Selection of Thermal Insulation Thickness of Cold Store Enclosures

Jehad Al-Radaedeh[1*] Bassam Al-Zgoul[2] Muhamad Frehat[3]

1. Al-huson University College, Al-Balqa Applied University, P.O box 50, Alhuson 21510, Jordan
2. Al-huson University College, Al-Balqa Applied University, P.O box 50, Alhuson 21510, Jordan
3. Al-huson University College, Al-Balqa Applied University, P.O box 50, Alhuson 21510, Jordan

*E-mail of the corresponding author: adam.ibragim@mail.ru

Abstract

This paper aims to set a mechanism in order to calculate the economical thickness of thermal insulation layer of external walls of cold storage plant based on a comprehensive techno-economic analysis of thermal insulation cost, in addition to the cost related to the production of necessary refrigeration to compensate for heat flow through the exterior walls into the cold storage and conservation plant. Some research that dealt with this topic provided techno-economic analysis for the cost of thermal insulation and the production of refrigeration based on exterior walls area of the cold storage plant, which does not make sense, and that it is difficult to determine the effect of the operational expenses. Therefore, the present study stems from the idea that the cold storage and conservation plant is dedicated to prolong the period of food conservation, so the course of techno- economic analysis has been shifted to take into account one ton of food stuff stored in cold storage and conservation plant to be refrigerated and conserved instead of considering the external walls area. In addition, this paper provides a more accurate formula to calculate the specific cost of refrigeration equipment bx in order to skip the percentage of mistake used to occur in calculating the overall standard heat transfer coefficient of external walls caused by applying the weighted average value of the specific cost of refrigeration equipment bxa. The obtained results resulting from the use of a computer-programmed method in techno-economic analysis of the cost enhanced the fact that the impact of cold storage plant capacity and specific cost of refrigeration equipment on the economical thickness of the insulation layer is correct. This justifies the concept proposed in this paper that associates the techno- economic analysis of costs to be the capacity of the cold storage plant instead of the exterior walls area unit, where obvious decease in the values of the operational cost O_c , O_d and the minimum cost (P_{min}) with the increase cold storage and conservation plant capacity. The results also show that economically optimal thermal resistance (Ro.ec) of heat transfer through the exterior walls and the economic thickness of insulation layer have been effected by the specific cost of refrigeration equipment . It has been noticed that *bx* decreases from 0.94- 0.54 with increase of the cold storage plant capacity from 400 to 5000 ton. This leads to 6% decrease in economically optimal thermal resistance and the economical thickness of the insulation layer.

