DETAILED PROJECT REPORT
ON
NEW REFRIGERATION COMPRESSOR– 75HP
(BHIMAVARAM ICE MAKING CLUSTER)










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Engineering Growth

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ISTSL

NEW REFRIGIRATION COMPRESSOR-75 HP

BHIMAVARAM ICE MAKING CLUSTER

BEE, 2010
Detailed Project Report on New Refrigerator Compressor 75 HP
Ice Plant SME Cluster, Bhimavaram, Andhra Pradesh (India)
New Delhi: Bureau of Energy Efficiency;
Detail Project Report No.:

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We take this opportunity to express our appreciation for the excellent support provided by Ice making unit owners, local service providers, and equipment suppliers for their active involvement and their valuable inputs in making the program successful and in completion of the Detailed Project Report (DPR).

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APITCO Limited

Hyderabad

Contents

List of *Annexure*

List of Table

List of Figure

Lists of Abbreviations

BEE	- Bureau of Energy Efficiency
DPR	- Detailed Project Report
DSCR	- Debt Service Coverage Ratio
GHG	- Green House Gases
HP	- Horse Power
IRR	- Internal Rate of Return
MoP	- Ministry of Power
MSME	- Micro Small and Medium Enterprises
NPV	- Net Present Value
ROI	- Return on Investment
SIDBI	- Small Industrial Development Bank of India
MoMSME	- Ministry of Micro Small and Medium Enterprises
COP	-Co Efficient of Performance

EXECUTIVE SUMMARY

APITCO Ltd. is executing for BEE-SME program in Bhimavaram Ice Plants Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in Ice Making units.

Bhimavaram is renowned for sea food business and is a big hub for fish and prawns culture. The prawns and fish are exported to various countries throughout the world. There are about 80 ice making units in the cluster and majority of industries located in Bhimavaram are engaged in production of ice blocks required for storage and transportation purpose of sea food.

The major Energy consumption in Ice making cluster are grid electricity and HSD oil. Electricity is used for driving the prime movers of installed in the Ice making plants i.e. compressors, pumps, agitators, drives and for lighting. HSD is used as fuel in DG sets for generation of electricity during the power failure from Electricity board. In Ice Making Units total energy cost is varies from 48 to 54% of the total Ice Production cost. The major cost component of ice production is energy cost followed by labor cost.

In Ice making units, refrigeration compressors are major energy consuming equipment and which required higher capacity of motors for the operation. The motor is used to drive the refrigeration compressor to compress the refrigerant during the operation. Many of refrigeration compressors used in the ice making plants in Bhimavaram are age old and the performance of the refrigeration compressors are low compare to its technical specifications. Due to the lower refrigeration effect, refrigeration compressors are consuming more electrical energy.

As per detailed studies undertaken in various units and discussions held with the supervisors and workers, major refrigeration compressors are age old at least 20 years and installed at the time of plant construction.

Replacement of existing compressor with new energy efficient compressor in the Ice unit would lead to reduce specific power consumption. New compressor would also increase production capacity of unit.

The DPR highlights the details of the study conducted for assessing the potential for reducing electricity consumption by installing New Refrigeration Compressor in various units of the cluster, possible electricity savings and its monetary benefit, availability of the technologies/design, local service providers, technical features and proposed equipment

specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, and schedule of project Implementation.

This bankable DPR also found eligible for subsidy scheme of MoMSME for "Technology and Quality Upgradation Support to Micro, Small and Medium Enterprises" under "National Manufacturing and Competitiveness Programme". The key indicators of the DPR including the Project cost, debt equity ratio, monetary benefit and other necessary parameters are given in table below:

Sr. No.	Particular	Unit	Value
1	Project cost	(` in Lakh)	3.94
2	Electricity Savings	kWh/annum	62284
3	Monetary benefit	(` in Lakh)	2.34
4	Simple payback period	Years	1.68
5	NPV	(` in Lakh)	5.04
6	IRR	%age	43.71
7	ROI	%age	27.20
8	Average DSCR	Ratio	2.47
9	CO2 emission reduction	MT/year	50
10	Process down time	Days	2

The projected profitability and cash flow statements indicate that replacing the new refrigeration Compressor with existing refrigeration compressor will be financially viable and technically feasible solution in the Ice making Units in the cluster.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 29 selected SMEs clusters. Bhimavaram Ice Making Units Cluster is one of them. The BEE's SME Programme intends to enhance the energy efficiency awareness by funding/subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation and technology up-gradation through studies and pilot projects in these SMEs clusters.

Major activities in the BEE -SME program are furnished below:

Activity 1: Energy use and technology audit

The energy use technology studies would provide information on technology status, best operating practices, gaps in skills and knowledge on energy conservation opportunities, energy saving potential and new energy efficient technologies, etc for each of the sub sector in SMEs.

Activity 2: Capacity building of stake holders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ Managers of SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting up of energy efficiency projects in the clusters

Activity 3: Implementation of energy efficiency measures

To implement the technology up-gradation project in the clusters, BEE has proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

Activity 4: Facilitation of innovative financing mechanisms for implementation of energy efficiency projects

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion.

1 INTRODUCTION

1.1 Brief Introduction about cluster

Bhimavaram is a town in West Godavari District in the state of Andhra Pradesh, India. It is located 395 kilometers east of state capital, Hyderabad. Bhimavaram is renowned for the sea food business and is a big hub for fish and prawns culture. These prawns and fish are exported to various countries throughout the world.

There are about 80 ice making units in the cluster and majority of industries located in Bhimavaram are engaged in production of ice blocks required for storage and transportation purpose of sea food.

The major Energy consumption in Ice making cluster are grid electricity and HSD oil. Electricity is used for driving the prime movers of installed in the Ice making plants i.e. compressors, pumps, agitators, drives and for lighting. HSD is used as fuel in DG sets for generation of electricity during the power failure from Electricity board. In Ice Making Units total energy cost is varies from 48 to 54% of the total Ice Production cost. The major cost component of ice production is energy cost followed by labor cost.

