ANALYSIS REPORT Nº: **MB- 4583-6596/05**
DATE OF EMISSION: **04/12/2005**
MATERIAL: **Raw Coffee bean**
CLIENT: **FAO (Food and Agricultural Organization of the UN)**
ADDRESS: **Viale delle Terme di Caracalla, 01100, Rome-Italy**
DATE OF ENTRY: **11/07/05**
DATE OF ANALYSIS: **26/07/05 - 11/11/05**
ANALYSTS: **Héctor Abel Palácios Cabrera & Juliano Luiz de Souza**
NATURE OF ANALYSIS: **Completation of a study into the fill-levels of coffee bulk transportation in 'mini-containers', in order to verify the effects of temperature oscillation and relative humidity in grain quality (including moisture content and sensory analysis).**

The gain or loss of moisture inside a dynamic, non-hermetic system such as containers used for the international transportation of coffee, is a common situation on maritime routes between tropical regions and the Northern hemisphere.

During the trip from tropical to temperate countries the external air temperature drops relatively rapidly due to the distance travelled and prevailing weather conditions. As a result the cargo in the container often cannot adapt rapidly enough to this temperature change. Clearly, as the container is cooled by the external air to below the dew point temperature of the air, container condesation is formed, especially on the container ceiling, from where, once sufficient condensation has formed, it drips down onto the cargo.

Changes in temperatures during grain transportation can result in humidity transference. Differences of 2 to 3°C favour migration, while differences of between 5 and 10°C between one region and another favour more rapid moisture transfer. This water, in vapour form, rises by convection, becomes cold and forms condensation on the cold surface of container and can rewet the cargo. Long periods of transportation and storage, including storage in ports, can provide conditions which generate and increase moisture in cargos.

The monitoring of grain intrinsic factors, such as moisture content and water activity, as well as extrinsic factors such as temperature and relative humidity, are useful parameters to evaluate some inherent grain quality characteristics like weight gain (moisture), beverage quality and physical defects.

The use of prototype mini-containers was previously validated during a live container trial, and has great importance in a simulating maritime transportation trials. Palacios et al (2001) studied three mini-containers and a conventional container in a commercial trip from Brazil to Italy. The values of moisture content of the coffee transported in the conventional and prototype mini-containers were similar.

Apparently, the external relative humidity had little influence over the grains' moisture gain. The temperature gradient container and the head space container play a important function in a non-hermetic system because all convection of moisture occurs inside the container and depends on temperature and area of head space available. It is thus important to evaluate the influence of temperature and head space area inside a container, in relation to cargo container during transport and storage.

Few studies have been carried out on coffee transportation and its influence on final product quality. For this reason the influence of the difference in fill levels on weight gain (moisture), beverage quality and physical defects of grain was studied.

1. SAMPLE DESCRIPTION

Hulled arabica coffee, classified as type 6 beverage and type 3-5 according to defects.

1.1. Sensory evaluation

500g of roasted and ground coffee beans, Arabica coffee, superior, commercial brand “coffee samples”, fabrication date 02/June/05 and good for consumption for 12 months.

1.2. Defect classification

The samples were classified according to type, separating and counting the main types of defect recognized as being potentially present in green coffee (*ardido*, insect-damaged, immature, dark-green, broken, malformed, stone (BRAZIL, 2003); ISO 10470).

2. METHODOLOGY

2.1. Sensory evaluation

The methodology described by the Specialty Coffee Association of America – SCAA Cupping Form was employed. Linear scales were used for the quantitative descriptive analysis. The sensory evaluation method was carried out with a selected and trained panel of six judges, using linear scales (0 to 10cm) to evaluate the powder fragrance, the brewed coffee aroma, defects, acidity, bitterness, flavour, aftertaste, astringency and body (Howell, 1998), according to the attached vocabulary (Annex 1) (Lingle, 1986).

The evaluations were carried out in individual booths illuminated with red light and operating with the computerized sensory data collector “*Compusense Five* release 4.6”. Purified water was provided for tasters to rinse their mouths between samples. Each panellist received the test sample in cups labelled with three random digit numbers, compared to the reference known as the “Superior” sample.

2.1.2. Brewing

The “Superior” reference coffee sample and the “coffee samples” were prepared by percolation using filter paper, 50 g (1.8 oz) of coffee powder was used for 0.5 litre of mineral water at 92°C (197.6°F).

2.2. Defect classification

The samples were classified according to type, separating and counting the main types of defects recognized as being potentially present in green coffee (*ardido*, insect-damaged, immature, dark-green, broken, malformed, stone (BRAZIL, 2003); ISO 10470).

2.3. Moisture content analysis

The following three methodologies for the determination of moisture content were compared:

a) Oven with forced ventilation (ISO 6673 method, 1983): 105ºC for 16± 0.5h;
b) Capacitance method using the Gehaka G 600 equipment;
c) Moisture gain (w/w): The percent gain in moisture content was determined from the weight gain of the samples, weighed using a calibrated Mettler Toledo analytical balance.

2.4. Water activity

The water activity was measured using the model 3TE Aqualab Equipment (Decagon, USA).

2.5. Temperature and Relative Humidity

Temperature and relative humidity were monitored using calibrated Onset (HO8-032-08) sensors.

2.6. Sampling

A single batch of 70 bags of coffee was randomly sub-divided into three equal sub-batches for the three trials. One sub-batch was used for each trial. 100% of each sub-batch was sampled (all the bags of each sub-batch were sampled). The area of the prototype container was divided into three regions: upper, middle and lower. Approximately 5 kg from each region of the container were sampled for each sub-batch. From each 5 kg, samples were separated for the determination of moisture, water activity, sensory analysis and defects analysis. The remainder (approximately 2 kg) was put back into their respective regions in pierced nylon bags, which did not interfere with bulk moisture diffusion or temperature

2.7. Prototype Containers (PC)

Three prototype containers with dimensions of: 1860mm x 730 mm x 730mm were used. In order to validate the prototype data for conventionally sized containers, polystyrene was placed on three lateral walls of the prototype. The top and one wall had no polystyrene. This simulated one segment of a real container. The prototypes were placed in a vertical position.

2.8. Filling the mini containers to three levels (one level per container)

Figure 1. Filling level full (600kg approx.) headspace 230mm

Figure 2. Filling level ¾ (450kg approx.) headspace 430mm

Figure 3. Filling level ½ (300kg approx.) headspace 850mm

Each of the three trials occurred over a period of 15 days. Transport simulation was carried out according to a real route from Santos (Brazil) to Livorno (Italy). The time where the biggest temperature gradients occurred and the temperature oscillations were considered.

3. RESULTS

3.1. Results of the Sensory Analysis

Frames 1 to 3 (below) show the results for the sensory analysis with respect to the characteristics of powder fragrance and beverage aroma, defects, acidity, bitterness, flavour, aftertaste, astringency and body for each group of samples from the same container.

Frame 1. Comparison of the samples from the different regions of Container 1 (full): lower (L), upper (U) and middle (M) at different periods: start (A) and end (B) of the treatment, according to the Tukey test.

	Lower region		Upper region		Middle region		m.s.d
	1LA	1LB	1UA	1UB	1MA	1MB	(5%)
1. Fragrance	7.0 ± 0.8 a	6.9 ± 0.6 a	6.9 ± 0.7 a	6.9 ± 0.7 a	7.0 ± 0.6 a	7.0 ± 0.6 a	0.50
2. Beverage Aroma	6.7 ± 0.7 a	6.7 ± 0.6 a	6.8 ± 0.5 a	6.6 ± 0.7 a	6.6 ± 0.5 a	6.7 ± 0.7 a	0.47
3. Defects	3.2 ± 0.8 a	3.4 ± 0.6 a	3.0 ± 0.5 a	3.1 ± 0.7 a	3.1 ± 0.6 a	3.2 ± 0.8 a	0.52
4. Acidity	3.9 ± 0.5 a	4.0 ± 0.5 a	4.1 ± 0.5 a	3.8 ± 0.6 a	3.8 ± 0.6 a	3.8 ± 0.6 a	0.43
5. Bitterness	4.4 ± 0.7 a	4.3 ± 0.6 ab	3.9 ± 0.5 b	4.1 ± 0.6 ab	4.2 ± 0.5 ab	4.2 ± 0.7 ab	0.44
6. Flavour	6.7 ± 0.5 a	6.5 ± 0.8 a	6.7 ± 0.4 a	6.7 ± 0.7 a	6.6 ± 0.5 a	6.6 ± 0.6 a	0.47
7. Aftertaste	6.7 ± 0.7 a	6.6 ± 0.6 a	6.7 ± 0.4 a	6.7 ± 0.7 a	6.6 ± 0.5 a	6.5 ± 0.6 a	0.45
8. Astringency	3.2 ± 0.6 a	3.2 ± 0.5 a	3.0 ± 0.4 a	3.1 ± 0.4 a	3.3 ± 0.5 a	3.1 ± 0.7 a	0.41
9. Body	6.7 ± 0.6 a	6.7 ± 0.4 a	6.7 ± 0.4 a	6.7 ± 0.6 a	6.7 ± 0.5 a	6.6 ± 0.6 a	0.40

*Values expressed as the *mean ± standard deviation* obtained in the evaluation carried out by panellists from ITAL for each of the sensory aspects of the coffee samples.

m.s.d: minimum significant difference at an error level of 5% (Tukey test). For each aspect evaluated, values followed by different letters are statistically different at an error level of 5%.

Frame 2. Comparison of the samples from the different regions of Container 2 (¾): lower (L), upper (U) and middle (M) at different periods: start (A) and end (B) of the treatment, according to the Tukey test.

