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Tulip bulb trial shipment

fresh air exchange 100, 125 and 150 m³/h

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Report 991

Colophon

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Content

1 Introduction

Tulip bulbs are sensitive to high ethylene concentration and high relative humidity (RH). Therefore shippers aim to reduce both ethylene and RH during shipment in reefer containers. These aims are contradictory. To reduce ethylene one should maximize ventilation (= fresh air exchange). However, to reduce RH one should avoid the intake of warm humid ambient air. Especially for shipments through tropical areas this means one best closes the vent lids from an RH point of view. So the shipper has to balance his desires and seek the optimal compromise. The longer the transit time the more critical the effect of suboptimal climate.

Hypothesis: setting fresh air exchange at three levels 100, 125 and 150 m^3/h and humidity control at 65% will yield the same RH, but a lower ethylene level for the higher fresh air exchange. Hence more fresh air should yield better flowerbulb quality at delivery.

1.1 Objective

This study aims to test the above hypothesis.

2 Methods

Three 20 ft. containers, loaded with tulip bulbs, are shipped together from The Netherlands to Australia. See Table 1 for further specs of the containers involved. Appendix 1 (p. 14) shows the detailed shipping data for all containers, and appendix 2 (p. 15) gives a photo impression of the container stuffing.

Table 1, specification of containers involved.

container no.	HLXU3733385	HLXU3729174	HLXU3730149
unit type	Carrier, 69NT40-551-502	Carrier, 69NT40-551-502	Carrier, 69NT40-551-502
box type	MCI Qingdao, MQRS-20SS-351C	MCI Qingdao, MQRS-20SS-351C	MCI Qingdao, MQRS-20SS-351C
date of manufacture	2006	2006	2006
temperature setpoint	20 °C	20 °C	19 °C
RH setpoint	65%	65%	65%
fan speed setting	Alternating	Alternating	Alternating
ventilation setting	100 m^3/h	125 m^3/h	150 m^3/h
Position on board	Bay 027, row 04, tier 84: on deck	Bay 027, row 02, tier 84: on deck	Bay 041, row 05, tier 84: on deck

Table 2, voyage characteristics

Date of stuffing	18 Aug. 2008
Date of stripping	23 Sept. 2008
Vessel	Ute Oltmann
Voyage number	8032
Position on board	See table 1

Four ways of measuring are applied:

1. The routine measurements of supply air temperature, return air temperature and RH in return air, as collected by the reefer unit, are used.
2. Four extra sensors for temperature and RH are placed between the flowerbulbs in each container.
3. Two ethylene sample bottles are placed between the flowerbulbs in each container.
4. The quality upon arrival is judged by the consignee.

During the shipment the four sensors between the bulbs in each container log temperature and relative humidity at intervals of 10 minutes. Table 3 describes the sensors used and their positions. These positions are also graphically depicted in Figure 1. The identification numbers in column 1 of Table 3 will be used in the remainder of this report. CTR I 1 means sensor no. 1 in the container with ventilation setting I, CTR II 1 is sensor 1 in container with ventilation setting II, etc.

Table 3, description of cargo sensor locations

ident. no.	container no.	vent. setting	type	serial no.	hor. pos.	vert. pos. in pallet
CTR I 1	HLXU373338-5	100 m^3/h	escort junior	0825-060	unit end	on top
CTR I 2	HLXU373338-5	100 m^3/h	escort junior	0826-101	unit end	centre
CTR I 3	HLXU373338-5	100 m^3/h	escort junior	0825-143	door end	on top
CTR I 4	HLXU373338-5	100 m^3/h	escort junior	0826-062	door end	centre
CTR I a	HLXU373338-5	100 m^3/h	bottle	1	door end	on top
CTR I b	HLXU373338-5	100 m^3/h	bottle	2	door end	on top
CTR II 1	HLXU372917-4	125 m^3/h	escort junior	0825-148	unit end	on top
CTR II 2	HLXU372917-4	125 m^3/h	escort junior	0825-043	unit end	centre
CTR II 3	HLXU372917-4	125 m^3/h	escort junior	0826-036	door end	on top
CTR II 4	HLXU372917-4	125 m^3/h	escort junior	0826-025	door end	centre
CTR II a	HLXU373338-5	125 m^3/h	bottle	3	door end	on top
CTR II b	HLXU373338-5	125 m^3/h	bottle	4	door end	on top
CTR III 1	HLXU373014-9	150 m^3/h	escort junior	0826-097	unit end	on top
CTR III 2	HLXU373014-9	150 m^3/h	escort junior	0826-095	unit end	centre
CTR III 3	HLXU373014-9	150 m^3/h	escort junior	0826-029	door end	on top
CTR III 4	HLXU373014-9	150 m^3/h	escort junior	0825-047	door end	centre
CTR III a	HLXU373338-5	150 m^3/h	bottle	5	door end	on top
CTR III b	HLXU373338-5	150 m^3/h	bottle	6	door end	on top

