

# White Paper



## Introduction

This White Paper is intended to be an informative and concise guide to inform the reader about applications for Hopzoil™, the fresh-hop, steam-distilled essential oil used in brewing and other beverage infusions.

Hopzoil is a pure ingredient that is produced by Glacier Hops Ranch, Inc.

Findings reported from numerous brewers across the U.S. who have tested and used Hopzoil in various applications since 2015 are compiled and reported in this White Paper.

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## 1. Frequently Asked Questions

1. **WHAT IS IT?** Hopzoil™ is the result of taking only fresh hops at harvest time and steam-distilling them on the farm to capture all of those essential oils found in fresh hops in the field. It is distinctly different from traditional liquid extracts in both the raw ingredient (fresh hops vs. dried, soft pelletized hops) and the process. Because it is steam-distilled and not processed using a CO<sub>2</sub>, propylene glycol or other solvent-based extracts, there is no chance of residual solvent. It is one ingredient, made of only pure fresh hop oil.
2. **WHAT DOES IT DO?** AN AROMA ADDITION. Brewers use Hopzoil™ to add back the volatile, aromatic oils, which are only found to that extent in fresh hops. It has no bittering properties, as it is pure oil. It contains neither Alpha nor Beta acids.
3. **WHEN DO YOU ADD IT?** COLD SIDE ONLY. It is added exclusively on the cold side, typically post-fermentation and before commercial packaging. If it were added on the hot side, most of the oil would evaporate, due to the extraordinarily high levels of myrcene captured at the point before hops are traditionally dried and processed.
4. **IS IT A SUBSTITUTE FOR TRADITIONAL DRY-HOPPING?** YES. It can be. Think of it as “liquid dry-hopping”. The best results seen to date have been as either a partial or full replacement of pellets, for several reasons, with a couple of caveats: dry-hopping at standard recipe rates and then adding a full dosage of Hopzoil, would be effectively doubling the suggested dry-hopping rate (consumer reaction has ranged from “wonderful” to “overhopped”). “Spiking a keg” of an existing beer with Hopzoil has worked in small, controlled research tests, but in production, best results appear to either reduce or eliminate the amount of pellets used in dry-hopping, depending on what you are trying to achieve.
5. **CAN IT BE A SUBSTITUTE FOR ANYTHING ELSE?** YES. Brewers cited it as a potential substitute for more expensive, proprietary hops that are sometimes challenging to obtain.
6. **WHAT IS THE DOSING RATE?** A LITTLE GOES A LONG WAY. The best dosing rate seems to be in the range of 5 ml per BBL, slightly plus or minus, depending on recipe, pellet substitution rate and regional preference. Local tastes and recipes can impact what the ideal dosing rate for each situation, however, that rate has provided the most consistent, positive results. We have seen ranges from 4.6 to 6.2 ml per BBL.

*“Based on new science that was presented at the CBC, we are discontinuing our dry hopping in all of our beers except one.*

*The presentation was Dry Hopping and Bitterness. It was the straw that broke the camels back.*

*We already know that dry hopping causes oxygen ingress (dissolved O<sup>2</sup> in the final product), and that hops have a degree of fermentable extract (potential re-attenuation issues), and those factors combined may cause potential diacetyl problems. The assertion was that a 0.5 to 2.5 lb. rate of dry hopping actually decreases bitterness. So if we can achieve the same or better results with Hopzoil, then it’s really a no brainer for us.*

*We are invested in the technology and the product. In my opinion, these oils and lupulin powder are the new paradigm. “Finishing Hops” in the form of oils will be the future.”*

**Tim Schnars II**  
Brewmaster  
Meadowlark Brewing Co.  
Sidney, Montana

7. **WHAT IS THE DOSING PROCEDURE?** Of the several procedures tested, (more detail in the [Dosing Procedure](#) section), best results have been seen with the following:
  - a. Always on the cold side
  - b. Post-fermentation
  - c. Dosed with some agitation (in-stream transfer from fermenter to bright tank is one recommended method)
  - d. If substituting pellets altogether, no need to dry-hop or condition for days. Packaging from bright tank with only overnight conditioning also maximizes throughput.
  
