic dosing systems that you use in your production process. If you add SPECTRUM at higher temperatures then pre-dispersion is not necessary.

We recommend to shift most of the dry-hopping additions with Spectrum to the fermentation step to have the best flavor extraction and the most impactful impact.

REPLACEMENT OF T90 HOP PELLETS

If you are looking at replacing T90 pellets in a current recipe you can expect a 1:5 – 1:8 replacement ratio (i.e. 1 kg of SPECTRUM for every 5-8 kg of pellets).

We have found that it is useful to initially only partially replace around 25% - 50% of the pellet load with SPECTRUM. This allows you to understand the flavor impact that SPECTRUM is having and adjust both the replacement ratio and the dosing rate to get the best results.

REPLACEMENT OF ENHANCED HOP PELLETS

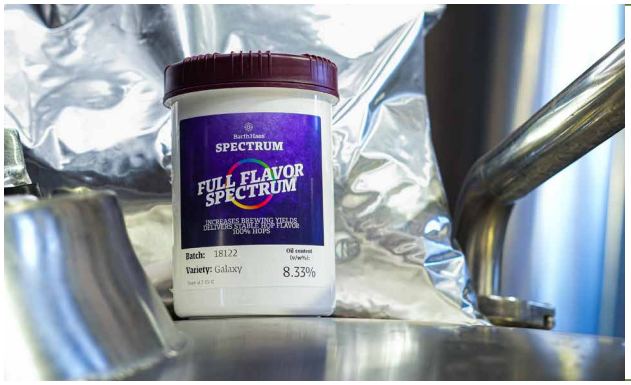
For concentrated pellets such as LUPOMAX® you will need a lower replacement rate. We recommend starting at the 1:5 ratio and adjusting based on the results of your trial brew.

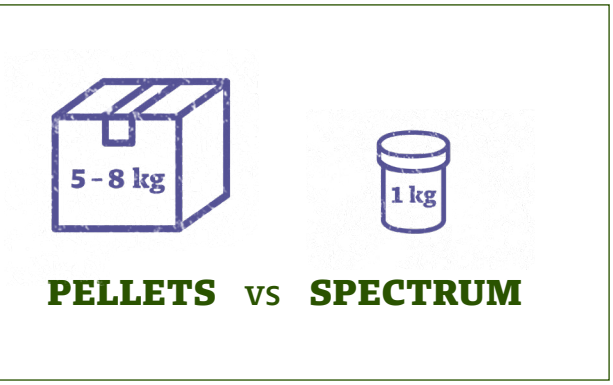
MAXIMUM DOSING RATES

When using SPECTRUM for the first time or when replacing hopping rates above 8 g/ L pellets, we strongly recommend replacing no more than 80% of the pellet load with SPECTRUM. Stick to a replacement rate of 1:5 to 1:8 (w/w SPECTRUM to pellets) and use no more than 1 g/L of SPECTRUM.

TAKING IT FURTHER

It is possible to exceed these dose rates, but we recommend that this is only done once you have experience working with SPECTRUM and have consulted our Brewing Solutions team.