Keywords: thermal insulation, economical thickness, techno-economic analysis

1. Introduction

The intensification of cooling of food stuff and the economical tendency of consuming the energy available, in addition to the development of more effective new thermal insulation materials requires the need to review the total heat transfer coefficient required for the cold storage plant exterior walls $K_{o.req}$ [4] based on techno-economic analysis of cost related to thermal insulation and that related to the production of refrigeration to compensate for heat flow through the cold storage plant exterior. The goal of researchers in the field of food stuff cooling is to keep the nutritional value of food stuff as long as possible with minimum cost. Thickness of thermal insulation of exterior walls and the type of thermal insulation that significantly effects the primary capital and operational cost of the cold storage plant since the increase in insulation layer thickness increases capital cost and reduces the operational cost. This requires conducting a comprehensive techno- economic analysis to calculate the economic thickness of the insulation layer. In addition, the capital and operational cost are influenced by the capacityof the cold and conservation storage plant, which in turn affects the economic thickness of the thermal insulation layer. So, this demands that a study be carried out to determine this trend and value of this effect. In research [*1 and 3*] one systematic method was used to determine the exterior walls economical optimal thermal resistance, which is the inverse value of $k_{o.ec}$, which represents modern methodologies used to determine the economic efficiency of using new technology in the national economy. Analysis of the results of these research papers shows that cost of the thermal insulation spent on the refrigerator envelope and on refrigeration production to compensate for heat flowing from the outside is associated with the surface area unit of the cold storage plant exterior walls, which is considered as an architectural indication of the building. This hinders the determination of the effect of running cost, i.e. operational cost items , such as ongoing cost ,including the cost of electrical energy required for the operation of the refrigeration machine and the cost of food stuff weight loss due to drying up , or food stuff (transpiration) (1 M^2) of the wall surface of the cold storage plant, and that this does not make sense. In contrast, this study stems from the idea that the cold storage plant is dedicated to prolonging food preservation and it proposes what agrees with methodology number [7], which determines cost spent on the exterior walls thermal insulation of cold storage plant and on the production of refrigeration to compensate for the heat flow from the outside associated with the capacity of the cold storage plant. It is worth mentioning that it should be noted that there is a relationship between the area of exterior surface of the cold storage plant and its capacity, as shown in figure 1. This can be taken into account in the value of the specific area of the exterior walls ($F_{sp} = F_o / G$), the value of which is In the range of ($1.55\ M^2/T$ to 4.0). Figure (1) Cold storage plant of the capacity of 50- 8000 ton are considered standard projects. One of the cost items is that related to weight loss of the stored food stuff which occurs due to (transpiration) caused by heat flow through the exterior walls into cold storage plant . In fact, transpiration from food stuff happens not only because of heat flow through the exterior walls, but also because of internal heat load , that is the heat load of fans engines , lighting, workers , and so on, in addition to the respiration process of stored food stuff associated with the release of heat. This study takes into account components of food stuff weigh loss caused by the transpiration due to heat flow effect through the exterior walls only. According to the results reached by research [3], the percentage of this weight loss caused by the flow of heat through the exterior walls does not exceed 13% of the total weight loss value caused by the transpiration in the case of storing frozen meat. Moreover, when calculating the capital cost spent on refrigeration equipment, the authors of research three suggest that probable average value of the specific cost bx of refrigeration equipment which equals bx=0.64 $/w be used despite the fact that bx changes 4 times from 0.2 to 0.77. Calculation by using formula (1) listed in research [3] and using the data of frozen-meat rooms at an internal temperature of - 20c ° show that at the value of (bx = 0.2 $ / w), the economically optimal thermal resistance of heat transfer through the exterior walls of the cooling warehouse is $R_{o.ec}$=4.14 M^2.K/W, whereas at the value of bx =0.77 $/w The value of $R_{o.ec} = 5.22\left(M^2 \cdot K\right)/W$ This is to say, 1.26 times. To preserve apple at 0°c temperature and bx = 0.2 the value of $R_{o.ec}$=2.7 M^2.K/W When bx is bx= 0.77, the value of Ro.ec equals 3.8(M² K)/W Which is 4 times the value when bx is 0.2. It can be concluded that using weighted average value of the specific cost of refrigeration equipment where bx = 0.64$/w, leads to a notable mistake percentage in the calculation of the overall heat transfer coefficient of cold storage plant exterior walls w/(m2.k). This requires that a method leading to more accurate calculation of refrigeration equipment specific cost bx be reached.

2. Theory

When designing cold storage plants, thickness of the thermal insulation layer of the cold storage plant exterior walls is calculated , using the formula (1) below :

$$\delta_I = \lambda_I \left[\frac{1}{k_{o.req}} - \frac{1}{a_{ext}} - \sum_{i=1}^{n} \frac{\delta_i}{\lambda_i} + \frac{1}{a_{\text{int}}} \right] = \lambda_I (R_o - R_K) \qquad (1)$$

In equation (1) certain heat transfer coefficient of the exterior walls is determined. Accordingly, thickness of the thermal insulation that meets the required overall heat transfer coefficient is reached $k_{o.ec}$. This process is done without conducting a techno- economic study of the cost, which means that the economic aspect related to the design of cold and conservation storage plant is not clear.

To make the design process in line with energy and cost -saving trend, equation (1) is updated by replacing the total required heat transfer coefficient $K_{o.req}$ and heat resistance of the exterior walls in the equation by economic total heat transfer coefficient $k_{o.ec}$ and exterior walls heat resistance R_o by economic optimal thermal resistance $R_{o.ec}$, the formula should rewritten as

$$\delta_{I.ec.} = \lambda_I (R_{o.ec} - R_K) \tag{2}$$

Where $\delta_{i.ec}$ is the economical thickness of the exterior walls thermal insulation.