8. **WHAT BEER STYLES PRODUCE THE BEST RESULTS?** Consensus is that hop-forward beers consistently produce the best results, as the fresh hop notes in particular are proving to complement an otherwise already solid IPA, and take it to another level. Brewers also made reference to a making a seasonal fresh hop ale, when fresh hops are not seasonally or locally available, making note that even if they did ship fresh hops in overnight, the freight is far more expensive than the hops themselves.
  
9. **DOES IT IMPACT THE YIELD PER BATCH?** YES, SIGNIFICANTLY. Brewers have reported increased yield per batch by reducing filtration losses when using Hopzoil as a full or partial substitute for pellets. Simultaneously, the end result can be a fresher tasting, more aromatic & flavorful beer. Increased yield depends on filtration method, reduction in pellets and other factors, but it can be significant.
  
10. **IS IT TRUE-TO-TYPE, PER HOP VARIETY?** NO. Or put another way, would Chinook Hopzoil have the identical oil profile as dried, processed Chinook pellets? Hopzoil will contain a much higher level of volatile myrcene, in particular, so it will not be identical to the aroma and flavor derived from dried, processed Chinook, in much the same way as fresh basil is not the same as dried basil. Side-to-side oil chemistry comparisons are provided below.
  
11. **WHAT DOES IT DO TO THE AROMA AND FLAVOR PROFILE?** Observations made by brewers:
  - a. "It fills in some of the flavor gaps in the hop profile."
  - b. "It offers the opportunity to make a fresh-hop-style beer, or straddling the line between that and an IPA, depending on how it is used."
  - c. "It does not taste artificial, strange or out of place. It smells and tastes 'fresh'."
  - d. "It is a terrific balance of fresh hop aroma and pleasant bitterness with an overall hop impression that is spot on to the nature of the variety used."
  - e. "The resulting aroma is intense and unique and very pleasing to us brewers. It just doesn't seem to fade. The guest feedback was very positive as well and some were able to identify the aroma as fruity or tropical fruit, and all thought it was very unique and unlike anything they had ever tasted."

*"...it took what was already a pretty good beer and brought it to another level altogether."*

## 2. Case Study Detail

### A. Dosing Rates & Chemistry Profile Comparison

#### i. Viscosity and Color:

Unlike liquid extracts that have the consistency of heavy motor oil or honey, Hopzoil is highly viscous, lighter than olive oil, due to the absence of AA and BA, and the high availability of naturally-occurring, highly-volatile myrcene. It is also easy to accurately measure by fluid volume.

Color can range from clear to a slight amber tinge. It is clear, and neither milky or cloudy.

#### ii. Dosing Rates:

Best results seem to be found in the 4.6 ml to 6 ml per BBL range. Local and regional tastes require and allow for the ability to adjust dosing rates. A little goes a long way.



Using 5 ml or less, and cutting back dry-hopping pellets by 1/3 to 2/3 has proven a successful dosing rate. Some brewers have eliminated pellets altogether and have dosed from 5 ml to 6.1 ml per BBL.

Hopzoil™ is not a liquid extract replacement for standard pelletized hops, because of the raw ingredient (fresh hops vs. dried, processed hops). Expect Hopzoil to impart a more aroma and flavor, because Hopzoil contains a higher percentage of the most volatile oils than pellets or traditional extracts, as noted below.