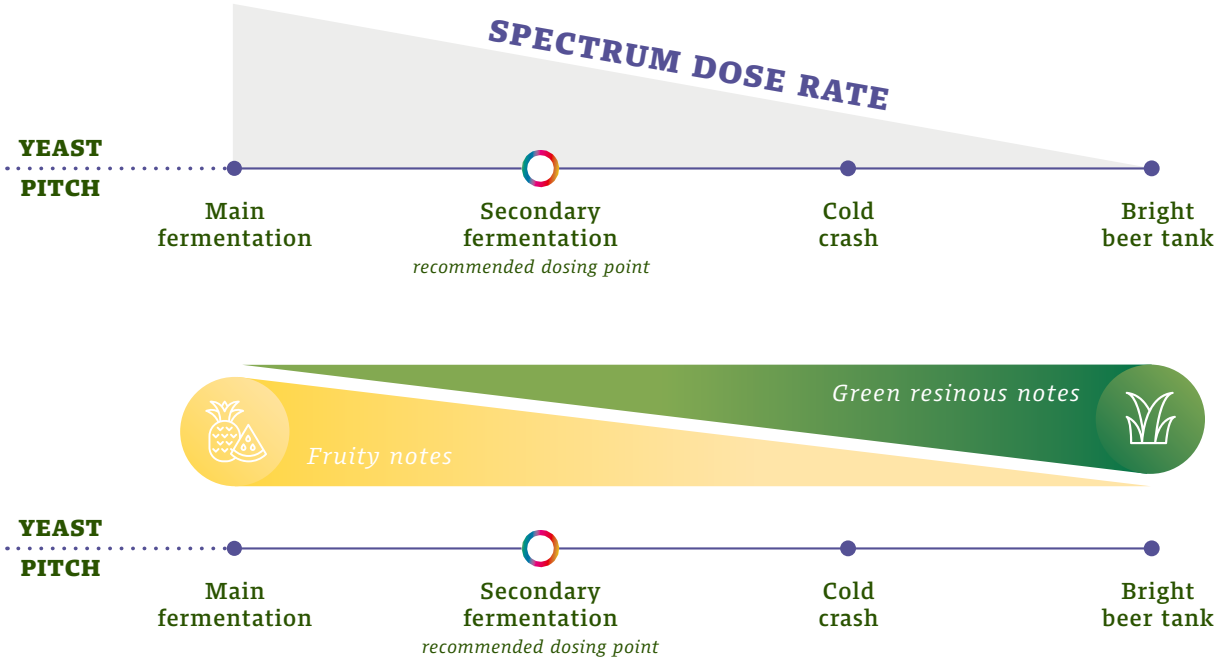




TARGETING DRY-HOP FLAVOR AND AROMA OUTCOMES BY ADJUSTING THE POINT OF ADDITION

BY INTENTIONALLY adding SPECTRUM at a certain points in your dry-hop process, it is possible to achieve either the fruity or resinous notes of the hop. Adding early during active fermentation moves the flavor and aroma in to the direction of fruitiness. Adding it later moves them to a predominantly grassy/resinous outcome.

Some trial brewers were concerned that SPECTRUM would have a negative effect on the yeast when used in this way. However, no negative effects were seen in any of the trials and the yeast performed exactly as it had before the introduction of SPECTRUM.



SPECTRUM dose rates need to be adjusted based on the point of addition, with less SPECTRUM required the later it is dosed. Dosing SPECTRUM early in the process will bring out the fruity notes, while late dosing will create a grassy, resinous character.

SPECTRUM VARIETIES AND PACK SIZES

VARIETIES

SPECTRUM is available in a range of popular hop varieties with more becoming available all the time. If you have a specific need for a variety not yet listed, please contact us to check availability.

PACK SIZES

SPECTRUM is available in 1kg, 5kg and 10kg sizes. All packaging is food safe. We recommend to shift most of the dry-hopping additions with Spectrum to the fermentation step to have the best flavor extraction and the most impactful impact.

TECHNICAL SUPPORT

At BarthHaas we have a dedicated team that are able to advise customers on all hop related brewing matters. If you have any further questions about introducing SPECTRUM into your brewing we will be happy to help. Please visit BarthHaas.com for more information or contact Brewing Solutions directly at:

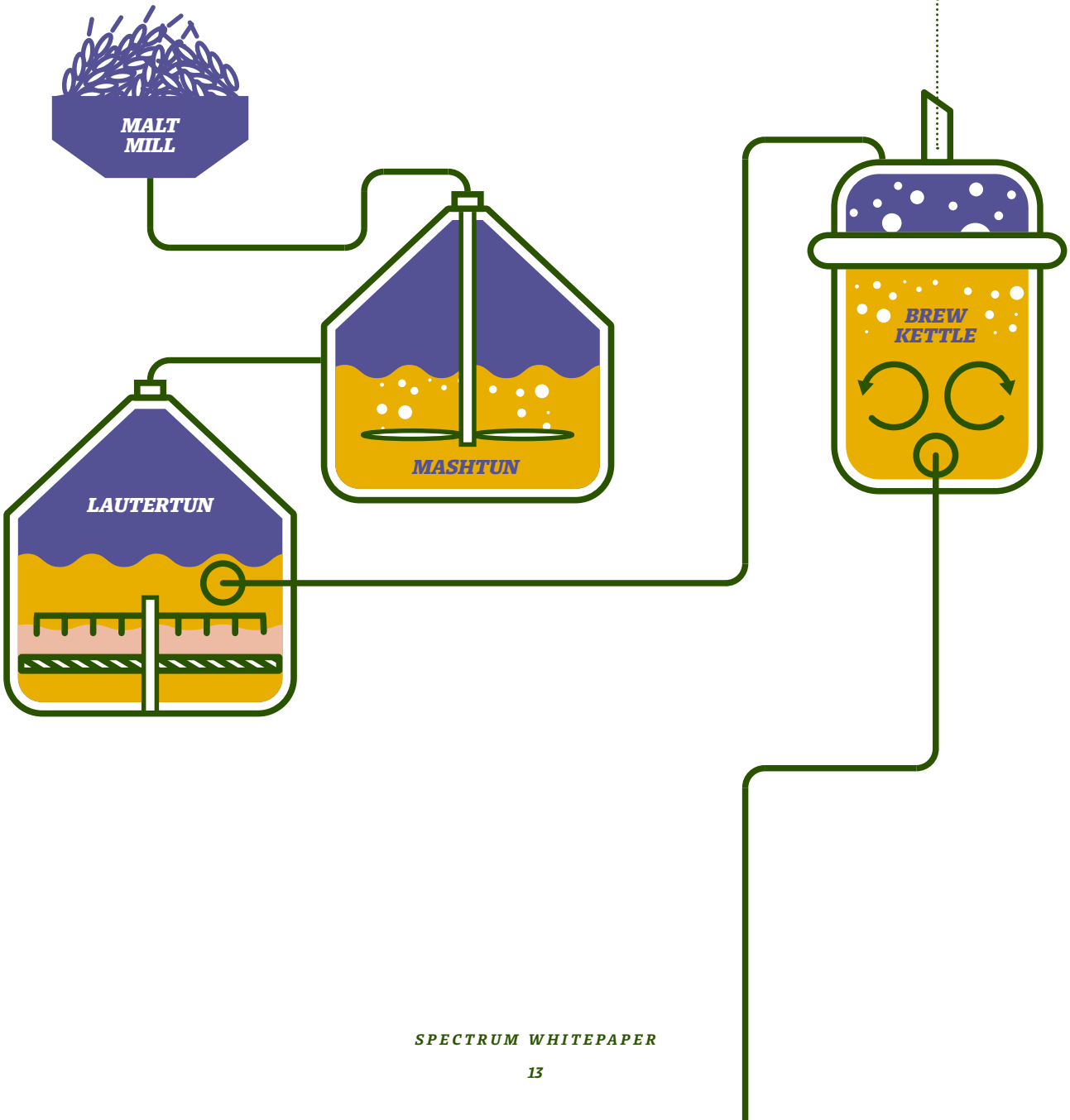
brewingsolutions@barthhaas.de

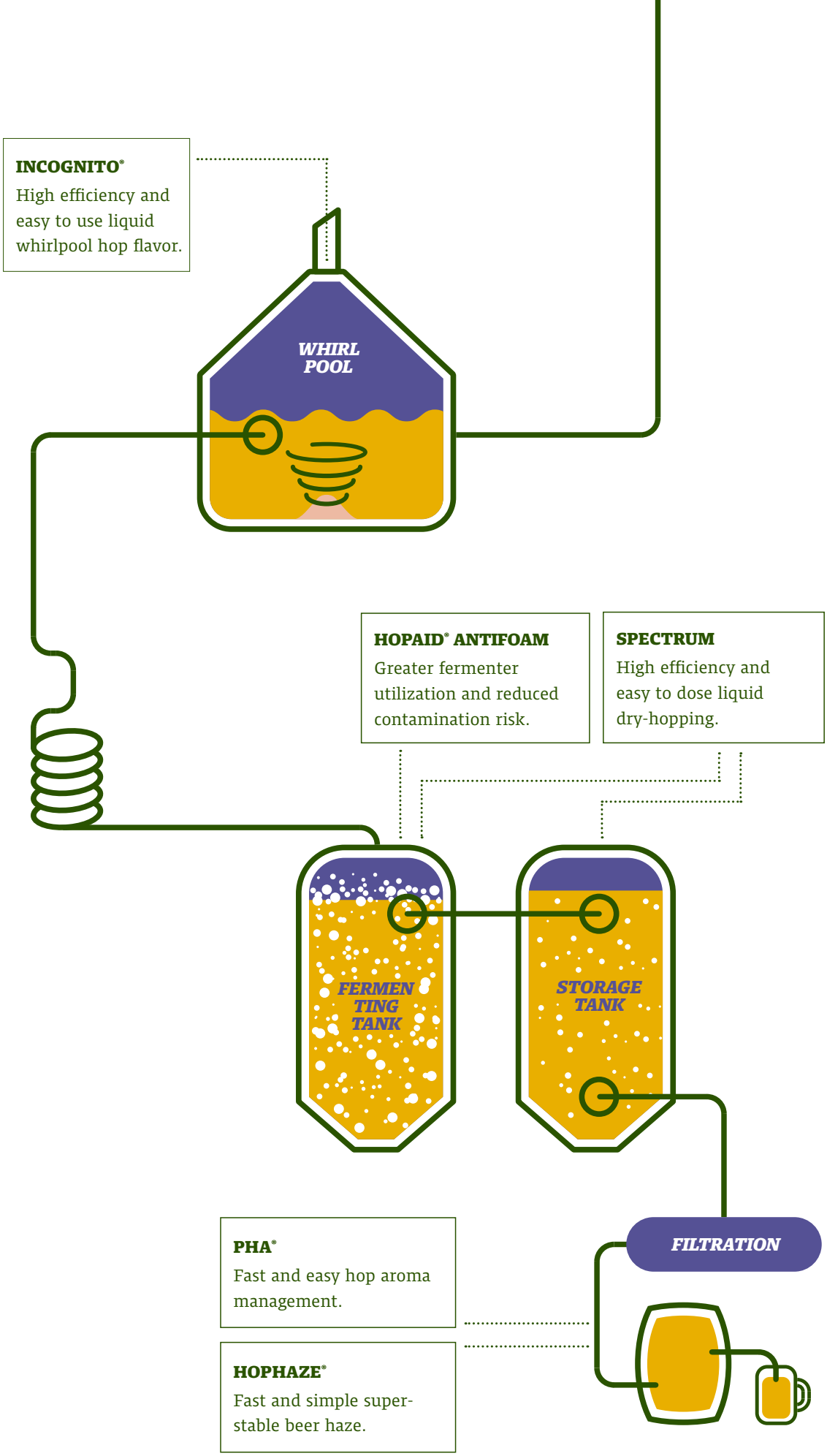
APPENDIX 1 – THE LIQUID HOP RANGE FROM BARTHHAAS

SPECTRUM is part of a family of flowable hop products now available from BarthHaas. Each has its unique place in the brewing process, and all can be used alongside each other to increase your efficiency while still using a 100% natural hop product for a full hop flavor.

FLEX®
Highly efficient natural hop bittering.

KETTLE REDI®
Light-stable kettle bittering for highly efficient brewing.




INCOGNITO®
High efficiency and easy to use liquid whirlpool hop flavor.
WHIRL POOL
HOPAID® ANTIFOAM
Greater fermenter utilization and reduced contamination risk.
SPECTRUM
High efficiency and easy to dose liquid dry-hopping.
FERMEN TING TANK
STORAGE TANK
FILTRATION
PHA®
Fast and easy hop aroma management.
HOPHAZE®
Fast and simple super-stable beer haze.

APPENDIX 2 – CASE STUDY

DOGMA BREWERY CREATES AMAZING NATURAL HOP FLAVOR WITH SPECTRUM WHILE TRANSFORMING BREWING EFFICIENCY WITH LIQUID HOPS.

DOGMA BREWERY – BELGRADE, SERBIA

are renowned for great beer including their flagship Hoptopod West Coast IPA. Together with BarthHaas they have looked at how they can enhance brewing efficiency while preserving the high-quality aroma and flavor that define their beers. By incorporating Spectrum Liquid Hop, alongside other advanced liquid hop products like Incognito and Flex, Dogma Brewery achieved remarkable improvements in yield, production time, and beer quality.

THE CHALLANGE

DOGMA BREWERY faced the challenge of maintaining consistency in aroma and flavor while improving the efficiency of their brewing process. Traditional hop pellets, while effective, introduced variability, led to higher levels of trub, increased production time, and required more intensive cleaning processes. The brewery sought a solution that would enhance efficiency, reduce waste, and maintain or improve the sensory qualities of their beer:

"We knew we had to find a way to streamline our process without sacrificing the distinct flavors our customers love," said Nemanja Petrovic, Head Brewer at Dogma Brewery. „Efficiency was key, but so was ensuring every pint tasted just as good as the last."

