UW - Extension
Hop Quality 102
Wisconsin Dells
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Hop Solutions

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Post-Harvest Handling of Hops
The Quality Chain

- Drying of hops is THE most critical process in the quality chain.
- The brewer wants moisture uniformity, high moisture (10%), low oxidation of alpha and retention of oil and aroma.
- If cones shatter when baled, you have failed!

2012 Hop Drying Study (Yakima)

- Funded and performed by Hop Quality Group in cooperation with John I. Haas
- Comparing drying temperatures of 130° F vs. 150° F. Does lower temp result in better aroma.
- Performed on Cascade & Citra®. Ran 3 kilnloads at each temp. for each variety. Sampled hops from top, middle and bottom of the bed in 3 different locations in each kiln.

Cascade Drying at Loftus Ranches

Collecting samples after one hour of unheated air blown through the bed.

54 samples collected for each Variety

- Moisture data complete.
- Sealed all samples in foils for oil analysis in October/November at Haas.
- Tom Nielsen (Sierra Nevada) plans to do GC profiling of the oils with remaining hops.
- Haas also collected some fuel usage data at the two temperatures.

Cascade – Loftus Ranches

Bed depth 27” – 30 “ – deeper at back of kiln

130° F Moisture Data

	Bottom Avg	Middle Avg.	Top Avg.
Kiln #1	6.04%	14.22%	20.51%
Kiln #3	7.83%	12.05%	15.95%
Kiln #5	6.70%	9.33%	13.44%
Avg	6.86%	11.87%	16.63%

150° F Moisture Data

	Bottom Avg	Middle Avg	Top Avg
Kiln #2	3.75%	8.45%	15.97%
Kiln #4	4.58%	9.61%	17.98%
Kiln #6	4.24%	11.59%	16.48%
Avg	4.19%	9.88%	16.81%

Cascade Data

Drying Times

Kiln # 130° F	Hrs	Kiln # 150° F	Hrs
1	8:14	2	5:48
3	7:24	4	4:52
5	7:06	6	4:32
7	7:03	8	5:56
9	8:05	10	4:55
11	7:07	12	4:17
Avg	7:29		5:03

130° & 150° kiln loads baled separately

	130° F	150° F
Lot bale H_2O	9.7%	9.2%
Alpha	8.2%	8.8%
Beta	7.1%	7.5%
H.S.I.	0.215	0.230
Batch oil	2.0%	2.0%

Cascade Observations

- Piled, cooled hops: Aroma much stronger in the mixed 130° F hops than the mixed 150° F. Baled separately for test brewing.
- Cascade samples from the bottom of the kiln at both temperatures had a garlic/onion aroma. Maybe stronger in the 150° F samples.
- Samples from the middle & top at both temperatures had little of this off-aroma.

Citra® - Haas Golding Farm

Bed Depth 26 inches

130° F Moisture Data

	Bottom Avg.	Middle Avg.	Top Avg.
Kiln #7	7.80%	13.66%	21.70%
Kiln #9	5.99%	10.39%	18.09%
Kiln #11	4.76%	8.66%	20.10%
Avg	6.18%	10.90%	19.96%

150° F Moisture Data

	Bottom Avg.	Middle Avg.	Top Avg
Kiln #8	7.47%	11.83%	24.13%
Kiln #10	3.51%	3.20%	12.39%
Kiln #12	2.96%	6.39%	19.36%
Avg	4.65%	7.14%	18.63%

Citra® Dried with Diesel Fuel

130° F

Kiln #	Drying Minutes	Fuel Used Gallons	Bale H_2O
7	770	203	9.6%
9	800	221	9.6%
11	855	226	9.3%
Avg	808	217	9.5%

150° F

Kiln #	Drying Minutes	Fuel Used Gallons	Bale H_2O
8	560	205	9.5%
10	745	217	9.5%
12	660	196	9.5%
Avg	655	206	9.5%

Citra® Baled Lots data

	Alpha	Beta	H.S.I.
130° F	14.6%	3.6%	0.270
150° F	14.7%	3.4%	0.280

- Lots baled separately for test brewing

Citra® Observations

- Hops from the bottom have onion/garlic aroma similar to the Cascade samples.
- Samples from bottom @ 150° F reported to have stronger onion/garlic aroma than bottom of 130° F. Middle samples @ 150° F also have some of this, but not middle at 130° F
- Hops dried at the two temps baled separately. Cones and perhaps pellets available.

Drying Study in Progress

- Collect oil data (distillation by Haas) Late Oct to early Nov. GC data early winter?

- Test brewing by interested HQG Members.

- Publish data and presentations at BA & MBAA? Updated report to be given at CBC in March – please come!

Conclusions for Growers

- Uniformity in Commercial American Operations terrible. Germany much better!
- Lower drying temp results in less garlic aroma, a smaller moisture gradient, and a longer window to turn off the heat.
- Down-side: Longer drying times – but same fuel consumption. It takes so many BTUs to evaporate so much water!

Cooling/Conditioning before baling

- Newly dried hops are VERY dry on the outside (bracts & bracteoles) and very wet inside (strig). Will shatter if baled.
- To transfer moisture from the wet inside to the dry outside, the hops need to sit and "cool" for 12 – 24 hr. Some transfer of moisture from wetter to drier cones also occurs.

Warehouse – Incoming bales are tested for proper temp. & moisture

Hand "Trying" of bales

Moisture and temp. probes

Spontaneous Combustion

Improperly dried & cooled bales pose a fire risk.