	Lower region		Upper region		Middle region		m.s.d
	2LA	2LB	2UA	2UB	2MA	2MB	(5%)
1. Fragrance	6.9 ± 0.7 a	6.7 ± 0.7 a	7.0 ± 0.7 a	6.8 ± 0.7 a	6.9 ± 0.8 a	6.8 ± 0.6 a	0.55
2. Beverage Aroma	6.8 ± 0.6 a	6.5 ± 0.7 a	6.9 ± 0.4 a	6.7 ± 0.5 a	6.7 ± 0.7 a	6.6 ± 0.7 a	0.47
3. Defects	3.1 ± 0.5 a	3.3 ± 0.8 a	3.2 ± 0.7 a	3.4 ± 0.8 a	3.2 ± 0.9 a	3.2 ± 0.7 a	0.56
4. Acidity	3.9 ± 0.6 a	4.0 ± 0.7 a	4.0 ± 0.5 a	3.7 ± 0.7 a	4.1 ± 0.7 a	3.9 ± 0.5 a	0.48
5. Bitterness	4.1 ± 0.5 b	4.3 ± 0.9 ab	4.1 ± 0.5 ab	4.6 ± 0.6 a	4.1 ± 0.7 ab	4.3 ± 0.6 ab	0.50
6. Flavour	6.8 ± 0.6 a	6.5 ± 0.8 a	6.9 ± 0.5 a	6.6 ± 0.6 a	6.8 ± 0.7 a	6.5 ± 0.8 a	0.50
7. Aftertaste	6.7 ± 0.5 a	6.7 ± 0.6 a	6.8 ± 0.5 a	6.5 ± 0.5 a	6.7 ± 0.6 a	6.6 ± 0.7 a	0.44
8. Astringency	3.1 ± 0.5 a	3.3 ± 0.6 a	3.1 ± 0.6 a	3.4 ± 0.6 a	3.1 ± 0.7 a	3.3 ± 0.8 a	0.49
9. Body	6.8 ± 0.4 a	6.7 ± 0.6 a	6.8 ± 0.3 a	6.7 ± 0.5 a	6.9 ± 0.5 a	6.6 ± 0.7 a	0.39

*Values expressed as the mean ± standard deviation obtained in the evaluation carried out by panellists from ITAL for each of the sensory aspects of the coffee samples.

m.s.d: minimum significant difference at an error level of 5% (Tukey test). For each aspect evaluated, values followed by different letters are statistically different at an error level of 5%.

From the results obtained in the sensory analysis of the coffee samples from Container 1, shown in Frame 1, no statistical differences were observed at an error level of 5% for the sensory attributes of powder fragrance or beverage aroma, defects, acidity, flavour, after taste, astringency and body. The initial sample from the lower region was considered to be bitterer than the initial sample from the upper region at an error level of 5%, whilst the remaining samples showed no difference amongst themselves or with respect to these two samples.

From the results obtained in the sensory analysis of the coffee samples from Container 2, shown in Frame 2, no statistical differences were observed at an error level of 5% for the sensory attributes of powder fragrance or beverage aroma, defects, acidity, flavour, after taste, astringency and body. The final sample from the upper region was considered to be bitterer than the initial sample from the lower region at an error level of 5%, whilst the remaining samples showed no difference amongst themselves or with respect to these two samples.

Frame 3. Comparison of the samples from the different regions of Container 3 (½): lower (L), upper (U) and middle (M) at different periods: start (A) and end (B) of the treatment, according to the Tukey test.

	Lower region		Upper region		Middle region		m.s.d
	3LA	3LB	3UA	3UB	3MA	3MB	(5%)
1. Fragrance	7.0 ± 0.6 a	6.9 ± 0.7 a	7.0 ± 0.7 a	6.9 ± 0.7 a	7.1 ± 0.5 a	7.0 ± 0.7 a	0.49
2. Beverage Aroma	6.8 ± 0.6 a	6.5 ± 0.8 a	6.8 ± 0.6 a	6.5 ± 0.8 a	6.8 ± 0.5 a	6.6 ± 0.8 a	0.53
3. Defects	3.1 ± 0.7 a	3.6 ± 0.7 a	3.0 ± 0.8 a	3.6 ± 0.9 a	3.1 ± 0.6 a	3.3 ± 0.8 a	0.59
4. Acidity	4.0 ± 0.7 a	3.8 ± 0.7 a	4.0 ± 0.6 a	4.0 ± 0.6 a	3.9 ± 0.6 a	3.8 ± 0.5 a	0.46
5. Bitterness	4.1 ± 0.7 b	4.8 ± 0.8 a	4.2 ± 0.6 b	4.4 ± 0.7 ab	4.2 ± 0.6 b	4.0 ± 0.6 b	0.52
6. Flavour	6.7 ± 0.6 a	6.2 ± 0.8 b	6.7 ± 0.7 a	6.5 ± 0.6 ab	6.7 ± 0.5 a	6.6 ± 0.6 ab	0.49
7. Aftertaste	6.8 ± 0.6 a	6.4 ± 0.7 a	6.7 ± 0.6 a	6.6 ± 0.5 a	6.6 ± 0.5 a	6.5 ± 0.4 a	0.44
8. Astringency	3.0 ± 0.5 a	3.4 ± 0.7 a	3.2 ± 0.6 a	3.1 ± 0.4 a	3.1 ± 0.8 a	3.0 ± 0.6 a	0.49
9. Body	6.8 ± 0.5 a	6.5 ± 0.8 a	6.7 ± 0.5 a	6.7 ± 0.5 a	6.8 ± 0.5 a	6.6 ± 0.6 a	0.46

*Values expressed as the *mean ± standard deviation* obtained in the evaluation carried out by panellists from ITAL for each of the sensory aspects of the coffee samples.

m.s.d: minimum significant difference at an error level of 5% (Tukey test). For each aspect evaluated, values followed by different letters are statistically different at an error level of 5%.

From the results obtained in the sensory analysis of the coffee samples from Container 3, shown in Frame 3, no statistical differences were observed at an error level of 5% for the sensory attributes of powder fragrance or beverage aroma, defects, acidity, after taste, astringency and body. The final sample from the lower region was considered bitterer than the initial samples from the three regions (upper, lower and middle) and than the final sample from the middle region, while the final sample from the upper region was considered to be intermediate, not differing from any of the other samples.

3.2 - Results: Physical analysis – Defects - (for more details see Annex 2)

Table 1. Comparison of the scores for total defects and *ardido* beans (three trials) between the three regions (upper, middle and lower) of Container 1*

	1LA	1LB	1UA	1UB	1MA	1MB	m.s.d. (5%)
Defects	36.7 ± 6.7 a	45.7 ± 2.5 a	41.0 ± 9.6 a	49.7 ± 7.0 a	39.7 ± 5.0 a	49.7 ± 12.3 a	21.54
Ardido	11.3 ± 5.8 a	14.5 ± 5.8 a	17.8 ± 10.4 a	18.5 ± 8.7 a	12.7 ± 1.0 a	23.2 ± 6.5 a	19.21

* full container

Table 2. Comparison of the scores for total defects and *ardido* beans (three trials) between the three regions (upper, middle and lower) of Container 2*

	2LA	2LB	2UA	2UB	2MA	2MB	m.s.d. (5%)
Defects	45.3 ± 4.9 a	60.0 ± 23.1 a	46.0 ± 3.5 a	47.0 ± 2.6 a	42.3 ± 10.5 a	49.3 ± 3.2 a	29.52
Ardido	17.3 ± 0.3 a	20.0 ± 7.9 a	15.2 ± 6.3 a	20.0 ± 1.3 a	21.5 ± 9.0 a	21.5 ± 1.5 a	15.29

* partially full container

Table 3. Comparison of the scores for total defects and *ardido* beans (three trials) between the three regions (upper, middle and lower) of Container 3*

	3LA	3LB	3UA	3UB	3MA	3MB	m.s.d. (5%)
Defects	41.0 ± 3.0 abc	50.7 ± 6.1 ab	52.7 ± 9.1 ab	54.0 ± 2.6 a	35.0 ± 3.5 c	38.0 ± 5.3 bc	14.83
Ardido	13.3 ± 4.8 b	20.7 ± 2.5 ab	21.2 ± 2.1 ab	25.7 ± 2.9 a	13.8 ± 2.0 b	17.3 ± 4.3 ab	8.95

* half full container

3.3 - Results: Physicochemical analysis (for more details see Annex 3)

Kinetic of Temperature and Relative humidity of three trials **(See Annex 4)**

Table 4. Comparison of the means for the determinations of moisture content and water activity (three trials) between the three regions of container 1*

Stages-Regions	1LA	1LB	1MA	1MB	1UA	1UB	m.s.d. 5%
Parameters**							
1-W/W	10.33 ± 0.23 b	11.77 ± 0.25 a	10.43 ± 0.40 b	11.07 ± 1.54 ab	10.31 ± 0.26 b	11.85 ± 0.34 a	0.96
2-ISO	10.33 ± 0.27 a	10.45 ± 0.25 a	10.31 ± 0.37 a	10.39 ± 0.25 a	10.25 ± 0.23 a	10.55 ± 0.17 a	0.36
3-CAPAC.	12.29 ± 0.20 b	12.51 ± 0.15 ab	12.26 ± 0.20 b	12.53 ± 0.17 ab	12.30 ± 0.24 b	12.70 ± 0.21 a	0.28
4-Aw	0.580 ± 0.010 b	0.587 ± 0.012 ab	0.586 ± 0.010 b	0.589 ± 0.010 ab	0.586 ± 0.009 b	0.600 ± 0.005 a	0.01

* full container
**1) w/w - weight gain; 2) ISO - ISO 6673 Moisture Method; 3) CAPAC-Capacitance Moisture Method; 4) Aw - Water activity

Table 5. Comparison of the means for the determinations of moisture content and water activity (three trials) between the three regions of container 2*

Stages-Regions	2LA	2LB	2MA	2MB	2UA	2UB	m.s.d. 5%
Parameters**							
1) W/W	10.29 ± 0.40 b	11.84 ± 0.51 a	10.44 ± 0.31 b	10.35 ± 1.50 b	10.37 ± 0.29 b	11.90 ± 0.36 a	0.99
2) ISO	10.21 ± 0.33 b	10.44 ± 0.22 ab	10.40 ± 0.26 ab	10.46 ± 0.33 ab	10.28 ± 0.23 ab	10.61 ± 0.21 a	0.37
3) CAPAC.	12.22 ± 0.25 c	12.56 ± 0.19 ab	12.30 ± 0.17 bc	12.54 ± 0.24 ab	12.33 ± 0.23 bc	12.63 ± 0.17 a	0.29
4) Aw	0.584 ± 0.009 b	0.587 ± 0.010 b	0.588 ± 0.010 b	0.591 ± 0.011 ab	0.588 ± 0.013 a	0.604 ± 0.004 b	0.01