THE SOLUTION

DOGMA BREWERY decided to conduct trials using Spectrum Liquid Hop alongside some of BarthHaas's other liquid products to compare them with their standard brewing process. The trials focused on their best-selling Hoptopod West Coast IPA and a new version named Metahoptopod, which was brewed exclusively with liquid hops.

THE BREWING PROCESS

BREWING HOPTOPOD (STANDARD PROCESS) In the traditional brewing process for Hoptopod, hop pellets were added during the whirlpool stage, followed by a half-hour rest before transferring the wort to the fermenter. This method typically yielded 41.5 hectoliters per batch. However, the process also generated significant cold trub, which reduced the final yield and required more CO2 for carbonation due to the lack of spunding during fermentation. Additionally, the beer required up to 28 days to be ready for packaging.

BREWING METAHOPTOPOD (USING LIQUID HOPS) For Metahoptopod, Dogma Brewery used Spectrum Liquid Hop and Incognito. Incognito was added at flameout, allowing for better integration with the wort, while Spectrum was utilized during two dry hop stages. The use of liquid hops resulted in a higher yield of 43 hectoliters per batch, avoiding the need for pellets in the whirlpool and boil. The beer was ready in 21 to 23 days, nearly a week earlier than the standard process, thanks to the spunding process that also reduced the need for additional CO2:

"The difference was immediate," explained Nemanja. „We saw a clear improvement in yield and efficiency right from the first batch. The fact that we could produce more beer in less time without compromising on flavor was a huge win for us."

CLEAR AND SIGNIFICANT BENEFITS

10% INCREASED YIELD By switching to liquid hops, Dogma Brewery achieved an additional four hectoliters of finished beer per batch. This was due to reduced trub formation, less sediment in the fermenter, and more efficient use of brewing ingredients.

25% REDUCTION IN PRODUCTION TIME The production time for Metahoptopod was reduced by almost a week, allowing the brewery to increase their output and better meet demand:

"Reducing our production time by nearly a week has been a game-changer," noted Nemanja. „It's allowed us to keep up with growing demand and focus on innovation, rather than just keeping up with orders."

GREAT NATURAL AROMA AND FLAVOR Liquid hops like Spectrum and Incognito provided consistent hop utilization, eliminating the variability often seen with traditional pellets. The aroma and flavor of the beer were enhanced, with cleaner, more distinct notes and a fuller, oilier mouthfeel. The bitterness was smoother and more controlled, thanks to Flex, leading to a consistent and desirable IBU level.

REDUCED CLEANING AND MAINTENANCE The use of liquid hops made the brewing process more efficient. The cleaning process was less labor-intensive, with significantly less sediment and trub, leading to reduced use of cleaning solutions and overall time spent on maintenance:

"The cleaning process has become much more straightforward," Nemanja added. „We're spending less time on maintenance, which means more time can be devoted to brewing and perfecting our recipes."

"One of the things that impressed us most was the consistency," said Nemanja. „Every batch of Metahoptopod had the same intense natural aroma and balanced flavor profile. That's something we could never fully achieve with traditional hops."

CONCLUSION

THE INTEGRATION OF SPECTRUM Liquid Hop and other liquid products into Dogma Brewery's process has proven to be a game-changer. Not only has it enhanced the efficiency of their brewing operations, but it has also allowed them to maintain—and even improve—the quality of their beer. Dogma Brewery hope to continue to leverage these advanced brewing solutions to produce exceptional craft beer while optimizing their production process.

"The results speak for themselves," concluded Nemanja. „We're producing more beer, more efficiently, without sacrificing the quality that our customers expect."

Nemanja Petrovic
Head Brewer at Dogma Brewery

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TECHNICAL SUPPORT At BarthHaas we have a dedicated team that are able to advise customers on all hop related brewing matters. If you have any further questions about introducing SPECTRUM into your brewing we will be happy to help.

Please visit BarthHaas.com for more information or contact Brewing Solutions directly at **brewingsolutions@barthhaas.de**

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