

# Project Proposal

## Solar Absorption Refrigerator

Absorption Refrigeration Team  
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Engineering  
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# Introduction

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## Origin of Proposal

The prices of energy have been increasing exponentially worldwide. Industrial Refrigeration is one of the most energy consuming sector. What if a refrigeration system is designed which uses no energy or minimal amount of energy?

The solution lies in absorption refrigeration system.

By producing an adsorption refrigeration system we are not only cutting down the energy costs but also preserving our environment. This refrigeration system doesn't use any of the CFCs so our ozone layer is safe.

Greenhouse gases and their damaging effects on the atmosphere have received increased attention following the release of scientific data by United Nations Environment Programme and World Meteorological Organization that show carbon dioxide to be the main contributor to increased global warming(UNEP, 1991). The domestic refrigerator-freezers operating on alternative refrigerants such as HFC-134a, contribute indirectly to global warming by the amount of carbon dioxide produced by the power plant in generating electricity to operate over a unit over its lifetime. This contribution is nearly 100 times greater than the direct contribution of the refrigerant alone.

Moreover, approximately 62 million new units are being manufactured worldwide every year, and hundreds of millions are currently in use.(UNEP,1995) it is anticipated that the production of refrigerator-freezers will substantially increase in the near future as a result of the increased demand, especially in the developing countries. Therefore, in response to global concerns over greenhouse resorts are being made to produce refrigerator-freezers with low energy consumption.

In most of the developing third world, adequate supplies of drinking water and water for irrigation are a scarce commodity. In many places in Africa, India and Central and South America, adequate supplies of water are found only at considerable depth below the surface. These locations generally do not have the infrastructure to provide an electrical grid to pump the water with electricity nor do they have the infrastructure to provide roads to bring in electrical generators or even the fuel for those generators. Therefore without an electrical grid or without

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generators to generate electricity, isolated areas do not have potable water nor do they have the refrigeration to keep medicine or foodstuffs from spoiling. Even in the United States, there are communities such as the Amish communities where electricity is banned. Here the lack of cooling capabilities severely limits the production of various products. Because of the lack of cooling, milk production is limited to Grade B.

Referred to as advanced adsorption chillers they represent one of the new technology options that are under development. Advanced adsorption cooling technology offers the possibility of chillers with greater COPs and reduce cost of the system.

The invention can improve refrigerating unit, raise coefficient of performance, reduce energy cost of refrigerating unit and has notably social and economic benefit.

Compared with the existing compressor refrigeration system, the system realizes simplified structure, low energy consumption and reduction of 'discharge and environmental pollution by hazardous substance'.

#### Benefits:

1. India is among the world leaders in agricultural production however much of our produce goes waste due to absence of proper storage facilities. Refrigeration is thus vitally important for our country.
2. Milk produce is also adversely affected due to lack of refrigeration.
3. Cool drinking water is unavailable to the people in non electrified villages.
4. Medical facilities are also adversely affected due to break in the cold chain as the medicines move from the production zone to the rural areas.
5. Usage of CFCs affect the environment adversely.

The current project can result in development of a system which can be a decisive step in bringing refrigeration to the far off rural areas.

In urban areas a huge chunk of households consume more refrigeration energy than is required due to inefficient usage. This project also holds promise to reduce if not eliminate this huge portion of energy consumption pie.

# Problem Definition

Though absorption refrigeration system is an ideal way to combat energy consumption of refrigeration sector, it suffers some serious faults like:

## 1. Low COP

Ideally speaking COP of an absorption refrigeration system is about 2.0. But in reality it is less than 1 (about 0.7).

## 2. Large Size & huge weight

They are much more complex than a normal refrigerator and occupy a huge space. They require much larger cooling towers to reject the waste heat owing to their low COPs, and thus servicing them is not less than a nightmare.

## 3. High cost

The absorption refrigeration systems are much more expensive than the vapor-compression refrigeration systems which are quite obvious as their cost of production is high because of complex and large parts. This also makes them difficult to service.

# Objective

## 1. COP

We aim to improve the COP of the adsorption/absorption refrigerator to make it more attractive for usage.

## 2. Size

We aim to reduce the size of the assembly by making it more compact.

## 3. Weight

The absorption/adsorption refrigeration system is too bulky. Its weight reduction is also one of the aims. It can be reduced by using polymers.