**EXAMPLE: El Dorado™ Comparative Oil Profile: Standard vs. Fresh Profile**

	Standard (Dried & Processed) Oil Profile	Hopzoil™ Oil Profile (Guaranteed Analysis from C of A)
Myrcene:	47.71%	80.21%
Farnesene:	.24%	.05%
Caryophyllene:	9.35%	2.80%
Humulene:	12.92%	3.57%
Linalool	.7%	.27%
Geraniol	.02%	.01%
B-Pinene	.56%	1.07%

**EXAMPLE: Chinook Comparative Oil Profile: Standard vs. Fresh Profile**

	Standard (Dried & Processed) Oil Profile	Hopzoil™ Oil Profile (Guaranteed Analysis)
Myrcene:	20-30%	78.16%
Farnesene:	<1%	.11%
Caryophyllene:	9-11%	2.93%
Humulene:	18-24%	4.70%
Linalool	0.3-0.5%	.22%
Geraniol	0.7-1%	.04%
B-Pinene	0.3-0.5%	1.11%

Some brewers have noted more effect on aroma than taste, and others have noted equal effect on both aroma and taste, depending on a variety of factors.

## B. Dosing Procedures

A variety of dosing methods have been introduced, but they have several things in common:

- a. Always on the cold side
- b. Post-fermentation
- c. Dosed with some agitation
- d. Packaging normally from bright tank with minimal conditioning

**i. Single Keg or Pilot System Dosing:**

Most tests used an existing base beer, rather than creating a new recipe, which allowed brewers to test against a control, reducing variables.

1. Stone Brewing’s Steve Gonzalez, Sr. Manager of Brewing and Innovation, first purged the Bright Tank of their pilot system with CO2, then dosed the Bright Tank and then filled it with beer for oil dispersal and conditioning, which worked well. Stone used their flagship IPA as the base beer (control) and only added Hopzoil (test) as the lone variable.
2. Great Northern Brewing Company’s Thomas Sierra, Director of Operations, used an inline keg-to-keg transfer system, dosing via an inline valve connecting the kegs, which worked well. These efforts also successfully allowed bracketed dosing of multiple kegs and defined the dosing rate differences with that existing base beer that had not been pulled prior to dry-hopping.
3. McFate Brewing’s Adam Schmeichel first sanitized the cask, added sugar to prime the cask, and dosed the cask via a sanitized pipette, then purged the cask with CO2, and racked the beer on top of it, with noticeably good results.

*“...it definitely straddled the line between a standard IPA and a fresh-hop beer. It offers a great opportunity to make a fresh-hop-style beer instead of how we used it.”*

4. Gordon Biersch brewer Gary Fritze pulled the valve on a sanitized, purged keg, dumped in the vial and counterpressure-filled the keg off the serving tank. Fritze noted that he bittered his batch with Bravo, had a late kettle addition with Cascade, Crystal and Citra, and dry-hopped with Crystal and Citra as well. He conditioned the keg for a 24-hour contact time before serving, with a well-received response.

iii. **Production Dosing:**

Dosing a small quantity of a pre-existing base beer that has already been dry hopped will provide different results than controlling the dry-hopping with pellet reductions. More variables and controls are available in production.