The economically optimal thermal resistance $R_{o.ec}$ listed in equation (2) requires conducting a comprehensive techno-economic analysis that includes the following procedures :

To determine more accurate specification of the specific cost of refrigeration equipment bx will be as in the following equation :

$$b_x = \frac{C_{eq}}{K_{all} Q_o} = \frac{C_{eq}}{K_{all}(Q_I + Q_x)} \tag{3}$$

Where, C_{eq} is the cost of cooling equipment and tools, $.

K_{all} is the coefficient of extra cost which takes into account cooling loss during the passage of the refrigerant in pipes and appliances. This coefficient equals 1.07 for direct cooling systems without secondary refrigerant. In cooling systems where salty solutions are used as secondary refrigerant the K_{all} is 1.12.

Qo is the cooling load on refrigeration system W.

Q1 is the heat flow load through the the cold storage plant exterior walls, W.

Qx – is the cooling load of food stuff , containers , fan engines, heat flow through the floors, lighting , workers in the plants W.

To calculate Qx, the method presented in paper (8) is used.

The results from research 8 conducted on one-storey cold storage plant with the capacity of 50-8000 ton show that Q1 is very less than Qx,

Where, $Q_I = 0.1\ Q_x$

This shows that in order to determine the value of bx with an error rate acceptable in engineering calculations, an equation that does not contain Q1 can be used , so equation (3) can be rewritten in the form:

$$b_x = \frac{C_{eq}}{1.1 K_{all} Q_x} \tag{4}$$

Figure 2 shows the relationship between the cost of equipment and supplies of a one–storey cold storage plant with forced air cooling units or surface cooling units of natural convection (batteries) , and the cold storage plant capacity is built based on the results of standard projects by Gyprokholoda.

It should be noted that formula (2) can be simulated by the following linear equation:

$$C_{eq} = a + bG \tag{5}$$

Where, (a and b) are coefficients derived from experiments ($a=10^4$, b=105) for cold storage plants with the capacity ranging from 50 to 1000 ton, and the values of (b=68.6, $a=4.10^4$) are for cold storage plants with capacity ranging from 8000-10000 ton. The above values are related to forced cooling system, and the values (b=90, $a=3.10^4$) are for storage capacity ranging from 1000 to 8000 Ton equipped with surface cooling equipment -batteries- (natural convection).

In the case of cold storage and conservation plant equipped with mixed equipment (air forced and batteries with storage capacity ranging from (1000 to 8000 T), where the cost of equipment and devices of cold storage are written as in the following equation :

$$C_{eq} = \frac{G_1}{G}\left(4 \cdot 10^4 + 68.6G\right) + \frac{G_2}{G}\left(3 \cdot 10^4 + 90G\right) \tag{6}$$

Where, G_1,G_2 are the cold storage chambers capacity of forced air cooling system , and battery system of natural convection respectively, in ton.

Absolute losses in food stuff weight as a result of transpiration caused by heat flow through exterior walls in ton can be represented in the formula listed in research (5) shown below:

$$W_1 = 10^{-6} Q_1 (1 - \varepsilon_{t.e}) \frac{Z_{cool}}{\varepsilon_h} \tag{7}$$

$\varepsilon_{T.E}$ is the technological coefficient of efficiency of the cooling system [6].

Z_{cool} is the duration of storage of food stuff in cooling mode , hour.

ε_h is the moisture thermal property of the process, kJ/kg, obtained from formula (6) or (7) in research [5].

To reach a formula that specifies economic optimal thermal resistance for heat transfer through exterior walls of the cold storage plant Ro.ec, this study used the components of cost as suggested in research 1 with significant modification in order that the cost and expenditure be based on the capacity of the cold storage and conservation plant (G) instead of the surface area unit of the exterior walls.