1.1.1 Production process

Raw water is pumped from local available water bodies such as pond / stream through raw water pump to overhead tank . The water from overhead tank is filled into the ice cans and kept in evaporation tank for ice formation.

The Ice production area i.e. Evaporation Tank of the plant has made of concrete. In the evaporation tank contains the direct expansion coils, equally distributed throughout the tank and these coils are submerged in brine. The tank is provided with a suitable frame of hard wood for support the ice cans and a propeller or agitator for keeping the brine in motion. The brine in tank acts as a medium of contact only. The ammonia is evaporated in ice coils by extract the heat from the brine, which again absorbs the heat for water in the cans.

The raw water in ice cans is chilled for 24-48 hours for complete formation of ice block. The sp. gravity of brine is maintained at 1180 by adding salt of required quantity. The formed ice blocks from ice cans are removed and emptied ice cans are again filled with fresh water. The removed ice blocks are further crushed as per the client requirements in to pieces using the ice crushes and loaded into plastic crates for transportation.

Detailed of process flow chart are finished in Figure 1.1 below:

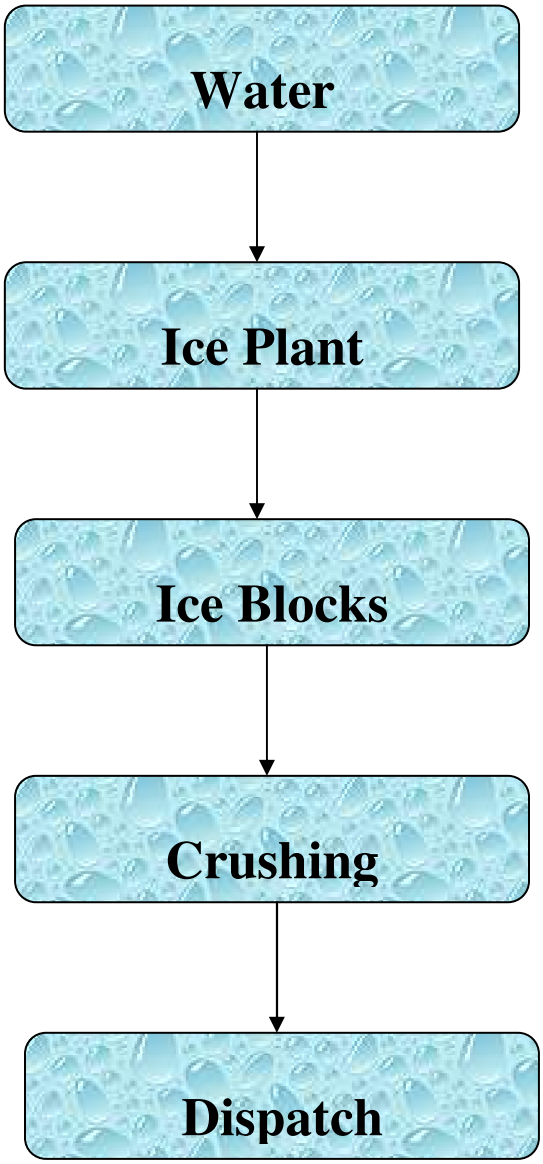


Figure 1.1: General process flowchart of a typical ice making unit

1.2 Energy performance in existing situation

1.2.1 Fuel and electricity consumption of a typical unit in the cluster

The main energy used in a typical ice making unit in the cluster is electricity and HSD. Electricity is used for driving the prime movers of Compressors, pumps, agitators, ice crushers, lighting etc. The HSD is used as fuel in DG Sets for generation of power during the power failures. The energy consumption of two typical ice making units in the cluster using inefficient refrigeration compressors are furnished in Table 1.1 below:

Table 1.1: Energy consumption of typical units

S.No	Unit Name	Electricity Consumption (kWh/annum)	HSD Consumption (Liters/annum)	Ice Production (tons/annum)
1	Krishna Teja Ice factory	622725	7283	5700
2	Sai Ratna Ice factory	438900	5133	4200

1.2.2 Average production by a typical unit in the cluster

The average production in a typical ice making unit is between 4200 to 5700 tons of ice blocks per annum.

1.2.3 Specific Energy Consumption

The major source of energy for ice making is electricity taken from grid and DG set and the specific electricity consumption per ton of ice production for typical units is furnished in Table 1.2 below:

Table 1.2: Specific energy consumption for typical units

Sr. No.	Unit Name	Units	Value
1	Krishna Teja Ice factory	kWh/ton of Ice	115
2	Sai Ratna Ice factory	kWh/ton of Ice	110

1.3 Existing technology/equipment

1.3.1 Description of existing technology

Refrigeration compressors are major energy consuming equipment and which required higher capacity of motors for the operation. The motor is used to drive the refrigeration compressor to compress the refrigerant during the operation. Many of refrigeration compressors used in the ice making plants in Bhimavaram are age-old and the performances of the refrigeration compressors are very low. Due to the lower refrigeration effect, refrigeration compressors are consuming more electrical energy.

As per detailed studies undertaken in various units and discussions held with the supervisors and workers, major refrigeration compressors are age old at least 20 years and installed at the time of plant construction.

The energy costs in Ice making Units are mainly dependent on performance of compressors. If the compressor performance is very good, the specific power consumption

per ton of Ice production will low. Detail of existing Refrigeration compressor is given in the Table 1.3 below:

Table 1.3 Existing Refrigeration Compressor specifications

S.No	Parameters	Unit	Details
1	Swept volume	m3/hr	398
2	Motor capacity	HP	75
3	Refrigeration Capacity	TR	144.3
4	Ice Making Capacity	TPD	29.30
5	Present Refrigeration Capacity	TR	54.24
6	Ice Production	TPD	18
7	Power per ton	kW/TR	1.03

1.3.2 Its role in the whole process

Any ice making unit requires a refrigeration compressor to compress the refrigerant for better refrigeration effect during the ice making process. The refrigeration compressor is heart of the Ice making unit and the ice making plant performance will depend on the refrigeration compressor. The duration of ice making and the specific power consumption of the ice plant will depend on the function of refrigeration compressor.