* partially full container
**1) w/w - weight gain; 2) ISO - ISO 6673 Moisture Method; 3) CAPAC-Capacitance Moisture Method; 4) Aw - Water activity

Table 6. Comparison of the means for the determinations of moisture content and water activity (three trials) between the three regions of container 3*

Stages-Regions	3LA	3LB	3MA	3MB	3UA	3UB	m.s.d. 5%
Parameters**							
1) W/W	10.32 ± 0.36 b	11.78 ± 0.42 a	10.30 ± 0.38 b	11.69 ± 0.49 a	10.37 ± 0.17 b	11.88 ± 0.18 a	0.49
2) ISO	10.28 ± 0.32 a	10.45 ± 0.21 a	10.31 ± 0.38 a	10.48 ± 0.32 a	10.34 ± 0.14 a	10.71 ± 0.39 a	0.43
3) CAPAC.	12.24 ± 0.25 c	12.44 ± 0.21abc	12.22 ± 0.25 c	12.57 ± 0.21 ab	12.32 ± 0.18 bc	12.73 ± 0.25 a	0.32
4) Aw	0.585 ± 0.012 b	0.590 ± 0.013	0.578 ± 0.012 b	0.590 ± 0.011 ab	0.588 ± 0.014 b	0.607 ± 0.012 a	0.02

* half full container
**1) w/w - weight gain; 2) ISO - ISO 6673 Moisture Method; 3) CAPAC-Capacitance Moisture Method; 4) Aw - Water activity

We would like to emphasise the fact that the increase in moisture content was considered to be that obtained from the weight gain of the product, leading to a more real measurement of the authentic gain in moisture by the beans, and harmonising better with the tendency for a loss of product quality to appear after situations of temperature oscillation.

The tendency for loss of beverage quality and appearance of defects after the trial did not apparently harmonise with the moisture gain as determined by either the ISO method or by the capacitance method, since, using these methods, the moisture gain was less than 0.3%. However, experimental data have confirmed the relation between loss of sensory quality (accentuation of the phenolic flavour of the beverage) with an increase of 0.5% in moisture content of the coffee. We believed the increase of moisture was not bigger principally in a simulated condition where the mini-container were transported in a deck of ship, because not radiation solar was utilised. During the trip the radiation solar influence above the gradient of temperature between the cargo, head space and the containers walls and that is very important in the formation of condensation that could be drop on cargo and rewet coffee.

3.4 - Conclusions

- According to the statistical results the quality of the beverage in relation to bitterness is less affected in the full filling container (1) than the others (partially full container (2) and half full container (3));
- In relation to defects (*ardido*, total defects) of the grain, the half full container (3) showed a higher negative tendency than the others;
- In relation to moisture increase the statistical results showed similar tendencies. The half full container (1) had a small disadvantage over the others because the tendency to gain moisture was a little higher, principally in the middle region;
- Although, in the majority of the situations, there were no statistically significant differences, a tendency was observed that suggested a correlation between moisture gain, beverage flavour and coffee defects. We believe that by maintaining the same parameters of temperature oscillation but extending the time of simulated transport, a trial with more significant statistical data would certainly be obtained. It is therefore recommended that a longer trial be undertaken.

4. REFERENCES

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ANNEX 1 – VOCABULARY

Fragrance: The sensation obtained from the gases released from roasted and ground coffee beans as aromatic compounds are inhaled through the nose by sniffing.

Aroma: The sensation obtained from the gases released from brewed coffee as they are inhaled through the nose by sniffing. In general, the aroma is a mixture of fruity, herbal and nut-like scents. When the coffee brew is slurped or vigorously sprayed toward the back of the palate, additional organic material present in the brew in a liquid state changes into a gaseous state. Also, any gaseous material previously trapped in the liquid is immediately released. These vapours, which are mostly sugar carbonyl compounds, resemble caramel, roasted nuts and toasted cereal grains.

Defects: The intensity of the defect can be mild, moderate or strong. Throughout the coffee bean's entire life span from first appearing on the coffee shrub to having its water soluble organic and inorganic materials consumed as a beverage, internal and external factors continually act upon it. If the influence of these factors is strong enough, a chemical change results and affects the flavour of the coffee. For example, earthy, rioy, musty, rubbery, fermented, rancid, stale, grassy, new crop, old crop, aged, strawy and woody are all terms that reflect the degree of chemical change. Excellent Quality means coffee free from defects.

Acidity: A basic taste characterized by the solution of an organic acid, described as a desirable sharp, fairly strong and pleasing taste with defined origins, as opposed to an over-fermented sour taste.

Bitterness: A primary taste characterized by the solution of caffeine, quinine and certain alkaloids. The taste is considered desirable up to a certain level and is affected by the degree of roast and brewing procedures.

Flavour: This is the sensory evaluation of the water-soluble matter from the coffee grounds extracted during the brewing process. Coffee flavour is the simultaneous sensation in the palate of aroma and taste. The process of sensing tastes is called degustation, which is the simultaneous sensation of four basic tastes: sweet, salt, acid and bitter.

Body: This attribute descriptor is used do describe the physical properties of the beverage, aiming at a characteristic strong but pleasant full mouth feel as opposed to being watery.

After taste: The sensation of brewed coffee vapours, ranging from carbony to chocolaty, spicy to turpeny, as these are released from the residue remaining in the mouth after swallowing.

Astringency: This attribute is characteristic of an after-taste sensation consistent with a dry feeling in the mouth, undesirable in coffee.

ANNEX 2 - DEFECTS - SUMMARY OF ALL TRIALS

Trial 1 – Amounts of defects found in the samples analysed at zero time and after 15 days of simulated transport.

Sample	Treatment	Ardido	Insect damaged	Light green	Dark-green	Broken	Hollow/ Underdeveloped	Black/green	Stone	Total
2 MA	Zero time	29	12	7	2	2	1			53
2MB	After 15 days	20	6.3	11.6	6	1.4	1.2			47
1UA	Zero time	9.5	6.7	5	7.5	5.2	2.8	0.5		37
1UB	After 15 days	14.00	4.60	10.80	7.50	2.6	2		1	43
3LA	Zero time	8.5	14	8.4	7	4.2	1.6	0.5		44
3LB	After 15 days	19.50	2.60	17.00	9.50	3.6	2.2	1.5		56
1MA	Zero time	11.5	5.3	7	6.5	4.4	3.4	1		39
1MB	After 15 days	21	3.3	15.2	16.5	2.2	1.4			60
3UA	Zero time	20.5	4	22.4	7	5.8	1.2	0.5		61
3UB	After 15 days	24	4	9	14.5	3.8	0.2			56
2LA	Zero time	17.5	5	15	5.5	5.2	3.2			51
2LB	After 15 days	27	4		49	1.6	1.4	3		86
3MA	Zero time	12	14	5.2	4.2		2			37
3MB	After 15 days	16.5	5.3	7	2.5	5				36
1LA	Zero time	5	9.3	6.2	3.5	2.6	2.6			29
1LB	After 15 days	14	6.3	15.2	9	2.6	1.2			48
2UA	Zero time	8.5	5	12	8.5	6.4	1	2		44
2UB	After 15 days	21.00	3.00	10.40	8.50	3.6	1.6			48

Trial 2- Amounts of defects found in the samples analysed at zero time and after 15 days of simulated transport.

Sample	Treatment\	Ardido	Insect damaged	Light green	dark green	Broken	Hollow/ Underdeveloped	Black green	Total
2MA	Zero time	24	4.6	4.2	6.5	1.0	1.2	0	42
2MB	After 15 days	23	6.6	7.2	7.0	1.2	1.8	1.5	48
1UA	Zero time	14.5	4.3	9.8	4	1.4	0.2	0	34
1UB	After 15 days	13	6.7	11.2	14	2.0	1.8	0	49
3LA	Zero time	13.5	4.6	12	6	0.8	1.4	0	38
3LB	After 15 days	19	6.3	12.6	3.5	1.2	1.2	0	44
1MA	Zero time	13.5	3	10	14.5	2.8	1	0	45
1MB	After 15 days	30.5	1.6	16	4.5	0.6	0.4	0	53
3UA	Zero time	23.5	4.3	9.8	11.5	3.2	1.6	0	54
3UB	After 15 days	24	5.6	9.2	13	0.8	2.2	0	55
2LA	Zero time	17.5	7.3	13.8	3.5	0.2	0.8	0	43
2LB	After 15 days	21.5	4.6	11	11.5	1.6	1.6	0	52
3MA	Zero time	16	3	8	6	2.2	1.6	0	37
3MB	After 15 days	13.5	3.6	6.8	5	1.8	1.2	1.5	34
1LA	Zero time	12.5	5.6	13.4	6.5	2.4	0.4	0	40
1LB	After 15 days	9	8	18.2	0	3.4	4.0	0	43
2UA	Zero time	16	6.3	10	13	3.2	1.2	0	50
2UB	After 15 days	18.5	10	12.2	4	2.6	2.0	0	49

Trial 3- Amounts of defects found in the samples analysed at zero time and after 15 days of simulated transport

Sample	Treatment	Ardido	Insect damaged	Light green	dark green	Broken	Hollow/ Underdeveloped	Black green	Total
2MA	Zero time	11.5	6.6	11.4	1.5	0	1.4	0	32
2MB	After 15 days	21.5	4.6	16.8	9	0.6		0	53
1UA	Zero time	29.5	5.3	12.8	3.5	0.8	0.4	0	52
1UB	After 15 days	28.5	2.6	16	8.5	0.6	1.2	0	57
3LA	Zero time	18.0	5.6	12.6	3.5		1.0	0	41
3LB	After 15 days	23.5	2.6	16.4	8.5	0.6	0.4	0	52
1MA	Zero time	13	5.3	11.4	3.0	10	1.0	0	35
1MB	After 15 days	18	4.6	11.6	1	0.4		0	36
3UA	Zero time	19.5	6.3	13.6	2.0	0.4	1.4	0	43
3UB	After 15 days	29	2.6	12.4	5.5		1.2	0	51
2LA	Zero time	17	6.0	10.6	7.5	0.4	0.8	0	42
2LB	After 15 days	11.5	3.6	13.2	13		0.6	0	42
3MA	Zero time	13.5	3	9.2	4.5	0.4	0.4	0	31
3MB	After 15 days	22	4	15.2	3	0.2	0.2	0	44
1LA	Zero time	16.5	4.3	12.8	6.0	0.2	1.0		41
1LB	After 15 days	20.5	4.3	12.8	7.0	1.2	0.6	0	46
2UA	Zero time	21	3.6	11	6	0.6	0.4	1.5	44
2UB	After 15 days	20.5	2.6	15.4	3.5	1.0		0	44

