Strawberry Container Cooling Test

April 3, 2002

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DRAFT 4-22-2002

Test design:

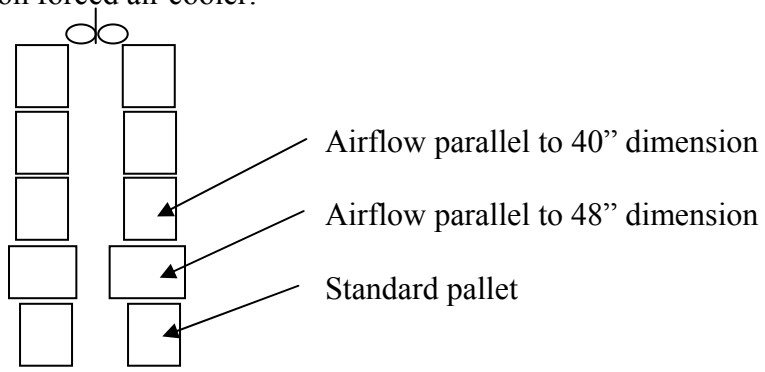
The test was conducted with Camorosa strawberries commercially harvested in the morning. All clamshell baskets contained approximately 15 to 20 berries each and had a net weight of 1.1 to 1.2 lbs. Treatments were forced air cooled later the same day. Three layers of trays for each treatment were monitored for temperature and a layer of trays was placed below and a layer above the test layers. A thermocouple was placed in one berry in the top or bottom layer of fruit in a basket. A single monitored basket was placed in the approximate middle of each of the trays on a layer. The five thermocouples per layer were connected in parallel and a single temperature was recorded for each layer. Air pressure difference across each pair of pallets was measured with a hand held manometer.

The following treatments were tested:

1. 8- Pacific Ag Modular clamshells in IFCO RPC.
2. 9- Pactiv clamshells in IFCO RPC.
3. 8- Pacific Ag Modular clamshells in FBA corrugated common footprint tray (CCF), DEFOR design made by IP.
4. Sambrailo MIXIM - PLUS (low profile) system.
5. Standard 16” x 20” tray with 8 – 1 lb clamshells.

The first four treatments were tested with pallets oriented so air flowed parallel to the 40” and parallel to the 48” pallet dimension. The pallet for the standard pack was oriented so that the air flowed parallel to the 40” dimension.

Location of pallets on forced air cooler:



Results:

The cooling times are based on reaching 7/8^{ths} cooling temperature. In this test the fruit started at about 63°F and cooling air temperature was about 33°F. The fruit were considered cool when they reached approximately 36°F. Most commercial coolers would cool for an additional half cooling period to about 34°F. This would add 33% more time to those listed in the tables 1 and 2. For pallets oriented in the 40" dimension on the cooler, the 8 – 1lb clamshells in an RPC cooled faster than the 8 -1lb clamshells in a CCF box and the MIXIM-PLUS system. For pallets oriented in the 48" dimension on the cooler, the 8 – 1lb clamshells in the CCF tray cooled faster than the other treatments. In both orientations, the MIXIM system required the longest cooling times.

The standard 16" x 20" tray with clamshells cooled in 56 min with a pressure drop of only 0.55in. w.c. The standard was cooled in the 40" orientation and cooled faster than the MIXIM – PLUS system with the same orientation even with a much lower pressure drop across the pallet, Table 1. It would likely require much longer cooling times than the standard with similar pressures across the two package types. The other data in the two tables can not be directly compared because the pressure differences across the pairs of pallets were significantly different. (The next test will be set up so that there is a constant pressure drop across all treatments.)

The MIXIM – PLUS system may have cooled slowly because its clamshell had venting only around the section between the lid and the clamshell body. Its vent area ranged from

6% to 9% on the short and long sides. THE MAXIM-PLUS TRAY had a venting level similar to the CCF tray. All of the other clamshell baskets had the vent area at the closure plus a considerable amount of venting on the sides of the lid and body. Their vent area ranged from 12% to 21%. The CCF tray cooled relatively slowly in the 40" orientation because much of the tray venting was blocked when the air flowed through section where the boxes were cross-stacked. Effective vent area was only 5.5% in the 40" orientation compared with 10% to 15% in the 48"pallet orientation.

We measured temperature of individual berries in various locations in a layer of boxes to determine if there were any locations with noticeably warm fruit. We saw a consistent 2° to 4°F increase in temperature across the layer, with the coldest fruit located on the side near where the cold air first entered the layer. In the several treatments we measured we saw no particular warm areas other than this.

Table 1. 7/8^{ths} Cooling time for pallets oriented so that cooling air flows parallel to the 40" pallet dimension. Pressure drop across pallets was 0.95 in. w.c. static pressure.

Clamshell container & tray	Cooling time[1] (min)
8- Pacific Ag Modular in IFCO RPC	38[a]
9- Pactiv in IFCO RPC	45[a,b]
8- Pacific Ag Modular in CCF tray	51[b]
MIXIM - PLUS (low profile) system	84[c]

[1] Times with the same letter are not significantly different based on Duncan's multiple range test, alpha=0.05.

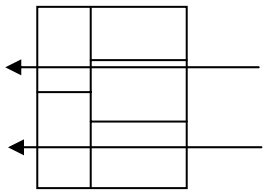
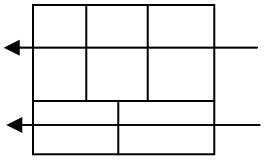


Table 2. 7/8^{ths} Cooling time for pallets oriented so that cooling air flows parallel to the 48" pallet dimension. Pressure difference across pallets was 0.71 in. w.c. static pressure.