1.4 Establishing the baseline for the equipment

1.4.1 Design and operating parameters

The present power consumption of Refrigeration compressor is 55.64 kW and the Refrigeration effect is 54.24 TR. The motor is operated for 24 hours in a day for 350 days in a year.

1.4.2 Electricity consumption in existing system

The electricity consumption of refrigeration compressor of two units is given in Table 1.4 below:

Table 1.4 Electricity consumption by Refrigeration Compressor

S.No	Name of the unit	Power consumption (kW)	Power per ton (kW/TR)
1	Sai Ratna Ice factory	55.64	1.03
2	Krishna Teja Ice factory	58.73	1.25

1.4.3 Operating efficiency of the existing motor

The detailed energy audit studies had been undertaken in various units of the cluster to evaluate the refrigeration effect and Co efficient of performance (COP). Details of operating parameters and COP of existing compressor are furnished in Table 1.5 below:

Table 1.5 Operating parameters

S.No	Parameters	Unit	Value
1	Quantity of brine	kg	81000
2	Specific heat of brine	kCal/kg ^{o}C	0.81
3	Motor capacity	HP	75
4	Initial Temperature of brine	^{o}C	12.25
5	Final Temperature of brine	^{o}C	14.75
6	Temperature difference	^{o}C	2.5
7	Power Consumption	kW	55.64
8	Refrigeration Effect	TR	54.24
9	Power per Ton of Refrigeration	kW/TR	1.03
10	Co efficient of Performance (COP)	---	3.43

In existing ice plant refrigeration system, the refrigeration effect by the existing compressor is 54.24 which is very low compared to the manufacturer's specification i.e. 144.3 TR and also the power per ton of refrigeration system is 1.03 which is higher than the manufacturer's specifications.

Based on the age and lower refrigeration effect by the existing refrigeration compressor, the net co-efficient of performance (COP) is very low as compare to the manufacturer's specifications.

1.5 Barriers for adoption of new and energy efficient technology / equipment

1.5.1 Technological Barriers

The major technical barriers that prevented the implementation of new refrigeration compressor in the cluster are:

- Lack of awareness on refrigeration effect and TR generated with existing refrigeration compressor
- Dependent on local service providers on operation and maintenances.
- Lack of awareness about New energy efficient compressors

1.5.2 Financial Barrier

- The replacement of new refrigeration compressor requires high investment however overhauling cost is very less. Hence, many of the owners don't show interest due to high initial investment.
- Lack of financial strength of unit owner to invest such amount of money.
- Further, lack of awareness on energy loss due to inefficient refrigeration compressors and monetary benefit by adoption new refrigeration compressors with existing refrigeration compressor.

Energy Efficiency Financing Schemes such as SIDBI's, if focused on the cluster, will play a catalytic role in implementation of identified energy conservation projects & technologies.

The cluster has significant potential for implementing new efficient refrigeration compressors.

1.5.3 Skilled manpower

Not applicable

1.5.4 Other barrier(s)

Information on the energy efficient technologies is not available among cluster unit owners even though local suppliers are available.

2. TECHNOLOGY/EQUIPMENT FOR ENERGY EFFICIENCY IMPROVEMENTS

2.1 Detailed description of technology/equipment selected

2.1.1 Description of equipment

The project activity is replacement of existing Refrigeration Compressor with new energy efficient Refrigeration Compressor (KC3). The New refrigeration Compressor has not required cooling water and increase the refrigeration effect.

The following are the special features of New Refrigeration Compressors (KC3) over existing Refrigeration Compressor.

- **No Water jacket Cooling required for Compressor**: The design of internal volume and increased surface area of cylinder heads helps natural cooling of cylinders.
- **Crescent type of gear pump technology:** The low pressure and internal gear technology helps reduce back pressure on the pump improving its life further.
- **Broad foot base:** Foot base is increased then of KC series, which ensures smooth running and minimize the vibrations.
- **Simplified loading and unloading:** Loading mechanism around cylinder liner is modified and made to operate with law pressure oil which ensures accurate operation of loading and unloading of pistons

Oil suction and delivery piping are routed internally to avoid exposure to atmosphere and damages due to rusting etc, also. This has added to aesthetics of compressor.

The main advantage of the new refrigeration compressor is to reduce the specific energy consumption with respect to the refrigeration effect and increase the Co efficient of performance (COP).

2.1.2 Technology /Equipment specifications

The detailed specification of the new refrigeration compressor suggested is furnished in table 2.1 below:

Table 2.1: New Refrigeration Compressor Specifications

S. No.	Parameter	Unit	Value
1	No of Cylinders	No.	3
2	Swept Volume	M3/hr	398.1

S. No.	Parameter	Unit	Value
3	No of Stages	No	1
4	Ice Making Capacity	TPD	29.3
5	Refrigeration Effect	TR	144.3
6	Power Consumption	kW	59.4

Further, detail product and technical specification is given in Annexure 7.

2.1.3 Justification of the technology selected & Suitability

The refrigeration compressors are major energy consuming equipment in Ice Making Cluster at Bhimavaram. Based on the detailed energy audits conducted for various compressors installed in cluster units, it was found few compressors are age old and having the lower Co efficient of Performance (COP) compare to the manufacturer's specifications. The following benefits are possible for selection of this technology

- Lower Power Consumption with respect to Ice Production
- Higher refrigeration effect
- It reduces the GHG emissions
- Lower payback period at continuous operation and higher production rate.
- More life of equipment.

2.1.4 Superiority over existing technology/equipment

The following are the superior features of New Refrigeration Compressors (KC3) over existing Refrigeration Compressor.

- Lower power consumption for same production
- Higher co-efficient of performance
- Less power per ton value

2.1.5 Availability of the proposed technology/equipment

The New refrigeration Compressors are available at Hyderabad and Vijayawada. The details of the suppliers are provided in Annexure-6.

2.1.6 Source of technology/equipment for the project

The source of the technology is indigenous and is locally available.

2.1.7 Service/technology providers

A detail of Refrigeration Compressors suppliers has been furnished in Annexure 6.