ANNEX 3 - COMPARATION OF THE MEANS (THREE TRIAL) INITIAL X FINAL

Container	Region	Parameter*	1MA	1MB	m.s.d.(5%)
Container 1	Middle	WW	10.43 ± 0.40 a	11.07 ± 1.54 a	1,12
		ISO	10.31 ± 0.37 a	10.39 ± 0.25 a	0,31
		CAPAC.	12.26 ± 0.20 b	12.53 ± 0.17 a	0,18
		Aw	0.586 ± 0.010 a	0.589 ± 0.010 a	0,01
	Region	Parameter	1LA	1LB	m.s.d.(5%)
	Lower	WW	10.33 ± 0.23 b	11.77 ± 0.25 a	0,24
		ISO	10.33 ± 0.27 a	10.45 ± 0.25 a	0,26
		CAPAC.	12.29 ± 0.20 b	12.51 ± 0.15 a	0,18
		Aw	0.580 ± 0.010 a	0.587 ± 0.012 a	0,01
	Region	Parameter	1UA	1UB	m.s.d.(5%)
	Upper	WW	10.31 ± 0.26 b	11.85 ± 0.34 a	0,30
		ISSO	10.25 ± 0.23 b	10.55 ± 0.17 a	0,20
		CAPAC.	12.30 ± 0.24 b	12.70 ± 0.21 a	0,23
		Aw	0.586 ± 0.009 b	0.600 ± 0.005 a	0,01
Container	Region	Parameter	2MA	2MB	m.s.d.(5%)
Container 2	Middle	WW	10.44 ± 0.31 a	10.35 ± 1.50 a	1,08
		ISO	10.40 ± 0.26 a	10.46 ± 0.33 a	0,30
		CAPAC.	12.30 ± 0.17 b	12.54 ± 0.24 a	0,21
		Aw	0.588 ± 0.010 a	0.591 ± 0.011 a	0,01
	Region	Parameter	2LA	2LB	m.s.d.(5%))
	Lower	WW	10.29 ± 0.40 b	11.84 ± 0.51 a	0,45
		ISO	10.21 ± 0.33 a	10.44 ± 0.22 a	0,28
		CAPAC.	12.22 ± 0.25 b	12.56 ± 0.19 a	0,22
		Aw	0.584 ± 0.009 a	0.587 ± 0.010 a	0,01
	Region	Parameter	2UA	2UB	m.s.d.(5%)
	Upper	WW	10.37 ± 0.29 b	11.90 ± 0.36 a	0,33
		ISO	10.28 ± 0.23 b	10.61 ± 0.21 a	0,22
		CAPAC.	12.33 ± 0.23 b	12.63 ± 0.17 a	0,20
		Aw	0.588 ± 0.013 b	0.604 ± 0.004 a	0,01
Container	Region	Parameter	3MA	3MB	m.s.d.(5%)
Container 3	Middle	WW	10.30 ± 0.38 b	11.69 ± 0.49 a	0,43
		ISO	10.31 ± 0.38 a	10.48 ± 0.32 a	0,35
		CAPAC.	12.22 ± 0.25 b	12.57 ± 0.21 a	0,23
		Aw	0.578 ± 0.012 b	0.590 ± 0.011 a	0,01
	Region	Parameter	3LA	3LB	m.s.d.(5%)
	Lower	WW	10.32 ± 0.36 b	11.78 ± 0.42 a	0,39
		ISO	10.28 ± 0.32 a	10.45 ± 0.21 a	0,27
		CAPAC.	12.24 ± 0.25 a	12.44 ± 0.21 a	0,23
		Aw	0.585 ± 0.012 a	0.590 ± 0.013 a	0,01
	Region	Parameter	3UA	3UB	m.s.d.(5%)
	Upper	WW	10.37 ± 0.17 b	11.88 ± 0.18 a	0,18
		ISO	10.34 ± 0.14 b	10.71 ± 0.39 a	0,29
		CAPAC.	12.32 ± 0.18 b	12.73 ± 0.25 a	0,22
		Aw	0.588 ± 0.014 b	0.607 ± 0.012 a	0,01

*Parameter: WW (Gain Weight); ISO 6673 Moisture Method; CAPAC, Capacitance Moisture Method; Aw, Wate Activity

ANNEX 4 - KINETIC OF TEMPERATURE AN RELATIVE HUMIDITY (THREE TRIALS)

Trial One

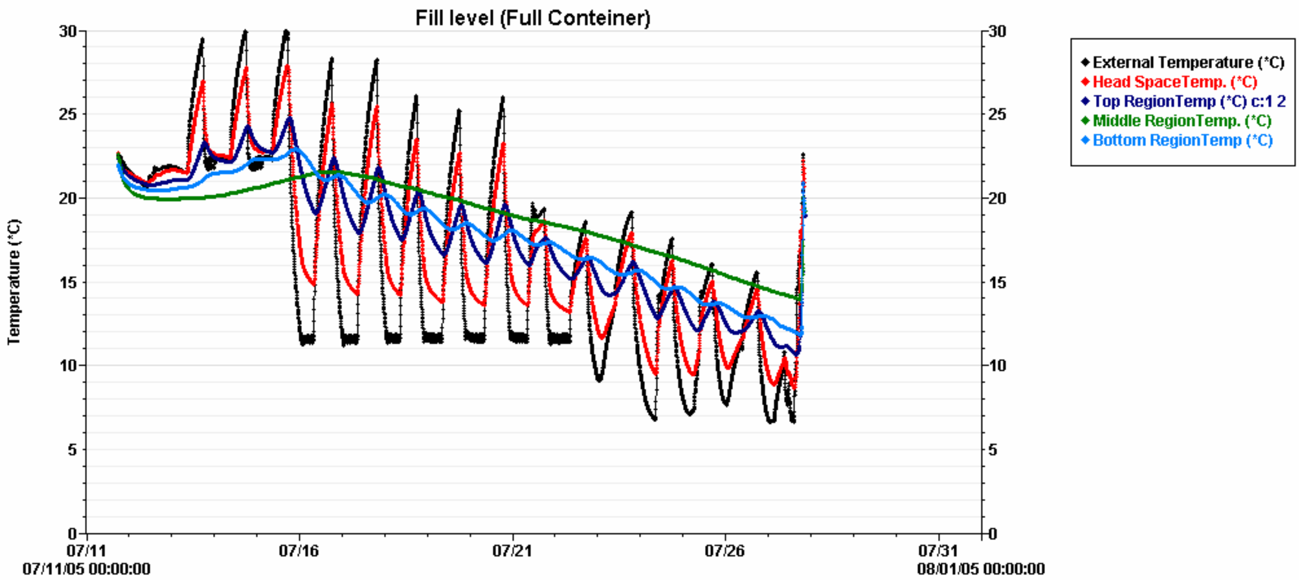

Figure 1 – Kinetic of Temperature in Fill Full Container Level.

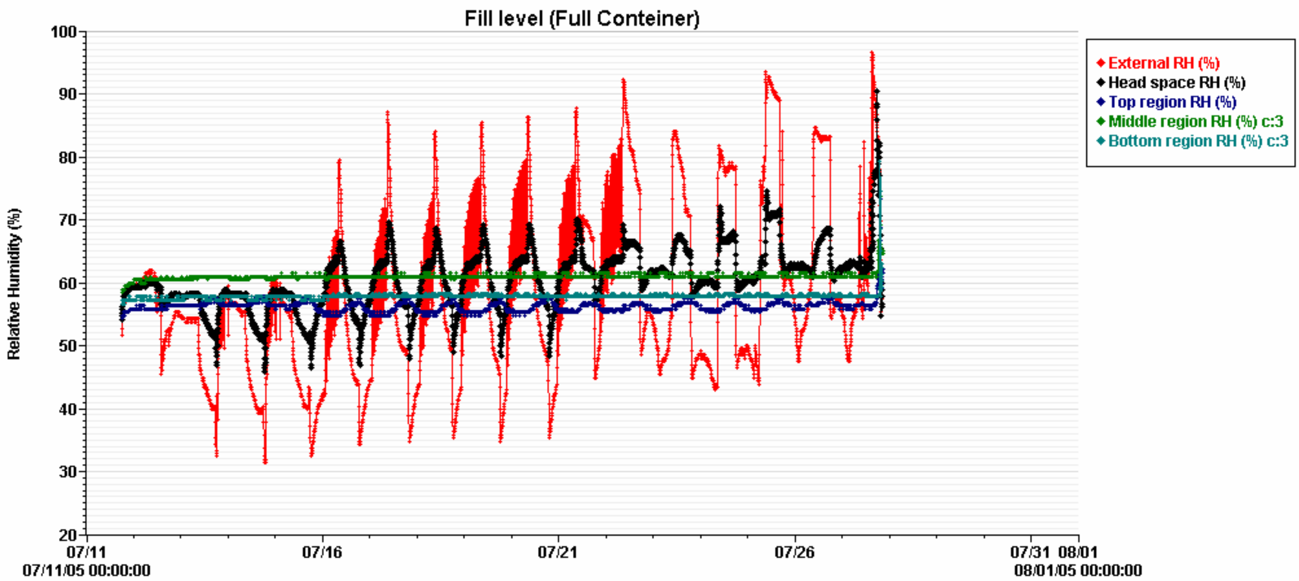

Figure 2 - Kinetic of Relative Humidity in Fill Full Container Level.