Formulas (4) and (7) give the following:

$$P = E_n (K_i + K_r) + Q_c + Q_h + Q_d \tag{8}$$

Where

$$K_i = \frac{C_i F_o \lambda_i (R_o - R_K)}{G} \left[1 + \frac{1}{\left(1 + E_{n.p}\right)^{T_1}} \right]$$

$$K_r = \frac{C_{eq} F_o \Delta t_{\max}}{1.1 K_{all} Q_X G R_O} \left[1 + \sum_{i=1}^{n} \frac{1}{\left(1 + E_{n.p}\right)^{iT_2}} \right]$$

$$Q_C = \frac{C_C F_O \Delta t_{ref} Z_{ref} m_1 a_1}{G R_O}$$

$$Q_h = \frac{C_h F_o \Delta t_h Z_h a_2}{G R_o}$$

$$Q_d = \frac{10^{-6} C_d F_o \Delta t_{ref} (1 - \varepsilon_{t.e}) Z_{ref}}{G \varepsilon_h R_o}$$

P- The cost of thermal insulation of the exterior walls of the cold storage plant and the cost of producing cooling to compensate for heat flow from outside the plant , and the cost resulting from food stuff weight loss due to transpiration \$/ (ton. year).

E_n is the standard efficiency coefficient of capital investment, and it is accepted at (0.15).

K_i - capital cost on thermal insulation \$/(Ton. year)

K_r - capital cost on the cooling station equipment that provide production of cooling to compensate for the thermal flow through the exterior walls \$/(Ton.year).

Q_c - Operational cost on the production of cooling to compensate for thermal flow through exterior walls \$/(Ton. year).

Q_h - Operational cost on the production of heating for heating refrigeration chambers in the cold days of winter time \$/(Ton. year).

Q_d -Operational cost for loss resulting from weight loss of food stuff as a result of heat flow through the exterior walls of the cold storage store.

C_i - estimated cost of the thermal insulation \$ /m$^{3.}$

$E_{\mathrm{n.p}}$ - coefficient of different time cost, it is taken as (0.1).

T1,T2- intervals of changing thermal insulation and the refrigerating equipment respectively (year).

$\Delta t\ max$ - difference between computational temperature of outside air $t_{\mathrm{o\ max}}$, obtained by formula (2) in research [2], and air temperature in the cold storage chamber t_{ch}, °C.

n- the number of replacement of refrigeration equipment $i = 1,2,3,\ \ldots n.$

C_c, C_h- the cost of the production of refrigeration under standard conditions of compressors function and cost of heating for heating the chambers in the cold days of winter time \$/J.

$\Delta t_{ref}, \Delta t_h$ -The difference between the average temperature of the outside air, respectively, in the cooling period $t_{\mathrm{o.av.cool}}$ and heating period $t_{\mathrm{o.av.\ h}}$ of the refrigeration chamber, obtained by formulas (8) and (9) in research [3], and air temperature in the refrigeration chamber t_{ch}, °C.

Z_h - duration of heating of the refrigerator chambers, hour.

m_1, a_1, a_2 - Refrigeration cost coefficients in standard conditions for the compressors function, and loss of cooling and heating in pipes, respectively which can be obtained from research [3].

C_d - The cost of food stuff weight loss caused by transpiration \$/Ton.

When the derivative *(dP/dR$_o$)* is solved and equated it to zero, after manipulation the following equation is obtained:

$$R_{o.ec} = \left\{ \frac{\dfrac{E_n C_{eq} \Delta t_{\max}}{1.1 K_{all} Q_X} \left[1 + \sum_{i+1}^{n} \dfrac{1}{\left(1 + E_{n.p}\right)^{iT_2}} \right] +}{E_n C_i \lambda_I \left[1 + 1 / \left(1 + E_{n.p}\right)^{T_1} \right]} \cdots \rightarrow \right.$$

$$\cdots \frac{+ C_c \Delta t_{cool} Z_{cool} m_1 a_1 + C_h \Delta t_{heat} Z_{heat} a_2 +}{E_n C_i \lambda_I \left[1 + 1 / \left(1 + E_{n.p}\right)^{T_1} \right]} \cdots \rightarrow$$

$$\left. \frac{+ 10^{-6} C_d \Delta t_{cool} Z_{cool} \left(1 - \varepsilon_{T.E}\right) / \varepsilon_h}{E_n C_i \lambda_I \left[1 + 1 / \left(1 + E_{n.p}\right)^{T_1} \right]} \right\}^{1/2} \tag{9}$$

