



The instrumented citrus transport ship sits at the dock awaiting departure. Inset photos: the rotary valve, datalogger, CO₂ analyzer, and tubing.

CR10X measures on-board CO₂ levels and temperature

South African Citrus Research Institute monitors exports

South Africa's subtropical climate is favorable for citrus fruit production. South Africa annually exports roughly one million tons of citrus fruit, comprised primarily of oranges, grapefruit, and lemons, to various overseas destinations. During shipment, the carbon dioxide (CO₂) and temperature levels surrounding the fruit play a vital part in preserving its freshness. A typical shipment from Maputo, South Africa to the USA takes about two weeks. During transit, many shipping companies promise to keep the CO₂ and temperature within acceptable tolerances.

To confirm this, the South African Citrus Research Institute initiated a project to measure CO₂ and temperature levels during a routine shipment to see whether the prescribed levels are continuously maintained. To reduce the cost of the study, the challenge was to measure CO₂ levels at eight points within the citrus cargo hull without using eight CO₂ analyzers. CS Africa developed the monitoring system using a CR10X datalogger, a VICI 8-port rotary valve (stepper motor controlled), a LI-COR LI-820 CO₂ analyzer,

hundreds of meters of tubing, and a vacuum pump.

A standard measurement cycle consisted of setting the rotary valve to the first port with a CR10X control port, initiating the vacuum pump, drawing a sample for 60 seconds through the connected tube, taking a CO₂ reading with the LI-820, then stepping the valve to the next position with a CR10X control port. This sequence was repeated until all eight lines were measured. Temperature was also simultaneously logged using thermocouples.

To accommodate the client's limited budget, CS Africa could not use an expensive vacuum pump; instead, we effectively modified an inexpensive air pump. The first instrumented shipment showed the measurement system worked as planned for the two week travel time. Beginning on day two, the CO₂ level not only exceeded the prescribed limits, they exceeded the LI-820's measurement range of 5000 ppm. To determine what the CO₂ levels are throughout the shipment, a 20,000 ppm optical bench has been fitted for the next trip.

APPLICATION AT A GLANCE

Application type:
Monitoring perishable goods during overseas shipment

Project area:
Transatlantic vessel at sea between South Africa and the United States

Author:
Johan Visagie and Charl LeRoux, Campbell Scientific Africa

Contracting agencies:
South African Citrus Research Institute

Datalogger(s):
Campbell Scientific CR10X

Measured parameters:
Carbon dioxide (CO₂) levels, temperature