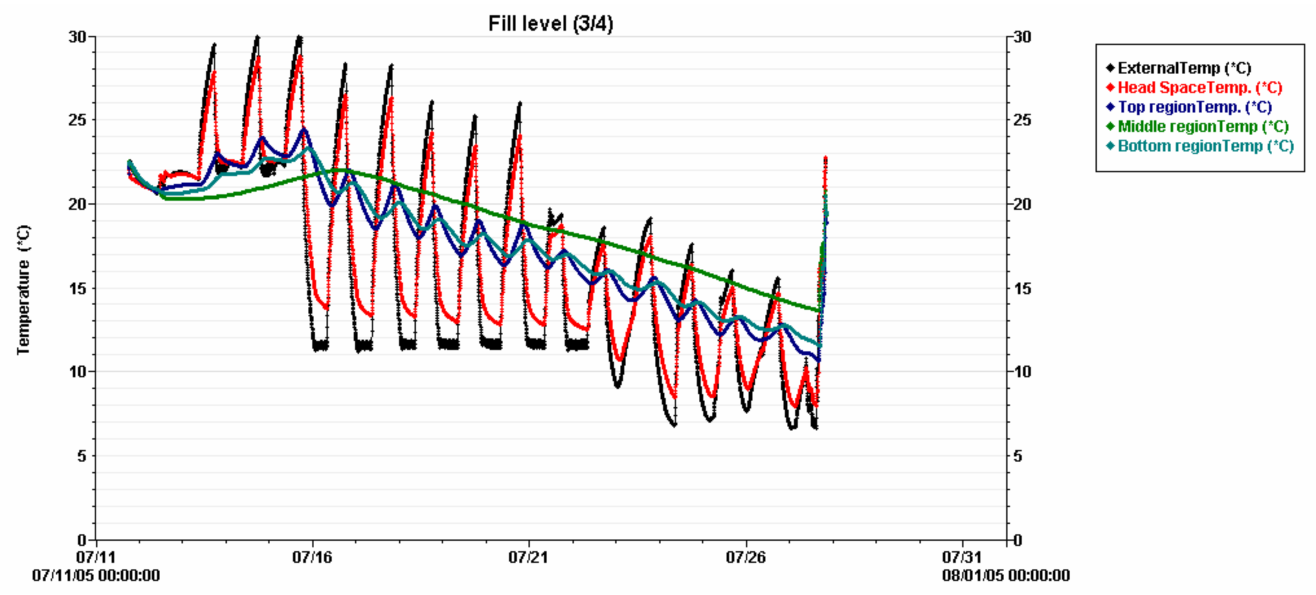

Figure 3 - Kinetic of Temperature in Fill ¾ Container Level.

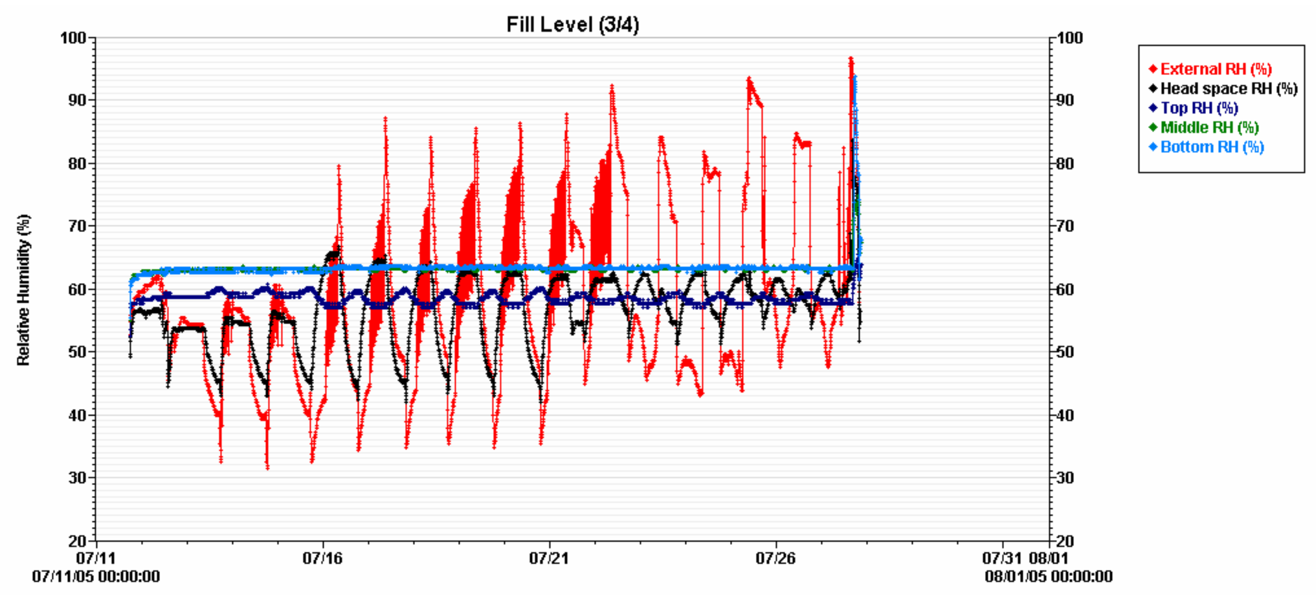

Figure 4 - Kinetic of Relative Humidity in Fill ¾ Container Level.

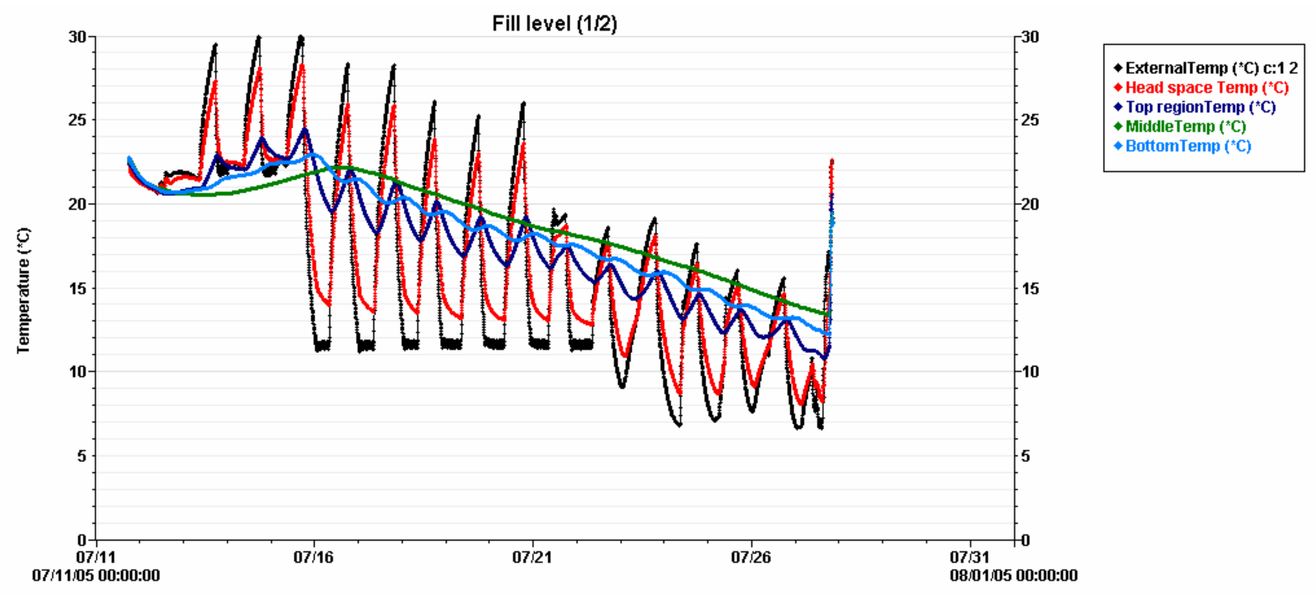

Figure 5 - Kinetic of Temperature in Fill ½ Container Level.

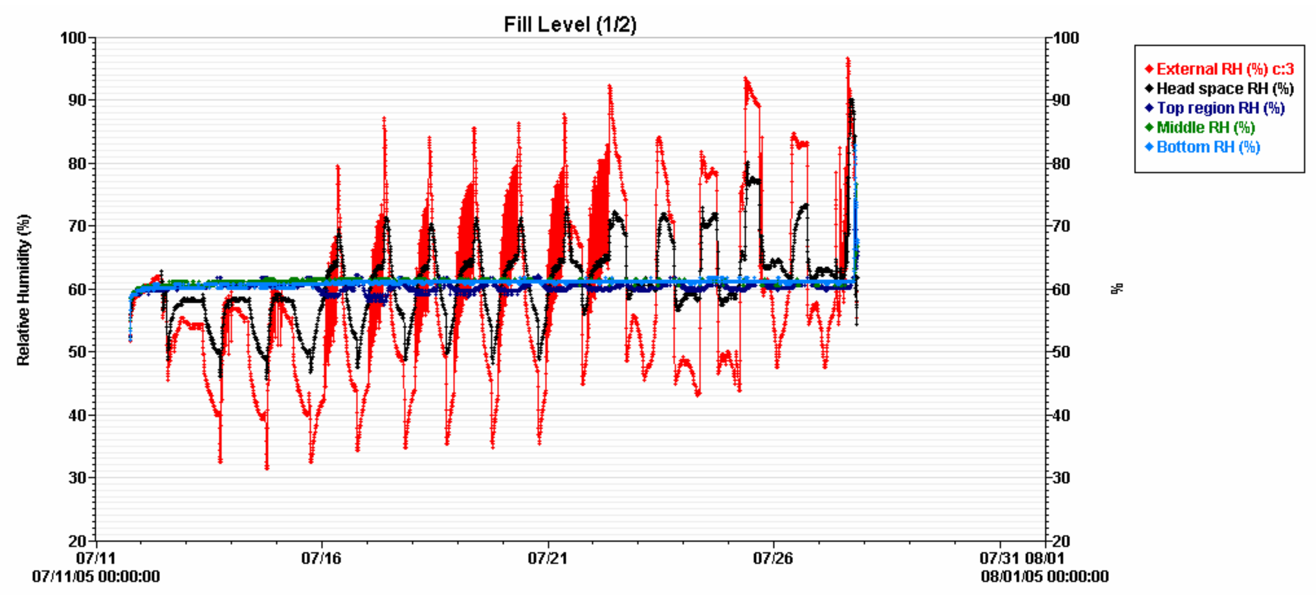

Figure 6 - Kinetic of Relative Humidity in Fill ½ Container Level.