A number of warehouses lost in last decade.

Brewers cut (USA)

Samples are cut from representative bales and sent to brewers for evaluation

Brewers Cut – USA – Represents 50 bales!

Composite samples - Germany

Mix from representative loosely packed bales

More Representative of lot


EARTH-HOPPER

Storage of Baled Hops

- Must be cold. Frozen best, refrigerated so-so.

  Frozen storage standard in USA. Good for 1-3 years frozen – depending on the variety.

Refrigeration ok for maybe 6 months (depending on variety) before processing to pellets or extract.

Pellets good 2 years refrigerated, maybe 5 frozen.

Hop Pellet Manufacture

- Critical Control points:

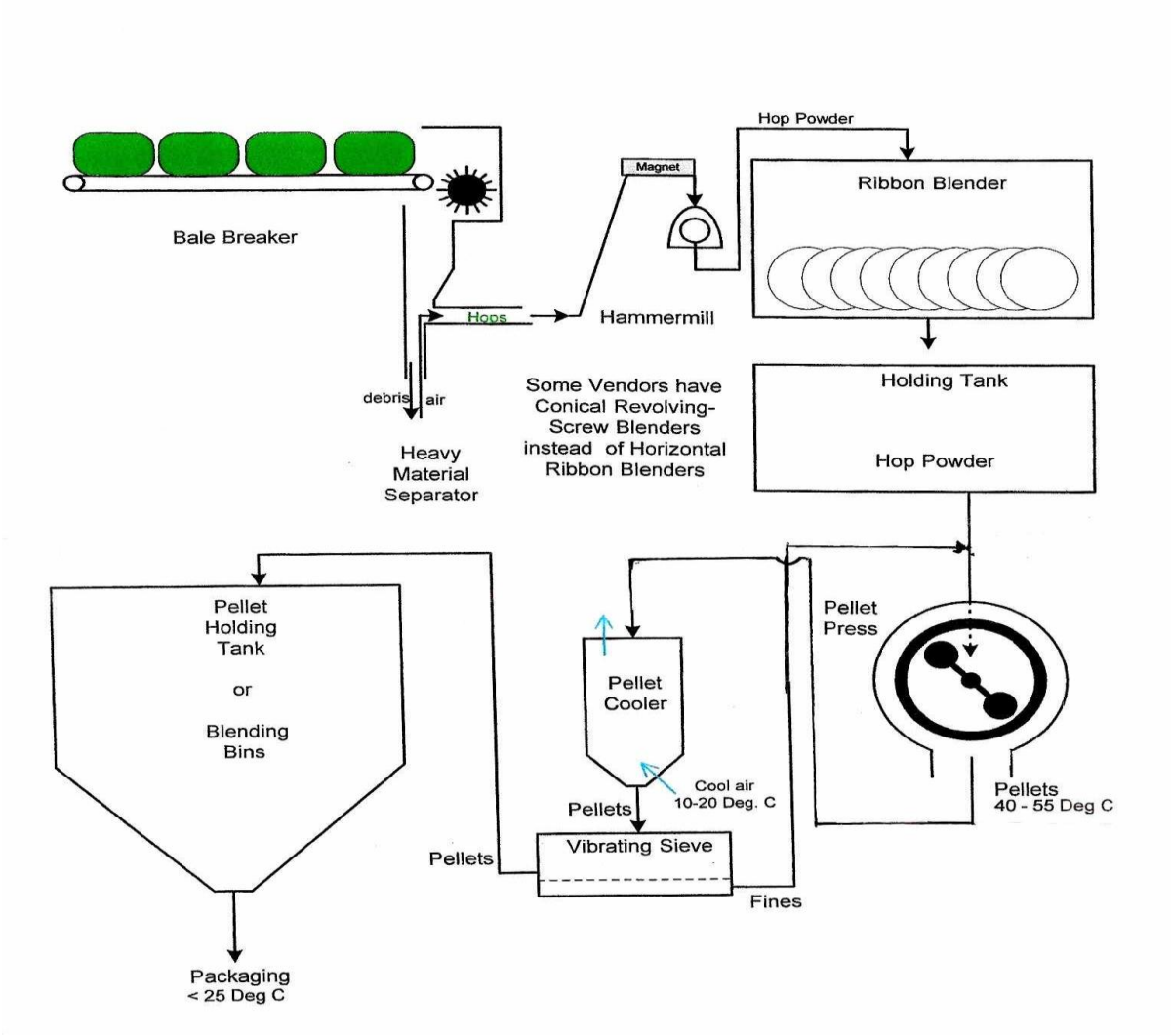
  Are correct hops in the pellets?