3. Calculation procedures

The mechanism of choosing the economic thickness of the thermal insulation layer of the exterior walls ($\delta_{\mathrm{I.ec}}$) includes the following:

Preliminary data for the calculation includes the construction location of the plant, the plant capacity and daily uploading commodities, the lay out and distribution and cooling chamber, climate data for the construction of cold storage and conservation plant and the temperature and duration of conservation required, climate date of cold the location of the cold storage plant, type of cooling system for each of each chamber, components of exterior walls and ceiling structure, characteristics thermal properties of wall and ceiling materials, cost indicators of thermal insulation materials and electrical energy required for the production of cooling and weight loss of food stuff due to the transpiration.

Calculations are carried out for each exterior wall of refrigeration chambers depending on the location of the wall, as well as the ceiling according to the following formulas:

Out of formula (9) we find the value ($R_{o.\,ec}$), and the two values ($\delta_{I\cdot ec}$) and Pmin which are obtained by using the formulas below:

$$\delta_{I.ec} = \lambda_I \left(R_{o.ec} - R_K \right) \tag{10}$$

$$P_{\min} = \frac{E_n C_i F_{oj} \lambda_I}{G_j} \left[1 + \frac{1}{\left(1 + E_{n.p}\right)^{T_1}} \right] \left(2R_{o.ec} - R_K \right) \tag{11}$$

Where

$$R_K = \left(\frac{1}{a_{ext}} + \sum_{i=1}^{n} \frac{\delta_i}{\lambda_i} + \frac{1}{a_{\text{int}}} \right)$$

F_{oj}- the surface area of the exterior walls of the cooling chamber (m^2).

G_j - is the chamber cooling capacity (Ton).

Similar calculations can be made for other insulation material that can be possibly used. The results of these calculations are used to select materials for thermal insulation, where the sum of the values (P_{min}) is the least for all cooling rooms in the cold storage and conservation plant.

4. Results and Discussion

A computer program has been used and it was specifically built to calculate economical optimal thermal resistance of the exterior walls of the cold storage and conservation plant ($R_{o.ec}$), relative weight loss of the stored food stuff due to transpiration because of heat flow through the exterior walls ($\Delta G_I = W_I/G$) and the minimum cost (P_{min}) as follows**:**

Calculations have been done for meat stores with the capacity of 50 to 5000 tons, and the technical efficiency coefficient ($\varepsilon_{T.E}$) which is variable. These calculation have been made by considering the the following facts:

C_i=104.28 \$/m^3; T_1=25 years; T_2=12.5 years; t_{ch}= -20 °C; n= 2; Δt_{max}= 67.9 °C; Δt_{cool}= 28 °C; C_c= 3.82.10 $^{-9}$ \$/J; z_{heat} =0; m_1=2.4; a_1=1.07; C_d=0.78 \$/kg; Z_{cool}=28.08 10^6 s; PSP-S (λ_I=0.047 W/(M.K).

The analysis of results listed in Table (1) shows the following:

1 - when the G is a fixed value , and $\varepsilon_{T.E}$ is variable (0 - 1), the values $R_{o.ec}$ and P_{min} are decrease by (1.5 -1.7) times. Ratio relative loss in the weight of food stuff resulting from transpiration falls from the maximum value of 2.44% to 0% (0% when $\varepsilon_{T.E}$=1).

2- when $\varepsilon_{T.E}$ is fixed and the capacity of the cold storage plant is variable, from 50 to 5000 tons, the value ΔG_1 goes down by 3.2 times, while P_{min} will be reduced by 3 times. This is explained by the big effect of the specific area of the exterior walls surface on these indicators.

3- The relationship between $R_{o.ec}$ and the capacity of cold storage plant and conservation plant is determined according to the method or behavior change of value b_x. So, when G=400-5000 ton, the value $R_{o.ec}$ decreases when capacity increases. This is explained by the availability of freezing rooms in these cold storage plants, and by the value (b_x=0.94-0.54). In 50- ton capacity cooling chamber $R_{o.ec}$ is lower than that in 400- 5000t on-capacity plant due to the lack of fast cooling rooms where (b_x=0.39).

