DETAILED PROJECT REPORT
ON
REPLACEMENT OF RECIPROCATING COMPRESSORS WITH SCREW COMPRESSORS
(BANGALORE MACHINE TOOL CLUSTER)











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INSTALLATION OF ENERGY EFFICIENT SCREW COMPRESSOR

(15 HP CAPACITY)

BANGALORE MACHINE TOOL CLUSTER

BEE, 2010

Detailed Project Report on Installation of Energy Efficient Screw Compressor

Bangalore Machine Tool cluster, Karnataka (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 Machine Tool 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 cluster manual. PCRA is also thankful to all the SME owners, plant in charges and all workers of the SME units for their support during the energy use and technology audit studies and in implementation of the project objectives.

Petroleum Conservation Research Association

Bangalore

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List of Abbreviations

BEE	Bureau of Energy Efficiency
DPR	Detailed Project Report
DSCR	Debt Service Coverage Ratio
EA	Energy Audit
EE	Energy Efficiency
GHG	Green House Gas
INR	Indian National Rupee
IRR	Internal Rate Of Return
kWh	kilo Watt Hour
NPV	Net Present Values
O&M	Operational & Maintenance
MSME	Micro Small and Medium Enterprises
PAT	Profit After Tax
PBT	Profit Before Tax
ROI	Return on Investment
MoMSME	Ministry of Micro Small and Medium Enterprises
SIDBI	Small Industries Development Bank of India

EXECUTIVE SUMMARY

Bureau of Energy Efficiency (BEE) appointed Petroleum Conservation Research Association as the executing agency for Machine Tools of Bangalore under BEE's SME programme. Under this project, the executing agency carried out studies in the Machine Tools of Bangalore. Out of a total of 100 machine tools units, study was conducted in 30 units. Preliminary audits were undertaken in all the 30 units whereas detailed energy audits were conducted in 10 of these units.

Bangalore has evolved as one of the most important production centers in the Machine tool sector despite there being nothing favorable for proliferation of a cluster. The place lacks all possible resources, from raw materials to fuels and to skilled man power newer technologies as well which is the most important for processing of Machine tools. Today there are 100 units in Bangalore alone and the production capacity of machine tool units in Bangalore cluster is in the range of 1500 kg per Annum –1050000 kg per Annum.

Energy forms a major chunk of the processing cost with over 30% weight age in the cost basket. As per the preliminary and detailed energy audit findings, there exists potential of saving over 30% electricity and 50% fuel in the applications in power process industries with over all general payback period of less than six year. The payback period in these industries is higher due to their working schedule and lower utilization of facilities.

Based on the energy audits, the executing agency submitted their report to BEE in form of a cluster manual with recommendations for energy conservation & savings potentials in the Machine Tools sector. The air compressors are one of the most important utility systems of the machine tools units as compressed air used in pneumatic control system of the CNC machine. The air requirements should be supplied by at least a 2-HP compressor with a minimum 20-gallon tank for one CNC machine. It is important that In order to operate the machine properly if the air nozzle is used during pneumatic operations, the air flow will need to be increased as outlined in the previous note. The screw compressor is not equipped with valves and has no mechanical forces that cause unbalance. This means it can work at a high shaft speed and combine a large flow rate with small exterior dimensions. An axial acting force, dependent on the pressure difference between the inlet and outlet, must be taken up by the bearings.

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:

S. No	Particular	Unit	Value
1	Project cost	` (in lakh)	2.63
2	Electricity saving	kWh	28567
3	Monetary benefit	`(in lakh)/Year	1.43
4	Simple payback period	Year	1.84
5	NPV	` (in lakh)	2.51
6	IRR	%age	35.84
7	ROI	%age	26.48
8	DSCR	ratio	2.12
9	CO_2 reduction	Tonne/annum	20.6
10	Procurement and implementation schedule	week	5

The projected profitability and financial indicators shows that the project will be able to earn profit from inception and project is financially viable and technically feasible.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Gujarat Dairy 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 about the SME cluster