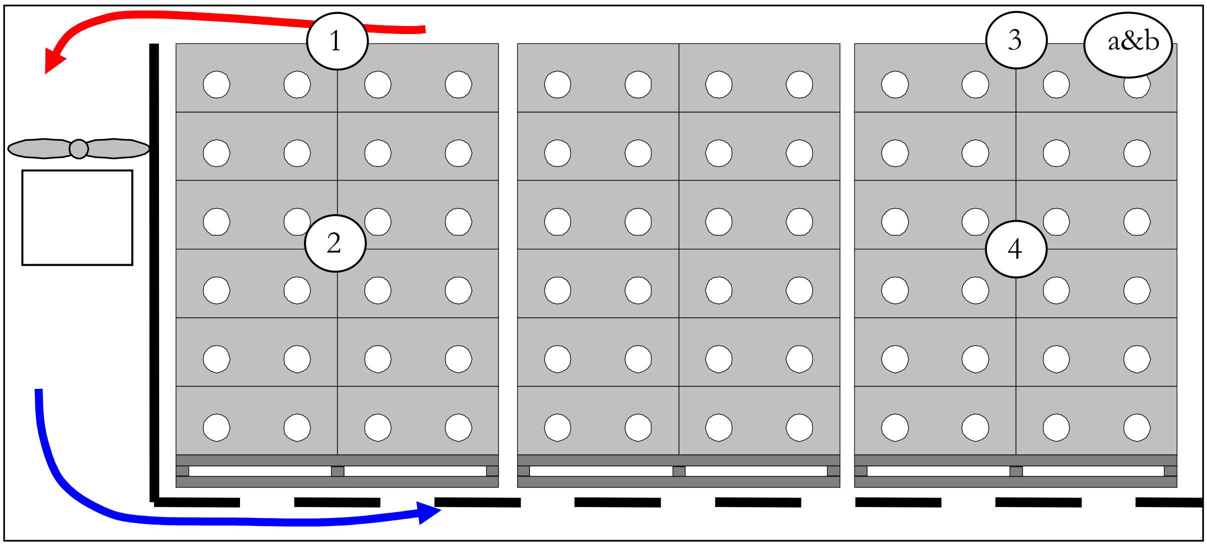

Figure 1 visualisation of cargo sensor locations 1 till 4 and bottles a and b.