4 - the larger the cold storage plant capacity, the lower the economic thickness of the insulation layer $\delta_{I\cdot ec}$, and the operational cost O_c, O_d as well as the minimum cost $P_{\min}$ will be lower .

5 - Economic thickness of the insulation layer $\delta_{I.ec}$ is associated with a direct correlation with the value $(\lambda_I/C_i)^{1/2}$, while the operational cost O_c, O_d and the minimum cost P_{min} will be associated with direct correlation with the same values but in different form $(\lambda_I C_i)^{1/2}$ in the same conditions.

6- So, It is clear that the selection of effective thermal economic appropriate insulation material should be reached in accordance with the divergent $(\lambda_{I1}/\lambda_{I2} \geq C_{i2}/C_{i1})$, where the numbers 1 and 2 are associated with the first, and that the second thermal insulation materials compared in the divergent are different in physical and thermal properties, as well as cost indicators. When the symbol (›) is achieved, this means that there are two benefits, the first of which is that the cost goes down and the second benefit is that the thickness of the insulation layer is also reduced. On the other hand, there will be one benefit when (=) is achieved, that is the thickness of the thermal insulation layer will be reduced at the same quantity of cost.

5. Conclusion:

When designing cold storage plant, it is necessary to calculate the economical thickness of the thermal insulation layer, taking into account not only the location of the plant and the temperature inside the plant, but also the technical efficiency of the refrigeration system that will be used as well as the capacity of the cold storage plant.

References

Gendoyan, A. G.,lefanov, B. V.,hodereova, V.T. (1980), “About optimization Thickness of the thermal insulation of the external walls of the cooling warehouses and conservation”, Refrigeration Technology (2), 9-13.

Gendoyan, A. G.,fainshten B. A. (1980), “ Determine the outside temperature in the summer for the purpose of calculating the greatest heat flow to the cooling warehouse and conservation”, Refrigeration Technology (9), 29-32.

Gendoyan, A. G.,fainshten B. A., hodereova, V.T. (1981), “Resistant exterior walls of a refrigerated warehouse for thermal transfer”, Refrigeration Technology (2), 33-38.

Dyranof, E. F.,Lefanof, B. V.,Kojevneikov , E. G. (1981), “ Improve the properties of thermal insulation material for walls of cold storage and conservation”, Refrigeration Technology (4), 14-19.

Jadan, V. Z. (1979), “Thermodynamic theory of thermal-humidity processes in cold storage plant. Refrigeration Technology”, (6),39-43.

Jadan, V. Z. (1975), “ Comparison of Cooling Systems”, Refrigeration Technology (12), 38-42.

MENMYCOMOLPROM. (1978), “ Method of determination of the economic effectiveness of using new created technology in industry of meat and milk: SSR”, 148-171.

GOSTORGEZDAT. .(1962), “Glossary of Refrigeration technology”, 485-517.

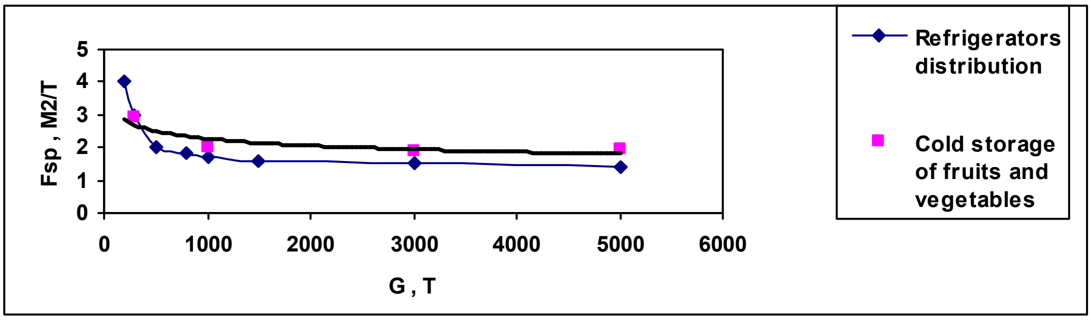

Figure 1. the effect of the cold storage plant capacity on the specific area of the plant exterior walls.