About SME cluster

The Machine Tools Cluster of Bangalore is located in the Bangalore district. Bangalore, also known as Bengaluru is the capital of the Indian state of Karnataka, located on the Deccan Plateau in the south-eastern part of Karnataka. Bangalore was inducted in the list of Global cities and ranked as a "Beta World City" alongside Geneva, Copenhagen, Boston, Cairo, Riyadh, Berlin, to name a few, in the studies performed by the Globalization and World Cities Study Group and Network in 2008. These machine units have been classified into following clusters within the district:

- Abbegere
- Bommasandra
- Peenya

Bangalore is the “HUB” for machine tools in India. The cluster accounts for 60% of the value of production of machine tools in the country. Bangalore is predominantly a metal cutting cluster. The structure of machine tool industry in Bangalore has at its apex 6 large machine tool manufacturers, about 100 small and medium machine tool manufacturers, their suppliers and vendors in large numbers.

Product Manufactured

In SME cluster of Machine Tools at Bangalore, there are varieties of products manufactured that include spindles, centre grinding machines, ID grinding machines, Self centering Steady Rests, Bar feeding attachments, Rotary tables, Index tables, Special purpose machines, Co-ordinate Measuring machines, aerospace fixtures, CNC Machine enclosures, Sound proofs, armature rewinding machines etc. There are supporting industries like heat treatment are also located in the cluster. These products/ machines are usually utilized in automobile industry, aerospace industry, CNC Machine industry across the globe. These are products custom made to suit the requirements of ISRO, HAL, BEML, MICO, BHEL, Kirloskar Electric, Bayforge Ltd etc.

Production Process

Typically, process for machine tool units in Bangalore is not the same for all industries involving various activities, as the end products of the industry are different for each industrial unit. Therefore, there is some variation in the flow of activities depending on the customized requirement of the products. However, these activities could be grouped together as shown below, though not in the same order as mentioned.

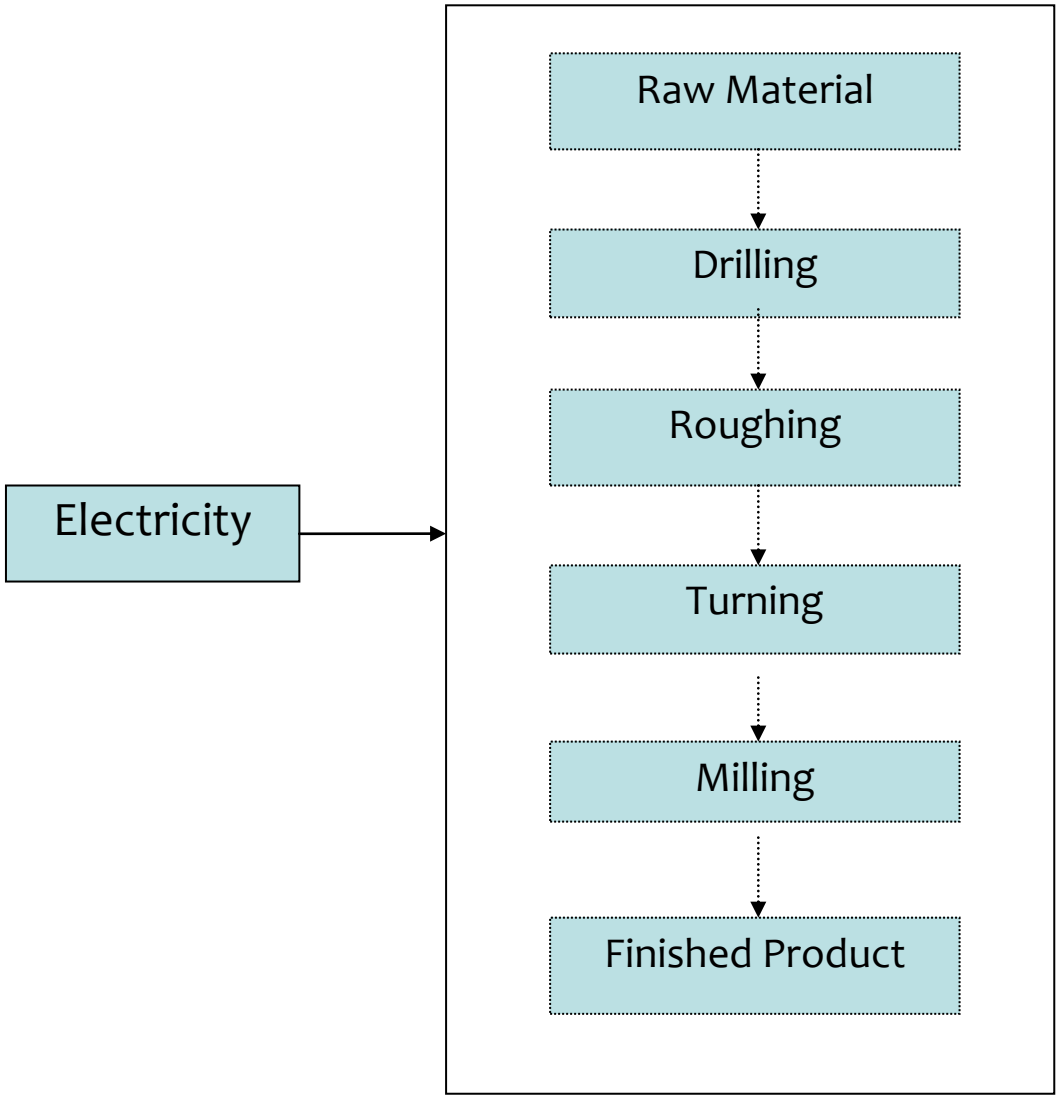
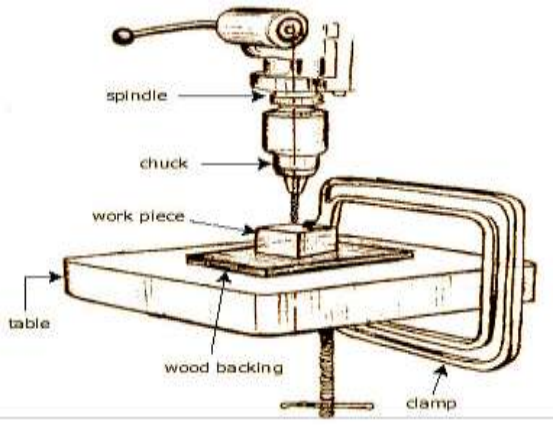