## 4. Cost

Cost is the biggest barrier in implementation of Adsorption/absorption refrigeration. We aim to minimize it as far as possible.

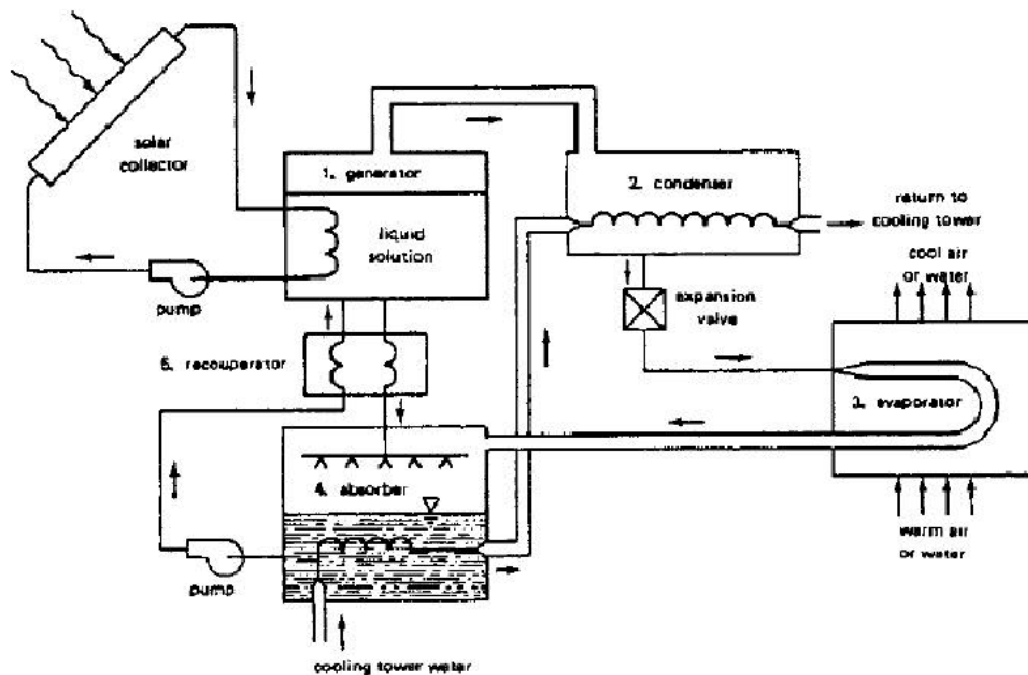
## 5. Extended Usability

Till date absorption refrigeration is limited for industrial purposes. We aim to make it available for mass rural use as stated above in small capacities by using solar adsorption/absorption.

# Technical Details and Introduction to the Technology

## Key Words

1. absorption refrigeration system – solar absorption based refrigeration system.
2. absorber
3. collector-generator
4. evaporator
5. condenser



Schematic of a Lithium Bromide absorption refrigerator  
Absorption Chillers

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### Working

The working is very simple

1 to 2

Solution of LiBr is heated to generate water vapour which is transferred to the condenser. In the condenser the vapour is cooled by circulating running water.

2 to 3

The water is then throttled and moved to evaporator at a low temperature and pressure where it is evaporated.

3 to 4

The water vapour is then transferred to the absorber where it is absorbed in the concentrated solution of LiBr and heat is rejected to the cooling coils.

4 to 1

The water is then pumped again to the generator from where the cycle is repeated.

The performance of the system is governed largely by the temperature difference between the generator and the condenser and absorber units. Since the generator temperatures in solar driven systems are only moderate, it is important to keep the condenser and absorber temperatures as low as possible.

The LiBr system is preferred over ammonia systems for solar energy applications because of the lower generator temperatures required. Permissible generator temperatures for a water-cooled LiBr system range from 76 deg. C-99 deg. C compared to the 95 deg. C-120 deg. C temperatures required for a water-cooled ammonia absorption system. Most, if not all, of the commercially available absorption units use LiBr and water as the absorbent-refrigerant fluid pair. Because the LiBr will crystallize at the higher absorber temperatures associated with air cooling, these units must be water cooled. A prototype ammonia-water unit, amenable to direct air cooling, has been built by Lawrence Berkeley Laboratories.