1. McFate Head brewer Adam Schmeichel commented that in his opinion, if dosed into a Bright Tank, he saw no need to condition the beer after carbonation. His recommended dosing protocol in larger batches would be to dose it into the Bright Tank first, then fill the tank, then carbonate to agitate and mix it. For conditioning, he would let it sit at least overnight and then keg, package or tap it (depending on the system). Schmeichel added "I see no reason why it can't be turned in a day."
2. Travis Peterson, Founder of Meadowlark Brewing and Head Brewer Tim Schnars, provided explicit step-by-step procedures:
  - a. We ran the beer through the centrifuge and filtered it into the bright tank.
    - i. First, the Bright tank port is equipped with butterfly valve.
    - ii. A "chamber" is built with a 90-degree elbow fitting and a second butterfly valve.
    - iii. Chamber is sealed. Gas to TC fitting is assembled to top of chamber, with appropriate pressure of CO2 feeding to it. Butterfly valves to Bright tank and gas feed are both closed.
  - b. We opened the outside valve and poured in 1/3 of the of the Hopzoil liquid. Closed the outside valve, opened the inside valve to flush the elbow with beer. We then attached a CO2 fitting to the outside valve and blew the beer/oil mixture into the bright tank.
  - c. Gas feed valve is opened, forcing solution out of "chamber" into Bright tank, in a swift "burp" shutting the valve immediately.
  - d. Closed the inside valve and repeated for the next two 1/3 dosing pours. After this we applied CO2 to the carb stone.
  - e. Bright tank is set to carbonate, slow and low, over a period of 15 hours, allowing oil to diffuse.
  - f. Beer is kegged/bottled normally.
  - g. Peterson said, "we theorized that the blast of CO2 would stir up the oil into the beer enough to cause equal distribution for the whole tank. Combining that with the carb stone bubble effect we think achieved our goal. We couldn't just dump in the oil prior to filling the bright tank because the oil may have all run down into the draw port and sightglass tube." He added, "judging by sampling after carbonation and now off the first keg I think we achieved good results."
  - h. Schnars added his reasoning: "Hopzoil allows us to make significant reductions in our dry-hopping hops usage. It also enables us to use fine filtration, recuperating lost oils with post-filtration diffusion. Hopzoil™ is an amazing alternative and/or compliment to dry-hopping that adds a layer of complexity to IPAs or Pales that may be heavily processed or require a vibrant boost to their package aromatics."
3. Tyson Read, of Iron Horse Brewery provided his procedure, differentiating his process with an ingredient modification for added water solubility, utilizing a Hop Gun.
  - a. Beer was chilled to -1C in the fermenter and centrifuged into a bright tank.
  - b. 65ml of hop oil were blended with 500ml of grain alcohol.
  - c. The mixture was added to a CO2 purged Braukon HopGun.
  - d. HopGun was filled and circulated with the bright tank for 1 hour at a flow rate of 60bb/hr.
  - e. Beer was then carbonated and allowed condition for a week before packaging.

*"Would I recommend it? Definitely. It's a no-brainer for casks, for instance. No bagging, no clogging the spigot, no waste, you get a full yield, it's super easy and no worry about sanitizing bags, etc."*

*"Our customers loved it. Our owner absolutely loved it. It took our good IPA to another level altogether. One cask we sold at our main brewery taproom and it sold out in one night. A smaller cask went to our other taproom and it sold out in 2 ½ hours. We had a lot of regulars try it, and I saw them order it again over our regular IPA. No doubt about this stuff."*

**Adam Schmeichel**  
**Head Brewer, McFate Brewing**  
**Scottsdale, Arizona**

f. The goal of this procedure was to introduce as little gas washing to the product as possible.

**CAUTION: DO NOT ADD ON THE HOT SIDE.** Because of the volatility of the aromatic oils contained in Hopzoil, it is not advised to add it into any heated liquid, certainly not into the boil. Doing so will cause the majority of the oils in Hopzoil to evaporate.

All test results were performed post-fermentation.

## C. Efficiencies/Yield Gain

Reducing filtration losses and increasing yield has proven to provide the greatest bottom-line benefit to brewers.

*“We produced our first batch with the Hopzoil, and the results were...spectacular! Our thoughts were to decrease the total beer loss while still retaining prominent hop aroma and flavor. The finished product is a terrific balance of fresh hop aroma and pleasant bitterness with an overall hop impression that is spot-on to the nature of El Dorado.*

*What we were missing from filtration before is now prevalent and wonderful. The Hopzoil elevated the beer to a truly ‘badass’ flavor. It allows us to be better brewers because the beer obtains the flavor we intend the beer to have”*

**Travis Peterson, Founder  
Meadowlark Brewing Co.  
Sidney, Montana**

1. Schmeichel said “we lose a lot of beer when we dry-hop heavily. For our hoppiest IPA, we might get 13 BBL out of a 15 BBL batch. If we can increase our yield by just one keg using this product, it more than paid for itself.”