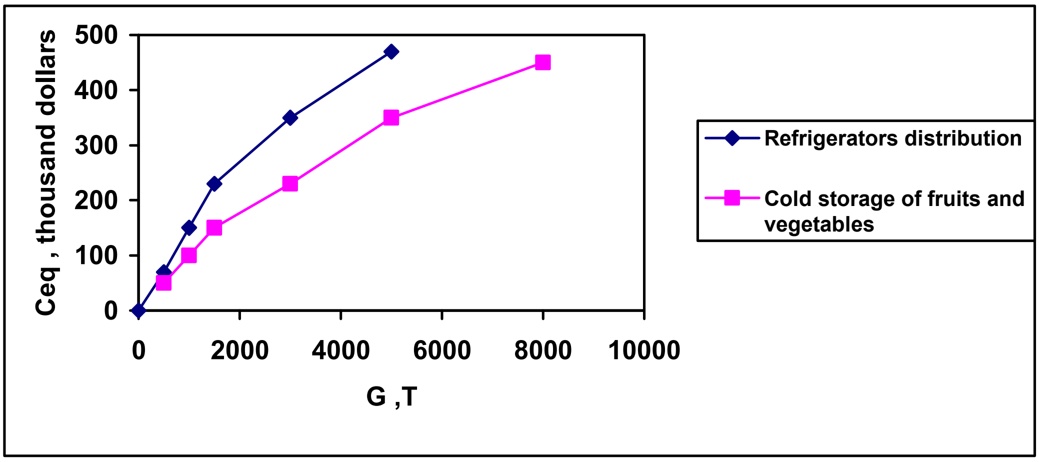

Figure 2: the effect of the cold storage plant capacity on the cost of equipment and supplies of the cold storage plant.

Table 1. Result Sheet of Calculation

ε	$R_{o.ec}$, $m^2.k/w$ at G, T					$\Delta G_1=W_1/G$, at G, T					P_{min}, $/ (T. Year) at G, T				
	50	400	1000	3000	5000	50	400	1000	3000	5000	50	400	1000	3000	5000
0.0	7.08	7.73	7.66	7.28	7.26	2.44	1.25	0.95	0.81	0.76	56.8	34.8	25.8	19.9	18.7
0.1	6.83	7.52	7.47	7.04	7.03	2.26	1.16	0.88	0.75	0.71	54.9	33.8	25.1	19.2	18.1
0.30	6.32	7.06	6.97	6.55	6.53	1.91	0.96	0.73	0.63	0.59	50.8	31.7	23.5	17.9	16.8
0.5	5.77	6.56	6.47	6.02	6.00	1.50	0.74	0.56	0.49	0.46	46.3	29.5	21.8	16.4	15.4
0.7	5.16	6.03	5.93	5.43	5.41	1.00	0.48	0.37	0.32	0.31	41.4	27.1	20.0	14.8	13.9
0.9	4.46	5.45	5.33	4.77	4.75	0.39	0.18	0.14	0.12	0.12	35.8	24.5	18.0	13.3	12.2
1.0	4.06	5.13	5.00	4.41	4.38	0	0	0	0	0	32.6	23.1	15.2	12.0	11.3

This academic article was published by The International Institute for Science, Technology and Education (IISTE). The IISTE is a pioneer in the Open Access Publishing service based in the U.S. and Europe. The aim of the institute is Accelerating Global Knowledge Sharing.

More information about the publisher can be found in the IISTE's homepage:
http://www.iiste.org

CALL FOR PAPERS

The IISTE is currently hosting more than 30 peer-reviewed academic journals and collaborating with academic institutions around the world. There's no deadline for submission. **Prospective authors of IISTE journals can find the submission instruction on the following page:** http://www.iiste.org/Journals/

The IISTE editorial team promises to the review and publish all the qualified submissions in a **fast** manner. All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Printed version of the journals is also available upon request of readers and authors.

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar