DEVELOPMENT AND FABRICATION OF SEED STORAGE SYSTEM FOR COMMUNITY LEVEL SEED BANK FOR MARGINAL FARMERS

Akshayakumar S H[1], Dundayya V H[2], Ajay S D[3], Mahendra B B[4], Prof.R.H.Angadi[5]

[1,2,3,4]Akshayakumar S H: Dept. of Mechanical Engineering, Angadi institute of technology and management Belagavi, Karnataka, India.
[5]R.H.Angadi: Professor, Dept. of Mechanical Engineering, Angadi institute of technology and management Belagavi, Karnataka, India.

---***---

Abstract - *There are several operations between seed production and distribution. Data were collected on socioeconomics, seed procurement, handling and distribution activities of marketers, as well as seed production, storage and distribution activities of seed producing institutions. This study analyzed the prevailing situation surrounding seed business and considered its implication on seed quality in Southwestern Nigeria. Surveys were conducted in 2009 on seed marketers and public Institutions handling seeds within the zone using structured questionnaires. In present scenario, with the increase in awareness towards environmental degradation due to the production, use and disposal of Chloro-Fluoro-Carbons (CFCs) and Hydro Chloro-Fluoro-Carbons (HCFCs) as refrigerants in conventional refrigeration and air conditioning systems has become a subject of great concern and resulted in extensive research into development of alternate refrigeration systems. A thermoelectric refrigerator is a refrigerator that uses the Peltier effect to create a heat flux between the junctions of two different types of materials.*

Key Words: Seed storage system, seed handling, seed inspection, Peltier effect, thermo electric cooling, portable cooler.

1. INTRODUCTION

Community seed banks are collections of seeds of local landraces that are maintained and administered by the communities themselves. Seeds can be stored by a community either in large quantity to ensure that planting material is available, or in small samples to ensure that genetic material is available even if varieties become endangered or extinct. The main aim of community seed bank is to increase local seed security and contributing to the possibilities to continued utilization of locally important genetic diversity. Community seed banks, therefore, play a vital role in ensuring seed security and improving farmers' access to seeds, conserving agricultural biodiversity and the associated traditional knowledge, providing options for adapting to climate change, as well as can contribute to the realization of Farmers' Rights. Community seed banks have the advantage of giving easy access to farmers, and are easy to link to constant on-farm conservation. In situ or on-farm conservation where farmers actively maintain diversity in their fields is crucial in order to continue the dynamic evolutionary process of local genetic diversity and its associated knowledge and culture. In 1821, Thomas See beck discovered that a continuously flowing current is created when two wires of different materials are joined together and heated at one end. This idea is known as the See beck Effect. The Peltier effect was discovered in 1834 by a French physicist Jean Charles Peltier. Peltier found that the application of a current at an interface between two dissimilar materials results in the absorption/release of heat. They can be extremely compact than compressor-based systems. According to Nolas et al [1], from the middle 1950s to the present the major thermoelectric material design approach was that introduced by A.V. Ioffe, leading to semi-conducting compounds such as Bi_2Te_3 (Bismuth telluride), which is currently used in thermoelectric refrigerators. The Peltier effect is one of 3 types of thermoelectric effect [4].

1.1 Thermoelectric Module

A typical peltier plate is of 4x4cm^2 semiconductor. Thermoelectric module is made up of thin ceramic wafers with P and N bismuth telluride semiconductor material connected in series between them. These elements are electrically parallel connected .The doping of P type semiconductor is done with some atoms having fewer electrons than what is required to complete the atomic bond within the crystal lattice. The thermoelectric couples are thermally in parallel while electrically in series. The thermoelectric module work according to peltier effect.

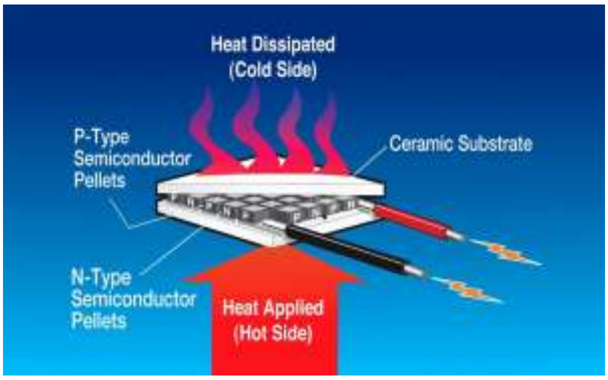

Fig -1: Schematic of Thermo Electric Module Operation – Cooling Mode [7]

The peltier effect produces a temperature difference by exchanging heat between two electrical junctions. A potential difference is applied across joined conductors to generate current. As the electrons travels from P type material to N type material, the electrons hop to the higher energy state hence absorbing thermal energy (cold side). Then as the electrons travels from N type material to P type material, the electrons drop to the lower energy state hence dissipating thermal energy (hot side). The higher is the rate of dissipation of heat, the cooler it gets inside the cabinet and hence increasing the efficiency of the cooling module proportionally [4].