2. Gonzales said “we did get a 20% higher yield in our pilot system, compared to dry hopping, but there are a lot of other variables that in production would be different.”

3. Peterson noted, “our centrifuge really cuts down on our losses on a 15 BBL batch. But by substituting this fresh hop oil for dry hopping, we eliminate most of those remaining losses. This fresh hop oil is slightly more expensive than dry hopping, but when you factor in the more than two additional keg yield from each batch, it’s like found money in the taproom. And that’s not even talking about the positive reaction we had from our customers.”

4. Sierra also noted two additional efficiencies:

a. if substituting Hopzoil from pellets altogether (“liquid dry-hopping”), the added throughput obtained by an overnight turnaround to packaging vs. three or more days of dry-hopping conditioning is significantly better utilization of hard assets.

b. Second, he noted that depending on the filtration methodology (if a brewer filtered off the initial hot-side hops and yeast, dry-hopped and filtered again), that this could reduce or eliminate that second filtration labor cost.

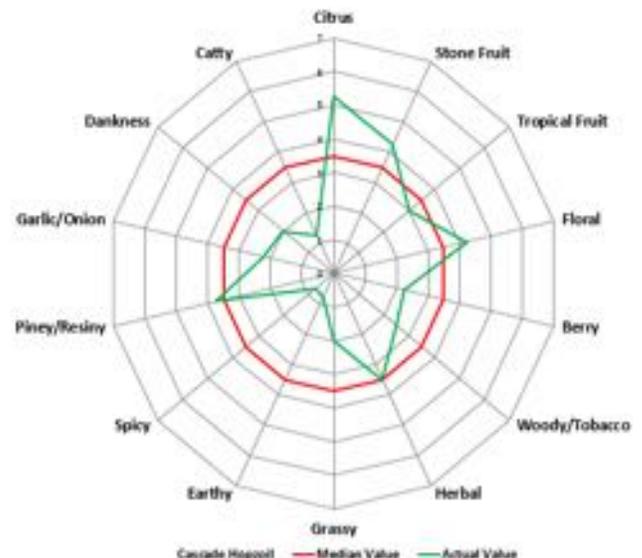
*“If we can increase our yield by just one keg using this product, it paid for itself.”*

## D. Sensory/Aroma Observations

The original Hopzoil hop variety tested by Stone was Cascade. The Sensory Chart at right was created by Steve Gonzalez, Senior Manager for Brewing and Innovation at Stone Brewing demonstrates that it gave off higher than expected values for Citrus, and lower than expected values for Piney, compared to what would be expected from processed Cascade pellets, for instance.

Therefore, Cascade Hopzoil™, he said, would not be considered an equal substitute for Cascade hops in a recipe, because it is not the same flavor profile as hops that have been dried and processed with heat (which was to be expected).

Schmeichel was more specific. “The Hopzoil filled in some gaps of the flavor profile. It was really smooth tasting, and took what was already a pretty good beer and took it to another level. It did not taste artificial, strange or out of place.”



*"It depends on what you are trying to achieve... it had some very different, unique aromas and flavors not expected from Cascade."*

He continued, "we did not get a typical Cascade aroma, rather, it was another layer, almost a citrusy/ grapefruity aroma, complimentary to the existing base IPA, almost a Citra-like addition."

He added, "it definitely straddled the line between a standard IPA and a fresh-hop beer. It offers a great opportunity to make a fresh hop-style beer instead of how we used it."

Fritze, from Gordon Biersch commented "We used one vial of the El Dorado to create a keg for our 10th Anniversary celebration. We dosed it into a Belgian IPA. The resulting aroma is intense and unique and very pleasing to us brewers. It just doesn't seem to fade. The guest feedback was very positive as well and some were able to identify the aroma as fruity or tropical fruit, and all thought it was very unique and unlike anything they had ever tasted."

