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Precooling Machine

Prayouth Suwanchewakorn[1] and Bundit Jarimopas[1]

ABSTRACT

This research is aiming to develop a precooling machine. Forced Air Precooling Room has been designed and constructed with the insulated room of 3.0 x 3.6 x 2.4 m^3. The unit consists of a cooling system using R12 refrigerant with cooling load of 1.5 tons, humidity control system, and forced air axial flow fan. Results showed that it took 8 hours to precool 484 kgs. of tangerine from 32°C to 4°C.

Keywords : Forced Air Precooling, Tangerine Precooling.

INTRODUCTION

This research and development project has been established from the budget year of 1989. The aim of the projuct was to develop equipments for packing house for agricultural preducts to enhance export of fresh produce to foreign markets.

Presently, the duty of Department of Agricultural Extension, Ministry of Agriculture and Cooperative and Ministry of Interior are encouraging the farmers to increase the production of horticultural crops for local and exported markets. Professor Dr. Hirotoshi Kitakawa mensioned that Thai fruits and vegetables such as young coconut, mango, durian, pomelo, papaya, mangosteen, rambutan, longan, asparagus, onion, roselle, baby corn, ginger and green nut [5] had high potential in Japanese market. Ministry of Science, Technology and Environment has supported all the postharvest technology transfer, research and development works and farm machinery manufacture industry. The universities are the center of knowledge and consultants for establishment.

The feasibility and technology of packing house from foreign countries was dissiminated to farmers and other Thai people [8]. Furthermore, the thinking and performance of distincted farmer who tried to develop postharvest equimpments and packing house for Thai fruits in East region by himself, were also propagated (Jarimgas and Sihawong, 1989). This phenomena revealed that the technology of postharvest equipments and packing house were needed and really benefitted to commercial scale. The interest of farmers was expanded until the group of farmer in East region asked for the center of fruits for export and processing (Poorpanich, 1989). The center equipped with packing house and equipments was supported by government after farmer requirements. Ministry of Agriculture and Cooperative, The Board of National Economic and Social Development and the Committee of promoted policy for Development of fruit and vegetable for export, also realized the importance of packing house and hvae established the project of development center for production and pest control of exported vegetable and fruit with imported equipments from abroad (Meenanant, 1987). Each center had the value of about 100 million baht. For private agro industries such as Kun Arronsri, Shell and C.P. Intertrade Co. ltd. were constructing packing house for exported fruits and vegetables. Thai government supported to establish the development center for production and pest controls of exported vegetable and fruits in Chacheongsao Province [16]. As Thai produce has typical characteristics which are different from foreign produce, hence the machinery and packing house suitable for Thai environment should be developed beside the sizing, waxing and ripening machines for fruit which already developed (Jarimopas *et al.*, 1990, 1991).

1 National Agricultural Machinery Center, Kasetsart University Research and Development Institute, Kasetsart University, Kamphaeng Saen Campus, Nakhon Pathom 73140, Thailand.

METHODS

Components and Performance

The precooling machine of forced air type was constructed from the following components (Figure 1).