1.2 Seeds Used For Storing

Sl No	Seeds used for storing	Temp(°C)
1	TOMATO SEED (Lycopersicon esculentum Mill)	12-14
2	PEPPERS (Capsicum annuum L.)	13-14
3	OKRA: (ABELMOSCHUS ESCULENTUS (L.) MOENCH)	12-13.5
4	ONION (ALLIUM CEPA L.)	12-14
5	GARDEN PEA: (Pisum sativum L.) [6]	12-15

2. LITERATURE SURVEY

Rakesh B K and Anuj Shayan ,et al(2016)

The authors reviews on " study, analysis and fabrication of thermoelectric cooling system". The seed storage system is an essential for alternative storage method using Peltier effect.In this paper author studied the experimental and practical analysis to find the cooling parameter like temperature, cooling effect ,sensor and COP of a system. This helps to store the seed for long time to increase the germination rate.

Kshitij Rokde and Mitali Patle ,et al(2017)

The author studied on " Peltier Based Eco-Friendly Smart Refrigerator for Rural Areas". In conventional cooling system coolants are used which are not eco-friendly. But in case of thermoelectric cooling system coolants are not used which makes it eco-friendly. In this paper author studied about the cooling system to be used in the rural areas which can be run on the solar also. This system can be used for applications other than cooling , that is for storing the seeds.

Abdelgabar S. Ahmed and Sayda Mahgoub Mohammed (2014)

The goal of the study on "Effect of storage types on seed moisture content and germination" was to measure the temperature (25-30°C) and storage period of up to 18 months and to ensure that the seeds will be preserved for longer periods without any harm including its atmospheric effect on the seeds. Seed were stored in three storage conditions viz:-Cool store, normal store and natural conditions store. The study revealed significant differences in moisture content and seed germination between different types of seeds.

J. A. Adetumbi, J. O. Saka and B. F. Fato (2010)

The author made analysis on "Seed handling system and its implications on seed quality". In this paper author made analysis on the prevailing surrounding situations on seed business and studying its implications on seed quality. Based on the survey conducted data was collected on the seed procurement ,handling , and distribution activities . During storage deterioration was detected.

Prabhakar and Mukherjee (1977)

Studied the extent storage of seeds at low temperature (10°C to 15°C) and also maintained seed moisture at a favorable level (10%) and there by germination potential at a high level for a considerable period (270 days). Room temperature (26°C) or high temperature (32°C or 35°C) resulted in the decline environment delayed the decline in germination potential of the storage [1].

Birewar (1981)

Highlighted the magnitude of storage losses in India and the importance of scientific storage for minimizing losses. It dealed with various improved storage structures at farm level. The role of IGSI, Hapur in design, construction and popularization of modern storage structures has been described. He also mentioned construction details of a number of structures [2].

Singh and Singh (1981)

Studied the effects of methods and duration of storage on seed germination and seedling vigor in papaya (Carica papaya L.). They found that cold stored papaya seeds maintained significantly higher germination and better seedling vigor than the room stored seeds. With the increase in the duration of storage, seed germination decreased after 20 months at room temperature whereas it declined marginally during the same period when kept in the cold storage. Irrespective of the storage conditions, seeds kept in sealed polythene bags or plastic bottles had better germination and seedling vigor than in paper and cloth bags [3]. **Gough (1985),** studied the physical changes in large-scale hermetic grain storage. Moisture content (m.c.) and temperatures were measured in two 1300 t semi-underground hermetic concrete silos filled with maize, which was stored for nearly three years in an upland equatorial climate. Gradual cooling of the maize took place in the first year of storage and the temperature remained constant thereafter [2].