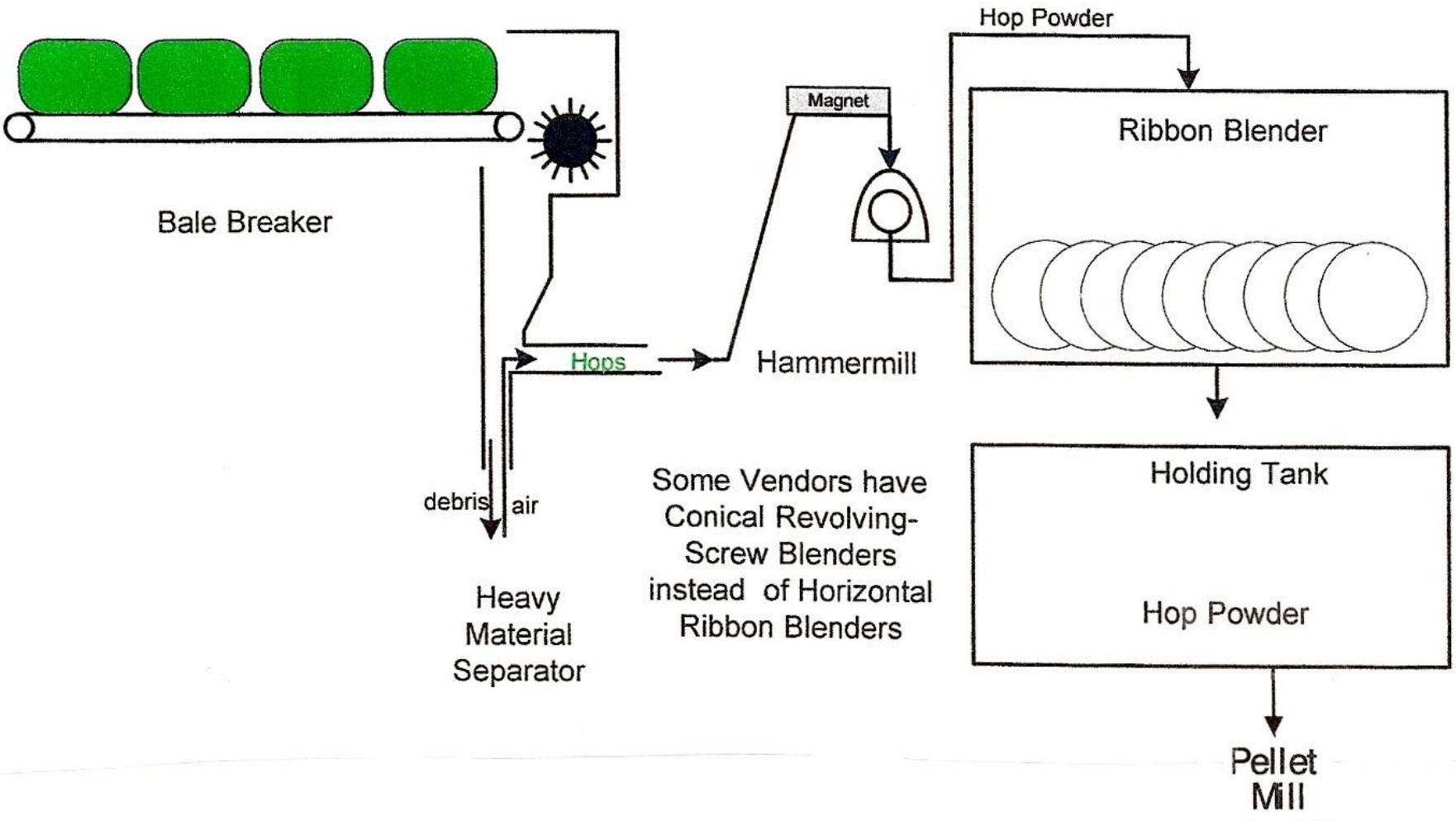
  How well blended is powder before Pelleting?

  Pellets exiting the pellet press should be no warmer than 55° C and cooled to 25° C quickly.

  Is there a QC program to test seal of foil bags?

Type 90 Process




Hop Powder
Magnet
Ribbon Blender
Bale Breaker
Hops
Hammermill
debris
air
Some Vendors have Conical Revolving-Screw Blenders instead of Horizontal Ribbon Blenders
Holding Tank
Hop Powder
Heavy Material Separator
Pellet Mill

