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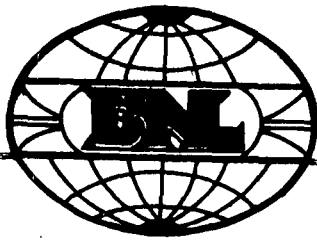
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OUR REF: BNL/UNIDO/02/051/04

YOUR REF: ML/SB

DATE: 15<sup>TH</sup> JANUARY, 2003.

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**ATTN: MOUNIRA LATRECH**

Dear Miss Latrech,

**MP/NIR/01/022 REDESIGN CONVERSION OF REFRIG. CYCLES  
OF ICE-MAKER, COLD-ROOM CONTRACT NO. 02/051**

### **FINAL REPORT**

I have the pleasure to submit to you herewith the FINAL REPORT three copies of REDESIGN of our REFRIGERTION CYCLE APPLIANCES.

We also forward our invoice two copies.

### **ACKNOWLEDGEMENT**

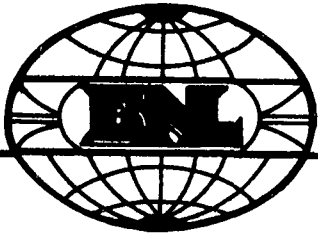
I would like to acknowledge the cooperation of yourself and staff of UNIDO concerned with the project, for giving us the opportunity to perform this services, its indeed a great experience.

We look forward to hearing from you.

Best regards.

**BOSMAK NIG. LTD.**

  
M. S. ALAO Director



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OUR REF:

YOUR REF:

DATE: 15<sup>TH</sup> DECEMBER, 2003

## FINAL REPORT

FOR REDESIGN AND CONVERSION OF REFRIGERATION CYCLE OF  
APPLIANCES FOR ICE BLOCK MACHINE B03K ICE MAKER BS 280L  
FSREEZER MODEL BT 10T AND BF 15T COLD ROOM.

**PRODUCED BY:**

**BOSMAK NIGERIA LIMITED**

**PREPARED BY:**

**M.S. ALAO**

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**OGBA, LAGOS STATE**

**BOSMAK NIGERIA LIMITED**  
**UNIDO PROJECT NO MP/NIR/01/022**  
**FINAL REPORT**

**INTRODUCTION**

THE FINAL REPORT refers to the activities included between steps 1 and 3 of the UNIDO TERMS OF REFERENCE.

**OBJECTIVE**

The overall project objective is to eliminate the use of CFC-11 and CFC-12 through the conversion to the use of HCFC-141B as blowing agent for the polyurethane insulation and HFC-134A as refrigerant.

The redesign of the refrigeration cycles to HFC-134A aiming at least at maintaining the present quality of ice-makers especially with regard to cooling capacity and energy consumption and the redesign aiming at production involving optimized cost.

It consist in a summary of the logistic activities, technical services for the redesign and conversion of refrigeration cycle appliances produced by **Bosmak Nigeria Limited**

**FOR REDESIGN AND CONVERSION OF REFRIGERATION CYCLE  
APPLIANCES FOR ICE-BLOCK MAKING MACHINES MODEL NO  
B03K FREEZER BS 280L AND COLD ROOM BF 10T AND BF 15T**

**AIM**

We have achieved our main aim of using R-134A as a cooling medium and the insulation was converted from R-11 to HCFC-141B blown P.U foam.

**CONVERSION**

During the conversion process the modification of the refrigeration cycles components such as Condenser, Evaporators Capillary tube, Heat Exchangers and drier was carried out.

Our selection of components also took into consideration the utilization of locally available components.

We also considered the question of compatibility of materials with HFC-134A and polyester system performance. We manufactured prototype systems of Ice-maker, Freezer and Cold-Room.

The wall thickness of existing ice-maker model, was not changed. However the insulation was converted from R-11 to HCFC-141B blown polyurethane insulation foam.

**REPLACEMENT OF CFC-12**

Of the two main possibilities for the replacement of CFC-12, HFC-134A has been chosen (as against R-600) because its technology has been well developed and tested. Although its Global Warming Potentials (GWP) is high, it has ZERO ODP, while its thermodynamic properties are similar to CFC-12. Its major drawbacks are that it is immiscible with mineral oil and so needs hygroscopic polyester oil. It requires the use of dedicated compressor, Heat Exchangers, driers and adjustments of capillary tube length. Also while vacuum pumps need to be adequate for the required levels of dehydration, New Leak detectors are required because the current ones are sensitive to chlorine which is not present in HFC-134A.

## OPTIMISATION

The refrigeration system was optimized to use HFC-134A by optimizing some parameters such as the superheat and sub cooling with selection of adequate components such as Compressors, HEAT EXCHANGER AND CAPILLARY TUBE.

## DRYNESS AND CLEANLINESS

HFC-134A requires a much cleaner and drier cooling system than CFC-12 to avoid degradation of the polyester lubricant. Therefore very strict rules for dryness and cleanliness should be applied at all times. During the factory process careful consideration was given to cleanliness to soldering joints, brazing and lock rings because of R-134A material compatibility related to non soluble substances to impurities in the system.

## R134A MATERIAL COMPATIBILITY

The most known problems with R134A were related to Non soluble substances, to impurities in the system. As the capillary has a cross flow section for below 1mm<sup>2</sup> and a temperature drop, these substances resulted in blockage there, when exceeding a few milligrams. A milligram is around a mm<sup>3</sup>, thus able to block more than a mm of capillary, R-134A behaviour is very much different in area of solubility than R-12 because of its polarity.

**There is only one way of avoiding these serious problems. Keep clean. And use only lubricants compatible to R134A/ester oil system.**

## COMPRESSOR

Check cleanliness with a simple test circuit some companies use a circuit with small bended tube heat exchangers and a screw connected capillary tube. The clean capillary is measured for volume flow having a flow rate according to typical appliance. Test time and conditions should be agreed on with your suppliers and according to your experience. In compressors Ester oils are more hygroscopic than previous R12 oils, so the oil has to be kept closed. All used materials in the compressor have to be tested for compatibility.

## DRIER

Compatible drier have to be with 3A molecular sieve material.

R-12 materials with 4A pores can lead to damages.

Soldering brazing and lock rings are possible with R134A.

Tube forming has to be made with ester oils, or very well washed.

Essence of all above is simply: Work clean, Dry and Compatible to R134A and ester oil at every time in every production step.

EFFICIENT APPLICATION OF REFRIGERANT R134A AS CHOICE OF REFRIGERANT. THE REPLACEMENT REFRIGERANT WILL BE COMPARED TO CHOOSE THE BEST SOLUTION.

## REFRIGERANT DATA COMPARISON

<u>REFRIGERANT</u>	<u>12</u>	<u>134A</u>
Formula	CF <sub>2</sub> CL <sub>2</sub>	CF <sub>3</sub> CHF <sub>2</sub>
Critical temp in oc	112	101
Molecular weight in kg/kmol	120.9	102
Normal boiling point in oc	-29.8	-26.5
Pressure at -25oc in bar (abs)	1.27	1.07
Liquid density at -25oc in Kg/l	1.47	1.37
Vapour density at -25/+32oc in kg/m <sup>3</sup>	6.0	4.4
Volumetric Capacity at -25/55/32oc in KJ/m <sup>3</sup>	727	658
Enthalpy of vaporization at -25oc in kj/kg	163	216
Pressure at +200c in bar (abs)	5.7	5.7

The efficiency differences is in the order of magnitude of measuring accuracy, mostly below compressor and appliance standard deviation. The efficiency of well-tuned compressors and appliance will only differ with a few percent, depending on the refrigerant and the appliance. Since refrigerant R134A prove to be possible substitute, material characteristics may be can lead to one or the other as a solution. R134A show values a little closer to R-12.

All refrigerants will, if applied properly, lead to same efficiency.

## SUCTION LINE HEAT EXCHANGER

R134A has higher specific heat capacity of suction gas, this leads to higher dependency of the system efficiency on the suction gas and liquid line, or capillary, heat exchange efficiency,. Increase in efficiency is much higher at R134A. This means a good suction line heat exchanger is part of proper application without this, efficiency will be less than R-12 in several cases, because efficiency at 25oc to 35oc suction gas temperature is almost the same for both refrigerants. It is also necessary to get the suction line temperature above humidity condensation of surrounding air with no changes. Many R-12 appliances refilled with R134A will show cold suction lines.

### **ICE-MAKER**

#### **MODEL – B03K**

60 MOULDS ICE BLOCK M/C CUSTOMER'S NAME ALHAJA SIBIAT  
GBADAMOSI PLOT 1, ABOLUBODE CLOSE AJAH, LAGOS

#### REFRIGERANT USED – 134A

DIMENSION = 5 X 25 X 25  
NET CAPACITY = 360 ICE BLOCK PER DAY  
UD FOAM THICKNESS = 100MM  
TEMPERTURE MINUS = -25oc  
UNIT RATING = 4 HORSE POWER  
CONDENSER AIR COOLED FORCED DRAFT  
EVAPORATOR PIPE DIAMETER = 16MM (5/8)  
US/TASE 380 – 420 VOLTS 50HZ  
POWER CONSUMPTION 6 AMPRE RUNNING LOAD AMPS.

a 60 can (mould of ice-block of 60kg) is been harvested at every 4 hours which is powered by a 4 horse power condensing unit at a low temperature of minus -25.

The thermostat adjustment cut out time -25 to cut in time -18 30 mins. Evaluation by customers; we have received a good performance report from our customers. Infact, we are preparing to show case this latest Redesigned model of B03k in the up coming Trade FAIR Exhibition in Lagos coming up very soon.



## COLD-ROOM

The Cold-Room body cabinets was produced with blown polyurethane foam HCF 141b. Manuerop Condensing Unit with manuerop compressor was used.

R-134A refrigerant was used to replace R-12. The temperature required by the client and which was achieved was minus – 40 and recorded. This particular Unit is used for Blast-Freezing (chicken).

This particular Cold Room/Blast Freezer was INSTALLED FOR ELITE FARMS NIGERIA LIMITED, NO 2 AKOREDE CRESENT, IJU, ISHAGA, LAGOS.

Reports from the Farm Manager has been very impressive.

Caked chicken is harvested and unloaded for packing at every Nine hours. The control used was A Defrosting Timer with a thermometer as an indicator of the Room temperature Thermostat setting cut out time at –40 to defrost for 25 minutes. Evaporator defrost system is by Electric heaters, and the defrost timer used is PARAGON TIMER. We also plan to produce and promote the sales of this redesign models for Dairy Farms for Blast-freezing chicken.

## **EVACUATION AND CHARGING**

There is need for improved system evacuation before charging of refrigerant. A content of a few (%) percentage by volume of Non condensable gases can increase the energy consumption of a sensitive appliance like R-134A appliance up to 10%.

Design and optimization of a circuit for a chosen refrigerant is a standard work in refrigeration.

### **Conclusion**

Apart from the specific major points material compatibility, and cleanliness for R134A the energy efficient application is based on design criteria. The cost efficient implementation is a major engineering work. The cost efficiency of the refrigerant is very much depending on the manufacturers situation, appliance design, factory equipment, production volume and others. Technically it is possible to reach almost some efficiency quality and reliability.