2.1.8 Terms of sales

No any specific terms and conditions for sale of new compressor however, a general term and condition of supplier is given in Annexure 7.

2.1.9 Process down time during implementation

The process down time for installation of New Refrigeration Compressor is considered two days for removing the existing compressor and installation of new compressor and providing electrical connections.

2.2 Life cycle assessment and risks analysis

The life of the energy efficient motor is considered at 25 years. There is no risk involved as the compressor technology is proven and are successfully in operation in other industries of the country.

2.3 Suitable unit/plant size in terms of capacity/production

The compressors are selected similar to the existing capacity of the compressors.

3. ECONOMIC BENEFITS OF NEW ENERGY EFFICIENT TECHNOLOGY

3.1 Technical benefits

3.1.1 Fuel savings per year

No fuel saving is possible due to installation of proposed system.

3.1.2 Electricity savings per year

The co-efficient of performance of the new refrigeration compressor is more than the existing refrigeration compressor which will lead to reduce the power consumption and increase the Ice making Capacity. The power savings due to installation of new refrigeration Compressor (KC3) is 62284 kWh per annum at 80% loading condition. Details of electricity saving calculation are given at Annexure 3.

3.1.3 Improvement in product quality

There is no significant impact on the product quality.

3.1.4 Increase in production

The production capacity will be increase to some extent.

3.1.5 Reduction in raw material consumption

Raw material consumption would be same as present.

3.1.6 Reduction in other losses

There is no significant reduction in other losses.

3.2 Monetary benefits

The monetary benefits due to installation of new refrigeration Compressor is ` 2.34 lakh per annum. Details of electricity saving calculation are furnished in Annexure 3.

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

As installation of new refrigeration compressor may reduce the breakdowns and hence, working environment may improve.

3.3.2 Improvement in skill set of workers

The technology selected for the implementation is new and its installation will create the awareness among the workforce on energy efficiency and significance of power saving.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

There is no reduction in effluent generation.

3.4.2 Reduction in GHG emission such as CO2, NOx, etc

The major GHG emission reduction source is CO_2. The technology will reduce grid electricity consumption and emission reductions are estimated at 50 tons of CO_2 per annum due to implementation of the project activity.

3.4.3 Reduction in other emissions like SOx

No significant impact on SOx emissions.

4. INSTALLATION OF NEW ENERGY EFFICIENT MOTOR

4.1 Cost of technology/equipment implementation

4.1.1 Cost of technology/equipments

The total cost for new refrigeration compressor is ` 3.76 lakh, which includes solenoid valves, drive set, fly wheel cost and other charges etc. as per the quotation in Annexure 7.

4.1.2 Other costs

Other charges include cabling and panel modification. Project cost details are furnished in Table 4.1 below:

Table 4.1: Project detail cost

S. No.	Particular	Unit	Value
1	New Refrigeration Compressor (KCX2)	` in lakh	3.74
2	Panel, Switch & Cabling, Elec. and Modifications etc.	` in lakh	0.20
3	Total Investment	` in lakh	3.94

4.2 Arrangement of funds

4.2.1 Entrepreneur's contribution

The entrepreneur's contribution is 25% of total project cost, which works out at ` 0.99 lakh.

4.2.2 Loan amount

The term loan is 75% of the total project cost, which is ` 2.96 lakh.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10.0% which is prevailing interest rate of SIDBI for energy efficiency related projects. The loan tenure is 5 years and the moratorium period is 6 months.

4.3 Financial indicators

4.3.1 Cash flow analysis

Considering the above discussed assumptions, the net cash accruals starting with ` 1.79 lakh in the first year operation and increases to ` 8.99 at the end of eighth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ` 3.94 lakh and monetary savings due to reduction in electricity consumption is ` 2.34 lakh and the simple payback period works out to be 1.68 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10.0% interest rate works out to be ` 5.04 lakh.

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 43.71%. Thus the project is financially viable.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 27.20%. The average DSCR is 2.46.

4.4 Sensitivity analysis in realistic, pessimistic and optimistic scenarios

A sensitivity analysis has been worked out to ascertain how the project financials would behave in different situations like there is an increase in power savings or decrease. For the purpose of sensitive analysis, two scenarios are considered are.

- Increase in power savings by 5%
- Decrease in power savings by 5%

In each scenario, other inputs are assumed as constant. The financial indicators in each of the above situation are indicated along with standard indicators.

Table 4.2: Sensitivity analysis

Particulars	*IRR* %	*NPV* ` in lakh	*ROI* %	*DSCR*
Normal	43.71	5.04	27.20	2.47
5% increase in power savings	46.48	5.49	27.36	2.59
5% decrease in power savings	40.92	4.59	27.02	2.35

4.5 Procurement and implementation schedule

The project is expected to be completed in 1 week from the date of release of purchase order. The detailed schedule of project implementation is furnished in Annexure 5.