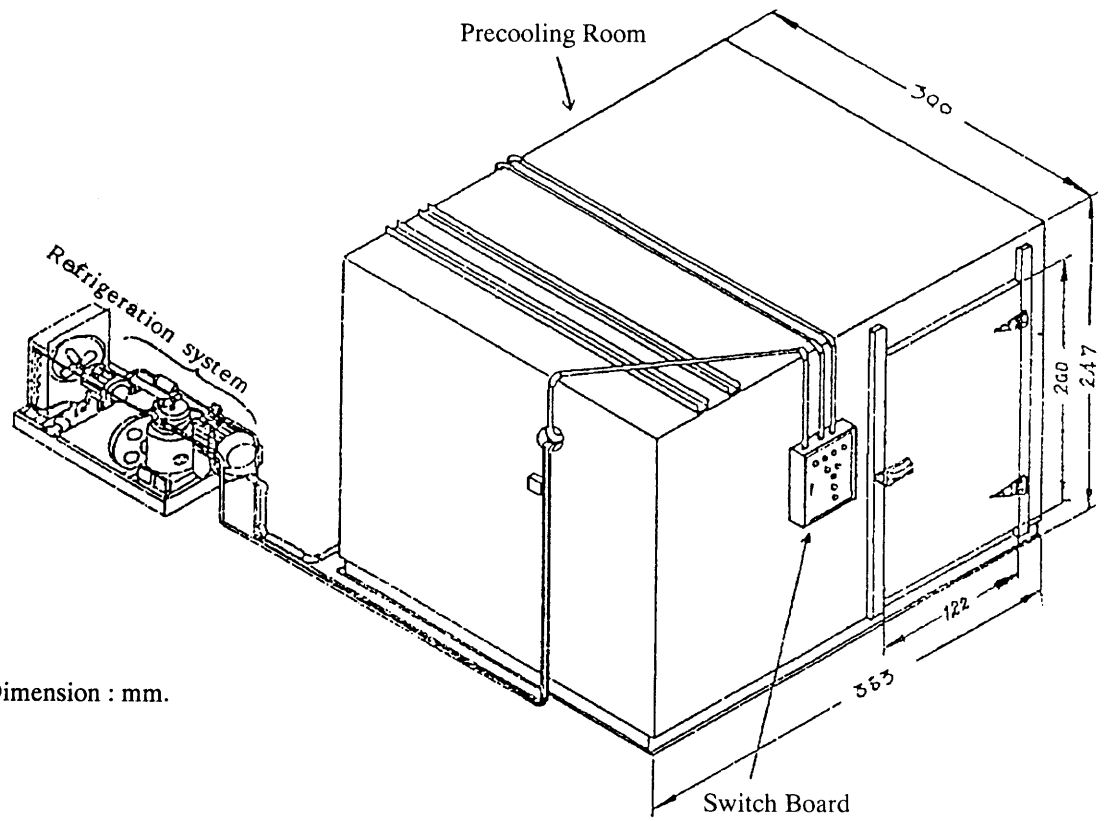
1. Precooling room had the same characteristice as other refrigeration room by the size of 3x3.6x2.4 m., interior capacity of 20 m^3, 4 inch thick foam for wall insulation and the room placed upon the floor made from I shaped steel frame for easy movable.
2. Refrigeration system composed of refrigeration eqiupments, R. 12 as refrigerant, cooling load of 1.5 tons and digital temperature measuring and control set equiped at control board.
3. Humidity control set composed of measuring equipments and hygrostat, compressor, water tank and tube, and water atomizer.
4. Blower set for cooled air circulation composed of axial flow fan sized of 12 inch and 0.5 hp. driven motor equipped over air suction chamber which the air suction opening could be adjustable.
5. Control switch board

Performance of precooling machine

Place the required fruit for precooling in the fruit containers, then piling the containers before the air suction opening and cover the piles of containers by plastic cloth. The covering of plastic cloth was opened at the opposite side to air suction chamber hence cooled air could be moved through the pile of fruits and sucked out by blower to the back of refrigeration system where the air was cooled down before suction back to the pile of fruit again as the cycle of cooling. (Figure 2,3).

Humidifying

While the refrigeration system was on operat-



Dimension : mm.

Figure 1 Schematic diagram of precooling machine and equipment.