3 Results

3.1 Cargo sensors between flowerbulbs

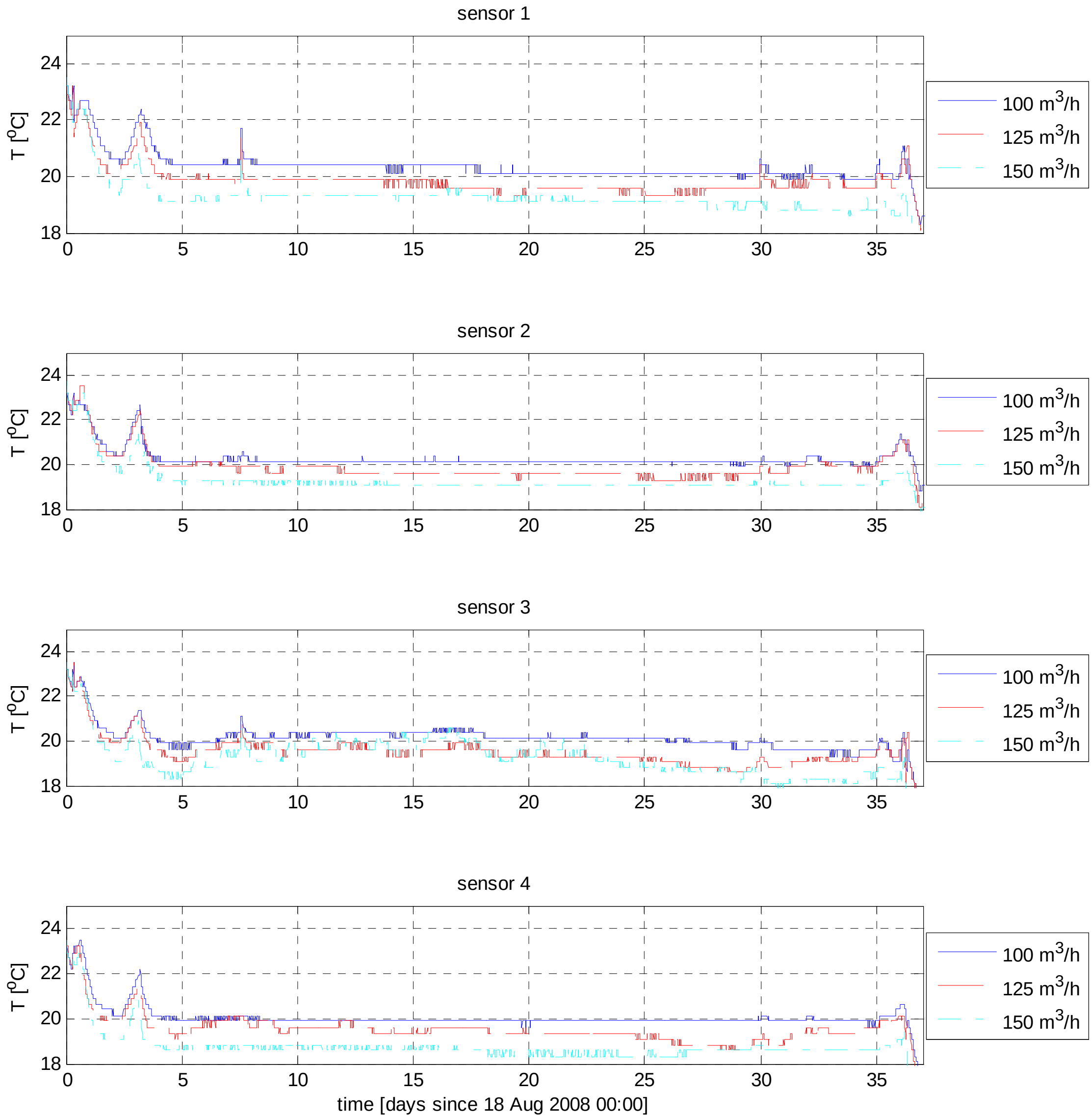

Figure 2 temperatures registered at the 4 locations indicated in Figure 1 throughout voyage.