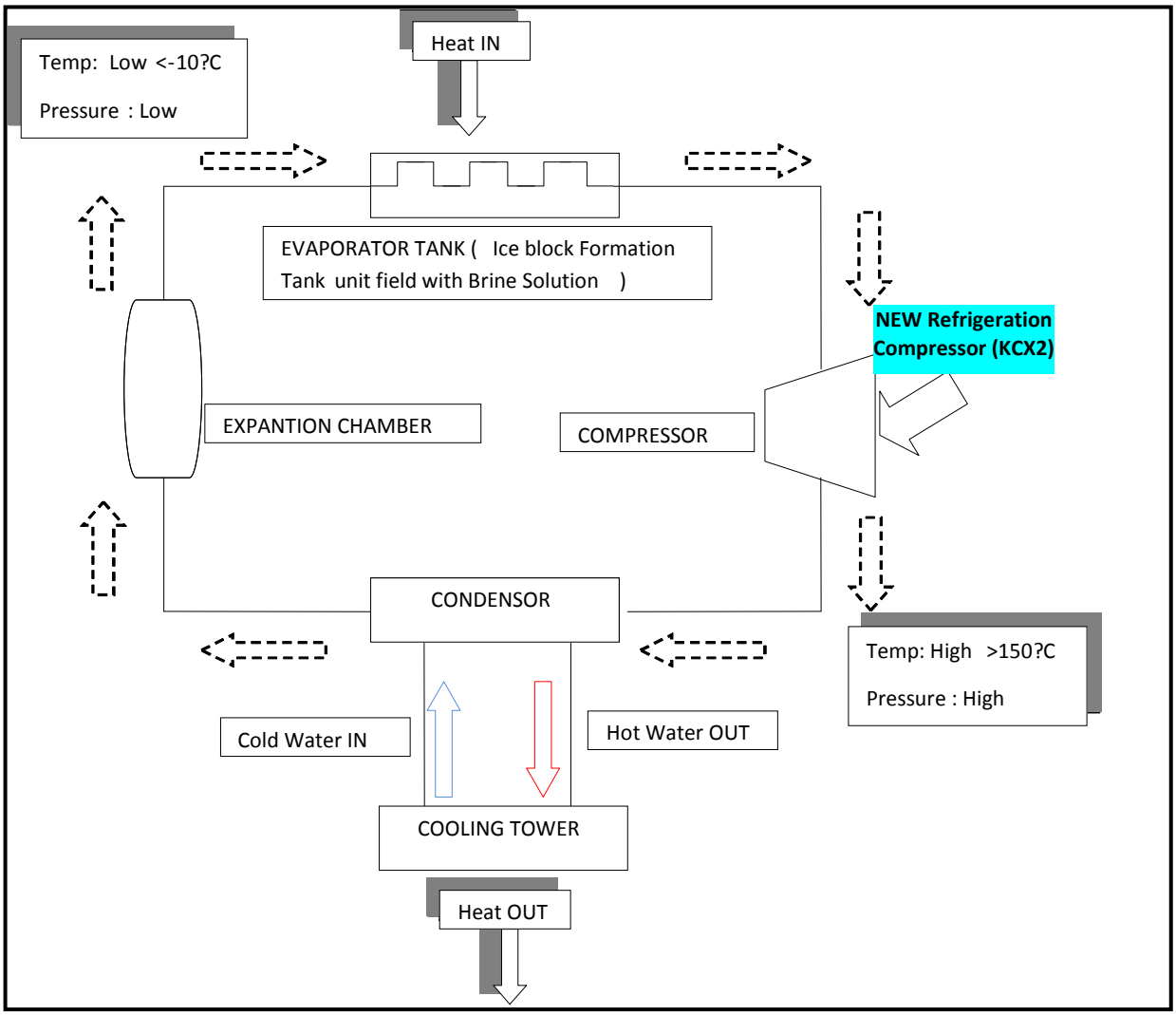
ANNEXURE

Annexure 1: Energy audit data and baseline establishment

S.No	Parameter	Unit	Value
1	Refrigerant	Name	Ammonia
2	Swept Volume	m3/hr	398
3	Compressor Motor	HP	75
4	Quantity of brine	kg	81000
5	Specific heat of brine	kCal/kg ^{o}C	0.81
6	Initial Temperature	^{o}C	12.25
7	Final Temperature	^{o}C	14.75
8	Temperature difference	^{o}C	2.5
9	Power Consumption by Compressor	kW	55.64
10	Refrigeration Effect	TR	54.24
11	Power per Ton of Refrigeration	kW/TR	1.03
12	Co efficient of Performance (COP_	--	3.43

Annexure 2: Process Flow Diagram

Process flow diagram will remain the same after implementation of proposed New Refrigeration Compressor.



Annexure 3: Detailed technology assessment report

S.No	Parameter	Unit	Existing Compressor	New Compressor
1	Compressor Model	Name	---	KC3
2	Refrigerant	Name	Ammonia	Ammonia
3	Swept Volume	m3/hr	398	398
4	Compressor Motor	HP	75	75
5	Power Consumption by Compressor	kW	55.64	62.80*
6	Refrigeration Effect	TR	54.24	115.44*
7	Power per Ton of Refrigeration	kW/TR	1.03	0.54
8	Co efficient of Performance (COP)	---	3.43	6.46
9	No of Hours per Day	Hrs/Day	24	24
10	No of days per Year	Days/Year	350	350
11	Production	Ton/Day	18	23.4*
12	Yearly Production from compressor	Tons/Year	6300	8204
13	Power Consumption	kWh/Year	467376	527520
14	Power Consumption by Compressor	kWh/Ton	74	64
15	Energy Savings	kWh/Ton		10
16	Total Energy Savings for existing production (6300 T/Y)	kWh/Year		62284
17	Energy Tariff	`/kWh		3.75
18	Energy Savings Cost	`In lakh/Year		2.34
19	Investment Cost	` In Lakh		3.94
20	Payback	Years		1.68

*Refer to manufacturer quotation and considering 80% loading.

Annexure 4: Detailed financial calculations & analysis

Assumptions

Name of the Technology	New Refrigeration Compressor		
Rated Capacity	KC-3		
Details	**Unit**	**Values**	**Basis**
Installed capacity	HP	75	
No of working days	Days	350	
No of Shifts per day	Shifts	3	
Capacity Utilization Factor	%	80	
Proposed Investment			
New Refrigeration Compressor	` in lakhs	3.74	
Cabling, Civil and Modifications	lump sum	0.20	
Total Investment	` in lakhs	3.94	
Financing pattern			
Own Funds (Internal Accruals)	` in lakhs	0.99	Feasibility Study
Loan Funds (Term Loan)	` in lakhs	2.96	Feasibility Study
Loan Tenure	Years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%	10	SIDBI Lending Rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	2	Feasibility Study
Annual Escalation	%	5	Feasibility Study
Estimation of Revenue			
power savings	kWh/annum	62284	
power cost	`/kWh	3.75	Detailed calculations enclosed in DPR
St. line Depn.	%	5.28	Indian Companies Act
IT Depreciation	%	80.00	Income Tax Rules
Income Tax	%	33.99	Income Tax

Estimation of Interest on Term Loan **` (in lakh)**

Years	*Opening Balance*	*Repayment*	*Closing Balance*	*Interest*
1	2.96	0.12	2.84	0.34
2	2.84	0.24	2.60	0.27
3	2.60	0.48	2.12	0.24
4	2.12	0.72	1.40	0.18
5	1.40	0.92	0.48	0.10
6	0.48	0.48	0.00	0.01
		2.96		

WDV Depreciation **` (in lakh)**

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	3.94	0.79
Depreciation	3.15	0.63
WDV	0.79	0.16

Projected Profitability **` (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8
Fuel savings	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34
Total Revenue (A)	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34
Expenses								
O & M Expenses	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11
Total Expenses (B)	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11
PBDIT (A)-(B)	2.26	2.25	2.25	2.24	2.24	2.24	2.23	2.22
Interest	0.34	0.27	0.24	0.18	0.10	0.01	0.00	0.00
PBDT	1.91	1.98	2.01	2.07	2.14	2.22	2.23	2.22
Depreciation	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
PBT	1.71	1.77	1.80	1.86	1.93	2.01	2.02	2.02
Income tax	0.00	0.46	0.68	0.70	0.73	0.75	0.76	0.76
Profit after tax (PAT)	1.71	1.31	1.12	1.16	1.20	1.26	1.26	1.26

Computation of Tax **` (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8
Profit before tax	1.71	1.77	1.80	1.86	1.93	2.01	2.02	2.02
Add: Book depreciation	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Less: WDV depreciation	3.15	0.63	-	-	-	-	-	-
Taxable profit	(1.24)	1.35	2.01	2.07	2.14	2.22	2.23	2.22
Income Tax	-	0.46	0.68	0.70	0.73	0.75	0.76	0.76

Projected Balance Sheet **` (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8
Liabilities								
Share Capital (D)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Reserves & Surplus (E)	1.71	3.02	4.14	5.29	6.50	7.76	9.02	10.28
Term Loans (F)	2.84	2.60	2.12	1.40	0.48	0.00	0.00	0.00
Total Liabilities (D)+(E)+(F)	5.53	6.60	7.24	7.67	7.96	8.74	10.00	11.26
Assets	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Gross Fixed Assets	3.94	3.94	3.94	3.94	3.94	3.94	3.94	3.94
Less Accm. Depreciation	0.21	0.42	0.62	0.83	1.04	1.25	1.46	1.66
Net Fixed Assets	3.73	3.52	3.32	3.11	2.90	2.69	2.48	2.28
Cash & Bank Balance	1.79	3.08	3.92	4.57	5.06	6.05	7.52	8.99
TOTAL ASSETS	5.53	6.60	7.24	7.67	7.96	8.74	10.00	11.26
Net Worth	2.69	4.00	5.12	6.28	7.48	8.74	10.01	11.27
Debt Equity Ratio	2.88	2.63	2.15	1.42	0.48	-0.01	-0.01	-0.01

Projected Cash Flow **` (in lakh)**

Particulars / Years	0	1	2	3	4	5	6	7	8
Sources									
Share Capital	0.99	-	-	-	-	-	-	-	-
Term Loan	2.96								
Profit After tax		1.71	1.31	1.12	1.16	1.20	1.26	1.26	1.26
Depreciation		0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Total Sources	3.94	1.91	1.52	1.33	1.36	1.41	1.47	1.47	1.47

Application									
Capital Expenditure	3.94								
Repayment Of Loan	-	0.12	0.24	0.48	0.72	0.92	0.48	0.00	0.00
Total Application	3.94	0.12	0.24	0.48	0.72	0.92	0.48	0.00	0.00
Net Surplus	-	1.79	1.28	0.85	0.64	0.49	0.99	1.47	1.47
Add: Opening Balance	-	-	1.79	3.08	3.92	4.57	5.06	6.05	7.52
Closing Balance	-	1.79	3.08	3.92	4.57	5.06	6.05	7.52	8.99

IRR ***` (in lakh)***

Particulars / months	0	1	2	3	4	5	6	7	8
Profit after Tax		1.71	1.31	1.12	1.16	1.20	1.26	1.26	1.26
Depreciation		0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Interest on Term Loan		0.34	0.27	0.24	0.18	0.10	0.01	-	-
Cash outflow	(3.94)	-	-	-	-	-	-	-	-
Net Cash flow	(3.94)	2.26	1.79	1.57	1.54	1.51	1.48	1.47	1.47
IRR	43.71%								
NPV	5.04								

Break Even Point **` (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08
Sub Total(G)	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Interest on Term Loan	0.34	0.27	0.24	0.18	0.10	0.01	0.00	0.00
Depreciation (H)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Sub Total (I)	0.57	0.50	0.47	0.41	0.33	0.25	0.23	0.24
Sales (J)	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34
Contribution (K)	2.28	2.27	2.27	2.27	2.26	2.26	2.26	2.25
Break Even Point (L= G/I)	25.08%	22.05%	20.59%	18.06%	14.64%	10.93%	10.39%	10.47%
Cash Break Even {(I)-(H)}	15.94%	12.90%	11.42%	8.89%	5.45%	1.72%	1.17%	1.23%
Break Even Sales (J)*(L)	0.59	0.51	0.48	0.42	0.34	0.26	0.24	0.24

Return on Investment **` (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8	Total
Net Profit Before Taxes	1.71	1.77	1.80	1.86	1.93	2.01	2.02	2.02	15.12
Net Worth	2.69	4.00	5.12	6.28	7.48	8.74	10.01	11.27	55.60
									27.20%

Debt Service Coverage Ratio **` (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8	Total
Cash Inflow									
Profit after Tax	1.71	1.31	1.12	1.16	1.20	1.26	1.26	1.26	7.76
Depreciation	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	1.25
Interest on Term Loan	0.34	0.27	0.24	0.18	0.10	0.01	0.00	0.00	1.15
Total (M)	2.26	1.79	1.57	1.54	1.51	1.48	1.47	1.47	10.15

DEBT

Interest on Term Loan	0.34	0.27	0.24	0.18	0.10	0.01	0.00	0.00	1.15
Repayment of Term Loan	0.12	0.24	0.48	0.72	0.92	0.48	0.00	0.00	2.96
Total (N)	0.46	0.51	0.72	0.90	1.02	0.49	0.00	0.00	4.11
Average DSCR (M/N)	2.47								

Annexure 5: Details of procurement and implementation plan

Project Implementation schedule

S. No	Activity	Weeks			
		1	2	3	4
1	Placement of Orders for Equipment				
2	Supply of Compressor				
3	Installation of the Compressor				
4	Trial runs				

Process down time

S. No	Activity	Weeks			
		1	2	3	4
1	Removing of existing Compressor				
2	Electricity connections and modification of the pipe lines				
3	Installation of the New Compressor				
4	Trial runs				

Only two days required for process down time.

