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# SOLAR PLUS COMPRESSOR HEAT DESALINATOR WATER STILL

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## ABSTRACT

This report is describing testsof producing distilledwater using double sloped solar still, assisted by an air conditioning hot Freon unit. The report include design, daily production rate, relative effect of solar , Freon, wind and temperatureon production rate. Cost and other benefits arealso explained.

## 1. INTRODUCTION

My home, ALHASA (25° 22' N, 49° 34' E) located east of Kingdom of Saudi Arabia, is the largest oases worldwide and at close proximity to its oil fields. ALHASA means shallow sweet water right under sand in old Arabic word. During the 80s it lost all of its 180 beautiful natural springs and lakes that were producing over 0.56 million liter/mint of water (group photos 1&2) Consequently, to preserve the oases and due to country growth, government spent billions of dollars on desalination, recycling farms water run-off, sewage water treatment plants and distribution systems, also put sever restrictions on growing grains. Saudi Arabia is now the world's largest producer of desalinated water (50% of the world desalinated water.)Unfortunately, domestic crude oil consumption escalated to 2.4 million barrel (serving population of 27 million: 19 MM Saudi nationals and 8 MM non-nationals.) Sadly, Cost of thermal oil burning when used for direct desalination is unfeasible in relation to other options .Causes of losing aquifer water point out to human greed and inefficiency .This report is attributed to the hope of maximizing use of renewable energy, preserving our planet earth resources , combat global warming and reduce waste.

## 2. DESIGN CONSIDERATIONS

The Project is a research one and considered the following:

- Material Local availability.
- Dismantle and reconstruct flexibility.
- Rivets and transparent Silicon used to join all parts.
  Special high temperature Silicon is used to seal or help fuse parts , glass and aluminum are used to build still body ( material such as Lexan (Polycarbonate), Plexiglas (Acrylic) are excluded due to inability to fuse to silicon and the need to join parts by chemical welding ( does not help in dismantle and redesign.)
- Used solar preheater and AC compressor hot freon-22 from upstream a Split AC condenser radiator (85+ c during 6 days test) to maximize solar absorption, details are shown in still drawings A & B (Summer maximum air temperature can reach 50 c at test location at house roof)
- Insulation is very important; device will not work without it. Only condensing distilled compartment walls inside still and its water out tubing does not need insulation.

## 3. PRODUCTION PRIOROTY CONSIDERATIONS

- Priority was given to safety (hot (85 c) copper Freon-22 tubes at 240 psi operating pressure are used in direct contact with still hard water.) When possible, high priority was given in maximizing distilled water volume.
- Lesser priority was given to material compatibility during short term tests .Test consisted of filling electrolyte media (+70 c temperature hard tap water.) in bare Aluminum basin, heated by hot Freon Copper tubes.It operated for about one month period, and then Freon tubes were disconnected and plugged outside still. Purpose of above strategy is to establish trend and explore still productivity.A new still will be constructed and upgraded corrosion wise at a later date (outside this article scope.)

## 4. DAILY VARIATIONS

This design has higher heat input from Freon compressor discharge than from solar radiation; therefore variation in daily distilled water volume is attributed more to house room thermostat automatically switching "ON/OFF" (set point at 24 C.)Distilled water dramatically increases with increase in cold air escaping from room (forced fan ventilation, frequency of doors, windows and curtain opening .Turning a ventilation fan "ON" for couple of hours can increase

distilled water as high as 20% per day) moreover room insulation sometimes makes thermostat lag behind climatic temperature changes at this test season in our desert region, this occasionally affect controlled statistics results. Also it was noted that slight air temperature change can increases still water temperature several folds.

## 5. 80 CMX80CM DESALINATOR DOUBLE SLOPE (STILL)

I will refer to the device as "still", detailed design is shown in drawings "A" & "B" and photos A1 & B1.

### 5.1-DAILY PRODUCTION

Daily 24 HRS production rate of this still is shown in table 4.1. Maximum rate is 9.21 liter/day, and become 14.4 liter/day if rated to a 1.0 sq. meterarea still, and 27.0 liter/day if rated at a 1.0 sq. meter still and at max air temp of 50 c (as per table and graph 4.4)

### 5.2- SOLAR VS FREON EFFECTS ON DESTILTION

Per the experiment span period, Freon heat is producing 58% of distilled water, while solar heat 42% (table 4.2) It is possible first to calculate Freon heat productivity rate alone at night time (no solar heat, also deducted distilled water due to remaining solar heat just after sunset, the deductible amount was found from an earlier separate test with air conditioning turned off, and day and night production rates obtained.)

### 5.3-ENERGY SAVINGS VS STILL TEMPERATURE

Solar/Freon still can also save electrical energy only at anarrow still temperature window between 58 c and 69.4 c. Table 4.3 shows 16.6% highest electricalsaving at 58 c still temperature,and as low as 0.2% when still heat reach 69.4 c (this temperature is the highest during test period, Freon temperature is close to still inside temperature and heat exchanging is halted, in fact solar preheater upstream the still raised still temperature and stopped cooling Freon at hot weather condition, this result in more compressor work and electrical consumption. It is concluded that energy saving in this type of still is not a straight forward relation.

### 5.4-WIND SPEED / TEMPRATURE EFFECT

Test shows that increase in wind speed decreases distilled water production, while increase in air temperature increases it, this is illustrated in table and graph 4.4, keeping in mind that both, wind and air temperature work simultaneously, interact and reversely affect each other, table purpose is to illustrate their relative effect during test period.

## 6. EARLIER UNSUCCESSFUL TESTS

Earlier tested still devices (with jute rugs but without Freon, double and single slope) photo C1, produced contaminated and less distilled water. Contamination is due to soldering galvanized steel sheets using brass rods. Reduced productivity of single slope still might be attributed to too hot glass temperature at condensing surface.

## 7. CONCLUSION

Five years still life span analyses shows that cost is less than 2 cent/liter distilled water,it is high. however under certain air temperature condition our environment gain 1 degree c reduced heat emission from the condenser as a result of vaporizing still water (radiator) plus the energy saving in using Freon make this design even more feasible (Carbon taxes offer a potentially cost effective means of reducing greenhouse gas emissions.) Additionally anticipated 27.0 liter/daydistilled water production when rated at a 1.0 sq. Meter still and at max air temp of 50 c at test location addeven more advantage points to this design.

Earlier tested still devices (without Freon) produced contaminated or less distilled water. Contamination is due to soldering galvanized steel sheets with brass rods. Reduced productivity might be attributed to too high glass slope or too hot glass temperature at condensing surface such as at parallel glass device at front of photo.

## 8. ACKNOWLEDGEMENTS

My sincere thanks is extended to all respected persons assisted in creating this report,especially holders and contributors ofwebsites appearing in the reference section, The International **Journal of Engineering Research and Applications (IJERA) Abdulhadi A Alsabti from SEREC Air Conditioning Establishment, my wife Widdad A Alsabti and rest of my family and all individuals directly or indirectly provided help.**

## REFERENCES:

1-References at "INTRODUCTION "section:

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http://www.saudiaramcoworld.com/issue/196010/.ain.htm
[1.2]
http://www.aawsat.com/details.asp?section=43&article=464782&issueno=10715

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[1.4] http://ahsaweb.net/vb/archive/index.php/t-52864.html
[1.5]http://www.emirates247.com/business/economy-finance/saudi-oil-exports-set-to-dive-in-long-term-2011-07-20-1.408672
[1.6]http://www.water-technology.net/projects/shoaiba-desalination/
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[1.9]http://en.wikipedia.org/wiki/Demographics_of_Saudi_Arabia
[1.10] http://www.timegenie.com/latitude_and_longitude/country_coordinates/sa
2- References used at "DESIGN CONSIDERATIONS" section:
[2.1]http://answers.yahoo.com/question/index?qid=20081216032328AAlgLmX
[2.2] http://www.builditsolar.com/Projects/Cooking/SOLRSTIL.HTM

VANISHED RIVER LIKE SPRINGS AND CANALS (BEFORE & AFTER, LOCATIONS ARE NOT THE SAME)

BEFORE……..AFTER

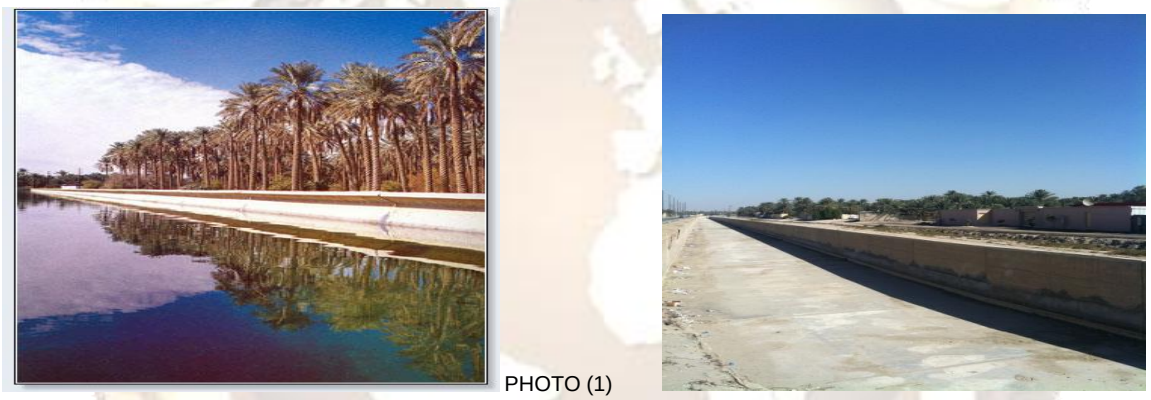


PHOTO (1)

PHOTO (2)

PHOTO A1 GENERAL VIEW OF STILL

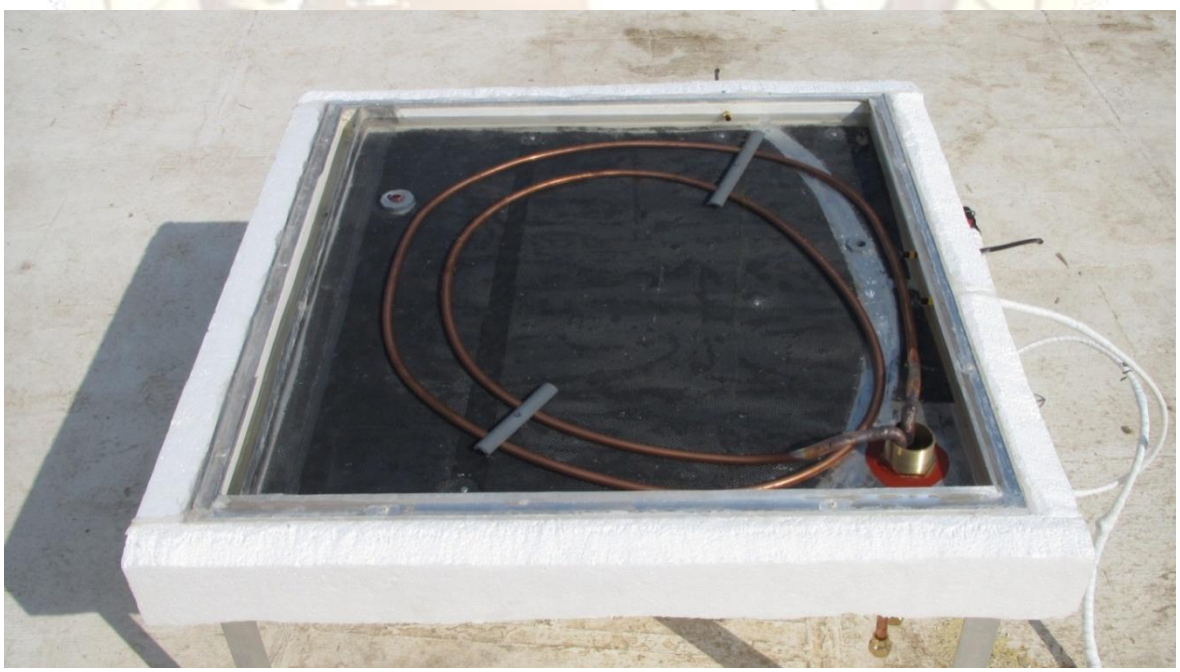
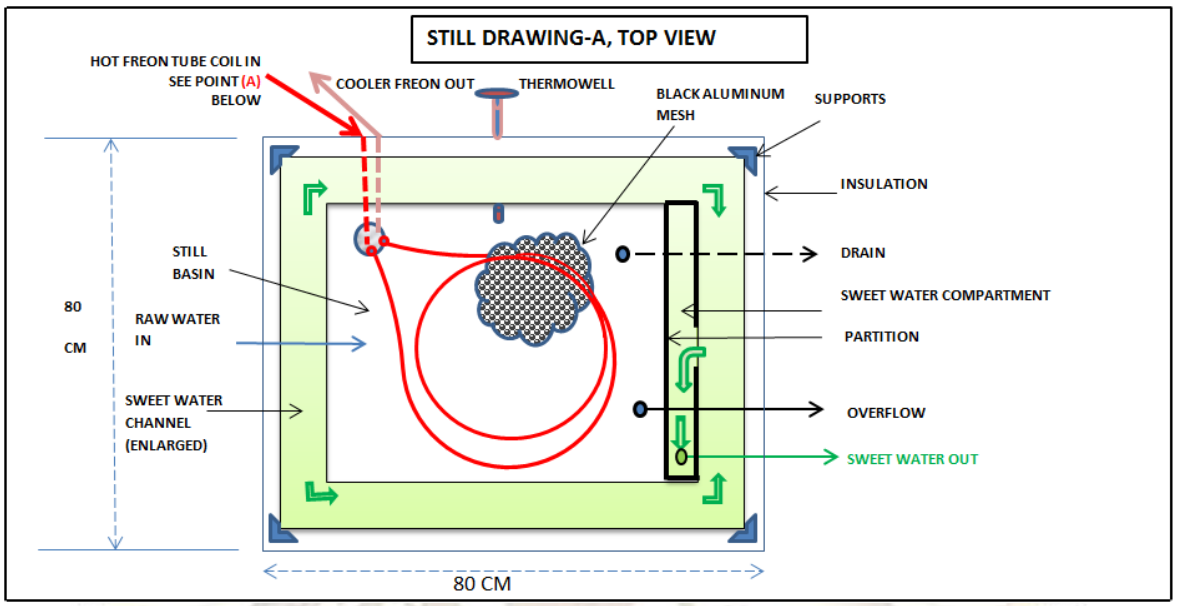
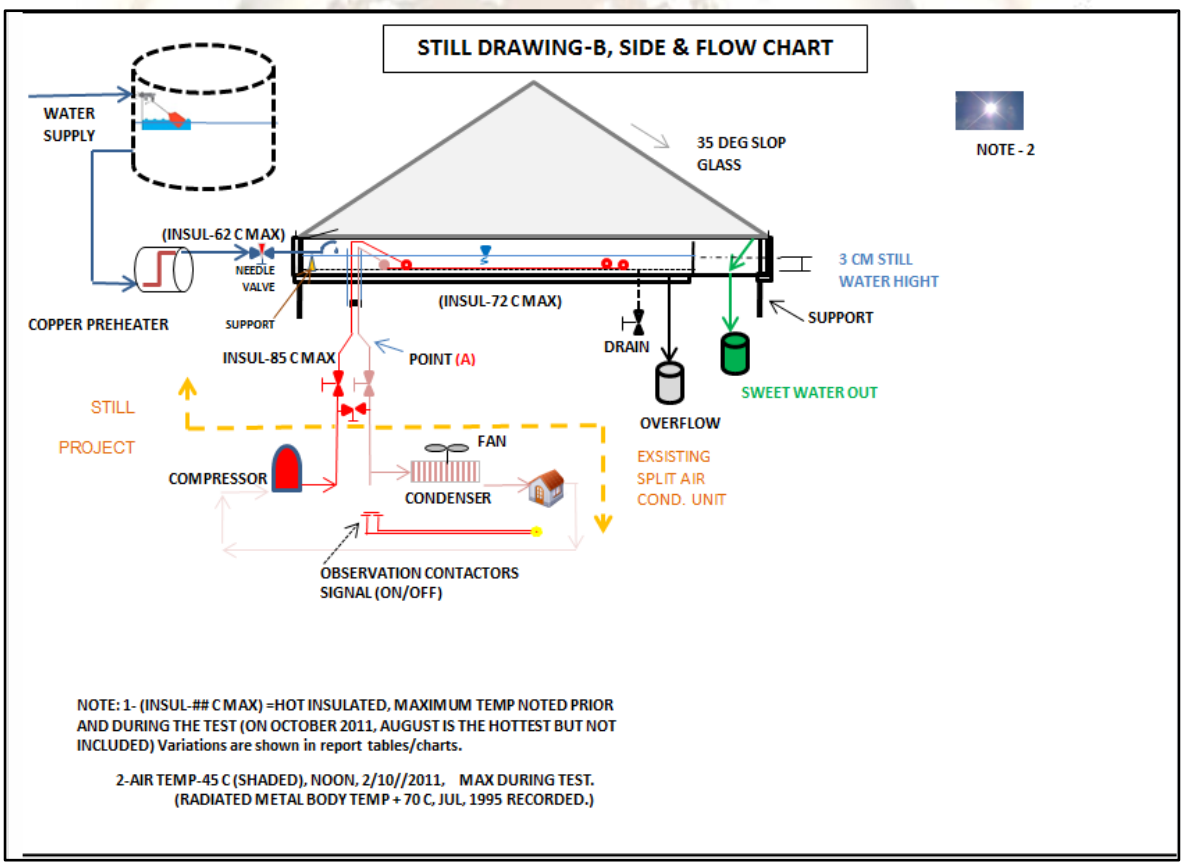


PHOTO B1 STILL WATER BASIN

# DRAWING


STILL DRAWING-A, TOP VIEW
HOT FREON TUBE COIL IN
SEE POINT (A)
BELOW
COOLER FREON OUT
THERMOWELL
BLACK ALUMINUM
MESH
SUPPORTS
INSULATION
STILL
BASIN
RAW WATER
IN
80
CM
SWEET WATER
CHANNEL
(ENLARGED)
DRAIN
SWEET WATER COMPARTMENT
PARTITION
OVERFLOW
SWEET WATER OUT
80 CM


STILL DRAWING-B, SIDE & FLOW CHART
WATER
SUPPLY
35 DEG SLOP
GLASS
NOTE - 2
(INSUL-62 C MAX)
NEEDLE
VALVE
3 CM STILL
WATER HIGHT
COPPER PREHEATER
SUPPORT
(INSUL-72 C MAX)
SUPPORT
DRAIN
INSUL-85 C MAX
POINT (A)
SWEET WATER OUT
STILL
PROJECT
OVERFLOW
FAN
EXSISTING
SPLIT AIR
COND. UNIT
COMPRESSOR
CONDENSER
OBSERVATION CONTACTORS
SIGNAL (ON/OFF)
NOTE: 1- (INSUL-## C MAX) =HOT INSULATED, MAXIMUM TEMP NOTED PRIOR AND DURING THE TEST (ON OCTOBER 2011, AUGUST IS THE HOTTEST BUT NOT INCLUDED) Variations are shown in report tables/charts.
2-AIR TEMP-45 C (SHADED), NOON, 2/10//2011, MAX DURING TEST.
(RADIATED METAL BODY TEMP + 70 C, JUL, 1995 RECORDED.)

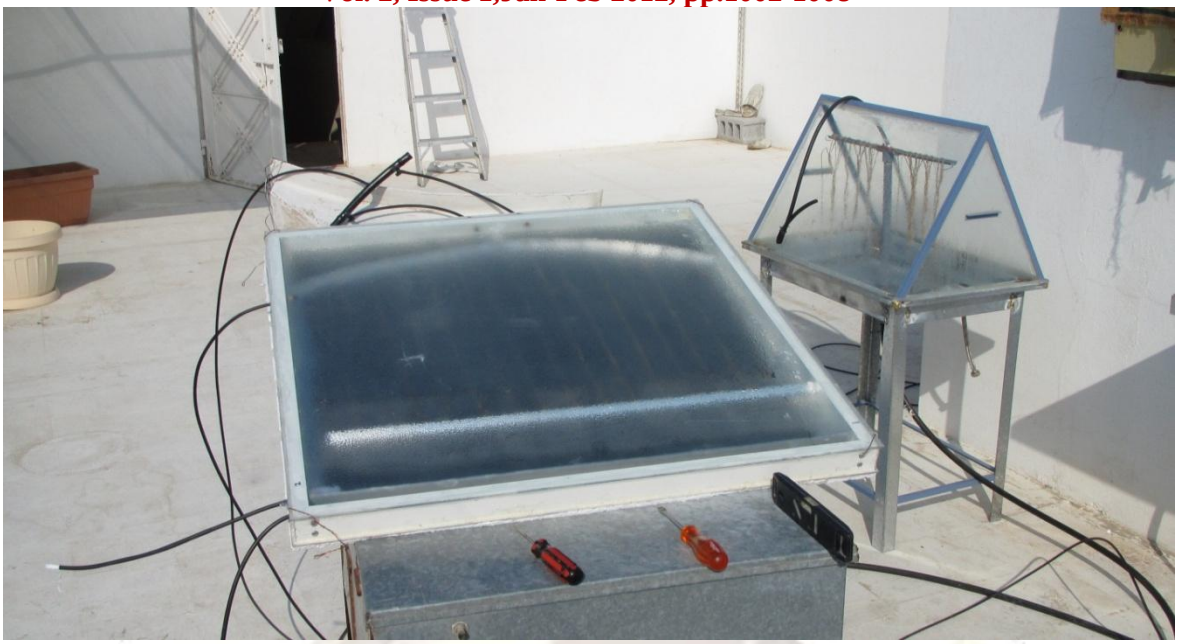
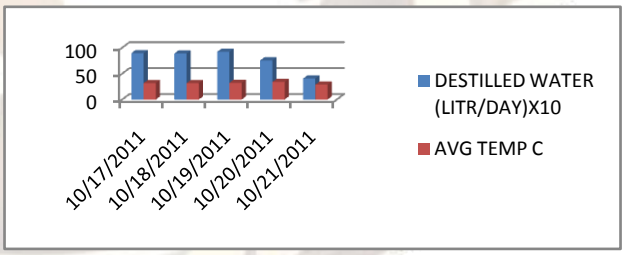


PHOTO C1, EARLIER STILL TESTS

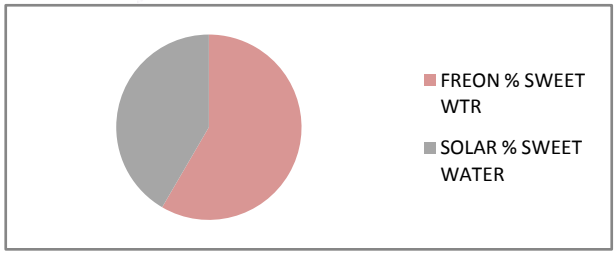
**4.1-DAILY PRODUCTION**

| DATE | DESTILLED WATER VOLUEM | AVG AIR TEMP |
|---|---|---|
| | (LITR/DAY)X10 | C |
| 17/10/2011 | 89.50 | 31.8 |
| 18/10/2011 | 88.70 | 31.7 |
| 19/10/2011 | 92.10 | 32.3 |
| 20/10/2011 | 75.50 | 33.9 |
| 21/10/2011 | 40.40 | 28.8 |



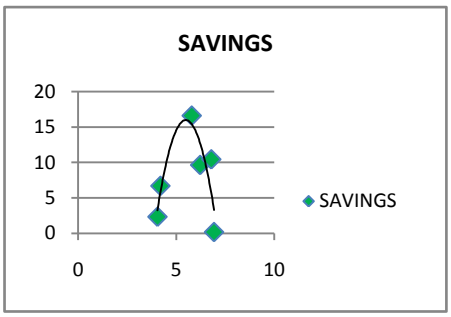

**4.2- SOLAR VS FREON EFFECTS ON DESTILTION**

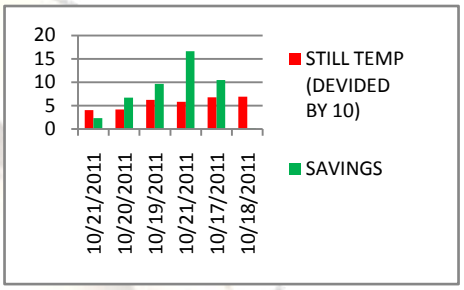
| ENERGY SOURCE % | |
|---|---|
| FREON | SOLAR |
| 58 | 42 |



**4.3-ENERGY SAVINGS VS STILL TEMPERATURE**

| DATE | STILL TEMP c (DEVIDED BY 10) | SAVINGS |
|---|---|---|
| 17/10/2011 | 6.800 | 10.5 |
| 18/10/2011 | 6.940 | 0.2 |
| 19/10/2011 | 6.230 | 9.7 |
| 20/10/2011 | 4.200 | 6.7 |
| 21/10/2011 | 5.800 | 16.6 |
| 21/10/2011 | 4.050 | 2.3 |




**4.4-WIND SPEED / TEMPRATURE EFFECT**

| DATE | DAILY TOTAL LITR | MAX AIR TEMP | WIND MTR/S |
|---|---|---|---|
| **17/10/2011** | **8.95** | 40.90 | **2.80** |
| **18/10/2011** | **8.87** | 41.30 | **1.90** |
| **19/10/2011** | **9.21** | 40.90 | **1.30** |
| **20/10/2011** | **7.55** | 41.90 | **3.60** |
| **21/10/2011** | **4.04** | 35.00 | **6.400** |