3. EXPERIMENTAL SETUP

The inner cabinet is made air tight with 4 mm of medium density fiber board of 2 ft × 2 ft × 2 ft which is internally covered with aluminum sheet from all sides having a total capacity of 56.63 liters. The cabinet is insulated by 0.8 mm thick sun mica sheet from outside for thermal insulation from surrounding and the polystyrene (thermocol) sheet is covered with 20 mm of medium density fiber board for maintaining the rigidity of the cabinet. The door is attached with hinges for better and easy movement of it [2].

Fig -2: Construction of Storage System.

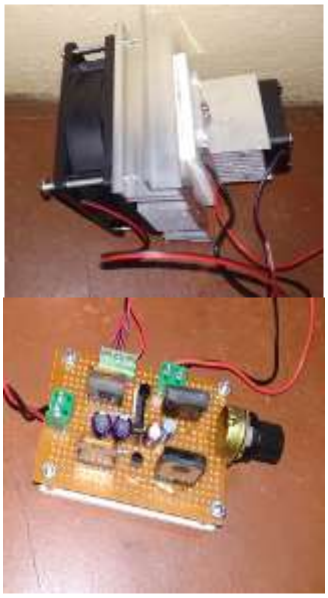

Fig -3&4: Two Peltier Cooling Kit and PWM Controller.

3.1 Fabrication Procedure

- A thermocol box of inner cabin volume of 2 foot is slotted on 1 faces with the reference of the measurement of CPU heat sinks (50mmx60mm).

- The inner surface of the cabin is insulated completely using thermocol sheets (20 mm) so as to isolate the cooling cabin from the atmosphere.

- The thermo electric module is sandwiched between two CPU heat sinks of different sizes using thermo paste to set a single unit (it will look exactly like peltier cooling kit which we shown in above). Thermo paste plays a vital role in conduction of heat from Peltier module to the aluminum heat sinks. And at the end it is attached to the left side of the storage system where pocket is made.

- These units are placed in the cut slots with the smaller CPU heat sinks facing the interior of the cooling cabin and the larger CPU heat sinks on the outside of the cabin to establish greater heat rejection.

- Addition fans are fitted on the outer side of the heat sinks. Electrical connections are made and power is supplied from a AC 12V 10A adapter is connected to the electric plug [2].

4. CALCULATION

For the Peltier module used (TEC1-12706),

Where,
Th and Tc are the temperatures at hot and cold side of the module respectively.

Qc max is the cooling capacity at cold side of the module when ΔT = 0.

ΔTmax is the maximum possible temperature difference between the cold and hot side of the module when Qc = 0.

Imax is the maximum input current at Qc= 0.

Vmax is maximum DC voltage at Qc=0.

αm is device see beck voltage.

Km is device thermal conductance.

Rm is device electrical resistance under assumption of all identical couple and the unidirectional heat flow [5].

1. $\alpha m = Vmax / Th$
   $= 14.4 / 298$
   $= 0.04832 /°K$

2. $Rm = ((Th - \Delta Tmax) \times Vmax)/(Imax\ Th)$
   $= ((298 - 66) \times 14.4)/(6.4 \times 298)$
   $= 1.7516\ \Omega$

$Km = ((Th - \Delta Tmax) \times Vmax \times Imax)/ (2\Delta Tmax \times Th)$
$= ((298 - 66) \times 14.4 \times 6.4) / (2 \times 66 \times 298)$
$= 0.5435 /°K$

3. $Qc = (\alpha m \times Tc \times I) - (I^2 Rm / 2) - Km(Th - Tc)$
   $= (0.04832 \times 283 \times 6.4) - ((6.4^2 \times 1.7516)/ 2) - (0.5435 (298 - 283))$

$= 43.1151\ W$

4. $W = \alpha m \times I \times (Th - Tc) \times I^2 \times Rm$
$= 0.04832 \times 6.4 \times (298 - 283) \times 6.4^2 \times 1.7516$
$= 76.9981\ W$

5. Theoretical COP
$COP = Qc / W$
$= 43.1151 / 76.9981$
$= 0.56$

Actual COP

$RE = (mCp\ \Delta T) / t$

Here,
m = 250 ml of water = 0.00025 m^3
Cp = 4.187 KJ/Kg
$\Delta T = (26 - 16)^0C = 10^0C$
t = 15 minutes
$RE = (0.25 \times 4.187 \times 10\ 15) / 60$
$= 0.01163\ KW$
$COP = RE / W$
$= (0.01163 \times 1000) / 76.3448$
$= 0.15$

5. FURTHER IMPROVEMENT

This system can be further improved by installing thermo sensor which can be programmed using arduino board, to vary the power supply within specified range of temperature.

