OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

IN THE NAME OF GOD

BAHMAN

Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

SYNOPSIS

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

Synopsis

The government of Islamic Republic of Iran has requested Unido to provide assistance in conversion of domestic refrigerator and freezer production facility at Bahman co. to phase out CFC 11 and 12.

The aim of the contract beeing to design, calculate and draft for model redefinition, prototype making and testing for operation and performance of 4 model refrigerators, and one freezer, so that they could run on 134a instead of ODP active CFC12.

The first progress report submitted on 25 July '95 contained physical specifications, insulation and unit component details, working performance and consumption and selection of new components.

The second progress report submitted on 6 th. August '95, covered details about necessary changes in refrigeration of 4 prototypes per model and testing them for functionality and performance.

This is the final report in this connection and covers the summation of all what has been done so far, and is the final evaluation of the project.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

TABLE OF CONTENTS

IN THE NAME OF GOD

BAHMAN

Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref : ....

Date: ....

Table of contents

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

INTRODUCTION

BAHMAN
Manufacturing Company

Tel : (021)348091-6
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

Introduction

Bahman has altogether five different models working on CFC12. Three of them are single door upright refrigerators in different sizes, one is a upright freezer. The original design of these was obtained from Phico USA. and later from Merloni Italia.

Under the UNIDO contract, the main task was to eliminate the use of CFC12 from the production line use in the Bahman factory Tehran.

This involved the following major tasks:

1) Definition of present models.
2) Calculation for using R134a instead of CFC12.
3) Making of prototype samples.
4) Testing these prototypes under ISO standard conditions.
5) Evaluation of the results and do any modifications necessary.
6) Make sugestions for future optimization plan.

All of the above has now been accomplished.

Fortunately since good guidance and technical assistance was provided by UNIDO right from the beginning, the work was channelled very smoothly.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

The system design calculations were so accurate that little of any modification was necessary in the original component selection saving great amount of time and effort.

Guidance from international agencies and component manufacturers was also very helpful. Hence a good balanced design has been obtained which in practice works far better in performance compared to the old unaltered design.

During the project work, a lot of testing equipment was made available to keep the accuracy and repeatability of the tests. In component selection field, due consideration was made to those items, which are more easily procurable in the market, and require minimal changes to the existing factory equipment available for production. This helped keep the present and future expected costs to a low acceptable value.

During the implemention of the project, step by step the work done and reports created were checked by UNIDO and utmost attention has been paid to UNIDO guidance and operational instructions to produce work of reasonably good standard.

IN THE NAME OF GOD

BAHMAN

Manufacturing Company

Tel : (021)348091-8

Tlx : 223657 BAHM IR

Fax: (021) 340722

PROJECT BACKGROUND IN THE COMPANY

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

Project background in Bahman Mfg. co.

Bahman company was established in 1965 under the licensing agreement with Philco USA. Complete technical assisstance was provided by Philco at that time. Recently the company Merloni from Italy has been involved in changing the design and production facilities at Bahman by introducing totally new and modern concept in terms of quality of units made and revolutionary changes in production methods.

The company produces 200,000 units per year in five different models. The existing refrigerant used is CFC12, and the project with Unido will enable to eliminate this ODS refrigerant and replace it by R134a. Four models of refrigerators (3 single door and one double door refrigerator-freezer) and a upright freezer are involved in this change. All models use polyurethane foam as insulation.

A programme has already been implemented so that the 250 different service centres throughout the country get training in the use of R134a and the retrofitting process of old CFC12 models, when necessary.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM Ir
Fax: (021) 340722

Ref :

Date:

While designing for R134a, and redefination of the existing models, it has been kept in view that as far as possible the existing machinery jigs and fixtures be used to keep investment costs low.

Even when the components had to be changed, standard design exiting on the international market was adopted to keep component availability in good proportion.

For example four different compressor suppliers and their design of compressors were used, to gain larger experience and ensure accuracy of calculations.

The project has helped to raise the standard of the testing laboratories, since noticable amount of instruments and recorders and other equipment was installed there, due to requirements of the project. This will now be available for future R134a use in the factory.

Most of the highly trained staff of the company was involved in one way or other to accomplish the project, and this has helped to further raise the technical standard of the company staff.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

ACTIVITIES

BAHMAN
Manufacturing ...

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

Activites

The complete project was implemented with the following basic activities.

1) Understanding what is involved.

Detailed discussions with UNIDO officials helped the general information about the project and cleared all details involved.

2) Plan of work

very urgently suitable people were selected, duties were explained and assigned to them and strict supervioion and control of project started.

3) training

members of project staff were sent for successful technical training abroad and in Iran, with well renowned firms to prepare them for the task in hand.

4) Design calculations.

with the knowledge obtained, complete design and redefination of project was done, R134a being a totally new substance, great care had to be taken in all aspects of estimations and data evaluation.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

5) Standards

Iso standards were studied and facilities provided for the testing necessary for inplementation of the project requirements. Instruments and equipment was purchased.

6) Component purchasing.

As a result of the calculations made, component selection was made and necessary component and material was purchased.

7) Prototype

With production line facilily available prototype making was done using the new couponents and R134a gas obtained. Minimum four prototypes per model were made to cater for any possible future failures, which fortunately did not happen. The major part of the prototype making was the existing model and only the refrigerating circuit was changed.

8) Testing

prototypes were tested according to the iso standards involved. Very helpful was the fact that even the very first prototypes gave encouraging results hence very little change or modifications were required.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

9) Evaluation.

The testing results showed good and consistance collaboration and a design much more efficient than before is now in hand.

10) Optimizattion.

An optimization programme has been foreseen for future develpenent on the lines of less energy consumption, and further reduction in charge, keeping good temperatures of food preservation.

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

TASKS

BAHMAN
Manufacturing Company

Tel. (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

TASKS

Tasks are many and varied and covers duration of project and the time ahead.

The most important has been to find different procurement sources of components for future businesss dealings.

The other has been in training the staff in the concept and production methods of R134a.

In future lies ahead the main task of changing the complete production facilities of Bahman factory from CFC12 to R134a.

New conponents and raw material must be procured before the above production change can be implemented.

Because of special hygroscopic nature of R134a a new way of thinking in cleanliness of the component, from dust and moisture, creating better vacuum in the refrigerating circuit, and keep away from moisture is required.

Last but not the least is the training of after sales service staff to make them ready for the new technical revolution in the field of better living environments.

Registered Capital: Rls 3,000 000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

PROTOTYPES EVALUATION AND ANALYSIS

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

PROTOTYPES EVALUATION AND ANALYSIS.

It will be noticed that all of the five models under consideration are existing in production, using CFC12 as the refrigerant with quite good performance in its own context.

Because of montreal protocol regulations and the UNIDO contract requirements, when it was decided to take procedures to eliminate the use of CFC12 from the Bahman production line, and as a consequence, redesign and the prototype making was started, it was already kept in mind that the prototypes should have some new useful charachteristics which were not present in the older type.

1)Less energy consumption.

2)Less charge quantity.

3)Less noise level.

4)Better storage temperatures.

5)Less manufacturing cost.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

6)Better quality standard.

Keeping the above six points in mind, the design parameters were selected, and work started.

Now that the prototype making has been completed and all of these samples have gone stringent tests succesfully, the achievement of above goals has become a reality.

Further details of the steps taken in each instance is described below.

1)Energy consumption.