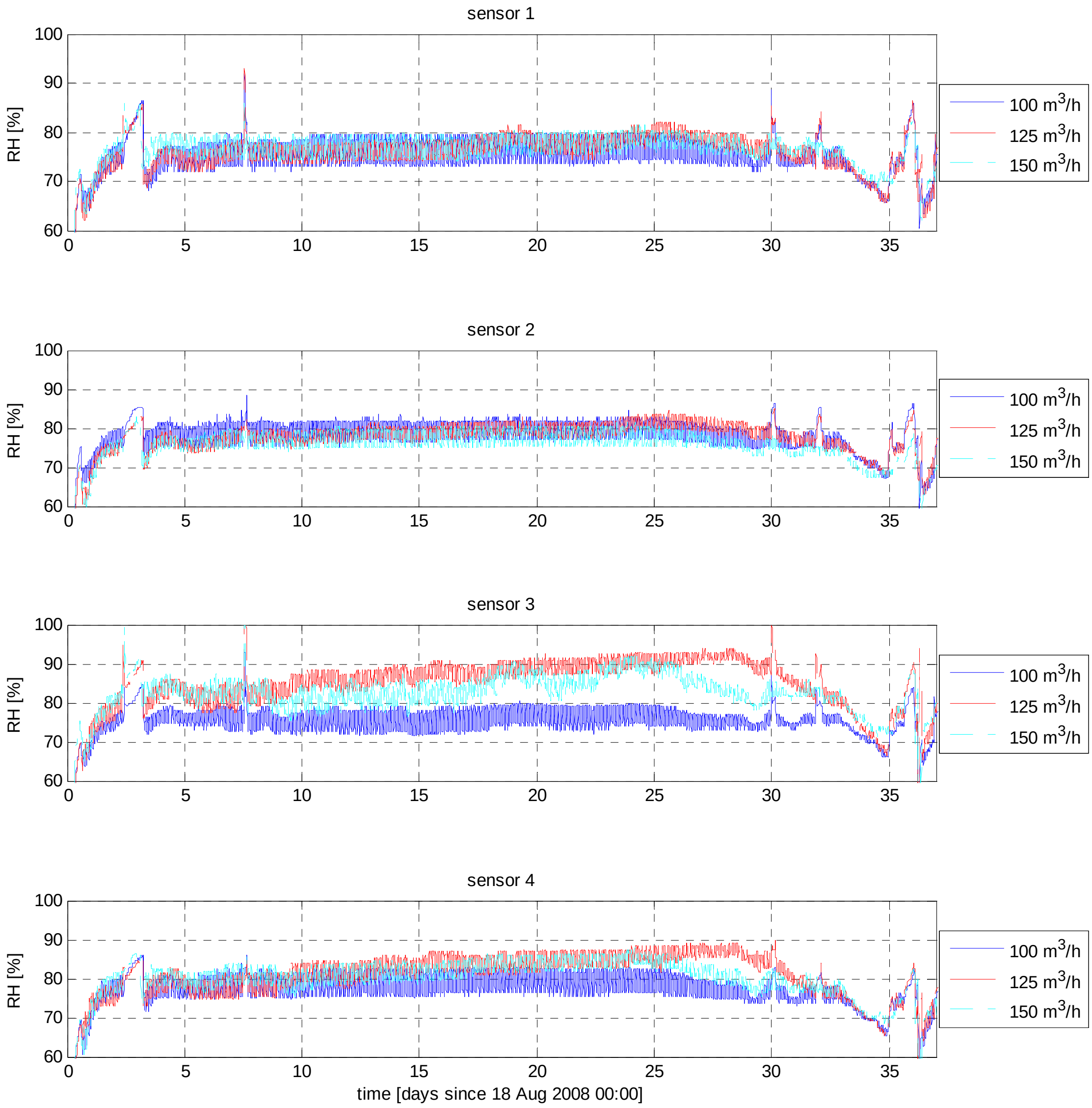

Figure 3 RH registered at the 4 locations indicated in Figure 1 throughout voyage.

