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REFRIGERATION

Mobile precooler for fruits and vegetables

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I.R. MacKinnon, R.K. Prange, and P.D. Lidster
Research Station,
Kentville, N.S.

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FOREWORD

This publication is the first in a series intended to respond to specific refrigeration needs in the agri-food sector. The series is sponsored by the Expert Committee on Refrigeration (ECR), which is part of the Canada Committee on Food (CCF) that reports to the Canadian Agricultural Services Coordinating Committee (CASCC) of Agriculture Canada. As part of its mandate, the ECR recommends to the CCF appropriate courses of action to take where solutions for problems are known to exist and no research is needed to implement known technology. In this instance, the ECR has recommended and Agriculture Canada has agreed to publish a series of pamphlets aimed at producers, agricultural engineers, and the service and technical supply industries. This series is intended to ensure that current and objective practical information is available for use mainly in the cooling and storage of fresh fruits and vegetables.

Later pamphlets in this series will address such topics as design and construction of controlled atmosphere storage, atmosphere generation and control, and determining refrigeration requirements for cooling and storage. The authors will review and revise their pamphlets from time to time to ensure that the contents remain current and useful.

P. PERRIN
Coordinator
Expert Committee on Refrigeration

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INTRODUCTION

Precooling is the rapid removal of field heat prior to the shipment or storage of fruits and vegetables. Precooling is one of the most important stages in handling harvested fruits and vegetables because it optimizes storage life. The use of forced air is the most versatile method of precooling and is suitable for a wide variety of produce. It can be performed in-transit with a mobile unit.

A mobile precooler can be moved through a field and loaded with cartons of the harvested crop. The doors can then be closed, the cooling equipment turned on, and the produce transported to the cold storage room or market. A mobile precooler has the potential to reduce energy consumption, to minimize handling, and to cool more effectively. Using a mobile precooler, the cooling of respiring produce can begin sooner than is possible using conventional, stationary precoolers.

Some general precooling information and guidelines are given, followed by details on the construction of the prototype unit.

GENERAL PRECOOLING REQUIREMENTS

A forced-air precooler needs to provide a minimum of 1 L/s of air for every kilogram of produce to be cooled. This air should be refrigerated to 0°C and maintained at a minimum relative humidity of 90%. It is useful to consult handbooks as to temperature requirements for individual crops, because some produce may be damaged by being chilled below 12°C.

MOBILE PRECOOLER SPECIFICATIONS

A prototype of the precooler unit was constructed from an insulated highway container 6.1 m long and mounted on a trailer chassis. The wheels are suitable for highway or field use (Fig. 1). A 0.6-m extension added to the front of the container accommodates the compressor, diesel motor, and condenser coils. The first 0.9 m inside the container houses the evaporator coils and fan, leaving about 5.2 m in which to place the harvested crop. A maximum of six standard pallets (1.20 × 1.07 m) can be loaded at any one time (Fig. 2).

Assuming that each pallet holds 570 kg of produce and based on general precooling requirements, this system would need, at the minimum, a 3420-L/s fan. In practice, the system is powered by a 17-kW diesel motor, which provides a 26-kW refrigeration effect. Its 50-cm diameter centrifugal fan circulates refrigerated air at 4700 L/s, which is well above the calculated minimum requirement. A large evaporator coil (990 × 2133 mm, 8 row, 8 fins per 25 mm), placed on the suction side of the fan, provides the precooling capacity and maximum humidity.