Clamshell container & tray	Cooling time[1] (min)
8- Pacific Ag Modular in CCF tray	55[a]
8- Pacific Ag Modular in IFCO RPC	61[b]
9- Pactiv in IFCO RPC	66[b]
MIXIM - PLUS (low profile) system	84[c]

[1] Times with the same letter are not significantly different based on Duncan's multiple range test, alpha=0.05.



Special thanks to Ron Kato of Nakamura Berry Farms for packing the test fruit and Mike Thompson at the St. Francis cooler for providing the forced air cooling facility used in the test.

UC–Davis 5-Down Strawberry Box Study

Sponsored by the *California Strawberry Commission*

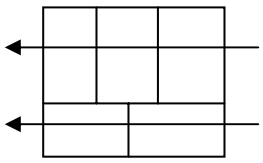
Part 2: Cooling and Transportation Abuse Results

This study was supported by funds from the FBA and the RPCC and compared the performance of the Corrugated Common Footprint (CCF) and returnable plastic containers (RPCs) Unlike previous studies, the clear plastic strawberry clamshell inner pack was a key variable.

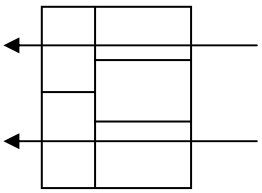
TABLE 1: Container/Clamshell Combinations Tested

test number	containers	footprint	clamshells type	clamshells / container	cooling direction
1	IFCO 608	5 down	*Pacific Ag-Pac* 9805	8	40"
2	IFCO 616	5 down	*Pacific Ag-Pac* 9805	16	40"
3	Hayes 6409	5 down	*Pactiv* 9762	9	40"
4	CHEP 6416	5 down	*Pactiv* 9762	18	40"
5	*Common Footprint*	5 down	*Pacific Ag-Pac* 9805	8	40" and 48"
6	*Common Footprint*	5 down	*Pactiv* Euro low-profile	8	40" and 48"
7	corrugated control	6 down	*Pactiv* 9762	8	40"

Air flowing through **48**" direction.



Air flowing through **40**" direction



In Part I of this testing sequence equal pressure-drops were not maintained across the pallets during cooling for all of the combinations evaluated. Thus several key cooling rate comparisons could not be made accurately. Care was taken this time in Part II to maintain nearly equal pressure drops across all test pallets while they were on the cooling tunnel.

Part II was performed on June 11th in Watsonville, CA. In April a short preliminary test was performed and the tables below show both results:

TABLE 2: June 11 test (0.62-0.70" water pressure drop across pallets)

test no.	container	clamshell type	clamshells/ container	cooling direction	7/8 cooling time (min)
7	corrugated control	*Pactiv* 9762	8	40"	53[a]
6	*Common Footprint*	*Pactiv* Euro low-profile	8	40"	54[a]
5	*Common Footprint*	*Pacific Ag-Pac* 9805	8	40"	55[a]
6	*Common Footprint*	*Pactiv* Euro low-profile	8	48"	58[a]
5	*Common Footprint*	*Pacific Ag-Pac* 9805	8	48"	60[a]
4	CHEP 6416	*Pactiv* 9762	18	40"	68[b]
2	IFCO 616	*Pacific Ag-Pac* 9805	16	40"	71[b]
1	IFCO 608	*Pacific Ag-Pac* 9805	8	40"	74[b]
3	Hayes 6409	*Pactiv* 9762	9	40"	75[b]

April 3 pre-test (0.71" water pressure drop across pallets)

-	*Common Footprint*	*Pacific Ag-Pac* 9805	8	48"	55[a]
-	IFCO 608	*Pacific Ag-Pac* 9805	8	48"	61[b]
-	IFCO 608	*Pactiv* 9762	8	48"	66[b]

[1] Times with the same letter are not significantly different based on Duncan's multiple range test, alpha=0.05. The April and June test treatments were evaluated separately.

What it means:

1 No statistically significant difference in cooling rate was seen between the 5-down *Common Footprint* boxes and the current 6-down corrugated control pallets. This was true when cooling was done in both the 40" and 48" cooling direction.

⇨ **2** The CCF boxes in both the 40" and 48" directions ***cooled statistically significantly faster than all of the RPCs tested***. Part II of this study thus confirms an earlier UC-Davis pre-test that also suggested the same results.

Potential Explanation: While RPCs have a much higher % open vent area, the corrugated boxes channel their airflow through smaller, more focused sidewall vents. At equal cooling-tunnel pressure-drops the air thus passes more slowly through the RPCs than through the corrugated vents. The corrugated vent pattern must channel the air more effectively through the vents in the interior clamshells than do the RPCs.

TABLE 3: Simulated truck, air-ride suspension transportation damage.

test no.	container	clamshell type	bruising score
7	unvibrated control	*Pactiv* 9762	3.0 [a]
6	*Common Footprint*	*Pactiv* Euro low-profile	3.0 [a]
5	*Common Footprint*	*Pacific Ag-Pac* 9805	3.1 [a]
7	control corrugated	*Pactiv* 9762	3.1 [a]
1	IFCO 608	*Pacific Ag-Pac* 9805	3.5 [b]
2	IFCO 616	*Pacific Ag-Pac* 9805	3.5 [b]
4	CHEP 6416	*Pactiv* 9762	3.5 [b]
3	Hayes 6409	*Pactiv* 9762	3.7 [b]

[1] Bruising scores with the same letter are not significantly different at the $\alpha = 0.05$ level.

What it means:

1 No statistically significant difference in fruit bruising was seen between the 5-down *Common Footprint* boxes and the current 6-down corrugated control pallets.

⇨ **2 All of the RPCs tested generated statistically significantly more fruit bruising than the *Common Footprint* boxes.**