Bale Breaker Platform

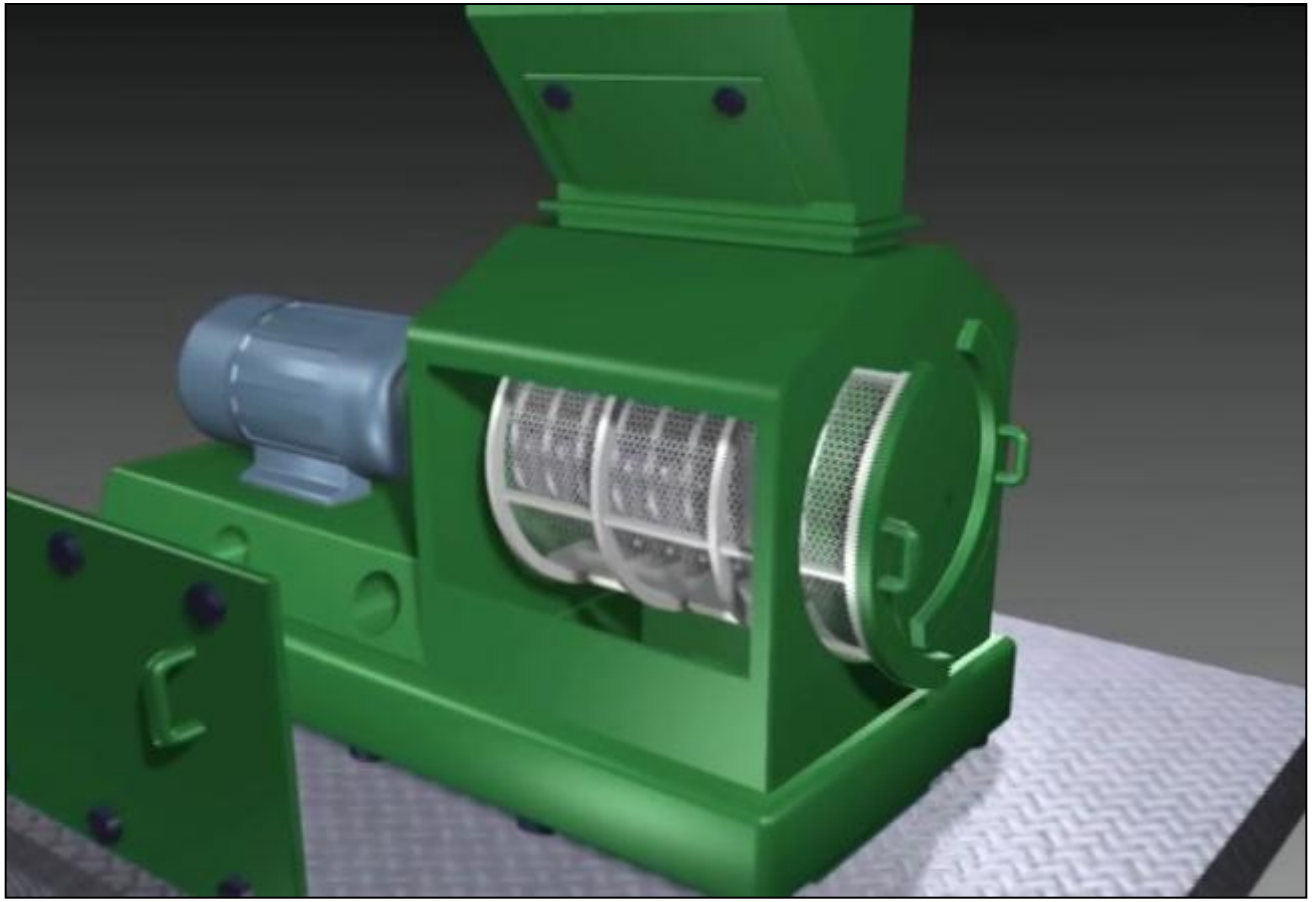
Bale Breaker Fingers

Heavy Material Separator

Heavy Material Removed

Hammer Mill

Hammer Mill Screen



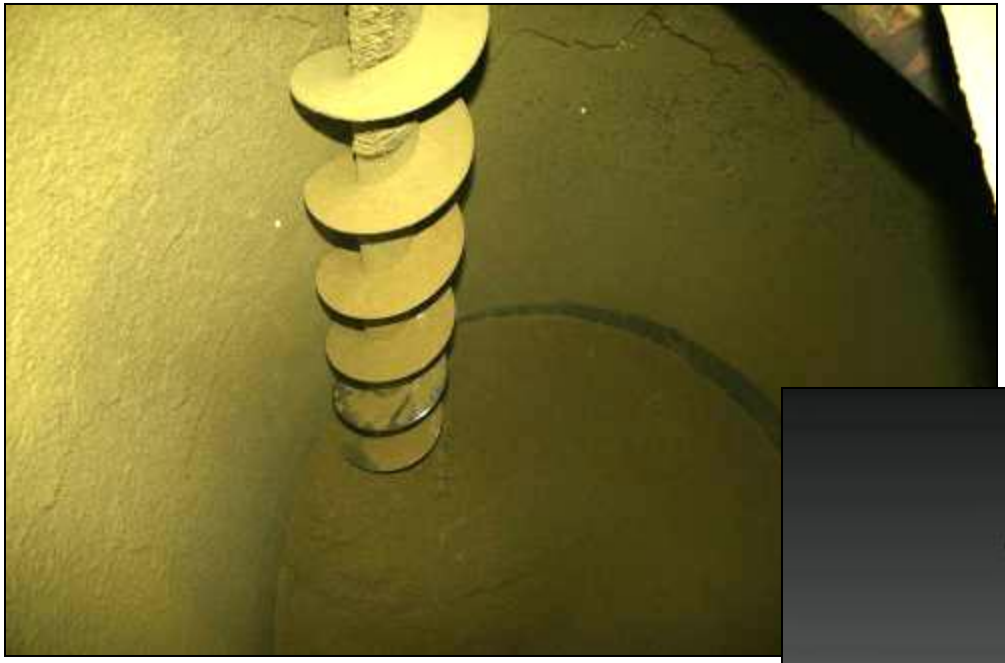
Mixing Tank

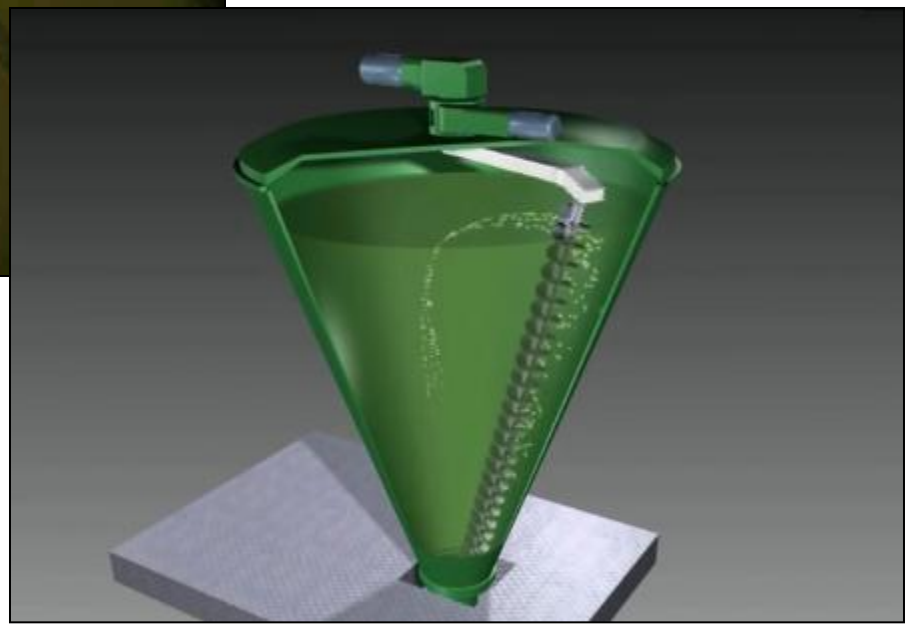
Conical Mixers give best uniformity