A number of equipment requirements and limitations must be considered in the analysis and design of solar powered absorption systems. The first consideration involves the type of collector used. The temperatures required by absorption coolers are obtainable with flat plate collectors but at low collection efficiencies.



## Status of Research on the topic

Going through the publications in the international journal of refrigeration we can evidently find out that worldwide there is a race to make and improve the performance of adsorption refrigerators.

Following are the citations of various publications that have appeared in this field the list is long so we are only appending some citations.

### Various National and International Patents that have been Granted

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<b>United States Patent</b>	<b>7,257,951</b>
<b>Xing</b>	<b>August 21, 2007</b>

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#### Solar water cooler

##### **Abstract**

The present invention discloses a solar water cooler, which includes a water tank, a condensing panel, and an auxiliary refrigerating device, wherein the water tank has an insulating panel transversely embedded into the water tank for separating the water tank into an upper cooling chamber and a lower chilling chamber, a pair of inner conduits for respectively communicating the cooling chamber to the chilling chamber, each of the cooling chamber and the chilling chamber has a water inlet port and a water outlet port, a plurality of conduits for respectively communicating the water tank to the condensing panel and the auxiliary refrigerating device, wherein the auxiliary refrigerating device electrically powered by solar cells and by thermocells.

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**Current International Class:** F25B 21/02 (20060101)

**Field of Search:** 62/3.2,3.6,156,259.1,389,395

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**References Cited** [\[Referenced By\]](#)

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**U.S. Patent Documents**

<a href="#">4058718</a>	November 1977	Palka
<a href="#">6029461</a>	February 2000	Zakryk
<a href="#">6058718</a>	May 2000	Forsberg et al.
<a href="#">6684648</a>	February 2004	Faqih

*Primary Examiner:* Jones; Melvin  
*Attorney, Agent or Firm:* Chan; Raymond Y. David & Raymond

**Claims**

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What is claimed is:

1. A solar water cooler, comprising: a water tank for reserving a predetermined volume of water; an insulating panel transversely embedded into said water tank for separating said water

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tank into an upper cooling chamber and a lower chilling chamber; a pair of inner conduits for respectively communicating a lower portion and an upper portion of said cooling chamber to a counterpart lower portion and a counterpart upper portion of said chilling chamber, wherein each of said cooling chamber and said chilling chamber has a water inlet port defined on an upper side wall and a water outlet port defined on a lower said wall; a condensing panel disposed above said cooling chamber and is mounted against an outer wall of a building to be integrally formed with said building, wherein said condensing panel comprises a radiating manifold and a plurality of radiating fins provided thereon, and an exposing opening defined on said radiating manifold for communicating said radiating manifold to outside; a pair of condensing conduit for correspondingly communicating an upper portion and a lower portion of said condensing panel to respective upper portion and lower portion of said cooling chamber; and an auxiliary refrigerating device disposed above said chilling chamber, wherein said auxiliary refrigerating device comprises a thermopile refrigerating unit and a temperature monitor unit, said thermopile refrigerating unit has a chilled water conduit respectively for communicating said upper portion and said lower portion of said chilling chamber.

2. The solar water cooler, as recited in claim 1, wherein said water tank is made of building material, or prepared in such a manner that the water tank comprises an inner flask made of stainless steel, an insulating layer made of foam plastic, and an outer casing made of aluminum plate.

3. The solar water cooler, as recited in claim 1, wherein a reflux pump coupled to said chilling chamber water inlet port for ensuring a chilled water be circularly serviced.

4. The solar water cooler, as recited in claim 1, wherein said auxiliary refrigerating unit is electrically powered by solar cells or by thermocells.

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### **Description**

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#### 1. Field

The present invention relates to refrigeration system, and more particularly, relates to a refrigerating system directly or indirectly utilizing solar energy to achieve an efficient performance.