Trial Two

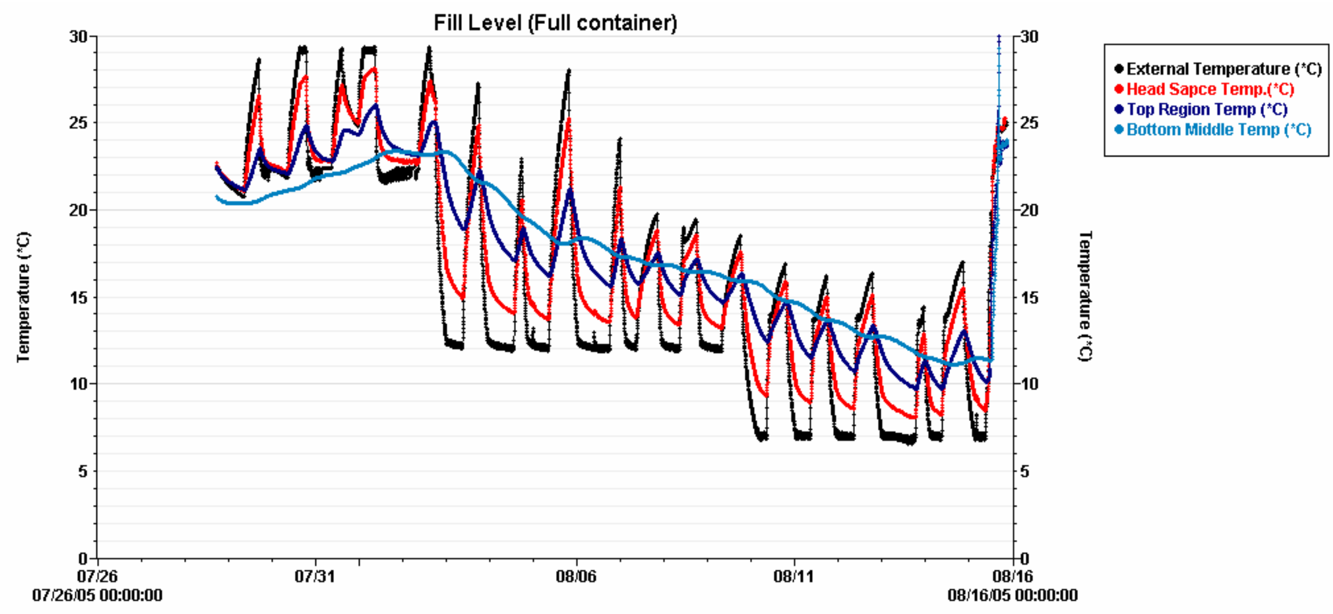

Figure 7 - Kinetic of Temperature in Fill Full Container Level.

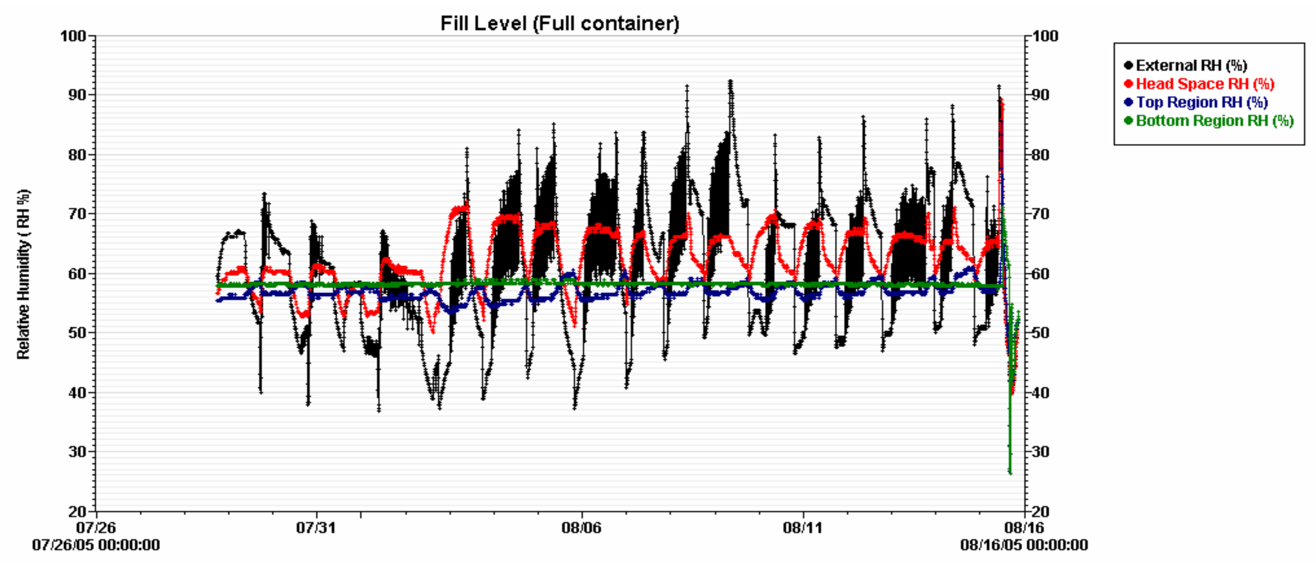

Figure 8 - Kinetic of Relative Humidity in Fill Full Container Level.

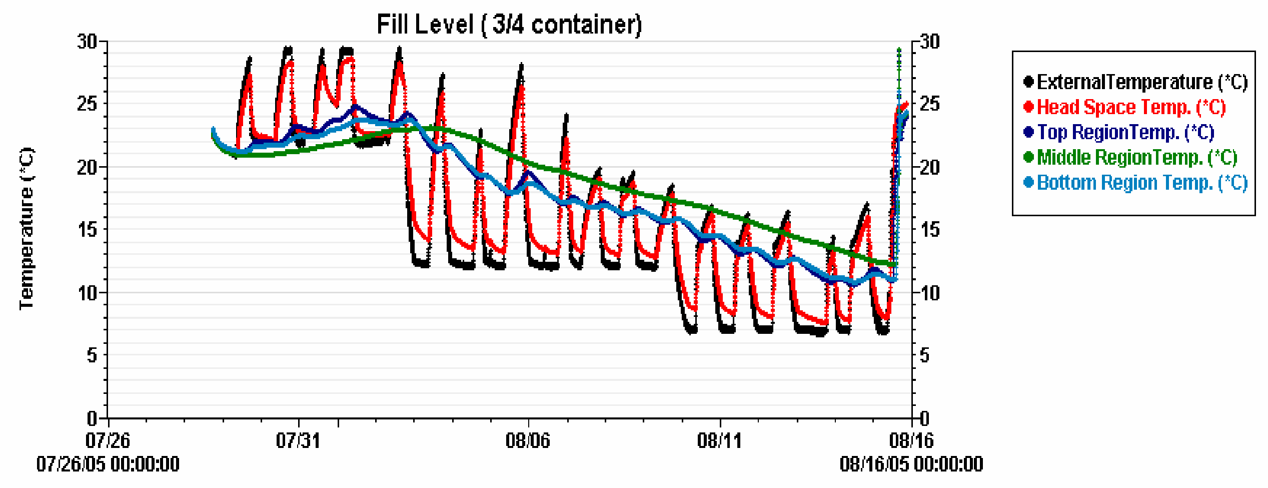

Figure 9 - Kinetic of Temperature in Fill ¾ Container Level.

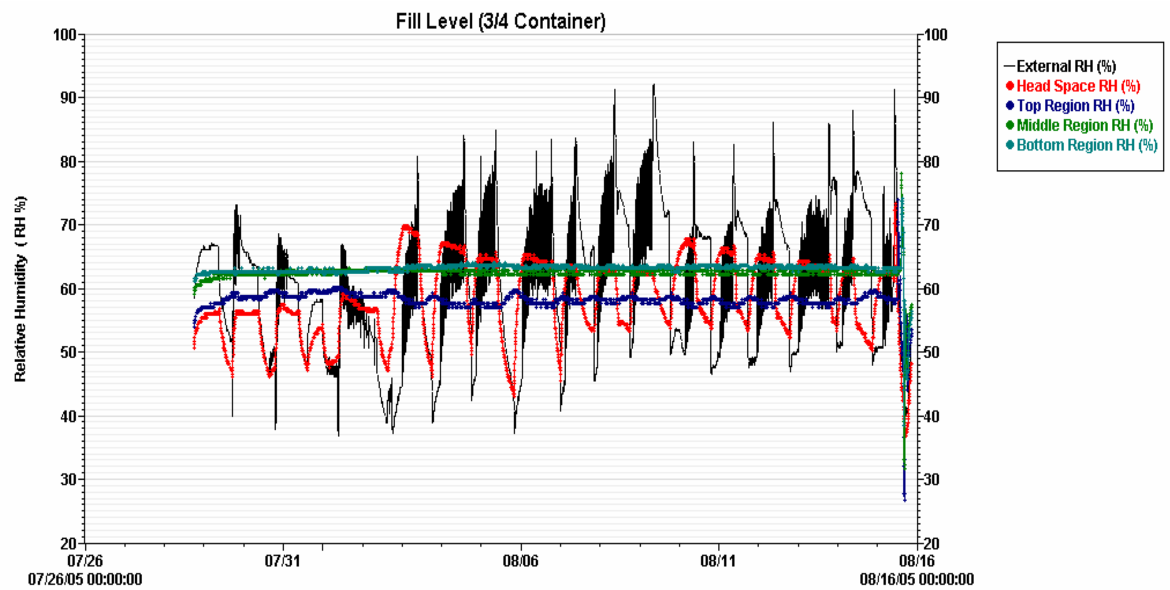

Figure 10 - Kinetic of Relative Humidity in Fill ¾ Container Level.