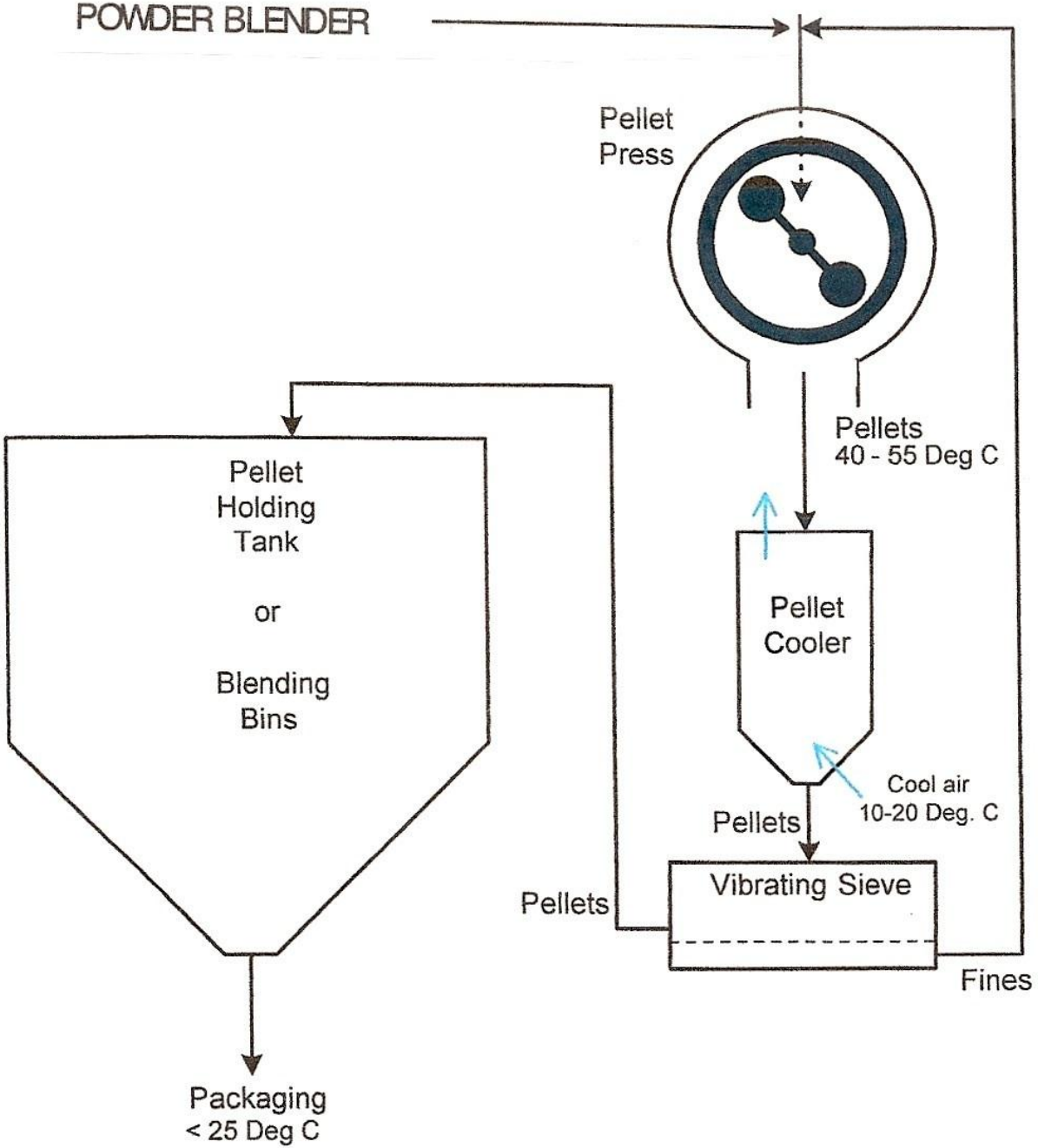
Some plants use horizontal ribbon blenders

- Or may mix pellets

Inside Conical Powder Blender






POWDER BLENDER
Pellet
Press
Pellets
40 - 55 Deg C
Pellet
Holding
Tank
or
Blending
Bins
Pellet
Cooler
Cool air
10-20 Deg. C
Pellets
Vibrating Sieve
Pellets
Fines
Packaging
< 25 Deg C