#### 2.

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Energy is an unavoidable topic in the new century. It is witnessed that sciences and technologies related to the energy industry had been significantly concerned all over the world. Especially, the solar energy, widely considered as an unexhausted energy source, had been employed in a variety of applications, such as refrigeration industry. Nowadays, the solar energy refrigeration is exclusively focused on the air-conditioning refrigeration, in which a plurality of refrigerating modes had been unveiled, such as, **solar absorption refrigeration**, solar adsorption refrigeration, solar mechanic compression refrigeration, solar dehumidification refrigeration, solar injection refrigeration, and so on. However, the above mentioned solar air-conditioning devices are so complicated and costly, which in turn, restricting its prevailed applications in practices. As a result, it is rarely seen such solar refrigerating means had been used for household purposes. What is more, such solar refrigerating means are supposedly operated under sealed or closed chambers, the ventilation is out of reach thus resulting the air quality really unserviceable. To a worse extent, CFC had been sometimes employed in some occasions. The damage to the environment of the CFC was terrible. The solar cold water air-conditioner had been introduced in 1980s, wherein the solar energy is converted into heat for producing cold water. A very common method for producing cold water is the heat absorption process, wherein the water is utilized as refrigerating medium, and the lithium bromide is employed as absorbing agent. Unfortunately, the dehumidification process would be a bottleneck and low temperature chilled water ranging from 7-9 degree. C. had to be prepared for ensuring such dehumidification. It is noted that whenever a single centigrade dropped of such chilled water temperature, the refrigerating efficiency of such refrigerating process would be decreased by 3%. This is undesirable for most users. In short, such **solar absorption refrigeration** is still costly, complicated, and bulky in occupied area.

#### SUMMARY

A primary object of the present invention is to provide a solar dual-temperature water cooler, which is capable of lowering the water temperature to the lowest temperature of surrounding environment by radiating means so as to obtain low-temperature cooling water, which in turn could be directed into the refrigerating device for enhancing the overall efficiency of the refrigerating device. Furthermore, such cooling water could be prepared to generate chilled water which is capable of absorbing heat along the conduit in the refrigerating process.

Accordingly, to achieve above object, the present invention provides a solar dual-temperature water cooler, comprising, a water tank for reserving a predetermined volume of water, wherein the water tank is made of building material, or prepared in such a manner that the water tank comprises an inner flask made of stainless steel, an insulating layer made of foam plastic, and an outer casing made of aluminum plate; an insulating panel transversely embedded into the water tank for separating the water tank into an upper cooling chamber and a lower chilling chamber;

a pair of inner conduit for respectively communicating a lower portion and a upper portion of cooling chamber to a counterpart lower portion and a counterpart upper portion of the chilling chamber.

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chamber, wherein each of cooling chamber and the chilling chamber has a water inlet port defined on a upper wall and a water outlet port defined on a lower wall, and a reflux pump is coupled to the chilling chamber water inlet port for ensuring a chilled water be circularly serviced;

a condensing panel disposed above the cooling chamber and is mounted against an outer wall of a building to be integrally formed with the building, wherein the condensing panel comprises a radiating manifold and a plurality of radiating fins provided thereon for radiating a heat of the condensing panel, a pair of condensing conduit for correspondingly communicating a upper portion and a lower portion of the condensing panel to respective upper portion and lower portion of the cooling chamber; an auxiliary refrigerating device disposed above the chilling chamber, wherein the auxiliary refrigerating device comprises a thermopile refrigerating unit and a temperature monitor unit, the thermopile refrigerating unit has a chilled water conduit respectively for communicating the upper portion and lower portion of the chilling chamber, so that water of the upper portion of the cooling chamber, having a higher temperature, will be flowed to the condensing panel to be naturally radiated, and then flowed back to the lower portion of the cooling chamber with a circular manner so as to ensure the water reserved within the cooling chamber reach a lowest temperature of the environment generating the cooling water, wherein the cooling water is capable of being directed to the refrigerating device to refrigerate the condenser of the refrigerating device for enhancing the refrigerating efficiency, and being refluxed to the upper portion of the cooling chamber; since the inner conduits are provided for correspondingly communicating the mating portions of the cooling chamber and the chilling chamber, the water reserved within the chilling chamber will be cooled down to the environmental temperature; furthermore, in case the chilled water temperature is now low enough, the temperature monitor unit would initiate the thermopile unit to lower the temperature of the water reserved within the chilling chamber, wherein the chilled water could be directed into the chilling conduit to absorb the heat under a refrigerating circumstance, afterwards, the heat absorbed chilled water would be refluxed into the upper portion of the chilling chamber, if the chilled water temperature is higher than the temperature of the cooling water, the water of the upper portion of the chilling chamber would be flowed into the upper portion of the cooling chamber via the inner conduit, at the same time, the water of the lower portion of the cooling chamber would be flowed into the lower portion of the chilling chamber.