Annexure 6: Details of technology/equipment and service providers

Equipment details	*Source of technology*	*Service/technology providers*
Heavy Duty Refrigeration Compressor	Kirloskar	Trade Links 5-4-76/3,4,5, First Floor Opp. TVS Honda Show room M.G.Road, Ranigunj Secunderabad Andhra Pradesh-500003

Annexure 7: Quotation or techno-commercial bid

Trade Links

REGIONAL OFFICE : [illegible]
BRANCH OFFICE : [illegible]

QUOTATION

QUOT NO. : ACR/359
DATE : 13.12.10

Dear Sir,

Sub: Requirement of Kirloskar KC3/KCX3 compressor

As Authorised Dealers for Kirloskar Pneumatic Co. Ltd., Pune for ACR Equipments for Southern Region and as also the exclusive Spare Parts & Pre/Post warranty Service Dealer for the state of Andhra Pradesh, we have pleasure in furnishing below our offer against your requirement of Kirloskar Compressor.

SL NO.	MODEL	QTY (Nos)	RATE/EACH (Rs.)	Value (Rs.)
1.	**KIRLOSKAR PNEUMATIC KC 3/KCX3 Refrigeration compressor with** Solenoid Valves	1	206240.00	206240.00
	DriveSet	1	64515.00	64515.00
	S D S Valves	1	13330.00	13330.00
	Cutouts, Guages & Panel board	1	16340.00	16340.00
	Compressor Baseframe	1	6060.00	6060.00
	Oil Separator	1	19690.00	19690.00
	Tools & Gaskets	1	3290.00	3290.00
	Tubing & Ferrules	1	2480.00	2480.00
	TOTAL :			331945.00
	EXCISE DUTY : As applicable at the time of supply be charged extra. Presently E.D. on compressor & all accessories is 10.30%		30925.16	30925.00
			TOTAL :	362870.00

OTHER TERMS:

SALES TAX	:	Extra as applicable at the time of supply. Presently CST @ 2% against form 'C'. If 'C' form is not given VAT @14.5% + 2% extra in lieu of CST paid by us.
DELIVERY	:	8 -10 weeks from the date of receipt of your P.O. and advance payment.
INSURANCE	:	Insurance is charged @ 1.0 % extra to your account
PAYMENT	:	50 % advance along with the P.O. and balance 50 % against proof of despatch on Proforma Invoice by DD
FREIGHT	:	Extra to your account from KPCL, Pune to your site at actuals
ENTRY TAX	:	Extra to your account, if applicable which please note
WARRANTY	:	**18 months from the date of commissioning OR 24 months from the date of supply, whichever is earlier.**
VALIDITY	:	30 days

KIRLOSKAR KC SERIES HEAVY DUTY REFRIGERATION COMPRESSORS

Kirloskar

Enriching Lives

Kirloskar Pneumatic Company Limited (KPCL) is known for the last four decades as the leading manufacturer of a wide range of: ■ Air-conditioning & Refrigeration Equipment, Systems/ Packages, Process Gas Packages ■ Air Compressors and Packages ■ Transmission Products in India.

KPCL has vast experience and the latest technology and up-to-date manufacturing facilities at its modern plants at Pune and Saswad. The Company has established a countrywide 'sales & service' network for up-keep of every product it manufactures. Today more than 28000 of various ACR compressor models are operating in India and abroad (over 30 countries) for more than 15 applications.

KPCL is an ISO9001-2000 company, the very first in India in its line of activities. Kirloskar Pneumatic is also an outstanding force in the areas of system engineering and turnkey projects in Refrigeration and Air-conditioning.

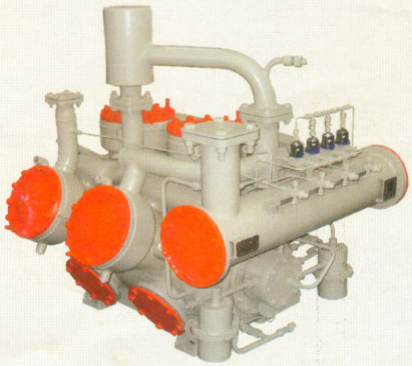
FEATURES

■ WELDED STEEL CRANKCASE

Apart from being the low weight and ensuring rapid heat dissipation, the crankcase is absolutely gas tight & impact proof. The smooth internal surfaces of the compressors guarantee the good condition of oil. The broad foot base ensures reduce vibrations.

■ PISTON CONNECTING ROD ASSEMBLY

The light aluminium alloy piston is fitted with two compression piston rings and 1 oil scraper rings, 2 oil rings for perfect sealing & low oil consumption. S.G. iron connecting rod is drilled through for pressure lubrication of the piston pin. It has steel backed, white metal shells on its big end and bronze bearing on its small end. The complete assembly can be removed from the top for servicing without withdrawing the cylinder liner.



■ CRANKSHAFT AND MAIN BEARINGS

The bearing surfaces of S.G. iron crankshaft are ground to fine tolerances. The main bushes are white metal lined, steel backed pressed into the cast iron bearing covers. Intermediate bearing blocks are provided with split type bearing shells of the same type. Each crankshaft is dynamically balanced together with the counterweights.

■ CYLINDERS AND SUCTION VALVE LIFTING

The interchangeable cylinder liners are made of fine-grained, centrifugal cast, alloy iron. Fine boring and honing result in a mirror-smooth running surface. Loading or unloading of the cylinders is achieved by a hydraulic mechanical suction valve lifting mechanism fitted on each individual cylinder. For unloading the suction valve ring is lifted from its seat in the cylinder collar by spring tension. Loading of the cylinder is effected by admitting control oil pressure to the control piston, allowing the suction valve ring to descend on its seat.