1-1 compressor selection was made of a better design which uses less energy for same Kcal/HR. capacity.

1-2 polyurethane foam density was adjusted to give improvement on the insulation K-factor.

1-3 Instead of electrical dew point heater, the gas heated pipe was used as the anti condensation device at the cabin edge to prevent moisture condensation on the outside of the cabin.

2)Charge of refrigerant.

Various tests showed the minimum and correct quantity of charge of R134a refrigerant.In CFC12 it was about 125 gams, and with R134a, it is only 65 GMS.

Registered Capital: Rls 3.000.000.000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN

Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

3)Noise level

Noise could be reduced because all unclamped piping moving under vibration was fixed by metal brackets and better rubber grommets for compressor footing was selected.

4)Storage temperatures.

This has been achieved by better foam insulation,as mentioned above and using ABS liners which have less heat leakage.

5)Manufacturing cost.

As for as possible, it was endeavoured to keep and use components whose manufacturing cost were reasonable and the factory already had the possibility of its manufacture. For instance the condenser design was kept same as what was under production already.Similarly capillary of 0.71mm internal diameter was selected as it is readily availably at a lower cost.

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

6)Quality standard.

Due to the sensitive nature of R134a to humidity, not only extra precautions to stop ingress of moisture were taken a bigger molecular sieve drier (10 gms instead of 7 gms) was introduced in the design.

Other step was to use extremely good dry air for inside tube pressure tests and for cleaning purposes to remove any possible moisture present.

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348031-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

CONCLUSION

IN THE NAME OF GOD

BAHMAN

Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :...................

Date:...................

Generally speaking the compressor temperature at discharge outlet was slightly lower in case of R134a compared to R12. Similarly the volumetric refrigerating effect is about 10% lower specially at lower evoporating temperature in case of R134a.

The point to note is that by circuit optimization, the energy consumption is not any higher when compared to R12.

The cooling capacity of refrigerant R134a and R12 are more or less in the same region. How ever bacause of R134a molecule being smaller, to keep the flow rate same in both case the compressor displacement has to be slightly bigger.

Kcal / Hr	Power	Necchi	GS.
115	1/6 Hp	ETR5.5	NR52 LAEG
135	1/5 Hp	ESC8	NR62 LAEG
195	1/4 Hp	ESC11	V75 LAEG

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref : ....

Date: ....

For 134a usage following levels are required:

1) Vacuum level must be below 100 micron.

2) System cleanliness should be better than that required for R12.

3) Moisture level must not exceed 150 mg.

4) Equalized pressure when the refrigeration system is soaked at an ambient of 43 °c should be kept lower than 6 Kg/cm2.
This willprovide a favourable starting condition for the compressor. An interval of 5 minutes before restarting has been forseen.

5) Last 1/3 condenser and dryer have no temperature difference showing that good vacuum has been obtained.

6) suction line temperature is slightly colder (about 2 degree) than the ambient showing R134a charge is correct.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

Test sheet evaluation R134a compared to R12.

1) R134a system requires much less charge of refrigerant compares to R12.

2) For same cooling capacity the length of capillary was about 80 cms longer (45% of R12 system).

3) Special dryer XH-7 must be used compared to XH-5 for R12 system.

4) Pressure eqalized times are slightly longer for 134a system.

5) Discharge temperature of compressor in 134a system is about 10 °c lower.

6) Thermodynamic efficiency was not any significantly different.

7) Dryer size is bigger in 134a, because of higher hygroscopicity.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

RECOMMENDATIONS

BAHMAN

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

RECOMMENDATIONS.

As mentioned in the previeous chapter under prototype evaluation, even though the standards set in the beginning for performance, cost, and energy consumption have been achieved, further steps must be taken to better optimize the product and also the production methods. The steps which will be taken are suggested in detail below.

1) Refrigerant charge reduction.

A further reduction can be made posible by using tube on plate condenser. Due to the reduced length of tubing, and as a consequence the reduction in the condenser internal volume, less charge will be required.

2) Consumption of energy.

Compressor manufacturers will be contacted to jointly investigate for increasing the working efficiency of the compressor.
At the same time the quality of heat transmission of the polyurethane foam can be increased by using better mixing at the injection head, and also by further increasing the insulation thickness.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

3) Door gasket design.

This plays a very important role in not allowing the hot and humid outside air to ingress inside the refrigerator or freezer. A special design crossection with double or triple pockets can be used which will reduce hot air ingress to a very low value.

4) Evoporator efficiency.

This can be increased by reducing the plastic ABS food liner thickness at back, where the food liner cooling tubing is attached from the other side. This will help the cold transmission from the cooling aluminium tubes to the inside of the refrigerator food liner, and colder temperatures will be achieved and maintained quickly.

Test results 32 c ambient

32 c Ambient continuous run performance

characteristics

Model	TMG 340
Thermostat type	Constant cut-in
Compressor power	1/5 Hp ---- NR62LAEG
Thermostat position	Shorted
Motor winding temp.	118 c
Volts /Ampere	220 V / 1.17 A
Freezer air	-27 c
Cabinet mean temp.	1.5 c
Meat tray temp.	-3 c
Veg. crisper temp.	1 c
Compressor top	80 c
Compressor exit	83 c
Condenser middle	37 c
Condenser exit	33 c
R134A charge	65 GMS
Remarks: 24 hours after pull down	

32 c Ambient continuous run performance

characteristics

Model	TDF 335
Thermostat type	Constant cut-in
Compressor power	1/4 Hp ---- V75LAEG
Thermostat position	Shorted
Motor winding temp.	117 c
Volts /Ampere	220 V / 1.15 A
Freezer air	-28.5 c
Cabinet mean temp.	2 c
Meat tray temp.	-2 c
Veg. crisper temp.	2.5 c
Compressor top	81 c
Compressor exit	84 c
Condenser middle	38.5 c
Condenser exit	36 c
R134A charge	65 GMS
Remarks: 24 hours after pull down	

32 c Ambient continuous run performance

charachteristics

Model	TUP 285
Thermostat type	With alarm contacts
Compressor power	1/4 Hp ---- V75LAEG
Thermostat position	Shorted
Motor winding temp.	118.5 c
Volts /Ampere	220 V / 1.05 A
Freezer air	-28.5 c
Cabinet mean temp.	29.7 c
Meat tray temp.	-----
Veg. crisper temp.	-----
Compressor top	83 c
Compressor exit	86 c
Condenser middle	38 c
Condenser exit	35 c
R134A charge	80 GMS
Remarks: 24 hours after pull down	

32 .c Ambient continuous run performance

charachteristics

Model	Fal 13
Thermostat type	Push button defrost
Compressor power	1/5 Hp ---- NR62LAEG
Thermostat position	Shorted
Motor winding temp.	120 .c
Volts /Ampere	220 V / 1.15 A
Freezer air	-15 .c
Cabinet mean temp.	2.2 .c
Meat tray temp.	-7 .c
Veg. crisper temp.	3 .c
Compressor top	84 .c
Compressor exit	88 .c
Condenser middle	42 .c
Condenser exit	36 .c
R134A charge	127 GMS
Remarks: 24 hours after pull down	

32 °c Ambient continuous run performance

charachteristics

Model	Fal 11
Thermostat type	Push button defrost
Compressor power	1/6 Hp ---- NR52LAEG
Thermostat position	Shorted
Motor winding temp.	119 c
Volts /Ampere	220 V / 1.05 A
Freezer air	-14 c
Cabinet mean temp.	2 c
Meat tray temp.	-5 c
Veg. crisper temp.	3.5 c
Compressor top	84 c
Compressor exit	87 c
Condenser middle	40 c
Condenser exit	35 c
R134A charge	137 GMS
Remarks: 24 hours after pull down	

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

BIBLIOGRAPHY AND REFRENCES

BAHMAN

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

Bibliography

1) ISO R916 Testing of refrigerating systems.