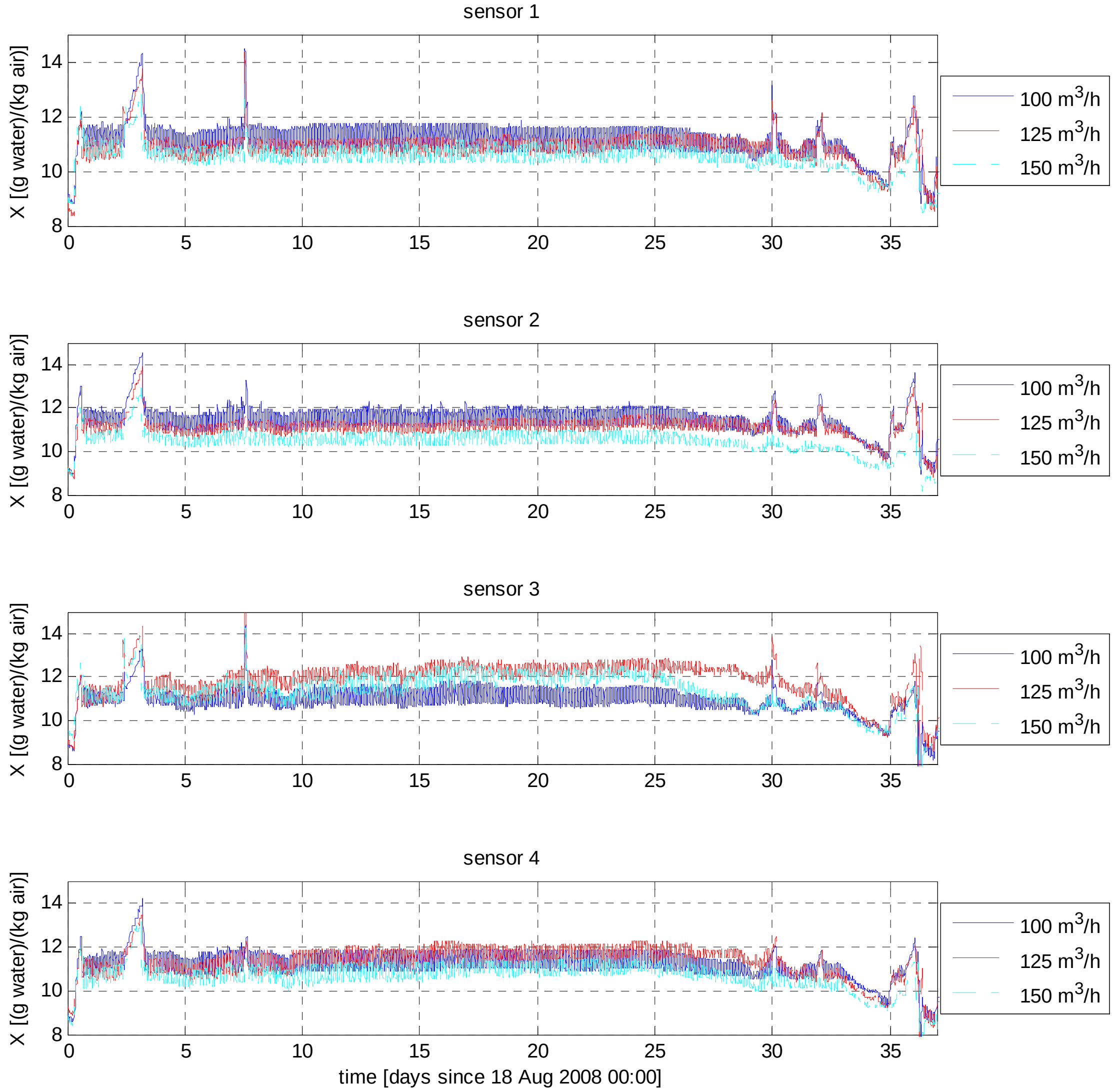

Figure 4 absolute humidity during voyage, calculated from measured T and RH.

3.2 Temperature and RH logged by the reefer units

In the figures below temperature and RH logged by the reefer units are graphically visualized. Setpoint temperature (SETP), supply air temperature (SUP), return air temperature (RET) and ambient temperature (AMB) during the trip are shown in the top of the figures. In the lower half of the graph relative humidity (RH) and relative humidity setpoint (RH.SP) are shown.

