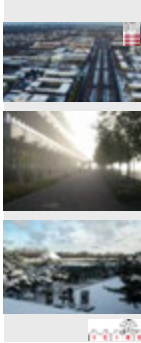


Limiting Criteria for Human Exposure to Low Humidity

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Learning Objectives



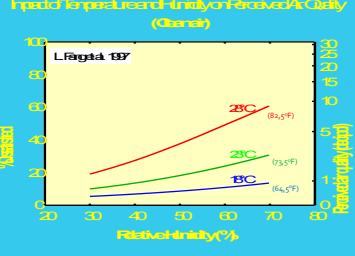
1. Understand the effects of humidity on health, comfort, IAQ and on elderly people
2. Understand that healthcare-associated infections increase when the humidity decreases too much
3. Understand the human physiological reactions to low humidity
4. Understand the effects of low humidity on working performance

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Reference



Perceived air quality as a function of temperature and relative humidity



Low humidity and the sensation of dryness



Reference	Results	Humidity range
Sundell and Lindvall (1994)	"Sensation of dryness" has little to do with physical air humidity	10 – 40% RH
Andersen and Proctor (1982)	Dryness of nose do not related to RH	9 – 50% RH
Andersson et al. (1975)	Decreasing relative humidity do not increase the sensation of dryness	25 – 40% RH

Low relative humidity requirements in standards



Objectives

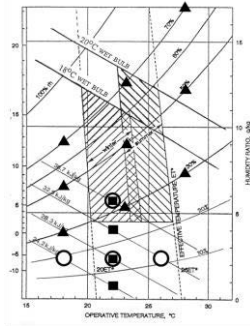
- To study the effect (both positive and negative) of low humidity on human health and comfort during a short term exposure
- To study the interaction of low humidity with air temperature and air pollution during a short term exposure
- To verify the sensitivity and suitability of the objective measurements for use in the field experiment

Laboratory experiment



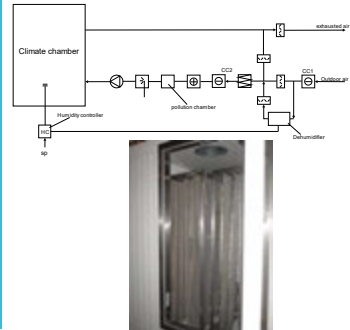
- Clean condition
 - four levels of humidity at 22°C (71.5°F): 5, 15, 25, 35 %RH
- Polluted condition
 - two levels of humidity at 22°C (71.5°F): 15 and 35% RH
 - three levels of temperature at the absolute humidity of 2.4g/kg (15%RH at 22°C (71.5°F)): 18, 22, 26 °C (64.5, 71.5, 80°F)

i-x chart



Pollution sources:

- carpet (28 m²/301 ft²)
 - linoleum (20 m²/215 ft²)
- in pollution chamber



Subjects and procedure



- 60 subjects both male and female including normal, sensitive and contact-lens wearers
- Performing simulated office work during 300 min exposure:
 - Text typing
 - Simple addition calculations
 - Reading

Subjective measurements



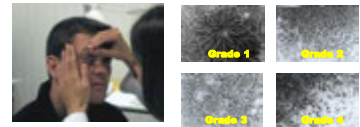
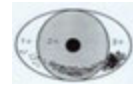
- Assessments of air quality:
 - acceptability and odor intensity
- Specific acute subclinical health symptoms:
 - eye, nose, lip, throat, and skin irritation and dryness
- Neurobehavioral (general) acute subclinical health symptoms:
 - headache, fatigue, dizziness and alike

Physiological measurements

- Eye measurements
- Skin measurements
- Nose measurements

Eye measurements:

- Tear film break-up time (BUT)
- Rose Bengal Score
- Inter-blinkrate
- Mucous ferning test



Skin measurements:

- Evaporimeter: Transepidermal Water Loss
- Corneometer: Skin Hydration
- Colorimeter: Skin colour