Finally, it is noted that the auxiliary refrigerating device of the present invention is electrically powered by solar cells or by thermocell. The solar energy dual-temperature water coolers according to the present invention is of solid cost saving, simple and convenient operation, and free of pollution, and more importantly, available to most household applications.

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<b>United States Patent</b>	<b>4,966,014</b>
<b>Erickson</b>	<b>October 30, 1990</b>

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## ***Solar absorption refrigeration***

### **Abstract**

This invention relates to ice-producing refrigerators which operate on an intermittent absorption cycle, and to solar heat collectors suitable for powering the intermittent absorption refrigerators. The refrigerators are useful for making ice and for storing vaccines and food in areas where electricity is unavailable, unreliable, or high in cost.

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Inventors: **Erickson; Donald C.** (Annapolis, MD)

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Filed: **May 15, 1989**

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**Current International Class:** F25B 17/00 (20060101); F25B 27/00 (20060101); F25B 17/02 (20060101); F25B 027/00 ()

**Field of Search:** 62/235.1,476,335

### **U.S. Patent Documents**

<a href="#">3817050</a>	June 1974	Alexander et al.
<a href="#">4448040</a>	May 1984	Kunugi

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<a href="#">4458499</a>	July 1984	Grossman
<a href="#">4667485</a>	May 1987	Ball et al.
<a href="#">4732008</a>	March 1988	DeVault
<a href="#">4744224</a>	May 1988	Erickson

*Primary Examiner:* King; Lloyd L.

***Claims***

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Claim:

1. An apparatus for producing refrigeration by an intermittent absorption cycle apparatus comprised of a generator/absorber, a condenser, and an evaporator, wherein the improvement comprises:

(a) a second absorber which is cooled by refrigeration produced by said evaporator;

(b) a second evaporator in which liquid refrigerant is evaporated;

(c) a means for routing evaporated refrigerant from said second evaporator to said second absorber;

(d) a means for transferring absorbent from said generator/absorber to said second absorber;

(e) a reservoir of liquid refrigerant for said second evaporator which is not supply liquid to said evaporator;

(f) a means for reducing the pressure of the liquid refrigerant supplied from said reservoir to said second evaporator; and,

(g) at least one means for supplying heat to said generator/absorber comprised of a solar radiation collecting apparatus comprised of a stationary arcuate central section having acceptance half angle relative to said generator/absorber of between 25.degree. and

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35.degree.; plus two arcuate outer sections which are hinged to said central section so as to be movable to acceptance half angles between 10.degree. and 24.degree. at any time of the year.

2. An apparatus for producing refrigeration by an intermittent absorption cycle apparatus comprised of a generator/absorber, a condenser, and an evaporator, wherein the improvement comprises:

(a) a refrigeration store which is intermittently cooled by said evaporator, and a second absorber which is cooled by said refrigeration store;

(b) a second evaporator in which liquid refrigerant is evaporated;

(c) a means for routing evaporated refrigerant from said second evaporator to said second absorber; and

(d) a means for transferring absorbent from said generator/absorber to said second absorber.

3. The apparatus according to claim 2 additionally comprised of a reservoir of liquid refrigerant for said second evaporator which is not supply liquid to said evaporator.

4. The apparatus according to claim 3 additionally comprised of a means for reducing the pressure of the liquid refrigerant supplied from said reservoir to said second evaporator; and at least one means for supplying heat to said generator/absorber.

5. The apparatus according to claim 4 wherein at least one of said means for supplying heat is comprised of a solar radiation collecting apparatus comprised of a stationary arcuate central section having acceptance half angle relative to said generator/absorber of between 25.degree. and 35.degree.; plus two arcuate outer sections which are hinged to said central section so as to be movable to acceptance half angles between 10.degree. and 24.degree. at any time of the year.

6. The apparatus according to claim 2 wherein said refrigeration store which is intermittently cooled by said evaporator and which cools said second evaporator is comprised of ice.