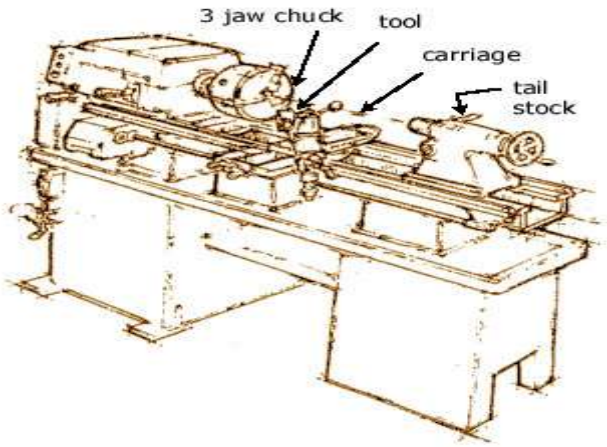
Figure 1.1 Process flow chart of typical Machine Tools Unit

Drilling Process



Drilling is the most common machining process whereby the operation involves making round holes in metallic and nonmetallic materials. Approximately 75% of all metal- cutting process is of the drilling operation. Drills usually have a high length to diameter ratio that is capable of producing deep hole, however due to its flexibility, necessary precaution need to be taken to

maintain accuracy and prevent drill from breaking.



Drilled holes can be either through holes or blind holes. A through holes is made when a drill exits the opposite side of the work; in blind hole the drill does not exit the workpiece.

Drilled holes are characterized by their sharp edge on the entrance side and the presence of burrs on the exit side (unless they have been removed). Also, the inside of the hole usually has helical feed marks.

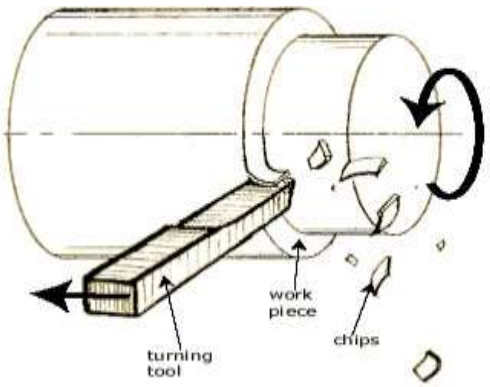
Drilling may affect the mechanical properties of the work piece by creating low residual stresses around the hole opening and a very thin layer of highly stressed and disturbed material on the newly formed surface. This causes the work piece to become more susceptible to corrosion at the stressed surface.

