INVESTIGATIONS OF CHINESE CABBAGE COLD STORAGE CHAMBER OPERATION

Mirosława KOŁODZIEJCZYK, Dariusz BUTRYMOWICZ, Jerzy GAGAN, Kamil ŚMIERCIEW

Bialystok University of Technology, Bialystok, Poland
• INTRODUCTION
• COLD ROOM AND MEASURING SYSTEM
• RESULTS OF MEASUREMENTS
• CONCLUSIONS
Experimental studies of inner-air parameters in cold storage chambers for fruit and vegetables are very difficult to perform due to:

- tightly stacked interior of cold stores,
- low temperature
- high humidity
- the bed of vegetables is not uniform

**Additionally:**
- heat exchanger of the cooler - freezing
- require periodic defrosting

During the long-term cold storage of the Chinese cabbage was investigated how the bed of vegetables reacts on changes in working conditions of the cooler consisting in different modes of power supply (100%, 80%, 60% and 40% of fan power drive).

**The particular attention was paid to the:**
- defrosting effect on temperature within the cabbage load
- possibility indicate places,
  - most exposed to the temperature changes,
  - excessive drying
  - cold injuries
COLD ROOM AND MEASURING SYSTEM

2.8m x 1.8m x 2.93m.

- speed of air at four different levels in the midplane of the chamber (V1 - 5 cm below the ceiling, V2 - 20cm below the ceiling, V3 - 40cm from the ceiling, V4 - just above the bed, 63 cm from the ceiling),
- relative humidity and temperature at a fixed height in the central plane of the room (RH2 - 40cm from the ceiling),
- velocity and temperature near the side wall (V5 - 52 cm from the ceiling),
- temperature at the same grid points of the mobile system as for the case of speed measurements (V1T at points of V1; V2T at points of V2; V3T – at V3 points, V4T – at points of V4 and V5T at points of V5).

The data were collected at 8 verticals during 10 min. of rest at each position with frequency of 1Hz.
COLD ROOM AND MEASURING SYSTEM

Measuring grid for fixed probes locations

- relative humidity at the inlet to the cooler (RH1) and
- temperature on the heat exchanger fins (T01),
- reference temperature near the inlet to the cooler T02,
- temperature on the ceiling (T03),
- temperature at two points on the wall opposite the cooler (T04 and T05),

**air temperature at 7 points inside the cabbage bed**

- Tp1 and Tp2 in the right rear corner of the bed looking from the cooler,
- Tp3, Tp4, Tp5 in the middle of the bed
- Tp6 and Tp7 in the left front corner).
During the experiment following measuring instruments were applied:

- to measure the speed:
  - omnidirectional probe Delta Ohm HD103t with accuracy of ±0.04 m/s in the range of 0÷0.99 m/s and ±0.2 m/s in the range of 1÷5 m/s; they were also used to measure temperature;

- to measure the relative humidity and air temperature above the bed and at the inlet to the cooler:
  - an EE Elektronik sensor of J type with accuracy of 2.7% in the range above 90% RH and 1.5% below 90% RH;

- to measure the temperature in the bed:
  - thermocouple CZAKI 361K-3-W3;

- to measure temperature at points T01, T02 and T03
  - CZAKI RTD PT 100.
Measurements were recorded on a continuous basis from November 2014 to March 2015 and also with the mobile system from January 2015 until March 2015.

RESULTS OF MEASUREMENTS

- **100% power drive**
- **80% power drive**
- **60% power drive**
- **40% power drive**
Results of Measurements

Temperature of air at fixed points of measuring grid versus time for different fan modes

- 100% power drive
- 80% power drive
- 60% power drive
- 40% power drive
RESULTS OF MEASUREMENTS

Relative humidity at a point RH1 and at RH2 level versus time for different fan modes

100% power drive

80% power drive

60% power drive

40% power drive
RESULTS OF MEASUREMENTS

Temperature in a bed versus time for different fan modes

100% power drive

80% power drive

60% power drive

40% power drive
CONCLUSIONS

The cold store for vegetables creates an extremely complex environment subjected to dynamic, time-varying processes of heat and mass transfer.

- Thermal conditions in the cold store were changing constantly
- Frost build-up in the cooler has a clear impact on the parameters of air in the chamber
  
  by reduction of the flow area in the cooler, causing an increase of the flow resistance, which consequently, reduces the speed of the air blown out of the cooler.

- The need of defrosting results is a rapid, short-term temperature rise across the whole cold room (to varying degrees, depending on location).

- Defrosting lasted 10 min., but its influence on the temperature in the chamber and in the bed extended to longer times.

- Air parameters are not fixed and depend strongly on the operation of the cooler.
- Decreasing the power of the fans reduces the negative impact of the defrost on the bed
CONCLUSIONS

- Unfavorable influence of decreasing of power drive was no observed (at least during the study period) up to 60% of nominal power

- Cooling operation mode of 40% carries too high a risk of overheating of the bed of vegetables due to too low speed, the poor ventilation of the bed, too low level of the moisture content in the chamber, and too large fluctuations of relative humidity in the store.

Thank You