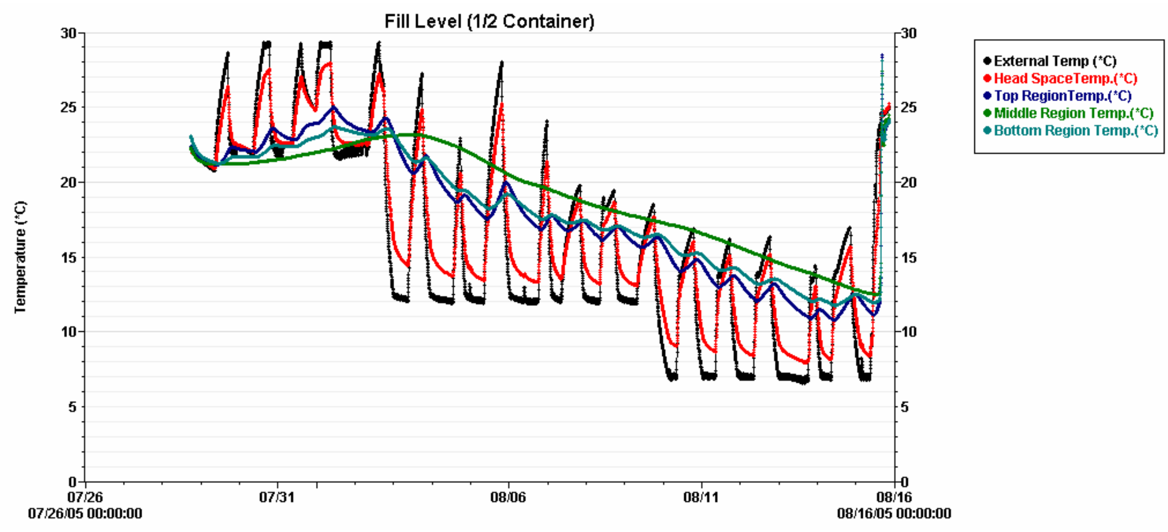

Figure 11 - Kinetic of Temperature in Fill ½ Container Level.

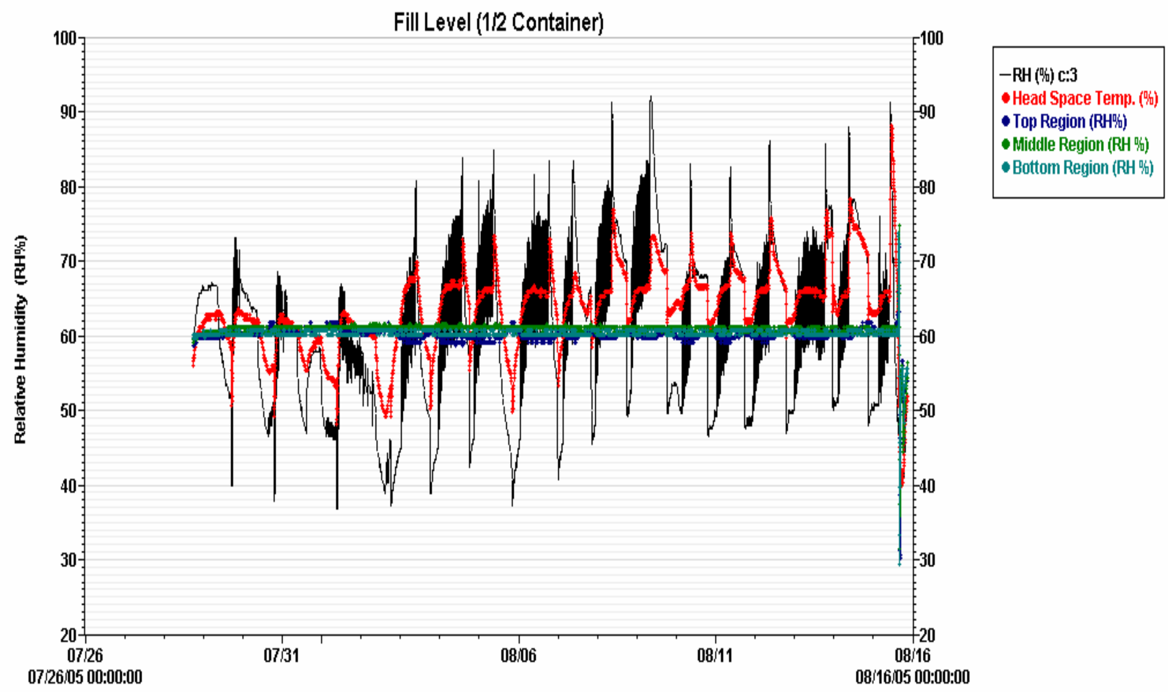

Figure 12 - Kinetic of Relative Humidity in Fill ½ Container Level.

Trial Three

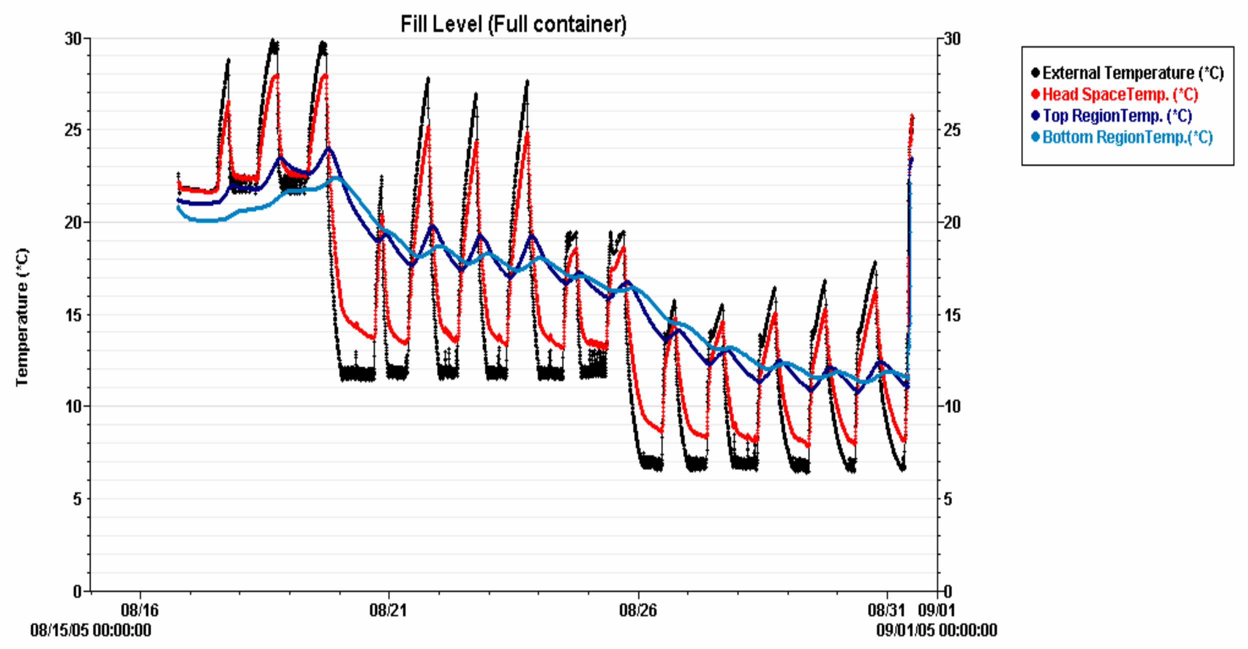

Figure 13 – Kinetic of Temperature in Fill Full Container Level.

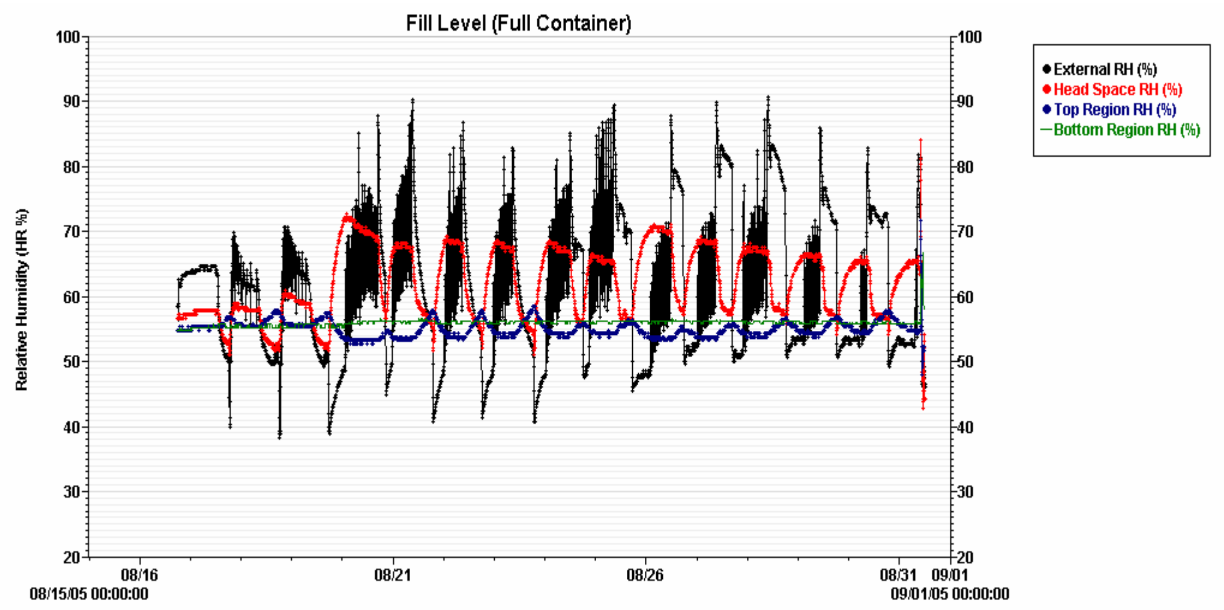

Figure 14 – Kinetic of Relative Humidity in Fill Full Container Level.