For fluted drill bits, any chips are removed via the flutes. Chips may be long spirals or small flakes, depending on the material, and process parameters. The type of chips formed can be an indicator of the machinability of the material, with long gummy chips reducing machinability.

When possible drilled holes should be located perpendicular to the work piece surface. This minimizes the drill bit's tendency to "walk", that is, to be deflected, which causes the hole to be misplaced. The higher the length-to-diameter ratio of the drill bit, the higher the tendency to walk.

Turning Process

Turning is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material. The turning process requires a turning machine or lathe, work piece, fixture, and cutting tool. The work piece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to the turning machine, and allowed to rotate at high speeds. The cutter is typically a single-point cutting tool that is also secured in the machine, although some operations make use of multi-point tools. The



cutting tool feeds into the rotating work piece and cuts away material in the form of small chips to create the desired shape. Turning is used to produce rotational, typically axi-symmetric, parts that have many features, such as holes, grooves, threads, tapers, various diameter steps, and even contoured surfaces. Parts that are fabricated completely through turning often include components that are used in limited quantities, perhaps for prototypes, such as custom designed shafts and fasteners. Turning is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that turning can offer, it is ideal for adding precision rotational features to a part whose basic shape has already been formed.

Turning is the process whereby a single point cutting tool is parallel to the surface. It can be done manually, in a traditional form of lathe, which frequently requires continuous supervision by the operator, or by using a computer controlled and automated lathe which does not. This type of machine tool is referred to as having computer numerical control, better known as CNC, and is commonly used with many other types of machine tool besides the lathe.

When turning, a piece of material (wood, metal, plastic, or stone) is rotated and a cutting tool is traversed along 2 axes of motion to produce precise diameters and depths. Turning can be either on the outside of the cylinder or on the inside (also known as boring) to produce tubular components to various geometries. Although now quite rare, early lathes could even be used to produce complex geometric figures, even the platonic solids; although until the advent of CNC it had become unusual to use one for this purpose for the last three quarters of the twentieth century. It is said that the lathe is the only machine tool that can reproduce itself.

The turning processes are typically carried out on a lathe, considered to be the oldest machine tools, and can be of four different types such as straight turning, taper turning, profiling or external grooving. Those types of turning processes can produce various shapes of materials such as straight, conical, curved, or grooved work piece. In general, turning uses simple single-point cutting tools. Each group of work piece materials has an optimum set of tools angles, which have been developed through the years.

The bits of waste metal from turning operations are known as chips (North America), or swarf (Britain). In some areas they may be known as turnings.

Turning specific operations include:

Hard turning

Hard turning is a turning done on materials with a Rockwell C hardness greater than 45. It is typically performed after the work piece is heat treated.

The process is intended to replace or limit traditional grinding operations. Hard turning, when applied for purely stock removal purposes, competes favourably with rough grinding. However, when it is applied for finishing where form and dimension are critical, grinding is superior. Grinding produces higher dimensional accuracy of roundness and cylindricity. In addition, polished surface finishes of Rz=0.3-0.8z cannot be achieved with hard turning alone. Hard turning is appropriate for parts requiring roundness accuracy of 0.5-12 microns, and/or surface roughness of Rz 0.8–7.0 microns. It is used for gears, injection pump components, hydraulic components, among other applications.

Facing

It is part of the turning process. It involves moving the cutting tool at right angles to the axis of rotation of the rotating workpiece. This can be performed by the operation of the cross-slide, if one is fitted, as distinct from the longitudinal feed (turning). It is frequently the first operation performed in the production of the work piece, and often the last- hence the phrase "ending up".

Parting

This process is used to create deep grooves which will remove a completed or part-complete component from its parent stock.

Grooving

Grooving is like parting, except that grooves are cut to a specific depth by a form tool instead of severing a completed/part-complete component from the stock. Grooving can be performed on internal and external surfaces, as well as on the face of the part (face grooving or trepanning).