Solar power can be used as power source to the system as it is a renewable source of energy. This immensely decreases the working cost of the refrigerator and burden on the earth [3].

6. OUTCOMES

- The stored seeds can be used by farmers for agriculture purpose for growing crops.
- The seed storage system helps the marginal farmers in saving the cost of buying new seeds from market.
- The seeds in the storage system can also be sold which can earn some profits.
- The quality of seeds will be maintained for longer duration.
- Seed storage system can be used in community seed banks and in super markets [1].

7. APPLICATIONS

- Vegetable and flower seeds may be kept for one year without appreciable decrease in germination.

- Storage may be extended to 10 or more years under proper conditions. Seed moisture and storage temperature are the most important factors in determining how long seed can be stored. The drier the seeds are, the longer they will store.
- Maintenance of seed quality in storage from the time of production until the seed is planted is imperative to assure its planting value [1].

8. RESULT

We have reach the temperature of about 14-15°C in 3 hours by using peltier cooling module. The stored seeds can be used by farmers for agriculture purpose for growing crops. The seed storage system helps the marginal farmers in saving the cost of buying new seeds from market. The seeds in the storage system can also be sold which can earn some profits. The quality of seeds will be maintained for longer duration. Seed storage system can be used in community seed banks and in super markets.

Seeds like Tomato, pea, Onion, Pepper and Lady's finger (OKRA) has been purchased from crop field of $1/8^{th}$ portion from an Acre land. And these seeds were kept under observation and tested in the storage unit for about 5-6 hours and finally got the temperature reading up to 14°C which was sufficient. And also the germination and fertility level of the seeds were increased which didn't cause any kind of damage or loss in the content of the seeds [6].

ACKNOWLEDGEMENT

We thank to the KSCST (Karnataka State Council for Science and Technology) for selecting our project. We wish to express my deepest gratitude to all the people involved in completion of this report. We wish to thank Professor R.H.Angadi our project guide for his constant help & guidance, without his involvement this work remains incomplete. We thank our beloved HOD Dr.Ashok.M.Hulagabali who was there for support & encouragement throughout our work, we also thank Dr.Sanjay.Pujari, principal, AITM for providing a peaceful & student friendly environment, lastly we thank staff members of mechanical department.

CONCLUSION

The stored seeds can be used by farmers for agriculture purpose for growing crops. The seed storage system helps the marginal farmers in saving the cost of buying new seeds from market. The seeds in the storage system can also be sold which can earn some profits. The quality of seeds will be maintained for longer duration. Seed storage system can be used in community seed banks and in super markets [2]. Thermoelectric refrigerators are greatly needed, particularly for developing countries, where long life, low maintenance and clean environment are needed. The efficiency of the refrigerator can be increased by increasing the number of peltier plate module which will eventually help in decreasing the temperature in less time [4].

REFERENCES

[1] Almekinders CJM, Louwaars NP and de Bruijn GH. 1994. "Local seed systems and their importance for an improved seed supply in developing countries" Euphytica. 78:207-216.

[2] Fodder Innovation Project. 2006. Groundnut-Livelihoods. "An Impact pathways analysis of groundnut innovation system"International Livestock Research Institute(ILRI). Hyderabad, India.

[3] Geervani, P., and V. Vimala. 1993. Rural food enterprises: "Operational research on development of sorghum food enterprises for alternate uses and supplementary feeding" Hyderabad 500 004, Andhra Pradesh, India: College of Home Science, Acharya N.G. Ranga Agricultural University. 126 pp.

[4] Nolas, G.S., Slack, G.A., Cohn, J.L., and Schujman, S.B., The Next Generation of Thermoelectric Material Proceedings of the 17th International Conference on Thermoelectric, pp. 292-298, (1998).

[5] Umesh V. Sangale, Prof. Priyanka Jhavar, Dr.G.R.Seloskar.S., Thermoelectric Refrigeration by Using Solar Energy for Domestic Appliance, International Journal of Research in Advent Technology, Vol.3, No.1, January 2015.

[6] "Seed Storage of Horticultural Crops" by S. D. Doijode.

[7] "http://www.huimao.com/about/show.php?lang=en&id=4".