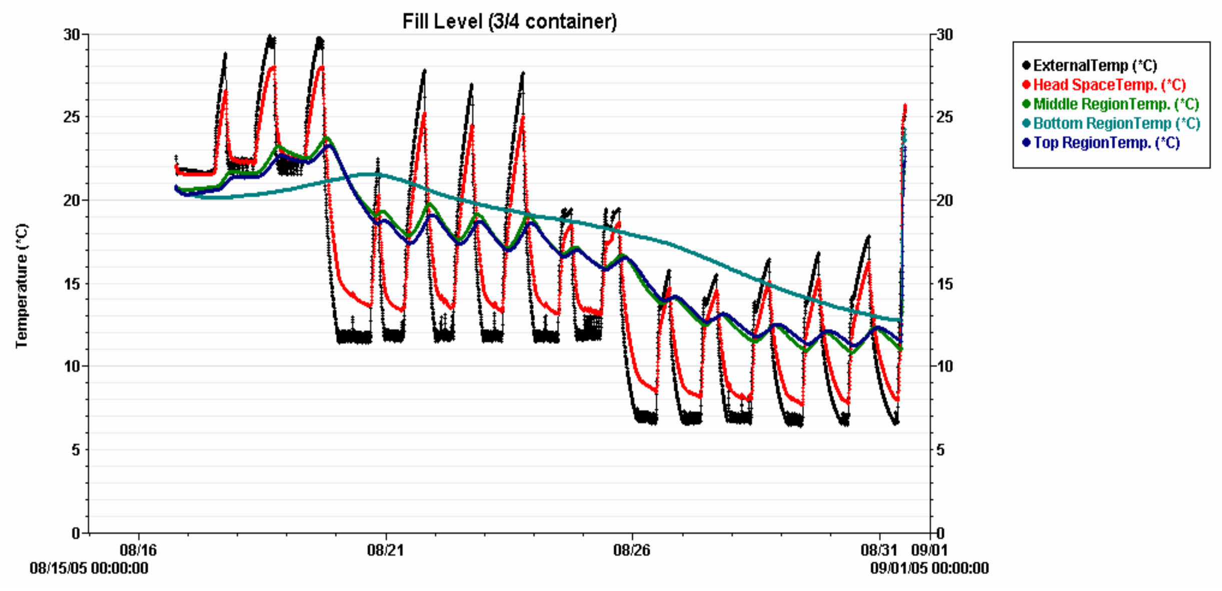

Figure 15 – Kinetic of Temperature in Fill ¾ Container Level.

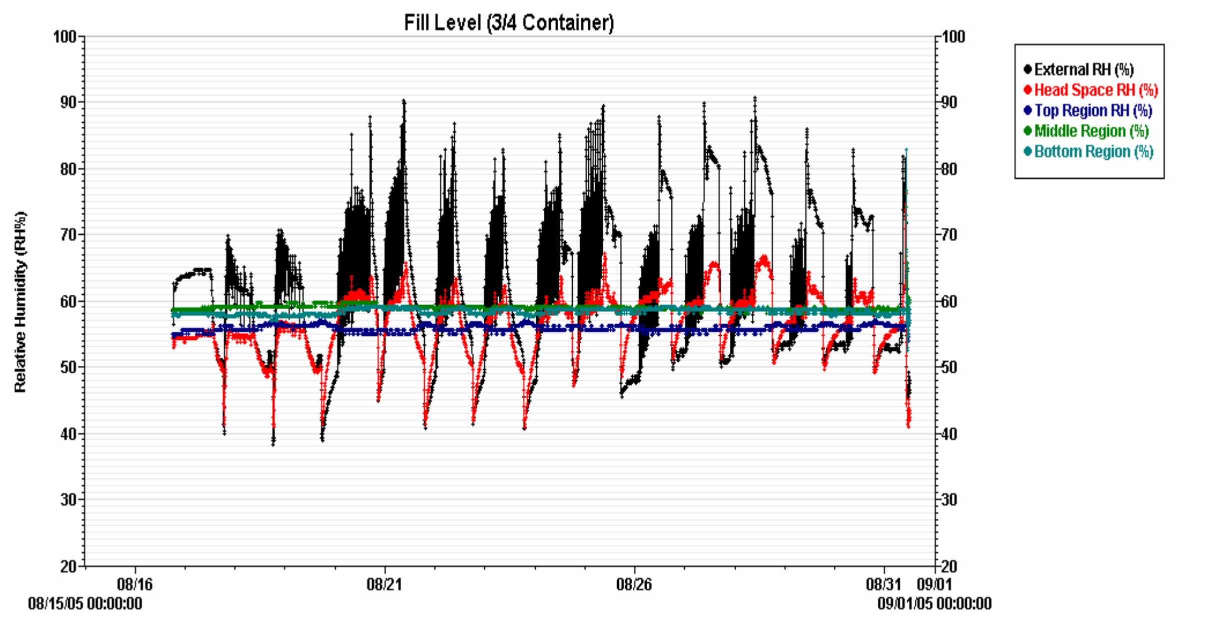

Figure 16 – Kinetic of Relative Humidity in Fill ¾ Container Level.

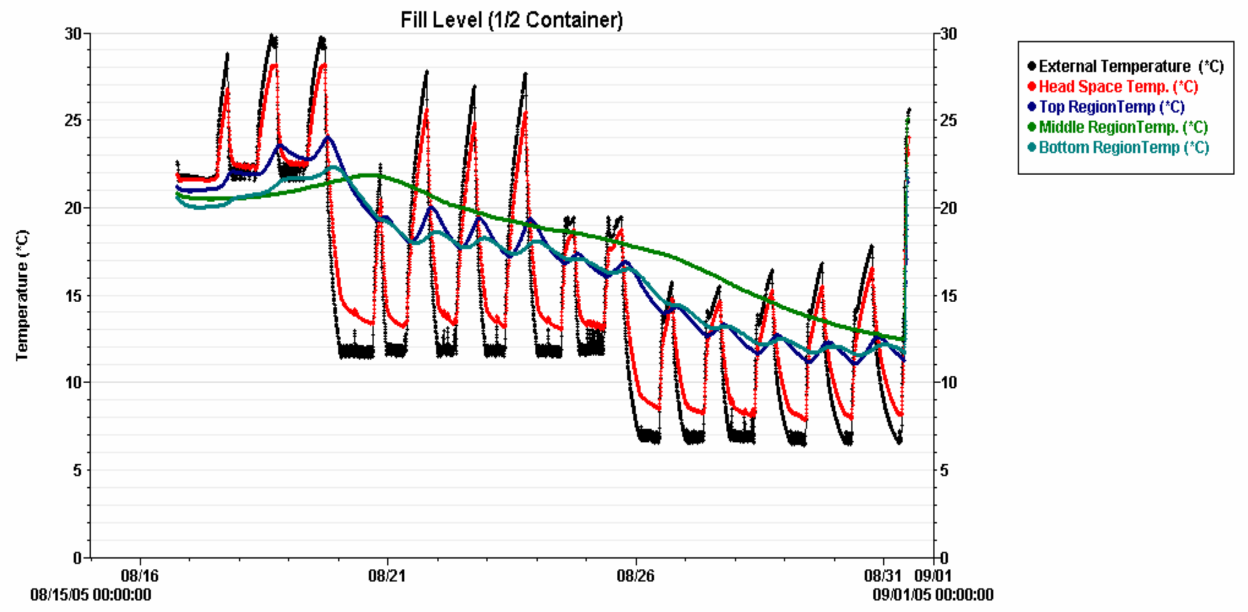

Figure 17 – Kinetic of Temperature in Fill ½ Container Level.

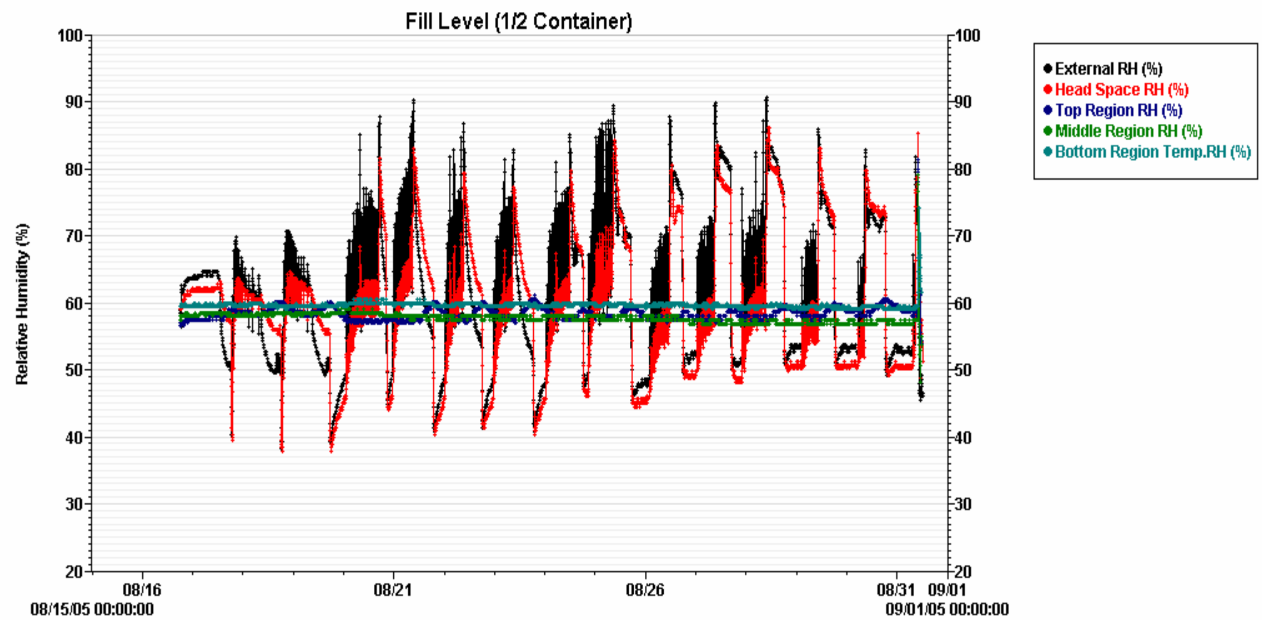

Figure 18 – Kinetic of Relative Humidity in Fill ½ Container Level.