*"if you are looking for something that tastes good and is differentiated from other beers, I would recommend this. It is intriguing with desirable flavor attributes. Its overall flavor is unique!"*

**Steve Gonzalez**  
**Sr. Manager Brewing & Innovation**  
**Stone Brewing**

Paul Segura of Karl Strauss followed up his test with a kolsch with the following results from his six-person tasting panel. "I just got the results from this morning's tasting panel. They were interesting! All 6 of the tasters made remarks on the enhanced aromas. Almost all of the comments mentioned the word citrusy, and half of them also included the word floral or flowery. Some of the tasters remarked that this beer had more flavor and aroma than our standard kolsch and that this beer should no longer be considered a kolsch because of its hop profile."

"I was hoping to hear these types of comments, honestly. This is good. And, just so you know, I wanted to use the hop oil in a non-hop-forward, non-dry-hopped beer FIRST, rather than a dry-hopped beer, to really get a good gauge on the usage rate and the particular aromatics. The idea was to reduce the interference of the other hops and really allow your hop oils to shine through" added Segura.

Peterson was again very specific: "Our thoughts, with the use of the Hopzoil, was to decrease the total beer loss while still retaining prominent hop aroma and flavor. To our joy, the finished product is a terrific balance of fresh hop aroma and pleasant bitterness with an overall hop impression that is spot on to the nature of El Dorado," he added.

*"We just finished tasting our first Hopzoil™ I hopped hard cider, and it is magnificent!"*

**Michael Billingsley**  
**Western Cider. Missoula. MT**

## E. Storage/Shelf Life

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While most essential oils are best stored at room temperature, Sierra Nevada does store their fresh distilled hop oil at sub-zero temperatures. Founder Ken Grossman said in a recent article (link below), "we freeze it in a -15 degree freezer, sealed in a nitrogen-flushed container. We have had some now for over three years and it retains pretty much 100 percent of where it was at."

**Source:** <http://www.liquidbreadmag.com/hop-hunter-ipa/>

Distilleries that have experience with other crop oils, specifically spearmint, peppermint, dill and coriander oils provided a different opinion. One distillery said about mint oil, "it's shelf life is indefinite, as long as it is kept sealed." Another distillery with 34 years of steam distillation experience said, "to our knowledge, mint and dill oil will keep at 11-12 years at room temperature...that we know of. No one has ever tested it beyond that." They added that mint oil has a tendency to create crystals when frozen, and without additional testing as to the effect of freezing of distilled hop oil over time, offered no opinion.

Some brewers initially expressed concern over the shelf life of the intense fresh taste and aroma in already hop-forward beer. Actual results indicate a stable and lengthy shelf life in a packaged beer.

Packaged samples of Stone's pilot batch were taste-tested four months after production, and compared in a side-by-side taste test against Stone's flagship IPA as the benchmark of the base beer used. The comparison was dramatically different between the two, and the pilot batch sample retained its complex, fresh aroma and taste in a package over that extended time frame, indicating stability.

Fred Karma, owner of Hoppin' Frog Brewery in Akron, Ohio said "we sued 6.1 ml per barrel in a triple IPA. Aroma and flavor is still darn good after adding it into Bright beer 6 weeks ago." But Karm added "brewers will have to factor in several variables. I feel that every beer will be different."

## F. Additional Resources

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### Other Reference Links

[https://www.youtube.com/watch?v=GPEnn\\_J9-yM](https://www.youtube.com/watch?v=GPEnn_J9-yM)

<http://draftmag.com/sierra-nevada-hop-hunter-oil-ipa/>

<http://www.taptrail.com/sierra-nevadas-hop-hunter-ipa-unlike-any-other-fresh-hop-beer/>

<http://fortune.com/2016/07/07/sierra-nevada-wet-hop-beer-brewing/>

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