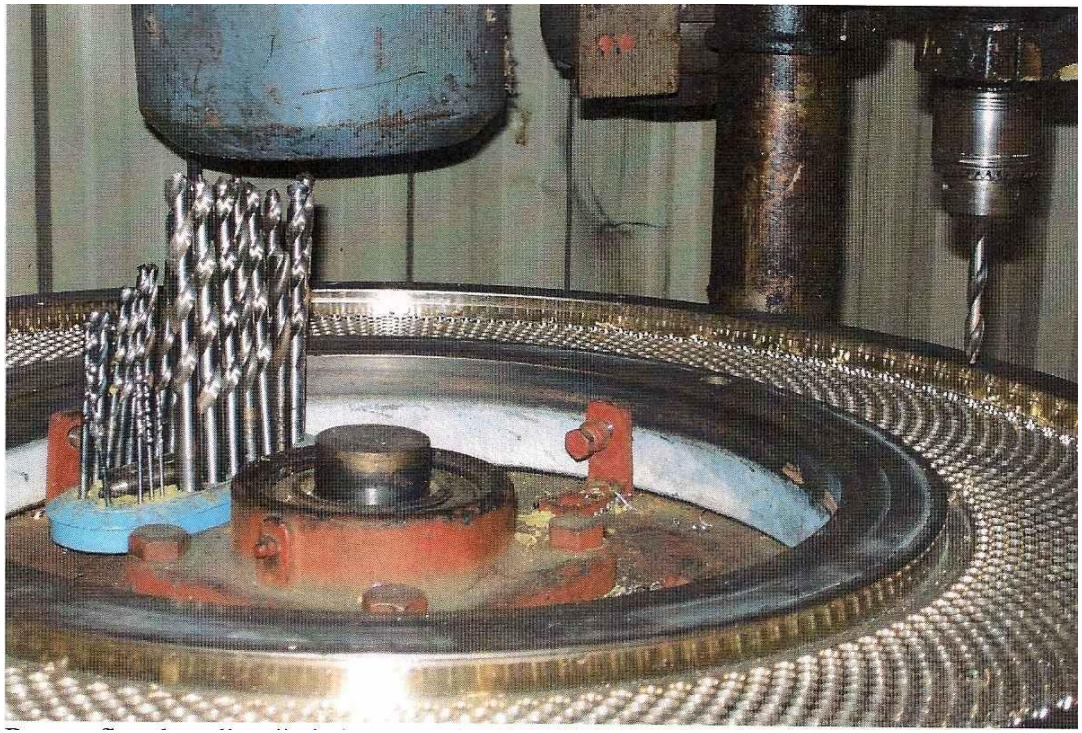
Pellet Press

- Compresses hop powder through a metal die hole (6mm?) to form a solid pellet.
- Temperature control (below 55° C) important.
- Parameters to use are:

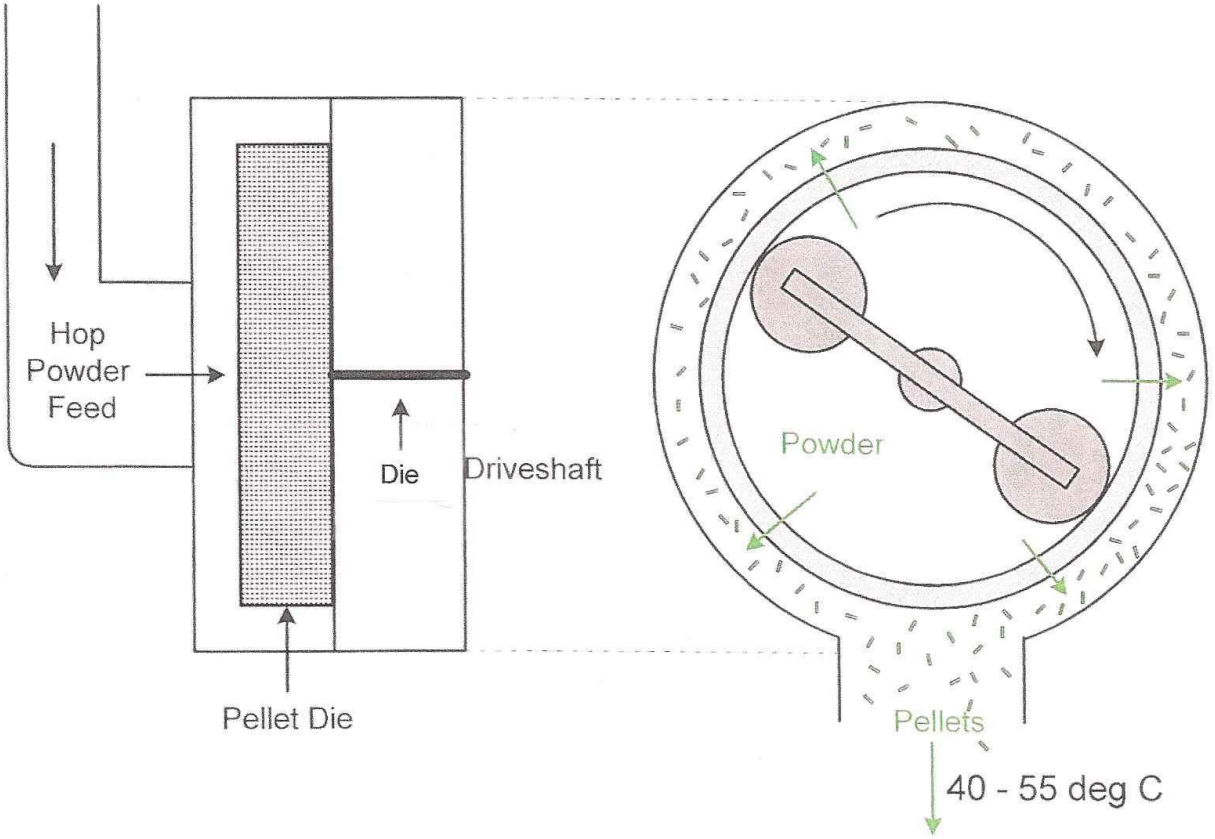
die diameter	feed rate
die path length	die geometry
die alloy	die roller clearance

Plate Die

Cylindrical roller rolls at the same speed at outer & inner portion of the die, must skip on outer portion causing friction.