Non-specific operations include:

Boring

Machining of internal cylindrical forms (generating) a) by mounting work piece to the spindle via a chuck or faceplate b) by mounting work piece onto the cross slide and placing cutting tool into the chuck. This work is suitable for castings that are to awkward to mount in the face plate. On long bed lathes large work piece can be bolted to a fixture on the bed and a shaft passed between two lugs on the work piece and these lugs can be bored out to size. A limited application, but one that is available to the skilled turner/machinist. In machining, boring is the process of enlarging a hole that has already been drilled (or cast), by means of a single-point cutting tool (or of a boring head containing several such tools), for example as in boring a cannon barrel. Boring is used to achieve greater accuracy of the diameter of a hole, and can be used to cut a tapered hole.

There are various types of boring. The boring bar may be supported on both ends (which

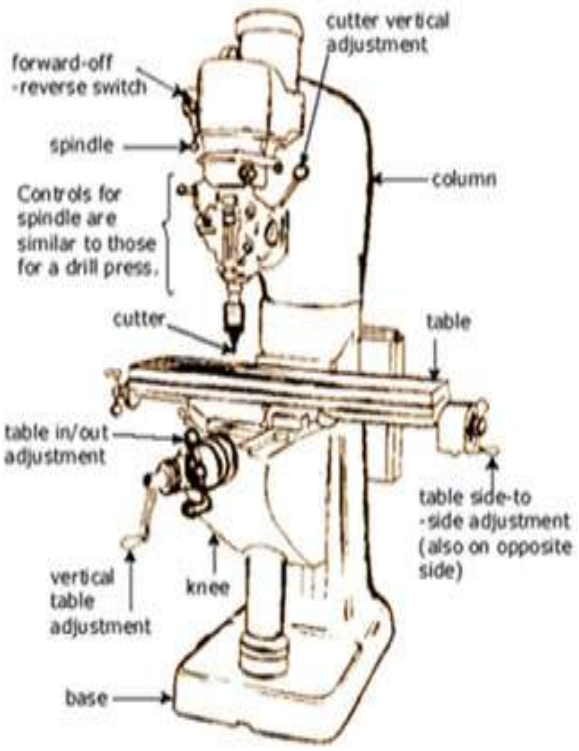
only works if the existing hole is a through hole), or it may be supported at one end. Lineboring (line boring, line-boring) implies the former. Backboring (back boring, back-boring) is the process of reaching through an existing hole and then boring on the "back" side of the workpiece (relative to the machine headstock).

Knurling

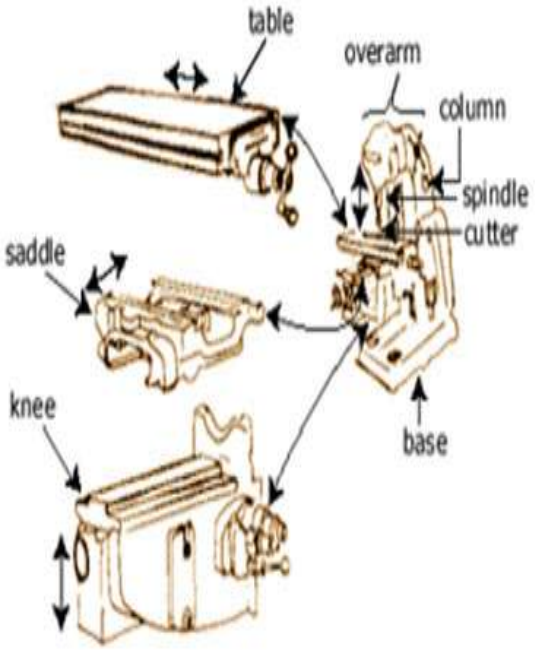
The cutting of a serrated pattern onto the surface of a part to use as a hand grip using a special purpose knurling tool.Threading both standard and non-standard screw threads can be turned on a lathe using an appropriate cutting tool. (Usually having a 60, or 55° nose angle) Either externally, or within a bore. [Generally referred to as single-point threading. tapping of threaded nuts and holes a) using hand taps and tailstock centre b) using a tapping device with a slipping clutch to reduce risk of breakage of the tap threading operations include a) all types of external and internal thread forms using a single point tool also taper threads, double start threads, multi start threads, worms as used in worm wheel reduction boxes, lead screw with single or multi start threads. b) by the use of threading boxes fitted with 4 form tools, up to 2" diameter threads but it is possible to find larger boxes than this.