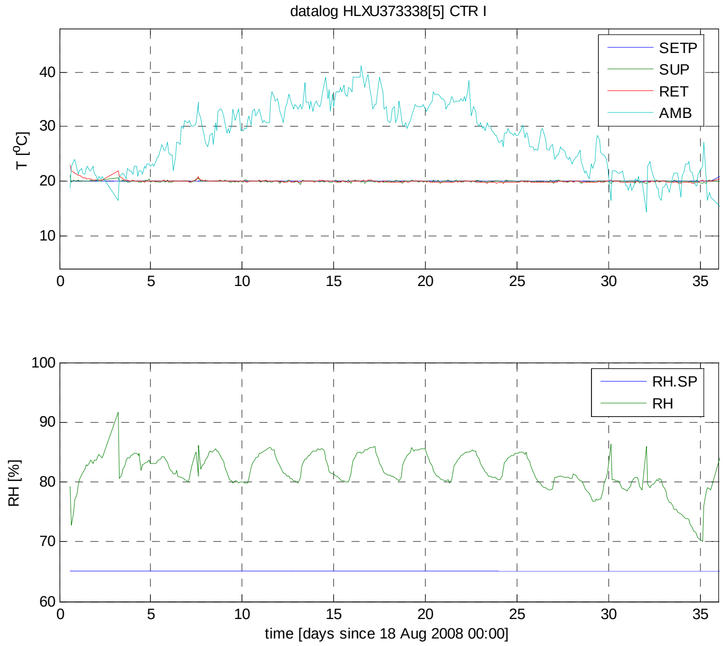

Figure 5 data registered by reefer unit in HLXU3733385 (100 m^3/h).

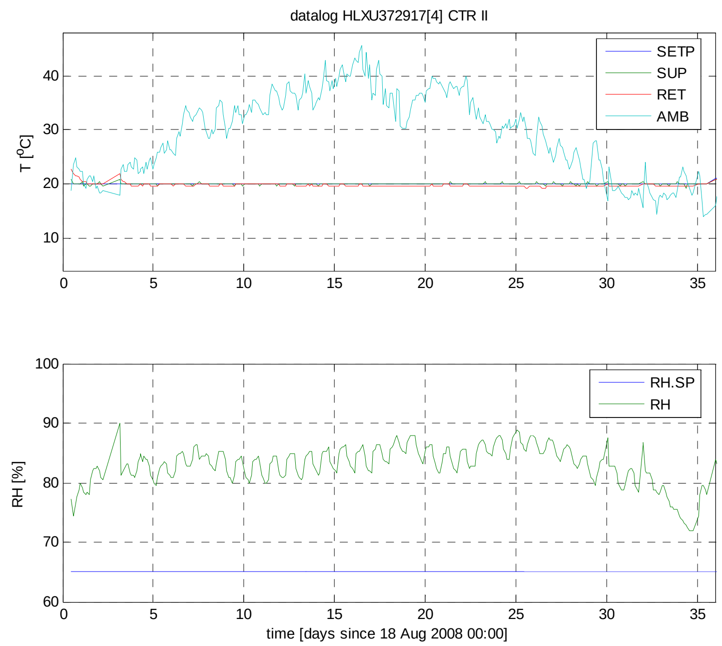

Figure 6 data registered by reefer unit in HLXU3729174 (125 m^3/h).

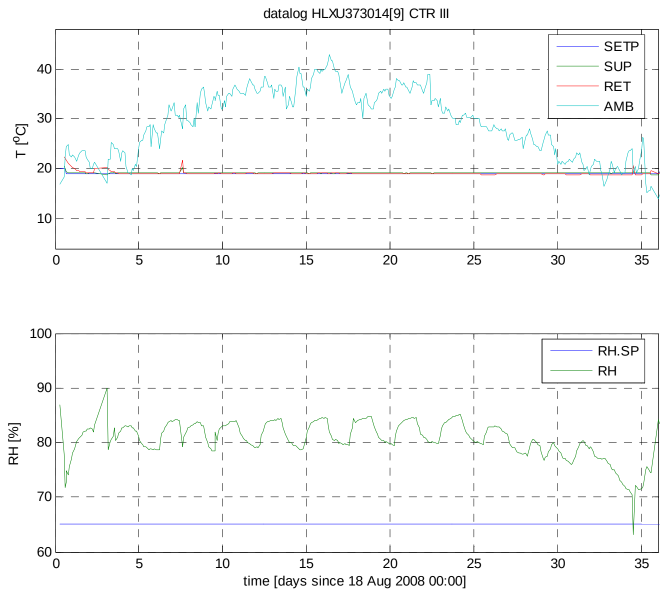

Figure 7 data registered by reefer unit in HLXU3730149 (150 m^3/h).