Ring Die Configuration
Rollers don't skip, less friction



Ring Die

Inside a Ring Press

The Pellet Process

- Compression heats up the Powder & melts the α & β-acids. As the pellet cools, these act as a glue to hold the pellet together.
- Die diameter and path length are best tools to regulate temperature (<55° C)
- When press starts up, die is cold – more friction = scorched pellets. The first 50 -100 lb should be discarded.

Breakout Pellets

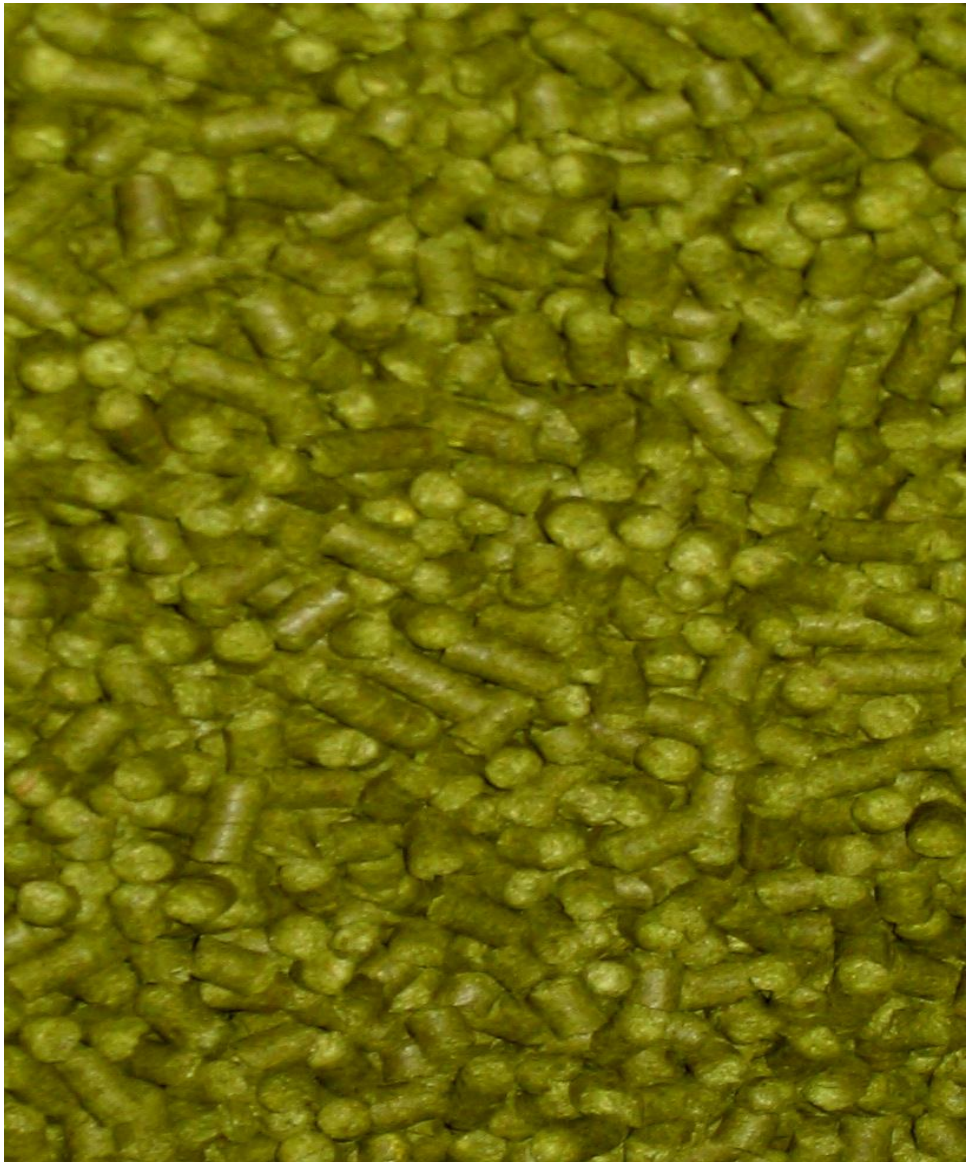
When pellets are no longer scorched or glassy, start to collect product.

Properly Made Pellets

Green with no glassy or shiny surface.

Hops lose ≈ 2% water in process.

0.75% in hammer mill & 1.25% in pellet press.



Pellet Cooling & “Bricks”

- Warm pellets are sticky. If packed warm, especially if vacuum packed, they often clump together so much they require a hammer to break up.
- Will NOT happen with a good vendor. Insist on cooling pellets below 25° C within 10 minutes to avoid bricks.