■ OIL PUMP & FILTERS

The single gear pump, driven directly by the crankshaft, incorporates a differential pressure regulator to provide separate pressures for two oil systems: lubrication system and control oil system. The pump also includes an automatically operating hydraulic delay valve, ensuring complete unloaded start.

A metal gauze suction filter & a throwaway paper discharge filter cartridge is provided for extreme filtering capacity of lubricating oil.

■ SUCTION/DISCHARGE VALVE ASSEMBLY

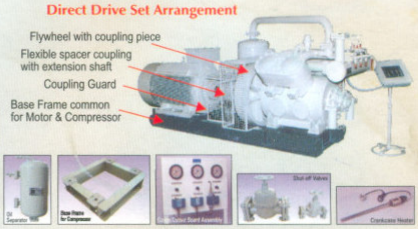
Three concentric discharge valve rings ensure ample gas passage at low lifting height. The use of sinusoidal springs together with precision machined and lapped surfaces, result in a trouble-free operation for a remarkably long time.

ACCESSORIES

- Drive set
  V-belt Drive (Flywheel, Motor Pulley, V-belts) for a wide range of standard speeds.
  Direct Drive (Flywheel, Coupling Piece, Flexible Spacer Coupling).
- Base Frame, Slide Rails, Foundation Bolts.
- Stop Valves (suction and discharge).
- Pressure Gauges, Safety Pressure Cutouts, Panel.
- Interstage cooling systems to suit 2-stage compressors.
- Crankcase Heater
- Oil Separator

V-belt Drive Arrangement

Direct Drive Set Arrangement



APPLICATIONS

KC series reciprocating compressors are most suitable for industrial refrigeration, low temperature applications, process refrigeration for continuous duty. They are designed to operate with ammonia, halocarbons and other refrigerants. Available in single and two stage versions, modular construction with 2, 3, 4, 6, 9 and 12 cylinders. All welded steel construction, built-in unloaded starting device and other safeguards against incidental liquid hammer are salient features of these compressors.

TECHNICAL DATA

			Compressor Models					
Compressor Type		Single Stage	**KC2**	**KC3**	**KC4**	**KC6**	**KC9**	**KC12**
		Two Stage		**KC21**	**KC31**	**KC42**	**KC63**	**KC93**
						KC51	**KC72**	**KC102**
Cylinder arrangement			1xV	1xW	2xV	2xW	3xW	4xW
No. of cylinders			2	3	4	6	9	12
Bore and stroke	mm		160x110					
Permissible speed	RPM		Belt drive from 400 to 1000 RPM in steps of 50					
Swept volume at 1000 RPM	m^3/hr	Single Stage	265.4	398.1	530.8	796.2	1194.3	1592.4
		Two Stage		265.4	398.1	530.8	796.2	1194.3
		Low Stage				663.5	928.9	1327.0
Direction of rotation			Anti-clockwise when viewed from shaft-end					
Maximum discharge pressure	bar		21					
Weight of comp. (without flywheel)	kg		435	535	665	900	1245	1585
Moment of inertia (GD^2) of crank mechanism	$kg.m^2$		0.356	0.422	0.446	0.594	0.829	1.045
Overall Dimensions	mm	Length	948	945	1150	1447	1861	2251
		Width	970	1130	970	1130	1130	1130
		Height	935	935	935	960	960	960

PERFORMANCE CHART AT 1000 RPM

SINGLE STAGE						TWO STAGE (Interstage gas cooling by liquid injection)			
Type	**Unit**	**NH_3***	**R22****	**Ice making capacity (Tonnes per 24 hrs.) with NH_3**		**Type**	**Unit**	**NH_3**	**R22**
		(1)	(1)	(2)				(3)	(4)
KC2	TR	96.2	81.1	TPD	19.5	**KC21**	TR	18.6	11.6
	kW	53.0	58.0	kW	40.5		kW	34.0	33.2
KC3	TR	144.3	121.7	TPD	29.3	**KC31**	TR	26.5	16.7
	kW	78.5	86.0	Kw	59.4		kW	47.1	45.2
KC4	TR	192.4	162.2	TPD	39.0	**KC42**	TR	37.1	23.3
	kW	104.1	114.0	kW	78.5		kW	65.9	64.2
KC6	TR	288.6	243.3	TPD	58.5	**KC51**	TR	39.9	25.3
	kW	155.0	170.0	kW	116.2		kW	72.1	69.0
KC9	TR	433.0	365.1	TPD	87.8	**KC63**	TR	55.7	35.0
	kW	231.4	255.0	kW	172.9		kW	97.9	95.3
KC12	TR	577.3	486.6	TPD	117.1	**KC72**	TR	60.4	37.9
	kW	307.9	340.0	kW	229.5		kW	104.9	100.3
						KC93	TR	79.6	50.0
							kW	137.0	131.3
						KC102	TR	79.8	50.3
							kW	141.9	135.8

(1)At +10 deg C/+40 deg C; 0 deg C subcooling & superheating. (2) At -15 dec C/+40 deg C; 0 deg C subcooling & superheating. 1000 rpm, make up temperature at 24°C max. (3) At -30 deg C/+40 deg C; 0 deg C subcooling & superheating. (4) At +40 deg C/+40 deg C; 0 deg C subcooling & superheating. The performance chart is only a guideline, for other details please refer to us. We reserve the right to modify specifications and technical data in accordance with improved designs.

WARRANTY: Every compressor carries a standard warranty against manufacturing defects of 12 months from the date of start-up/commissioning by a KPC authorised engineer OR 18 months from the date of despatch whichever occurs earlier. The warranty card must be produced for any warranty claims. Standard warranty does not include consumables like oil, filters, gaskets, O'rings, etc. and warranty is not applicable if failure occurs due to fault in system design.

Kirloskar

Enriching Lives

Kirloskar Refrigeration
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