3.3 Ethylene sample bottles

In each container two bottles were placed to sample ethylene concentration inside the reefer container. When the container was opened for the first time at place of destination the bottle was immediately sealed from the environment in order to preserve the atmosphere in the bottle as good as possible. Afterward the bottles were sent to our laboratory where the samples were measured for ethylene concentration. The concentrations found in the samples are presented in Table 1.

Table 1 Ethylene concentrations in parts per billion (ppb)

	a	b	Average
CTR I	697.7	417.5	557.6
CTR II	38.9	0	19.5
CTR III	390.0	76.6	233.3

CTR I had an average ethylene level of 0.56 parts per million (ppm), CTR II had 0.02 ppm ethylene and CTR III 0.23 ppm ethylene.

3.4 Quality assessment upon arrival

No quality issues were observed by the consignee.

4 Discussion

All cargo sensors show more or less the same pattern. In the containers with a fresh air exchange of 150 m^3/h temperature is slightly lower (Figure 2), because its setpoint is 1 °C lower. Due to physics RH is strongly correlated to temperature: RH increases when temperature drops. So to allow a more profound comparison also absolute humidity X is calculated from temperature and RH, and depicted in Figure 4. Observations from Figure 2 - Figure 4:

1. Differences between pallet centre and pallet top are negligible.
2. Mean temperature in container CTR I (100 m^3/h) is ~ 20.2 °C.
3. Mean temperature in container CTR II (125 m^3/h) is ~ 19.7 °C.
4. Mean temperature in container CTR III (150 m^3/h) is ~ 19.2 °C.
5. Mean RH in CTR II (80.1%) and CTR III (79.0%) is marginally higher then in CTR I (76.8%).
6. Mean abs. hum. is lowest in CTR III: mean absolute humidity is 11.2 g/kg in CTR I, 11.4 g/kg in CTR II and 10.9 g/kg in CTR III.
7. RH at the door-end in CTR II and CTR III slightly increases in time.
8. Absolute humidity at the unit-end is lower than at the door-end for CTR II and CTR III

What explains the observations 7- 8? Absolute humidity at door-end remains constant (Figure 4). Yet RH increases (Figure 3) because temperature at door-end decreases slightly (Figure 2). It remains to be explained why temp. at door-end decreases when sailing warm climates and rises again when sailing more moderate climates after day 25.

The difference between the three unit datalogs is minimal (Figure 5 - Figure 7). Observations:

1. Setpoint of CTR I and CTR II was 20 °C instead of 19 °C.
2. Supply temperature SUP is perfectly controlled at SETP ± 0.2 °C.
3. No defrosts occur, which is right.
4. RH registered by the unit is in range with RH measured in the cargo (Figure 3).

Ethylene levels were determined for all three containers (Table 1). The difference between bottle a and b is big in both CTR I and III. It is hard to say what causes this difference. Possible explanations are the time of bottle closure or possibly minor air leakages of the bottle closures in combination with the 3 weeks delay between sampling and analyses. There is no clear correlation between amount of ventilation set and ethylene level measured. The laws of physics dictate: the more fresh air exchange the lower the ethylene concentration. The fact that this correlation is not observed in the measurements shows that apparently there are other factors which are more decisive for the ethylene concentration in the container. Two containers (CTR I and CTRII) had an ethylene concentration higher than the generally accepted level of 0.1 ppm.

5 Conclusions

1. In this trial fresh air exchange setting has no measurable effect on absolute humidity in the container. The container with higher fresh air exchange does show slightly higher relative humidity, however this solely results from a slightly lower temperature in the container.
2. Worrying levels of ethylene are observed, even in the container with 150 m^3/h fresh air.
3. No clear correlation is observed between fresh air exchange set and ethylene concentration measured, apparently other factors are far more decisive for the ethylene concentration in the container.

6 Recommendations

Don't be afraid to increase fresh air exchange settings in shipments at 20 °C.
!! Warning: be careful not to simply generalize this advice to lower temperature ranges !
To increase understanding, and hence facilitate the achievement of better quality upon arrival, it would be good to do some follow-up studies.

7 Acknowledgements

The authors thank Triflor for facilitating and financially supporting this study, and their cooperation. The authors also thank both Hapag Lloyd and the flowerbulb consignee for their cooperation throughout the project.

Appendix 1, Tracing → container details

Container No.* HLXU 3733385 (e.g. HLCU1234567) Booking No. 32784369 Bill of Lading No. HLCUR

Find

Container Information
Type 22RT Description REEFER CONTAINER Dimension 20' X 8' X 8'6"

Last Movement
The container arrived in MELBOURNE at 2008-09-24 .

Status	Place of Activity	Date	Time	Transport
Gate out empty	ROTTERDAM	2008-08-15	6:19 PM	Truck
Arrival in	ROTTERDAM	2008-08-18	12:57 PM	Truck
Loaded	ROTTERDAM	2008-08-21	4:58 AM	UTE OLTMANN
Discharged	MELBOURNE	2008-09-22	9:34 AM	UTE OLTMANN
Departure from	MELBOURNE	2008-09-23	6:42 AM	Truck
Gate in empty	MELBOURNE	2008-09-24	1:38 PM	Truck

Please note that bold data represend actual data. Non bold columns indicate planned movements.

Container No.* HLXU 3729174 (e.g. HLCU1234567) Booking No. 38784386 Bill of Lading No. HLCUR

Find

Container Information
Type 22RT Description REEFER CONTAINER Dimension 20' X 8' X 8'6"

Last Movement
The container arrived in MELBOURNE at 2008-09-24 .

Status	Place of Activity	Date	Time	Transport
Gate out empty	ROTTERDAM	2008-08-15	6:20 PM	Truck
Arrival in	ROTTERDAM	2008-08-18	12:57 PM	Truck
Loaded	ROTTERDAM	2008-08-21	4:56 AM	UTE OLTMANN
Discharged	MELBOURNE	2008-09-22	9:36 AM	UTE OLTMANN
Departure from	MELBOURNE	2008-09-23	6:44 AM	Truck
Gate in empty	MELBOURNE	2008-09-24	12:52 PM	Truck

Please note that bold data represend actual data. Non bold columns indicate planned movements.

Container No.* HLXU 3730149 (e.g. HLCU1234567) Booking No. 37450557 Bill of Lading No. HLCUR

Find

Container Information
Type 22RT Description REEFER CONTAINER Dimension 20' X 8' X 8'6"

Last Movement
The container arrived in MELBOURNE at 2008-09-24 .

Status	Place of Activity	Date	Time	Transport
Gate out empty	ROTTERDAM	2008-08-15	5:56 PM	Truck
Arrival in	ROTTERDAM	2008-08-18	10:17 AM	Truck
Loaded	ROTTERDAM	2008-08-21	2:13 AM	UTE OLTMANN
Discharged	MELBOURNE	2008-09-21	9:46 PM	UTE OLTMANN
Departure from	MELBOURNE	2008-09-23	6:52 AM	Truck
Gate in empty	MELBOURNE	2008-09-24	1:38 PM	Truck

Please note that bold data represend actual data. Non bold columns indicate planned movements.

Appendix 2, Photos of container stuffing.

Figure 8 Escort T, RH logger.

Figure 9 Ethylene sample bottle

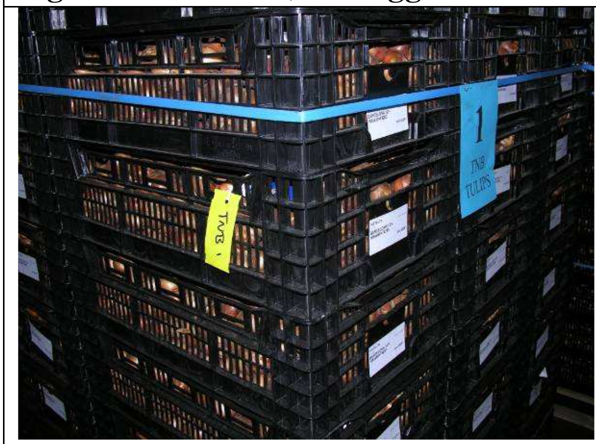

Figure 10 Crates

Figure 11 Label

Figure 12 Loading

Figure 13 Loading