7. The apparatus according to claim 2 wherein said refrigerant is ammonia and said absorbent is a liquid phase ammonia absorbent selected from the list comprised of  $\text{H}_2\text{O}$ ,  $\text{NaSCN}$ ,  $\text{NaI}$ ,  $\text{LiNO}_3$ ,  $\text{LiBr}$ ,  $\text{LiCl}$ , and mixtures thereof.

8. The apparatus according to claim 2 wherein said means for transferring is comprised of a charge tank which is dimensioned to contain the proper amount of absorbent charge for said second absorber; a valve for filling said charge tank from said generator/absorber; and a Group For Environment and Energy Engineering



separate valve for discharging said charge tank to said second absorber.

9. The apparatus according to claim 2 additionally comprised of a discharge tank, a valve for draining absorbent from second absorber to said discharge tank; and a valve and conduit for transferring absorbent from the bottom of said discharge tank back to said generator/absorber.

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### **Description**

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#### BACKGROUND

The current practice of solar-powered intermittent absorption refrigeration is exemplified in U.S. Pat. No. 4,744,224. This technology is simple, robust, and reliable. It meets the needs of lesser developed countries by being locally manufacturable and by producing ice at about one-tenth the cost of production by photovoltaic refrigerators, for ice capacity in the range of 10 to 1000 kg per sunny day.

Nevertheless, there still remain two limitations in the current practice of **solar absorption refrigeration** which have limited its spread. As with all solar technologies, high first cost is a problem. Any measures which would either increase the solar aperture or increase the overall collection efficiency without increasing cost would have the beneficial effect of lowering the first cost per unit of ice produced. Secondly, the inherent functioning of solar intermittent absorption refrigerators is to produce ice at night, which requires evaporator temperatures on the order of -10.degree. C., and then use stored ice by day to keep the cold box at slightly above 0.degree. C. In other words, the evaporator region inherently cycles between about -12.degree. C. and about +4.degree. C., depending on insolation and insulation. Clearly it would be possible to incorporate a separate thermostatted compartment cooled by storage ice which maintains a relatively constant +4.degree. C., and that would be useful for many refrigeration applications. However, there is another category of applications which require a relatively constant -20.degree. C. This is the temperature of the frozen food section of most domestic refrigerators, i.e., the "freezer compartment." Examples of commodities which require this level of refrigeration for long term storage include oral polio vaccine, measles, and yellow fever vaccines. Although conventional intermittent absorption cycles could easily be adjusted to yield -20.degree. C. at night, at some loss in efficiency, they have no practicable mechanism for maintaining that temperature by day. Multiple-staged absorption cycles are well-known in the art, especially for continuous cycles. See for example U.S. Pat. Nos. 4,402,795 and 4,475,361. Some previous work has also been done on intermittent cycles with multiple stages, for example the technical article by A. Mani and A. Venkatesh appearing at p. 271 of Vol. 26 No. 3/4 1986

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Energy Conversion and Management, entitled "A Two Stage Intermittent Solar Refrigeration System--Evaluation of Salient Parameters". In that article, a two-stage generator and absorber configuration is disclosed which enables use of much lower heat source temperatures (approximately 70.degree. C.), albeit at much lower Coefficient of Performance.

The capital cost problems relating to aperture size and collection efficiency stem from two constraints. First is the sidereal motion. The elevation angle of the sun at solar noon changes by 46.5.degree. through the course of the year. At three hours either side of solar noon, the change is about 5820 . Secondly, the inherent functioning of the intermittent absorption refrigeration cycle requires average temperatures on the order of 50.degree. C. above ambient, and afternoon peak temperatures some 15.degree. C. higher. The collection efficiency of flat plate collectors is simply too low at those temperatures. It is known that as the collection temperature increases, a concentrating collector (solar aperture larger than solar target) becomes more efficient than a flat plate collector. The decreased loss due to heat leakage from the smaller target offsets the increased loss due to reflections. In the technical article "Low Concentration CPC's for Low-Temperature Solar Energy Applications", February 1986, Journal of Solar Energy Engineering, Vol. 108 p. 49, J. M. Gordon shows that a truncated CPC with acceptance half angle of 30.degree. becomes more efficient than a flat plate collector at 21K above ambient for a concentration ratio (CR) of 1, and at 36K for a CR of 1.5.