2) ISO 917 Testing of refrigerating compressors.

3) Danfoss compressors: Hermatic systems for R134 (H. 80. B1. 02 Danfoss 1990).

4) Matsushita ref. co. Refrigerating systems (D-BOOE F02-E-1993).

5) Daewoo technical brief. (Iwar-10-1993).

6) Electrolux application quidline (LBP application).

7) 134a design: Sharif university Tehran paper 1993.

8) DKK-Foron seminar on design 1995.

9) UNDP preparation of Ind. Inv. studies 1992.

10) ISO 7371 Ref. performance 1985.

11) Sanyo application standards 1988.

12) Lematic-Evoporator use possibility 1991.

13) Evaluating compressors-Danfoss AE/AF4.

14) Necchi, Ozone friendly 1993.

15) Armco, static condensers 1994.

16) Samsung, Calorimeter tests 1994.

17) Goldstar-New environment 1994.

18) Synopsis on 134a design-compared to R12-Sharif university 1994.

19) Merloni technical calculation for unit design 1995.

BAHMAN

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

20)ASHRAE different reports 1992-1995.

21)ISO 8187 Performance of refrigerator-freezerss 1991.

22)Officino galileo-High volume and refrigeration industry 1990.

23)Condensers for refrigeration appliances Danfoss CF.88.A1.22.

24)Evoporator for ref. units DAnfoss CN.82.00.02 1987.

25)ICI. Thermodynamic properties of HF 134a -1989.

26)Galco,Belgium.Refrigerant news-(S/nd)7209/1991.

27)Afeas-Paft Environmental acceptibility study 1993.

28)Leybold-Heraes Vacuum technology 1992.

29)UNEP-Protecting the Ozone layer vol.1 Refrigerant 1994.

30)Refprop REfrigerator properties database Mclinden Aug '93.

31)Montreal protocol OORG policy document Oct'92.

32)L unit Hermetique environmental protection 1993.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

33) Officine Galileo

High vacuum and refrigeration industry.

34) Leybold-Heraeus

Vacuum technology, its foundations formulae and tables HV15?-section H-B.

35) Danfoss

Evaporators for refrigeration appliances CN.82.00.02

36) Aspera

Capillary tubes: function-selection tech. bulletin no. 6

37) Danfoss

Dessicants in Hermetic refrigeration systems.

38) Danfoss

Thermostat application.

39) Showa aluminium corporation

Roll-bond evoporators.

40) Armco

Static wired condesers.

41) Dena

Dryers for refrigerators.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

- Date:

42) Gold star

Green compressors.

43) Necchi

compressori ermetici per refrigerazione e condizionamento.

44) ISO 8187

Refrigerator-freezer:

Characteristics and test methods.

45) ISO 7371

Performance of household refrigerating appliances.

46) Samsung

Compressor test methods.

47) Danfoss

Compressor design, mechanical and electrical CF.10.02.02

48) Chemical industries of Northern Greece

Forane 134a

49) Freon products laboratory

Compatability of elastomers with R134a.

50) Hoechst chemicals

Refrigerant 134a including cycling concept.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

51) Merloni progetti

Balancing methods.

52) Sharif university Tehran

Refrigeration seminar proceedings.

53) Dupont

HFC 134a, properties storage and handling.

54) Goldstar

Hermetic compressor and cycle.

55) Matsushita refrigeration company

CFC elimination programme D-BOOEFO2-E.

56) Electrolux

R 134a application guidline(LBP).

57) Daewoo

HFC-134a refrigeration (DWAR-10).

58) Electrolux

Replacement of CFC-12, in domestic refrigeration systems.

59) Danfoss

R 134a state of affairs.

60) Danfoss

TL compressors for 134a.

61) Appliance

Various issues of recent magazines.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

62) ASHRAE journal

Different publication 1992-1995.

63) ISIRI 2482 (Iran standard)

Performance of household freezers and frozen food storage cabinet.

64) ISIRI 254 (Iran standard)

Household refrigerators.

65) DKK-FORON

Seminar March '95

CFC elimination technology.

66) General Electric

Motor performance.

67) Galco Belgium

R134a application.

68) ICI chemicals and polymers

Thermodynamic properties of HFA 134a.

69) Lematic Germany

Tube evaporators compared to roll bond type.

70) UNEP

Volume 1 refrigerants.

71) L'unite Hermetique

New refrigerant-green line.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

72) Agramkow

Leak detection systemas.

73) PAFT

Programme for alternative 134a toxicity testing.

74) Refprop

Refrigerant data base.

75) Kobe university Japan

Thermal conductivity of gaseous HFC 134a.

76) Iowa state university USA.

Comparision of heat transfer coefficients of HFC 134a and CFC 12.

77) UNEP

Industry and environment.

78) AFEAS

Environmental acceptability study.

79) Refrigeration and A/C

Althouse- Turnquist- Bracciano Goodheart- Wilcox.

80) Principles of refrigeration

R.J. Dossat - John Wiley.

81) Heat transfer

J.P.Holman - Mcgrawhill.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021) 348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

ATTACHMENTS

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

R 134A COMPRESSOR

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

1. Description of *HFC-134a* (CH_2F-CF_3, 1,2,2,2 - Tetra fluoro ethane)

(1) Toxicity

HFC-134a is a chlorine-free fluorinated non-ozone depleting refrigerant.

It is non-toxic, non-flammable, and non explosive.

Its AEL(Acceptable Exposure Limit) level is 1000 *ppm*.

(2) Purity

There may be impurities in the ***HFC-134a*** as the residues in the manufacturing process(R114, R114a, R124, etc.). The main concern of these impurities is the effect of chlorinated residues on the capillary tube. Therefore more than 99.95% of purity must be secured.

(3) Hygroscopicity

HFC-134a is more hygroscopistic than CFC12. The solubility of water in ***HFC-134a*** is 2800 *ppm* at 298.15K while in CFC12 is 90 *ppm*.

(4) Miscibility with Lubricant

It is desirable that the refrigerant and lubricant are completely miscible over the range of expected operating pressure-temperature conditions for the safe oil-return from condenser to compressor.

Mineral oils are not suitable as lubricant with ***HFC-134a*** due to insufficient miscibility and lubricity.

Polyol ester is miscible with ***HFC-134a*** although not all over the region but within the operating conditions.

Fig. 1 shows typical miscibility diagram of polyol ester with ***HFC-134a***.

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref : ....

Date: ....

(5) Stability

The stability of ***HFC-134a*** with metals and lubricant is evaluated by the sealed glass tube tests.

Tests were conducted at the 175℃ conditions for 21 days with the presence of steel, copper, aluminum, and ester oils. Gas samples were analyzed by gas chromatography and no indication of ***HFC-134a*** decomposition was observed.

(6) Compatibility with Desiccant

XH-7 or XH-9 is recommended. If not, decomposition of ***HFC-134a*** may be proceeded.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN
Manufacturing Comp.
Tel: (021)348091-۴
Tlx: 223657 BAHM IR
Fax: (021) 340722

Ref:

Date:

134a in Hermetic Applications
Heat Transfer Coefficients For R134a & R12

- Single Phase Heat Transfer
  - Dittus-Boelter & Petukhov-Popov correlations show that
  - R134a > R12 by 30-40%
- Evaporative Heat Transfer
  - R134a > R12 by 28-34%
- Condensation Heat Transfer
  - R134a >R12 by 35-41%

48

IN THE NAME OF GOD

BAHMAN

Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref:

Date:

134a in Hermetic Applications Performance Conclusions

- with reasonable value (30W) assumed for superheat, R134a COP is comparable to R12 COP
- to optimise system performance, reduce the superheat
- with no superheat, R12 is more efficient than R134a
- for equal cooling duty, mass flowrate is lower for R134a than for R12

49

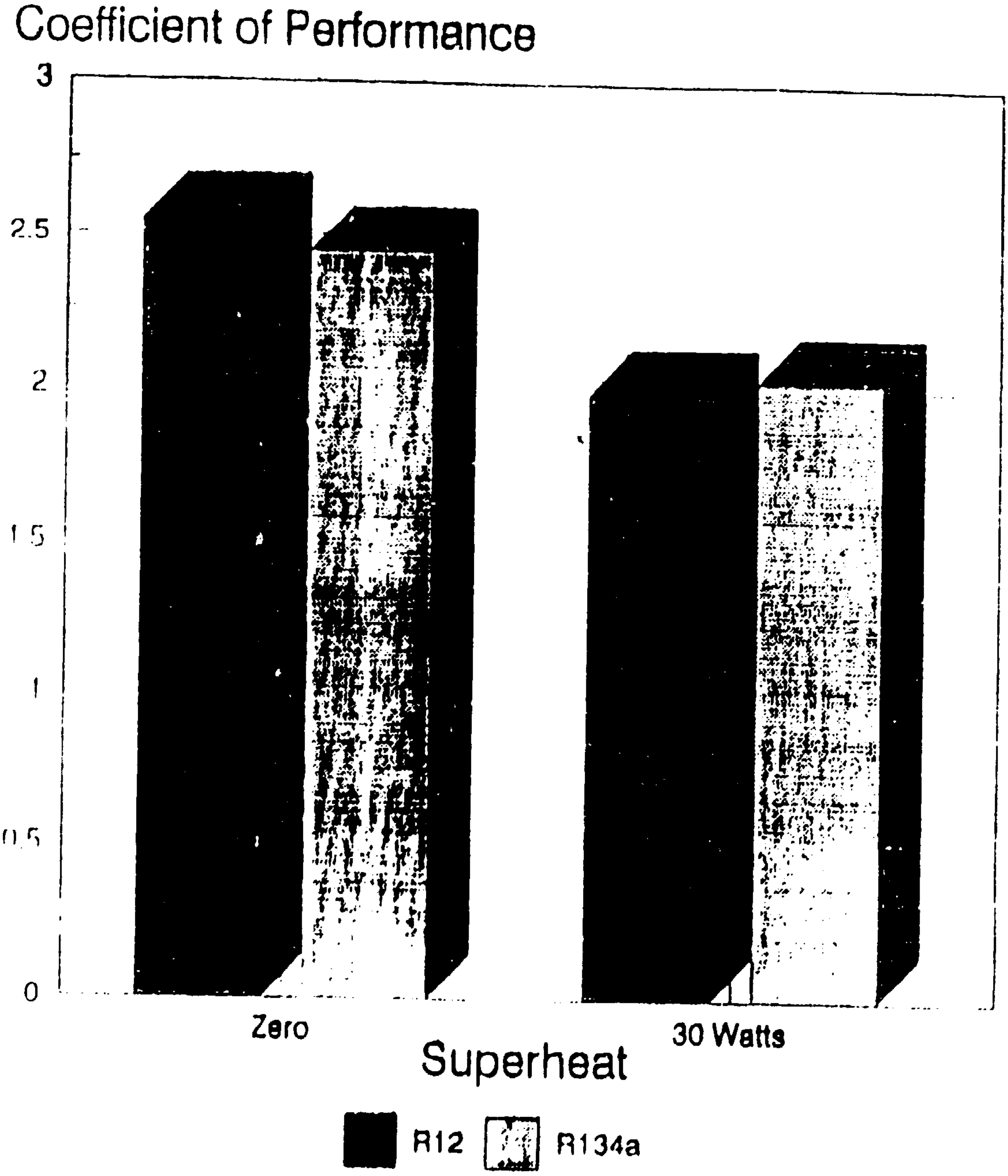
Registered Capital: Rls 3,000 000,000 fully paid
Postal Address 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Performance of R12 and R134a in hermetic applications (equal cooling duty 100W)



50

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

Description of *HFC-134a* Refrigerator

(1) Evaporator-Condenser-Pipe

It is generally concluded that the size of evaporator and condenser can be the same as those used for R12. Sometimes, 10 ~ 15% increase of condenser size is recommended. Mineral oil or similar process oil coated on the inside of pipe must be cleaned prior to use.

(2) Refrigerant charge size

The refrigerant charge size of ***R134a*** refrigeration system is about 10 ~ 20% less than that of R12 system.
Excessive charge may cause mechanical failure during flooded start condition.

Exact charge size must be determined through laboratory test.
Fig. 3 shows pressure - solubility diagram of ***HFC-134a*** with POE.

(3) Capillary tube

Generally the length of capillary tube may need to be adjusted through laboratory test.
For reference, 10 ~ 15% increase is recommended.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

(4) Dryer

XH-7 or XH-9 is recommended as described in 1-(6).

(5) Process Material

Residues of mineral oil based process material which is insoluble with POEs may contaminate the capillary tube and chlorinated substances are not admitted.

The compatibility of each process material must be checked through sealed tube test.

(6) Refrigerant Charge

The ***R134a*** refrigerant must be charged with ***R134a*** charging machine. Sealing material must be compatible with ***R134a***. If the charging process be done with R12 system, R12 residues remained in the sealing material may penetrate into the ***R134a*** refrigeration system to be a unacceptable chlorinated impurity.

(7) Vacuum and Leak Detection

As the molecule size of ***R134a*** is smaller than that of R12, ***R134a*** will tend to leak more easily than R12. Additional care is needed is pipe welding. Maximum acceptable system moisture is 100 *mg*.

52

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref : ....

Date: ....

Evacuation to 0.3 ~ 0.5 *mmHg* is recommended. Leak detection must be done with proper ***R134a*** leak detection equipment.

POE is hydrolyzed at very high temperature with the presence of moisture and air. Especially, the effect of air is remarkable.

Table 1 shows the effect of moisture and air on the hydrolysis of POE.

Table 1 Hydrolysis of POE

	with air	with N_2	with ***R134a***
T.A.N *	0.20	0.03	0.03

* T.A.N - Total Acid Number [*mgKOH/g*]

test condition : 130℃ × 10 days
moisture level : 1000 *ppm*

53

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN

Manufacturing Company

Tel : (021)348091-8

Tlx : 223657 BAHM IR

Fax: (021) 340722

Ref :

Date:

R 134A CAPILLARY TUBE

54

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref : ....

Date: ....

CAPILLARY TUBES

FUNCTION - ADVANTAGES - DISADVANTAGES - SELECTION

It is essential, for a correct refrigerating cycle, to control the refrigerant flow entering the evaporator. The exact function of a control device, in a refrigerating system, is that of producing a restriction, hence a pressure difference, between high pressure side and low pressure side.

Among the more common expansion devices employed on smaller size household refrigerators and unitary room air conditioners the capillary tube achieved a rapidly increasing popularity in the recent years.

The capillary operates on the principle that a fluid in the liquid state passes through it much more readily than in the gaseous state, and consists of a small diameter line of adequate length connecting the outlet of the condenser to the inlet of the evaporator. The use of a capillary tube is presently being extended to systems in sizes up to 10 tons capacity.

The predominant advantage inherent to capillary tube is simplicity, which implies on its turn much lower costs in comparison with the other expansion devices.

The main functions of capillary tubes are: a) to feed the evaporator with the right amount of refrigerant in accordance with design conditions; b) to allow a ready pressure balance at compressor stop.

55

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref : ....

Date: ....

Requirement as per point a) is met by employing either a short and small diametered capillary or a longer one having a larger diameter, whereas point b) condition may more easily be satisfied through a longer and larger diametered capillary tube.

Naturally the length / diameter combination will also depend upon required evaporating temperature.

During shutdown periods, the capillary continues to pass refrigerant from the high side to the low side until pressures are equalized and the motor compressor can then be one at low starting torque.

The employment of a capillary tube offers another advantage: the liquid receiver elimination on circuit high pressure side, which involves, besides a noticeable simplification in the system structure, a lower refrigerant charge. In this case however, it is necessary to foresee a condenser whose internal volume may be such to receive the whole refrigerant charge in case of a capillary clogging.

It must be noted, anyway, that capillary tube is an expansion device with fixed characteristics: i.e. it is not adjustable to changing load conditions.

In fact, leaving for a moment the physical conditions of the fluid out of consideration, it may be stated that the fluid rate itself exclusively depends on the pressures downstream and upstream the tube. Specifically, the flow rate through the tube is directly proportional to condenser pressure and inversely proportional to evaporator pressure. On the contrary, the refrigerant circulated by the compressor increases due to a reduction in condensing pressure and a rise in evaporating pressure.

Then it may well be understood how the system is balanced for only one and well determined load condition.

Any load variation - from fixed conditions - causes a reduction in the whole system efficiency.

56

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref : ....

Date: ....

An important novelty in the field of refrigeration equipments, after the introduction of the halogenated fluids, is given by the heat exchangers between the cool gas coming out from the evaporator and the hot liquid flowing to it. This leads to noticeable increases in compressor refrigerating capacity besides implying other advantages in installation building.

As far as Refrigerant 12 is concerned the advantage is extremely remarkable while for Refrigerant 22 has a minor importance. The lower the evaporating temperature is the more conspicuous this advantage does result and viceversa. It is to be remembered that, while a compressor refrigerating capacity increases subcooling the liquid, compressor energy consumption is kept almost steady.

A refrigeration system design is achieved through an adequate capillary selection as this device is responsible for suction pressure or temperature and, then, for refrigerating capacity.

Capillary tube selection is still to be regarded as a delicate operation - marked as it is by a certain empiricism - since there is not yet a deep knowledge of the influence, originating in numberless causes, which may affect refrigerating system running.

An expansion device shall meet some requirements which vary according to the applications where it is used as well as according to working conditions. In fact capillary flow rate is function both of evaporating temperature and of condensing temperature.

Other factors equally affect capillary definition so that capillary selection based on the strict application of a formula would be a mere illusion. In practice then the determination of an adequate capillary tube is generally based on experience and, in most cases, is the result of Laboratory tests directly performed on the application itself.

In spite of this, there is a number of methods of sizing a capillary, some based on empirical equations and others which apply the principles of fluid dynamics, but the problem grows more complex when capillary is attached to suction tube as it actually happens in almost all household refrigerating systems.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :.................

Date:.................

Since the calculation of a capillary based on the principles of fluid dynamics is more widespread compared with other systems, we are going to examine it briefly following the methods proposed by HOPKINS, COOPER, CHU and BRISKEN.

If the final objective is to determine the length of a capillary tube of a certain bore to reduce the pressure of a given mass flow of refrigerant from the condenser pressure to the evaporator pressure, the solution can be approached in a stepwise fashion, analyzing successive increments of line lengths (elementary lengths).

Total length will be given by adding the various elementary lengths found.

Determination of the Elementary Lengths of a Capillary Tube.

From the continuity equation:

$$V = \frac{Gv}{S} \qquad (1)$$

where: G = Fluid Mass Rate in Kg/sec. – prefixed

v = Specific Volume in m^3/Kg

S = Tube Section m^2

V = Speed in m/sec

Applying the principle of conservation of energy:

$$_{\circ}\Delta p_1 = -\frac{G\Delta V}{g} - \frac{G}{2\,D\,g\,S}\int_{\circ}^{1} f\,V\,dL \qquad (2)$$

where: $_{\circ}\Delta p_1$ = Total Pressure Drop in the First Elementary Tube Length dL.

g = Acceleration of Gravity

f = Friction Factor

D = Tube Diameter – prefixed

dL = Tube length

58

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref: ......

Date: ......

The exact solution of Eq. (2) will be difficult because of the complex variation of friction factor 'f' and velocity 'V' with the length 'L'.

In the first approximation calculation this obstacle is overcome assuming, for each elementary length of the tube, the mean value of the two above mentioned quantities indicated as 'fm' and 'Vm'.

Equation (2) in finished terms will then be:

$$_{s}\Delta P_{1} = A - B \cdot f_{m} \cdot V_{m} \cdot {}_{s}\Delta L_{1}$$

where 'A' and 'B' are the known terms.

The friction factor depends upon the REYNOLDS number.

The equation which, by experience, seems to be the most convenient in this particular case is:

$$f = \frac{0,32}{(R_e)^{0,25}}$$

'fm' value is given by the mean value of the 'f' values calculated at 2 points minimum (beginning and end) of each elementary length.

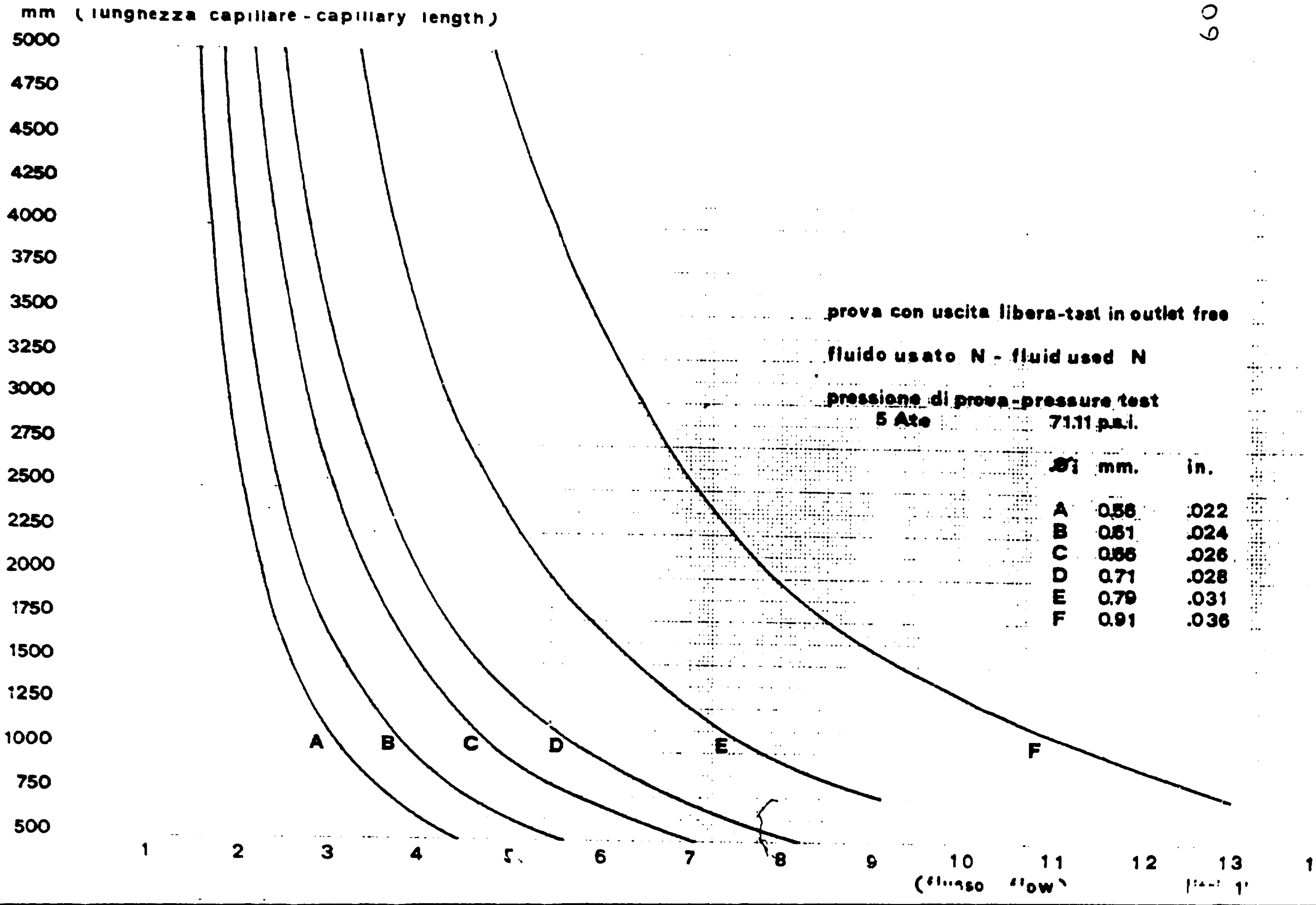
The same can be said for the mean velocity value reckoned at two points minimum by Equation (1).

As these calculations are rather complex, experimental tables are generally employed which are made by various manufacturers.

Such are the experimental tables of recommended capillaries which are enclosed to the present Technical Bulletin. The tables were made in ASPERA S.p.A.Laboratories.

Obviously the exact dimensions of capillary tubes will have to be checked in design and inspection stages of the single systems.

59


mm (lunghezza capillare - capillary length)
5000
4750
4500
4250
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
prova con uscita libera-test in outlet free
fluido usato N - fluid used N
pressione di prova-pressure test
5 Ate
71.11 p.s.i.
Øi mm. in.
A 0.56 .022
B 0.61 .024
C 0.66 .026
D 0.71 .028
E 0.79 .031
F 0.91 .036
A
B
C
D
E
F
1
2
3
4
6
7
8
9
10
11
12
13

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

R 134A MOISTURE AND DRYER

61

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223857 BAHM IR
Fax: (021) 340722

Ref :............

Date:.........

Moisture

Moisture inside refrigerating machine should be maintained below the allowed quantity so that machine can operate without trouble. Therefore it is important to remove moisture in the process of manufacture and assembly of parts. And attention should be paid so that moisture does not penetrate when connecting or maintaining machine at site.

And when it is found that intolerable quantity of moisture is contained within refrigerating mahine, it should be promptly removed.

1. Source of moisture

The followings are considered as causes of moisture penetration into refrigerating machine

(1) Insufficient drying when repairing machine

(2) Inadequate operation when connecting or maintaining machine.

(3) Penetration of wet air due to leakage in low pressure part

(4) Leakage at the hydro part of water-cooling condenser.

(5) Insufficient drying of lubricant (refrigerant oil).

(6) Moisture in the refrigerant not sufficiently dried.

(7) Moisture created from oxidation of hydrocarbon composing refrigerating oil

(8) Moisture created from thermal dissolution of insulation materials of motor.

2. Influence of moisture

Moisture in the refrigerating machine has the following bad effect.

(1) Water blockade in capillary tube or expansion valve, and evaporator freezing

(2) Corrosion and sludge creation on metal parts.

(3) Damage of valves.

(4) Copper coating phenomena.

(5) Deterioration of chemical parts such as insulation materials.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)342091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref : ....

Date: ....

Dessicants in Hermetic Refrigeration Systems

The latest Zeolith-based dessicant offers significant advantages as regards the binding of harmful elements in the refrigeration system like water, acid residue and other decomposition products. However, experience shows that not all types of Zeolith are able to withstand the mechanical influences in a refrigeration system and blocking in and around the inlet of the restrictor tube may occur, often followed by severe bearing wear in the compressor. Quality tests on the dessicants for household refrigeration systems ought therefore to include tests which ensure that the dessicant has sufficient mechanical stability.

Dessicant function

Ever since the manufacture of hermetic refrigeration systems of the domestic sector began there has been a need to incorporate a water-adsorbing dessicant. The purpose of the dessicant was primarily to retain and bind the water released during system operation and thereby prevent undesirable effects such as ice blocking the restrictor tube, untimely compressor breakdown, etc.

Even at the present stage of technology within the refrigeration industry, this need still exists, but the necessity of dessicant and its function in the refrigeration system has now to be seen from a slightly different viewpoint than previously. Moisture in a hermetic system is characterized by the terms "free water" and "captive water".

The amount of free water was previously determined mainly by the dryness of the components before assembly but in addition by the assembly conditions. The captive water came mainly from the motor insulation material and was released partly by ageing of the material and partly by the heating up of the motor during operation.

In this connection, there was mention of "expected" amounts of water based on a given lifetime of the system.

Developments within the production of refrigerators have however, through the years, led to both suppliers of components and producers of refrigeration systems to adapt to the relatively high dryness requirements that apply in this field. Furthermore, nearly all compressors for this branch of the refrigeration industry have synthetic insulation materials which have reduced the amount of captive water to a minimum.

An additional refrigerator development has also meant an extended application range for the system so that there are now greater temperature requirements for the compressor and for the other components in the system.

The dessicant cannot therefore be assessed only on the grounds of water retaining considerations. Just as important is the assessment of the conditions which will arise during the lifetime of the system.

Here, the dessicant must be chemically and mechanically stable under all operating conditions. Furthermore, the dessicant must not act as a catalyst for the other

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

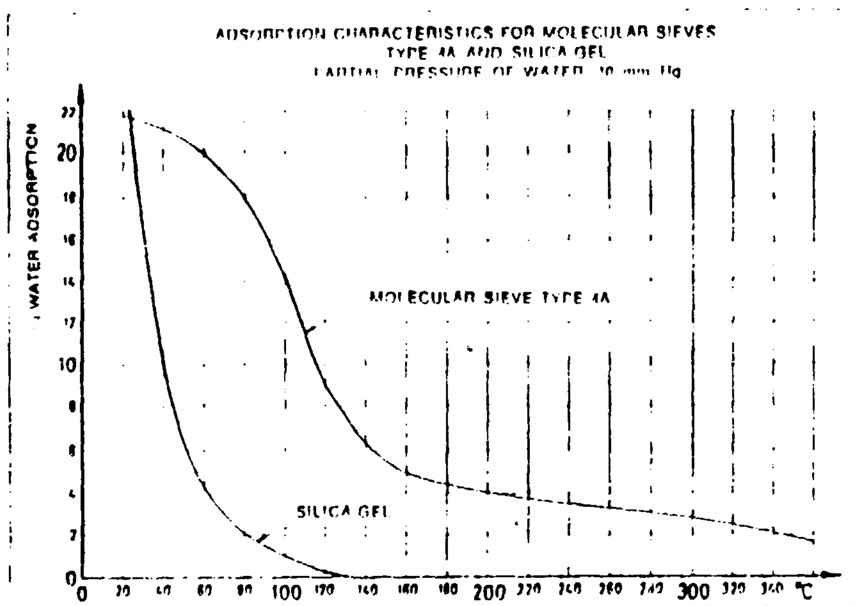
BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref : ....

Date: ....

Fig 1
Adsorption characteristics for Molecular Sieves type 4A and Silica gel
Partial pressure of water 10 mm Hg
According to Union Carbide



64

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

BAHMAN
Manufacturing Company

Tel : (021)348 91-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref : ....

Date: ....

elements which can cause compressor breakdown

The function of the dessicant today must be to bind ageing products in the form of acid residues and other decomposition products as well as to bind "free" and "captive" water

Silica-gel

For many years, Silica gel (Silicium oxide) dessicant has been used for hermetic refrigeration systems. This dessicant has many good characteristics, but for hermetic refrigeration systems it has a disadvantage: moisture adsorption is highly dependent on temperature even at low temperature levels. To maintain reasonable filter drier dimensions it is therefore necessary to place the filter on the cold side of the system - normally on the inlet side of the evaporator.

For several reasons such a location is not desirable and a distinct need for another dessicant with better characteristics arose

Synthetic Zeolith

In the beginning of the 1960s, synthetic Zeolith dessicant was introduced to the refrigeration industry

The dessicant was originally developed by Union Carbide in the USA for use in the petrochemical industry, but because of its adsorption characteristics it gradually became extensively used in other industries, including refrigeration.

This type of dessicant, chosen for hermetic refrigeration systems for domestic use, is known by its trade name Molecular Sieves 4A

Adsorption characteristics

Molecular Sieves 4A was chosen, first and foremost, for its moisture adsorption characteristics which far exceeds those of Silica-gel for example

Fig. 1 shows adsorption curves for Silica-gel and Molecular Sieves 4A.

The good characteristics are due, among other things, to the fact that the dessicant can be made with controlled pore sizes.

Type 4A is so-called because it only adsorbs molecules in sizes up to 4 Angström (4×10^{-7} mm)

For hermetic refrigeration systems this meant that substances like H_2O (2.8 Å) CO_2 (2.8 Å), N_2 (3 Å), etc., became retained in the dessicant while those like oil and refrigerant, whose size of molecule is more than 4 Ångström, were not adsorbed. Oil and refrigerant therefore took up no room in the dessicant, unlike the case with Silica gel for example. The pore size of the dessicant also meant that adsorbed water was bound to a significantly harder degree and to release it required correspondingly higher temperatures

This being so, the filter driers having Molecular Sieves no longer needed to be placed in a particular position in the refrigeration system and a natural outcome was to locate the filter at the condenser outlet. Not only was this a practical

65

IN THE NAME OF GOD

BAHMAN

Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref : ....

Date: ....

Description of HFC-134a Compressor

(1) Capacity

Due to the differences of thermodynamic properties between ***HFC-134a*** and CFC12, about 10~15% capacity drop is experienced at -23.3℃ (-10.4°F), and 20~30% at -30℃(-22°F) without any system modification.

This capacity drop has been compensated by the improvement of compressor design. (Improvement of volumetric efficiency, improvement of suction gas passage.)

(2) Material Compatibility

The compatibility of various commercially available motor insulating film, magnetic wire, plastic·materials has been evaluated and only suitable materials are selected.

The compatibility was estimated by the autoclave test.
Every test piece was aged at the 130℃~150℃ conditions for 7~40 days with the presence of ***HFC-134a*** and ester oil.
The physical properties of test piece, acidity of lubricant, extraction of oligomers were measured after the aging.

66

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address : 799 Enghelab Ave. Tehran - Iran   Factory : 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

(3) Lubricant

For the past 50 years, lubricant produced from naphthenic and paraffinic mineral oils have been used in refrigeration compressor systems.

Mineral oils were fully compatible with R12 and satisfied the system requirements of lubricity, chemical stability, materials compatibility, energy efficiency, etc.

Unfortunately traditional mineral oils cannot satisfy these requirements in ***HFC-134a*** refrigeration system due to the chemical differences between R12 and ***R134a***.

Mineral oils are not miscible with ***R134a***.

Oil particles separated from the liquefied refrigerant in the imaginary ***R134a*** - mineral oil refrigeration system may settle at the capillary tube and evaporator causing impedance to the refrigerant flow and reducing heat transfer efficiency.

In more severe case, difficulty of oil return to the compressor may cause system break-down.

Therefore, miscible lubricant must be used in the ***R134a*** system and any small amount of immiscible impurities, such as mineral oil, must be avoided for the system efficiency and reliability.

DAEWOO has been testing various kind of synthetic lubricant such as Poly alkylene glycol, modified PAG, Polyol ester(Base oil), Polyol ester formulated with additives.

Registered Capital: Rls 3,000,000,000 fully paid
Postal Address 799 Enghelab Ave. Tehran - Iran   Factory 777 Pirouzi Ave. Tehran - Iran

BAHMAN

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Ref :

Date:

Polyol ester formulated with additives showed the best result in view of stability.

One thing to note is the hygroscopicily of POE(Polyol Ester).

POEs can absorb moisture very quickly from the ambient air. The saturation level is approximately 1000 *ppm*, compared to 20 ~ 100 *ppm* for mineral oils. Fig. 2 shows hygroscopicity curve of POE and mineral oil.

Therefore it is imperative that compressor, evaporator, condenser, and other tubes must be kept sealed before the set assembly.

It is recommended that the maximum exposure time limit of compressor after opening the rubber caps is 10 minutes under th 60% relative humidity condition.

Registered Capital Rls 3,000 000 000 fully paid
Postal Address 799 Enghelab Ave. Tehran - Iran Factory 777 Pirouzi Ave. Tehran - Iran

IN THE NAME OF GOD

BAHMAN

Manufacturing Company

Tel: (021)348091-8

Tlx: 223657 BAHM IR

Fax: (021) 340722

The life time of a compressor used in an appliance is not only affected by the durability of the compressor itself, but also depend on the operating conditions which are related to the design of the refrigeration systems.

This is to specify considerations to obtain reliable operation of R-134a hermetic refrigeration systems.

1) Remarks on compressor handling

Refrigerant oil for R-134a should be handled thoughtfully and carefully, because of its nature which has high hygroscopicity compared with conventional refrigerant oils.

a) After removing the plugs from compressor tubes, the compressor should be assembled to the refrigeration systems within 30 minutes.

b) Reliability test should not be conducted once refrigerant oil is changed, which moisture level is concerned.