Pellet Foil Filling Operation

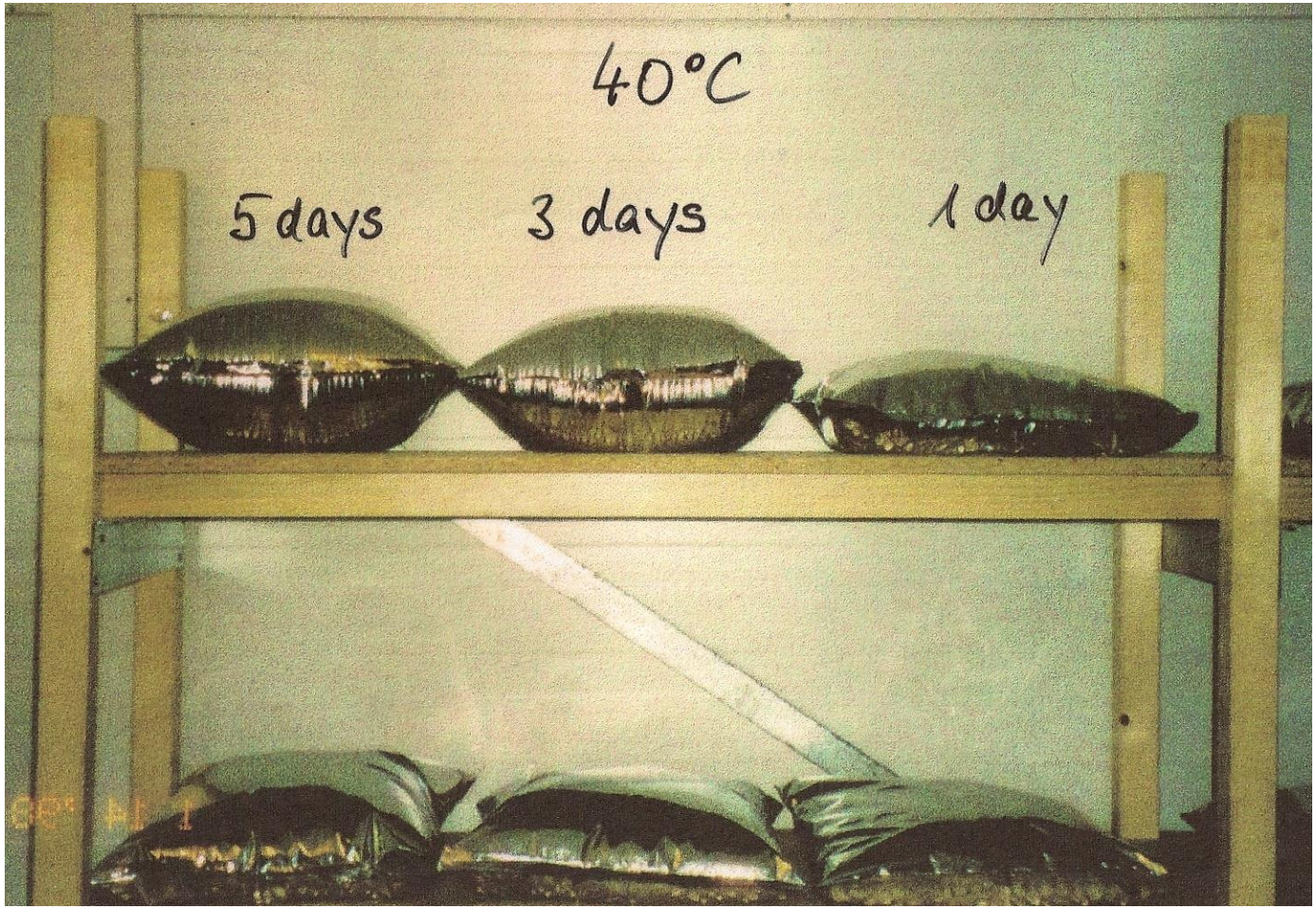
Storage of Hop Pellets

- Vendors recommend storage at refrigerated temperatures and say good for 2 years.
- If stored < 25° F, essentially stops all alpha loss! Pellets good for 5 years < 25° F if used in kettle. At least 3 years if used for dry-hopping.
- If opened, or foil compromised, store below -20° F long-term, or < 40° F up to 2 weeks, or < 25° F up to 5 weeks.

Shipping Hop Pellets

- Temp. & time VERY IMPORTANT – BEWARE!
- At > 90° F for more than a few hours, pellet foils may begin to fill with internally generated CO2 and possibly burst. Happens at a lesser rate down to 75° F. Disaster when this happens!
- DO NOT ship non-temp. controlled containers across the equator! Control temperature in shipping.

Ballooned Pellet Foils



Ballooning????

- Warm pellets generate CO2 which may burst the foil. Undamaged foils contract when cooled and damage hidden until opened.
- Acetone & many other “solvent-type” chemicals also generated.
- Color changes as well as aroma changes – even if foil NOT compromised.
- NOT a micro-biological problem – not understood!

Vacuum Pack vs. Soft Pack

Susceptible to mechanical damage

Damage harder to detect

Vacuum (Hard) Pack vs. Soft Pack

- Vacuum pack more susceptible to mechanical damage during shipping. But damage may be obvious – if it isn't really ballooning!
- With soft pack, foil partially back filled with CO_2 or N_2 after evacuation of air.
- Soft pack not damaged as easily – but how can you tell? Hold under water – no bubbles?
- Or put in vacuum chamber with CO_2 detector.