Clearly at the temperatures required for **solar absorption refrigeration** some degree of concentration is appropriate. However, just as clearly the cost and reliability constraints eliminate any use of automatic tracking concentrators. Winston (U.S. Pat. No. 4,002,499) has shown that with a full CPC geometry the concentration ratio achievable from a stationary collector is  $1/\sin .\theta$ , where  $\theta$  is the acceptance half angle. Unfortunately the full CPC geometry is very wasteful of reflective material--much of it is shaded for much of the year. When the CPC is truncated to avoid shading, the CR attainable at a given acceptance half angle is much lower. If the aperture of a truncated CPC is increased to get more CR, the acceptance angle decreases, thus either missing some sun or requiring tracking.

It is known to increase the solar aperture by adding one or more hinged reflectors to an array, where the hinges are seasonally adjusted. For example, U.S. Pat. No. 4,371,623 discloses addition of hinged flat plate reflectors to a flat plate collector.

What is needed, and one object of this invention, is a solar energy collector which achieves the advantages of a stationary truncated CPC collector without the attendant disadvantage of low CR. Preferably any required seasonal repositioning of such a device would readily be accomplished by one person. Also desirable objectives are that the same geometry be applicable at different latitudes, and that the collector be acceptably storm-resistant.

A second needed improvement, and object of this invention, is a simple add-on to a solar Group For Environment and Energy Engineering

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C. temperature, preferably without requiring an additional generator.

DISCLOSURE OF INVENTION

Two separate inventions are disclosed herein, each having potentially beneficial use independently, but the combination of the two cooperating to provide a uniquely advantageous result in solar refrigeration.

The first invention comprises an elongated arcuate stationary reflector which is mounted along an east-west axis, and which has two hinged arcuate extension reflectors, with the hinge axes being parallel to the stationary reflector axis. A stationary solar target is mounted within the reflection beam of the stationary reflector, and the acceptance half angle of the stationary reflector and target is about 29.degree.. The hinged reflector extensions are capable of being opened until their acceptance half angle is between 10 and 15.degree., i.e., they can be rotated approximately 45.degree. beyond their position in a fixed CPC geometry with  $\theta$  of 29.degree.. They are fitted with adjustable stops to allow seasonal repositioning.

Preferably the glazing is stationary and is attached only to the stationary reflector. Preferably the reflector extensions are approximately the same width as the stationary reflector. Preferably the reflector extensions can be folded together so as to envelop the stationary reflector and glazing, thereby protecting them from severe weather.

The second invention comprises adding a second evaporator and absorber to the conventional intermittent absorption cycle in the following cooperative manner:

- (a) the second absorber is cooled by storage ice made by the primary evaporator;
- (b) the second evaporator cools a freezer compartment to about  $-20^{\circ}\text{C}$ ;
- (c) the vapor from the second evaporator is absorbed in the second absorber; and
- (d) the second absorber is periodically refilled with absorbent solution from the primary generator/absorber.

Preferably a separate reservoir containing a supply of liquid ammonia for the second evaporator is also incorporated. Preferably the second absorber is filled by gravity transfer from a separate charge tank. Preferably the second absorber is emptied by gravity transfer to a separate discharge tank, which in turn is emptied by pressure transfer back to the primary generator/absorber.

In India absorption systems are in use mainly in the commercial sector and have not found their way in the rural sector as such because mostly we use ammonia systems. However research is going on the implementation level is low because of lack of focus and mostly because of high costs. LiBr systems are used less for want of corrosion resistant materials; a point that we will address in the course of the project.

## Project Summary

The outcome of the project will be a working prototype of an LiBr/water based adsorption refrigerator designed for rural application.

The construction of the assembly is relatively simple and we are sure will not take much time. Keeping the objective of the project in mind we will be stressing upon the design and idea part to enhance the learning experience and improving the

efficiency and portability of the system.

The project is envisaged to start in the summer break and will be completed within the break. The designing part of the project will start in this semester in March.