2) Remarks on refrigeration systems

a) Cooling performance test

a-1) Refrigeration systems are exclusively used only for R-134a systems.

a-2) Because of unique swollen and leak characteristics to the rubber which are much more severe than when used in conventional refrigerants, mechanical sealing and joints should be used in systems, but not rubber and/or O-ring.

b) Reliability tests

b-1) Materials for test equipments

- Materials used in the systems, like pressure gauges, hoses, valves and refrigerant charge equipment should be exclusively used for R-134a, especially pressure gauges used should come from non-oil, non water treated goods or to be used equivalent quality gauges.

b-2) Remarks for refrigerant oil

- Refrigerant oil should be well purified and controlled moisture level below 25 ppm.

b-3) Refrigerant : R-134a(CF_3CH_2F)

- Recommended refrigerant performances are shown below.

Items	Controlled value
Appearance	Color clearness liquefied gas
Purity (%) (Inc. HFC134)	Over 99.95

69

IN THE NAME OF GOD

BAHMAN
Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

Items	Controlled value
Evaporated residue (%)	Below 0.001
Acidity (%) (HCℓ)	Below 0.0001
Moisture(%)	Below 0.001
CFC & HCFC(%)	Below 0.01

b-4) Leakage in the systems

- Detection for leakage in the systems is recommended to use "Helium leak detector" or used nitrogen to confirm a reduction of a pressure after pressurize in the system with nitrogen.

b-5) Vacuum level

- Vacuum level below 0.5 torr is required after the evacuation in the system.

b-6) System cleanliness

- The system components must have a degree of cleanliness and equal to/or better than that of R-12 system.

b-7) Moisture level in the system.

- The maximum moisture content in a household refrigeration system should be 150 mg.

b-8) Brazing in the system

- Brazing should be done to avoid oxidation.
  (cf: To use nitrogen flow at brazing points.)

c) Selection of the drier

c-1) XH-7 or XH-9 are recommended to apply exclusively for R-134a system.

c-2) Selection of a drier volume is recommended 1.2 times of conventional type.

c-3) Drier should be selected so that the hygroscopic percentage level of a drier is below 4 % after operating the system.

c-4) Use sufficient dehydrated drier and keep moisture level below 10 mg.

IN THE NAME OF GOD

BAHMAN

Manufacturing Company

Tel : (021)348091-8

Tlx : 223657 BAHM IR

Fax: (021) 340722

2) Recommended condition at highest load in the system

① Discharge-2" temperature

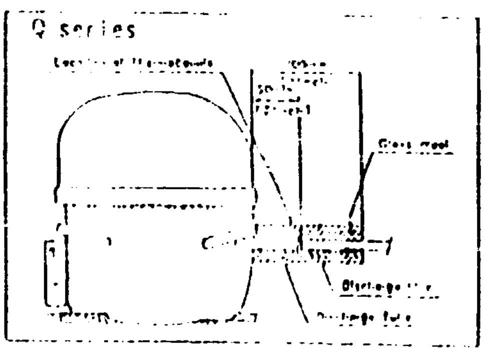
If the discharge 2" temperature rises, the compression gas temperature also rises at a same time. In the case of an excessive discharge temperature, the life of the refrigeration system becomes shorter due to carbon deposits in the valve mechanism.
Therefore, the discharge-2" temperature is one of the important factors for longevity of the refrigeration systems. Generally, the discharge temperature with a R-134a refrigeration system may be lower by approx. 10 ℃ as compare to a R-12 system. It may be necessary to keep it as below.

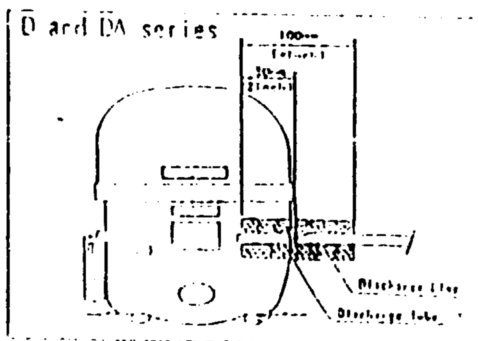
* Discharge-2" temperature

S series : Below 120 ℃ (248 °F)

Q,D and DA series : Below 110 ℃ (230 °F)

Fig.1 : The measuring method of discharge-2" temperature





② Motor winding temperature

The motor winding temperature at stabilized condition should be kept below 120 ℃(248 °F) for S,Q,D and DA series.

③ Condensing temperature

The compressor must be used with condensing pressure lower than that corresponding to 55 ℃ (131 °F) at continuous run and less than 65 ℃(149 °F) at momentary peak loads during pull down or freezing down.

④ Refrigerant charge

Excessive refrigerant charge not only causes frost and/or moisture on the suction line surface but also damages the valve mechanism due to slugging. In any compressor appliance, the refrigerant charge should not exceed the weight shown below.

S series : Below 200 g

Q,D, and DA series Up to 5.7 cm³: Below 200 g

Over 6.6 cm³: Below 300 g

IN THE NAME OF GOD

BAHMAN

Manufacturing Company

Tel : (021)348091-8
Tlx : 223657 BAHM IR
Fax: (021) 340722

⑤ Equalized pressure

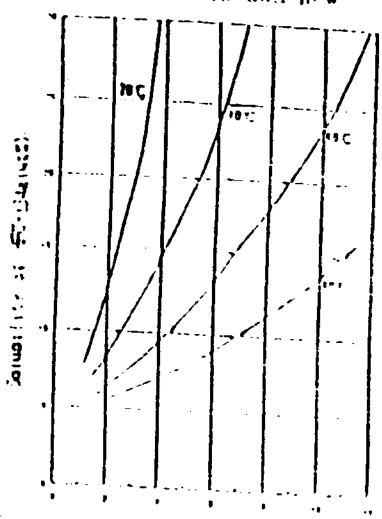
The equalized pressure when the refrigeration systems is soaked out at a 43 ℃(110 ℉) ambient temperature should be lower than 6 bar to obtain a favorable starting condition for a compressor.

Fig.2 shows the pressure-temperature solubility curve of a R-134a and new ester oil.

⑥ Interval for re-start

One of the important factors to re-start a compressor under a thermostat control in a refrigeration system is a interval.
. It is necessary to take at least 5 minutes interval until compressor starts again.

Fig.2



⑦ Confirmation of minimum refrigerant oil level (To confirm the compressor with a sight glass)

a) Reason
- Necessary for proper oil return to a compresser
- Poor solubility at low ambient temperature causes a refrigeration oil viscosity to increase.

b) Test method

b-1) Pull down test at ambient temperature of 43 ℃(110 ℉) or under highest load condition.

- At initial start ~ at peak ~ at stabilized (Including after defrost)

b-2) Pull down test at ambient temperature of -5 ℃(23 ℉).

- At initial start ~ at peak ~ at stabilized

c) Recommended oil level

- The oil level should be kept as below in height from the bottom of the compressor shell, showing following table and Fig.3,4.

Series		Oil level(mm)	Min. oil quantity (mm³)
S		Over 20	150
[illegible]	Less oil cooler	Over 18	150
	With oil cooler	Over 24	220
[illegible]	Less oil cooler	Over 24	180
	With oil cooler	Over 30	250