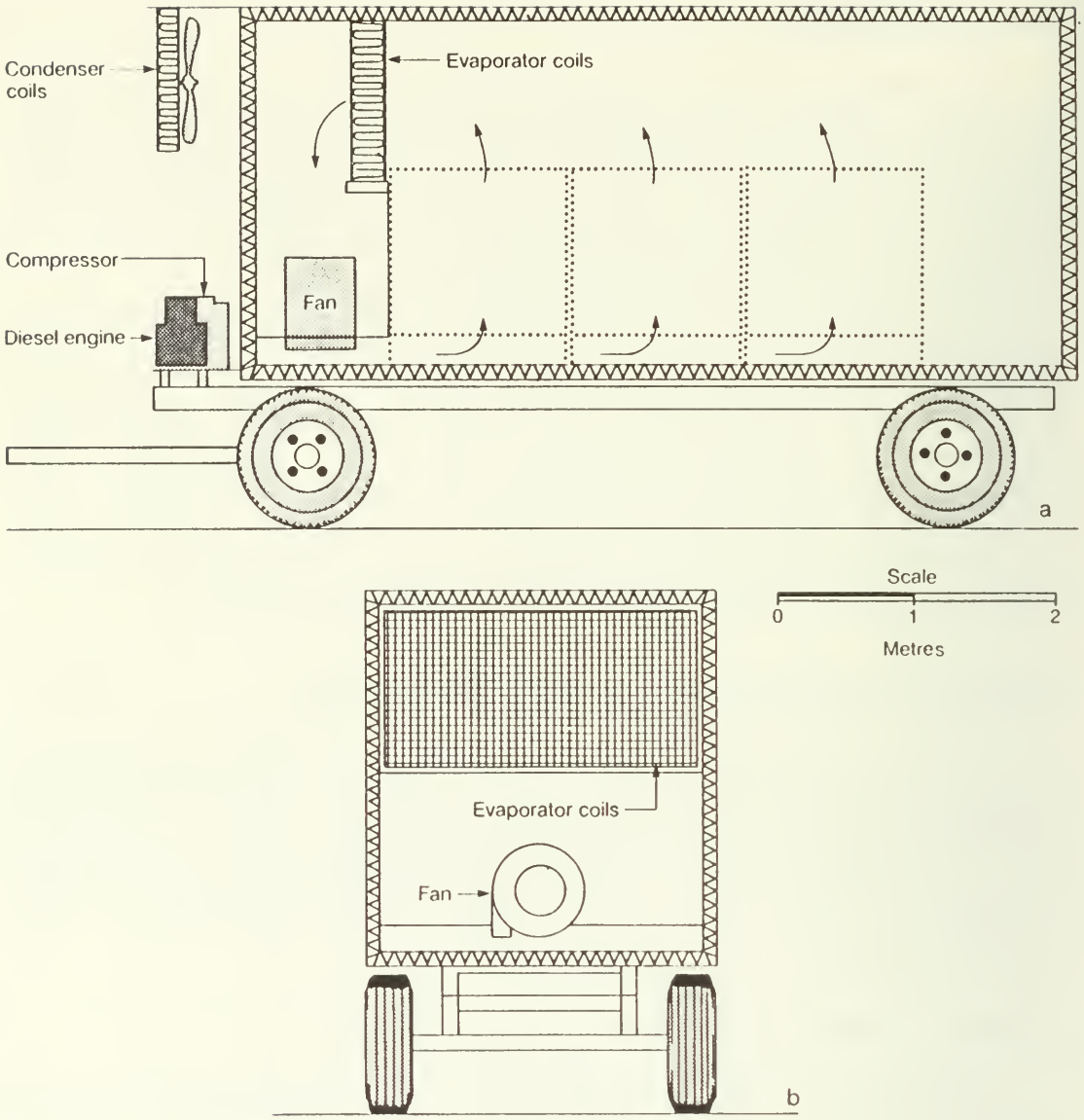

Fig. 1 Mobile precooler for fruits and vegetables: (*a*) side view, (*b*) end view.

Based on commercial experience during midsummer operation, the prototype unit could cool up to six pallets of moderately respiring crops, e.g., cauliflower, Romaine, or head lettuce, in 6 h.

The defrost system chosen depends on the usage patterns. Continuous usage requires a hot-gas defrost system whereas a power-off defrost system would suffice if precooling were used only once or twice per day.

Air movement

The large fan located in the front section of the container along with the evaporator coils is mounted so that air blows directly onto the floor. This air then escapes through a slot 0.1 × 2.4 m, opening into the pallet fork spaces. Air, being supplied from the bottom, rises from

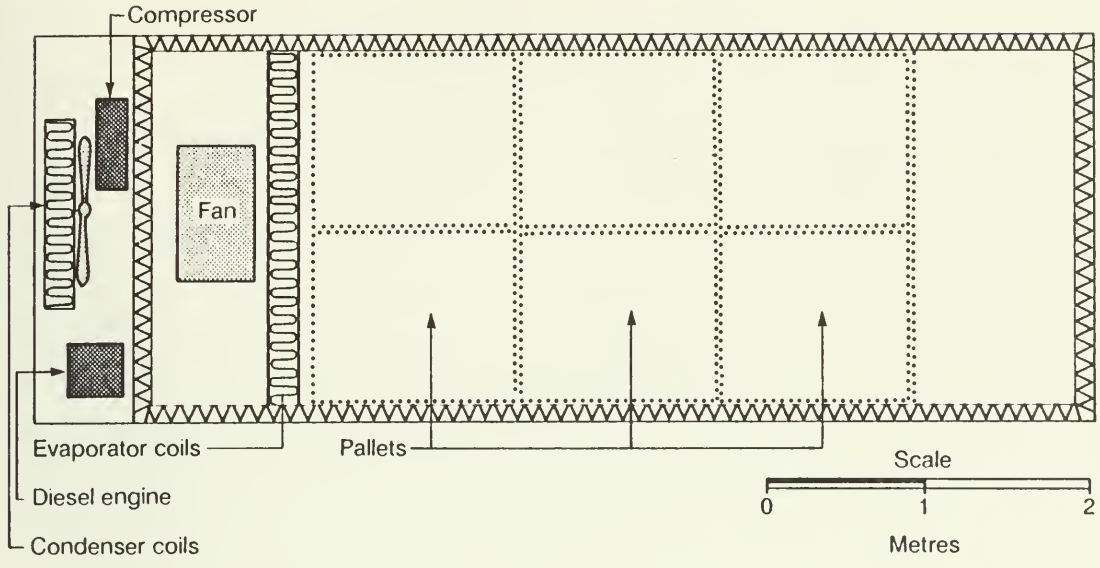

Fig. 2 Plan view of mobile precooler for fruits and vegetables.

an area of positive pressure through the pallets to an area of negative pressure in the head space above. The air returns from the top area to the evaporator coils. Reversing the direction of airflow draws air through the pallet fork spaces. In this way the produce may be cooled more effectively because heat generated from the fan is imparted to the return air rather than to the discharge air.

CONSTRUCTION NOTES

Inspect the container for soundness and refurbish the insulation where necessary. If using an uninsulated container, apply sufficient high-quality insulation, such as injected foam polyurethane, to the floor, walls, and ceiling, to achieve an RSI factor of 3 or higher.

Take care to select sizes of compressor and diesel engine that avoid excessive vibrations. For example, a three-cylinder compressor coupled with a three-cylinder diesel engine could produce harmonic vibrations that would reduce the life of the components in the system.

Carton design and stacking pattern

Carton design and stacking pattern are important in any forced-air cooling system, as they affect air movement through the pallets. Provide a minimum of 5% open area in the face of the carton surfaces through which air will flow. Use a stacking pattern that will stabilize the pallet and maximize the vertical airflow through the openings in the cartons. If the container openings are blocked by other containers, reduced airflow and insufficient cooling will result. Ensure that the pallet stacks remain intact during shipment so that removal from the precooler can be done with a forklift to minimize labor and reduce handling damage.