## Infrastructural Requirements

Sr. No.	Infrastructural Facility	Yes/No/ Not required Full or sharing basis
1.	Workshop Facility	Yes
2.	Water & Electricity	Yes
3.	Laboratory Space/ Furniture	Yes
4.	Power Generator	No
5.	AC Room or AC	Yes
6.	Telecommunication including e-mail & fax	No
7.	Transportation	Yes
8.	Administrative/ Secretarial support	Yes
9.	Information facilities like Internet/ Library	Yes
10.	Computational facilities	Yes
11.	Animal/ Glass House	No
12.	Any other special facility being provided	

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## Expertise available with the group

The staff at the RAC laboratory has a considerable experience in manufacturing refrigeration systems. They have in recent past manufactured experimental set ups in the laboratory and have sound practical experience. The students involved on the other hand have done quite a bit of literature survey and are convinced about the success of the project once it is started. The principal investigator himself specializes in heat transfer and will be of immense value during the project. The lab also has welding and machining stations and thus will be very useful during the project.

## Financial Aspects

All figures are in INR

### Raw material

Item	Estimation	Justification
Metal sheets aluminum copper etc.	15,000	Obvious
Pipes	5,000	Obvious
Welding Brazing machining	10,000	Obvious
Total	30,000	

### Equipments

Item	Estimation	Remarks
Solar flat plat collector	20,000	Required by design
Throttling Valves (2)	6,000	Required by design
Pump	3,000 x 2	Required by design
Dispensers	3,000	Required by design
Lithium Bromide	2000	Required by design
Total	37,000	

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## Labor Costs

Item	Estimate	Remarks
Manual Labor regarding welding etc	15,000	Shop-floor work for about three months
Total	15,000	

Other Costs	Estimation	Remarks
Site Preparation	1,500	Installation costs
Total	1,500	

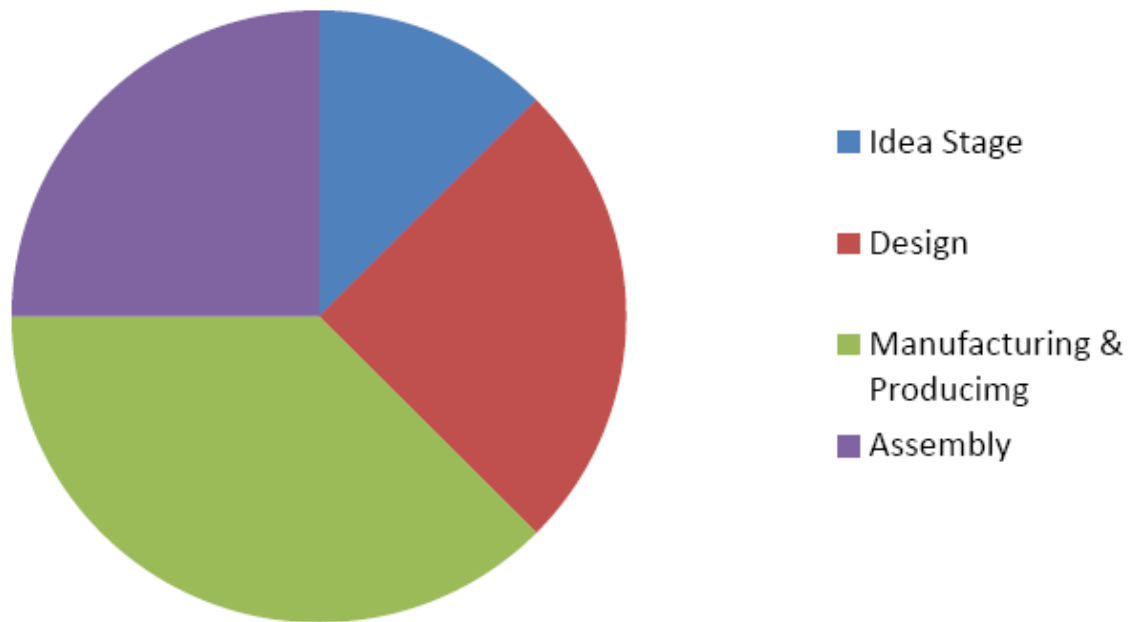
Approximating the Cost Contingencies to be about 20%

Approximate Total Cost of the project – INR 100,200

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Absorption Refrigeration Team

## Time line



The Project will be completed during the summer break and will take around 2-3 months if things go as per plan. However keeping in mind unforeseen difficulties a total time of around 4 months from the date of sanction is a reasonable estimate given the complexity and properties of the system envisaged.