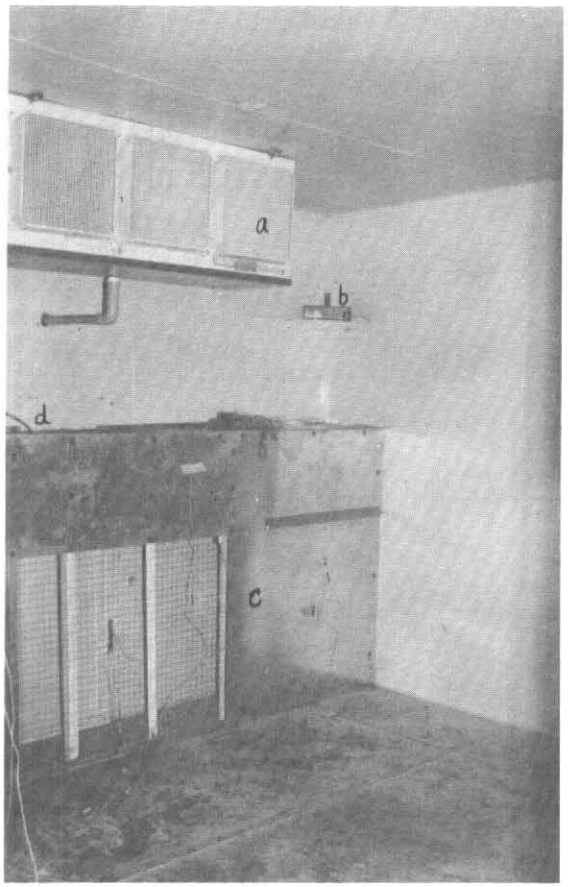


Figure 2 The interior of precooling room composed of
a) evaporator
b) water atomizer
c) air suction chamber
d) blower set for cooled air circulation

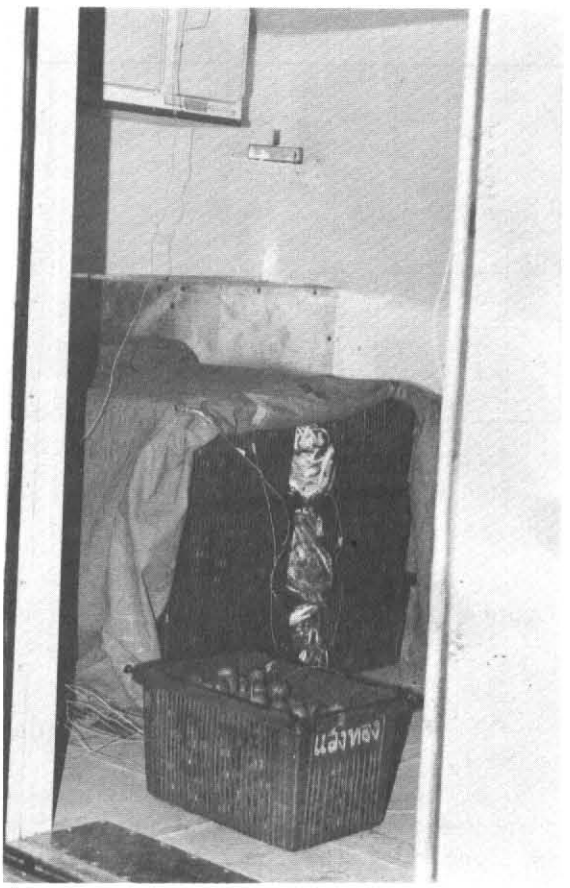


Figure 3 The interior picture of precooling room while precooling the orange fruit.

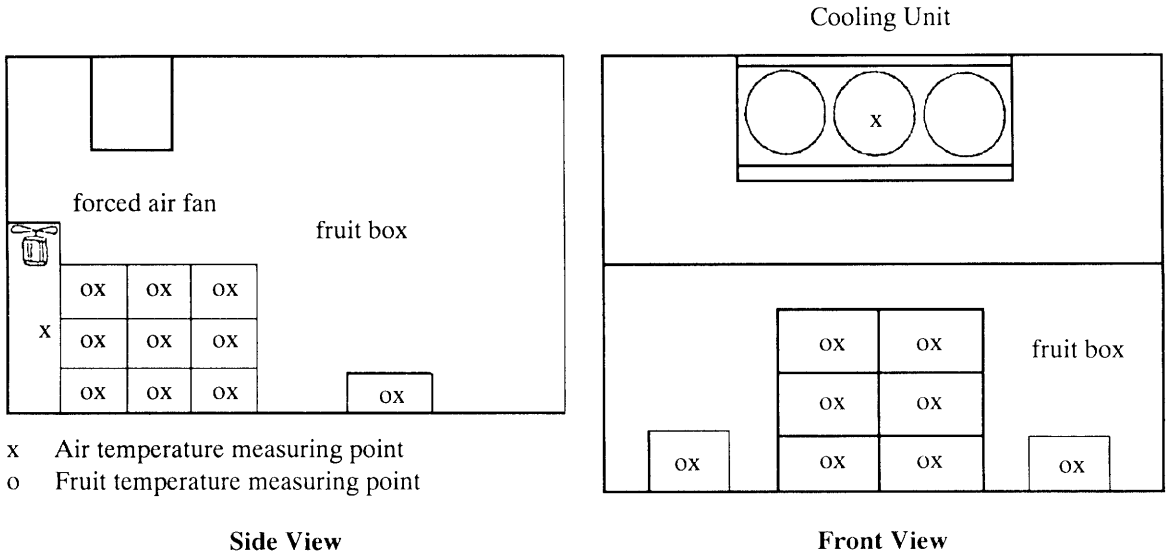
ing, some humid air would condense to water droplets at the refrigeration evaporator and was blown out from the precooling room. As the relative humidity in the precooling room decreases so the fruit will transpire which will increase the moisture loss from fruits, hence the humidifier's set was added into the precooling room where hygrostat was used for measuring the relative humidity of the air in the precooling room. When the moisture was lower than the set point, the compressor would press the air through atomizer then the sprays of water were distributed through the room for increasing humidity to the air in the precooling room.

However, the humidifying operation together with cooling process at the same time would increase the large amount of cooling load. In the case of the fruits which were not much damaged by moisture loss, the humidity would be adjusted to equilibrium after the temperature was cooled down to the required level.

Testing

Equipments and materials

1. Constructed precooling machine of setting temperature at 5 degree celcius



x Air temperature measuring point
o Fruit temperature measuring point

Side View **Front View**

Figure 4 Temperature measuring points, inside and outside precooling room.

2. Temperature recorder and measurring wires for 25 Channels.

3. Tangerine orange fruit was contained in plastic basket which had the opening for venting the air. The net weight of tangerine was 484 kg. contained in 20 plastic baskets of which 18 of them were placed in front of forced air while other 2 plastic baskets were placed in available vacant area in the precooling room

4. Watt meter

Testing methods

1. Connecting the temperature measuring points according to Figure 4.

2. Connecting the temperature measuring wire with data recorder. When the precooling room was begun to operate then measuring the change of temperature at various points every 5 minutes until the fruit temperature reached the required temperature.

3. Measuring the watt power requirement of precooling machine while operating.

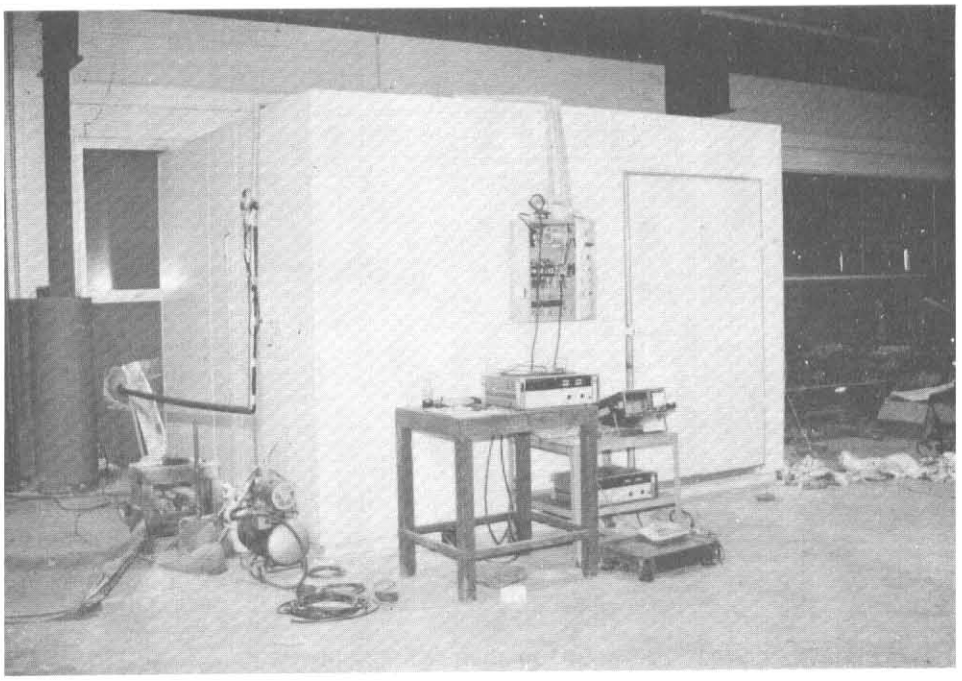
4. Pausing the operation of precooling machine and analysing the data of cooling performance

RESULTS AND DISCUSSION

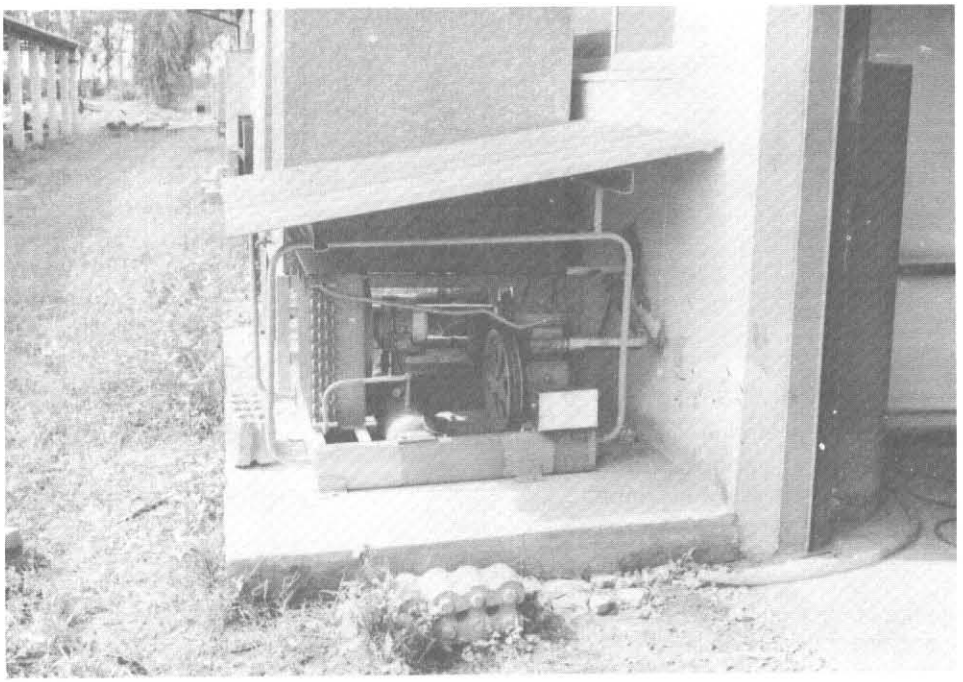
The real picture and schematic diagram of precooling machine were shown in Figure 5 and 6. The relation of changing temperature with time at various positions inside and outside the precooling room was shown in Figure 7, where the meaning of graph numbers were:

No. 1 temperature outside the precooling room,
No. 2 temperature inside the fruits piled outside the forced air area,
No. 3 temperature inside the cavity between fruits piled outside the forced air area,
No. 4 temperature inside the fruits piled inside the forced air area,
No. 5 temperature inside the cavity between fruits piled inside the force air area,
No. 6 temperature of cooled air blown back to evaporator again

The beginning temperature of 484 kg. tangerine was 32°C which was cooled to 4°C by precooling machine in 8 hours while the temperature of fruits which had no passing of forced air system were about twice of the forced air precooling fruits. When the temperature of fruits and the room was in equilibrium, the available temperature was lower than the setting temperture by controller of about 2°C. As the position of the temperature probe belonged to temperature control set, it was placed at the middle of the room but the circulated-cooled air stream was moved near the wall. So the temperature sensed probe measured



a) Precooling room of 3.0 × 3.6 × 2.4 m.



b) Compressor, Condenser and Reciever Tank

Figure 5 Real picture of precooling machine.

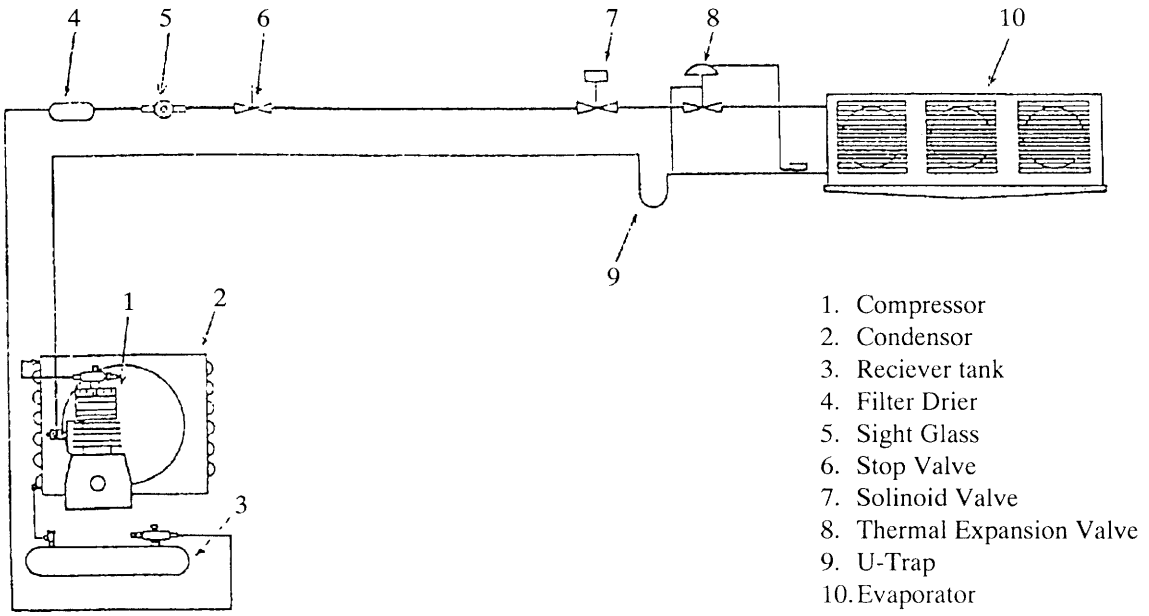


Figure 6 Schematic diagram of precooling machine's components.

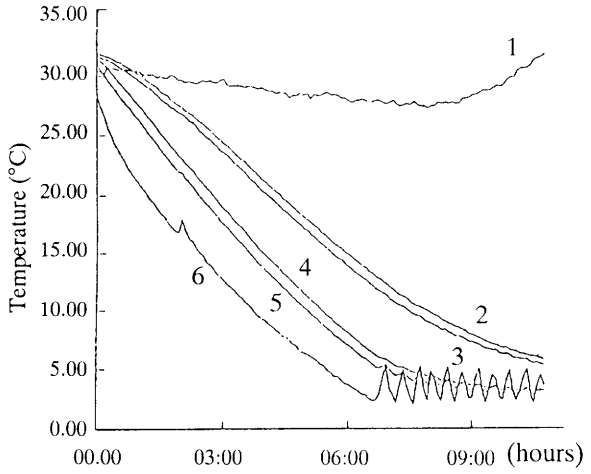


Figure 7 The relation of changing temperature with time at various positions inside and outside precooling room.

1 Temperature outside the precooling room
2 Temperature inside the fruits piled outside the forced air area.
3 Temperature inside the cavity between fruits piled outside the forced air area
4 Temperature inside the fruits piled inside the forced air area
5 Temperature inside the cavity between fruits piled inside the force air area
6 Temperature of cooled air blown back to evaporator again

higher value. Changing the position of connected probe to the back area of evaporator might be the suitable method.

The precooling machine required the electrical power 10.01 kilowatt, 3 phase and 4 wires electricity.

CONCLUSION AND RECOMMENDATION

The constructed precooling machine was able to reduce fruit temperature to 1/8 of original temperature in 8 hours while the fruits untreated with forced air cooling system required longer time than the treated system. The distribution of the amount of fruit and vegetable for precooling versus time of precooling to the required temperature should be studied further.

ACKNOWLEDGEMENT

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