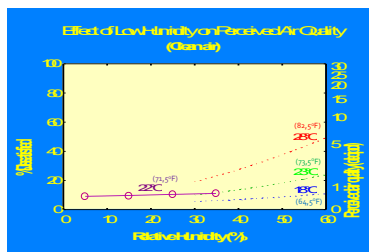


Nose measurements:

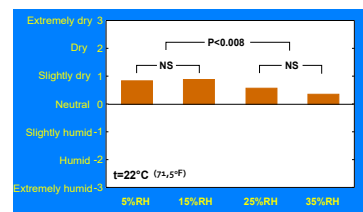
- Nasal peak-flow
- Nasal transit time



RESULTS: Effect on perceived air quality

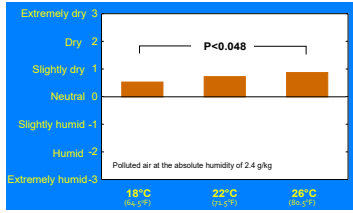


RESULTS: Humidity sensation @ constant temperature (clean air)



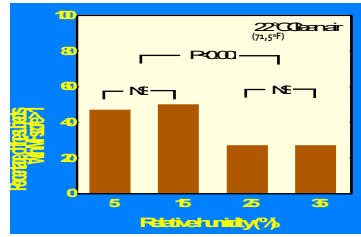
RESULTS:

Humidity sensation @constant absolute humidity (polluted air)



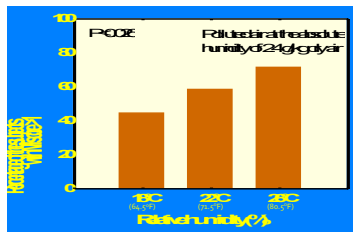
RESULTS:

Mucous fering (grade 2-4) @constant temperature (clean air)



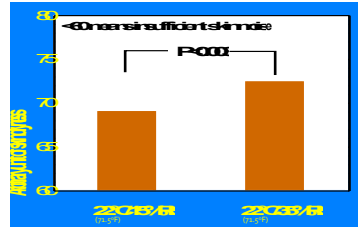
RESULTS:

Mucous fering (grade 2-4) @constant absolute humidity (polluted air)



RESULTS:

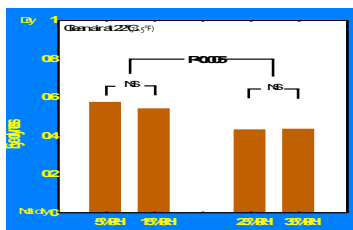
Skin dryness measured by corneometer



RESULTS:

Acute health symptoms (clean air)

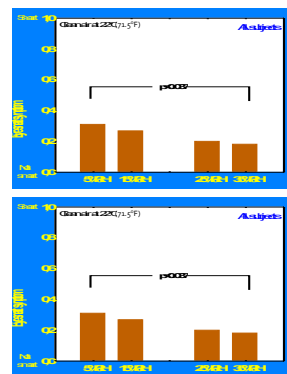
DRY EYES



RESULTS:

Acute health symptoms (clean air)

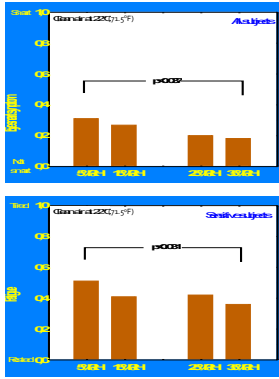
SMARTING EYES



RESULTS:

Acute health symptoms (clean air)

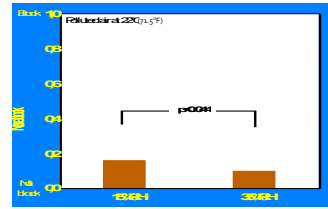
FATIGUE



RESULTS:

Acute health symptoms (polluted air)

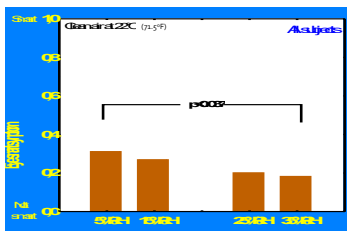
BLOCKED NOSE



RESULTS:

Acute health symptoms (polluted air)

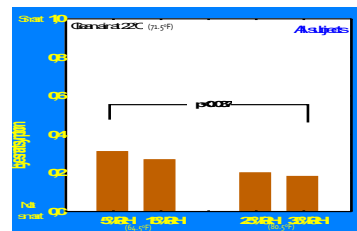
IRRITATION OF THROAT



RESULTS:

Acute health symptoms (polluted air)

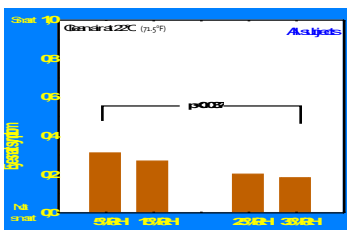
IRRITATION OF NOSE



RESULTS:

Acute health symptoms (polluted air)

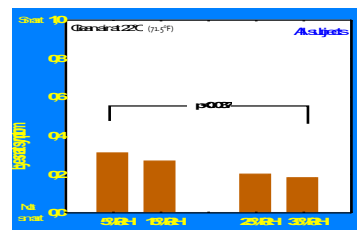
DRYNESS OF LIPS



RESULTS:

Acute health symptoms (polluted air)

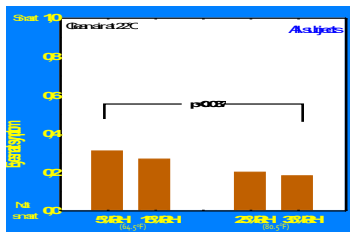
DRYNESS OF SKIN



RESULTS:

Acute health symptoms (polluted air)

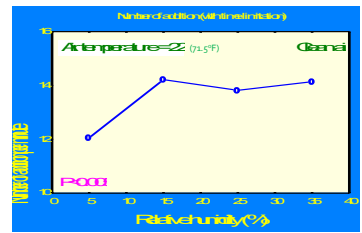
DRYNESS OF THROAT



RESULTS:

Performance

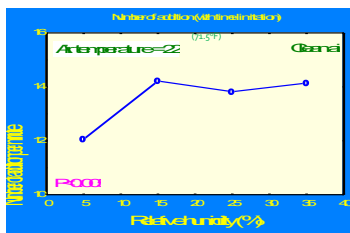
ADDITION (speed)



RESULTS:

Performance

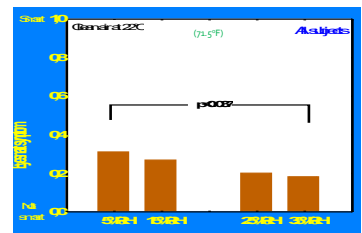
TEXT TYPING (speed)



RESULTS:

Performance

PROOF-READING (speed)

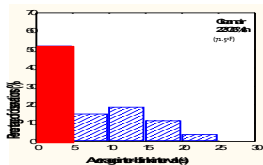
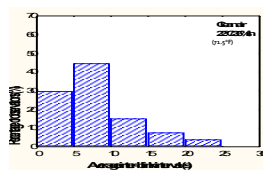


RESULTS:

Blink rate

35% RH vs. 5% RH

@ 22°C (71.5°F) and clean air



Summary

- Exposure to low humidity for five hours does not create severe SBS symptoms for normal healthy people.
- Exposure to humidity at 15% RH or below for five hours aggravates SBS symptoms for environmentally sensitive people.
- Exposure to high air temperature (26 °C (80.5°F)) at low humidity increases dryness sensations and other related symptoms for environmentally sensitive people.
- Air pollution at normally occurring levels exacerbates the effect of low humidity on the SBS symptoms of environmentally sensitive people.
- Performance of simulating office work decreased considerably when people exposed to the extremely low humidity, e.g. 5%RH.

Conclusions

- Little discomfort was observed when people exposed to low humidity.
- Measurable negative effects (both subject and objective) were observed when people exposed to humidity at or below 15%.
- Air pollution may interact with low humidity and cause throat, nose, skin and lips symptoms.
- Sensitive people is more likely be bothered by low humidity.

Questions and comments

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