Milling Process

Milling is the most common form of machining, a material removal process, which can create a variety of features on a part by cutting away the unwanted material. The milling process requires a milling machine, work piece, fixture, and cutter. The work piece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to a platform inside the milling machine. The cutter is a cutting tool with sharp teeth, which is also secured in the milling machine and rotates at high speeds. By feeding the workpiece into the rotating cutter, material is cut away from this work piece in the form of small chips to create the desired shape.

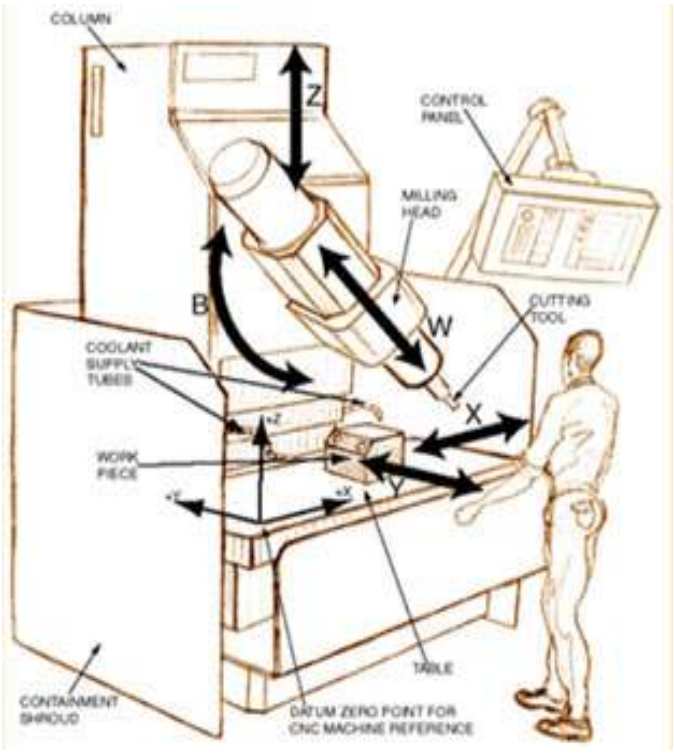


Milling is typically used to produce parts that are not axially symmetric and have many features, such as holes, slots, pockets, and even three-dimensional surface contours. Parts that are fabricated completely through milling often include components that are used in limited quantities, perhaps for prototypes, such



as custom designed fasteners or brackets. Another application of milling is the fabrication of tooling for other processes. For example, three-dimensional molds are typically milled. Milling is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that milling can offer, it is ideal for adding precision features to a part whose basic shape has already been formed.

Milling is as fundamental as drilling among powered metal cutting processes. Milling is versatile for a basic machining process, but because the milling set up has so many degrees of freedom, milling is usually less accurate than turning or grinding unless especially rigid fixturing is implemented. For manual machining, milling is essential to fabricate any object that is not axially symmetric. Below is illustrated the process at the cutting area. A typical column-and-knee type manual mill is shown. Such manual mills are common in job shops that specialize in parts that are low volume and quickly fabricated. Such job shops are often termed 'model shops' because of the prototyping nature of the work.



The parts of the manual mill are separated below. The knee moves up and down the column on guide ways in the column. The table can move in x and y on the knee, and the milling head can move up and down.

CNC Milling: Computer Numerical Control (CNC) Milling is the most common form of CNC. CNC mills can perform the functions of drilling and often turning. CNC Mills are classified according to the number of axes that they possess. Axes are labeled as x and y for horizontal movement, and z for vertical movement, as shown in this view of a manual mill table. A standard manual light-duty mill is typically assumed to have four axes:

Table X, Table Y, Table Z and milling head Z.

A five-axis CNC milling machine has an extra axis in the form of a horizontal pivot for the milling head. This allows extra flexibility for machining with the end mill at an angle with respect to the table. A six-axis CNC milling machine would have another horizontal pivot for the milling head, this time perpendicular to the fifth axis.

CNC milling machines are traditionally programmed using a set of commands known as G-codes. G-codes represent specific CNC functions in alphanumeric format.

1.2 Energy performance in existing situation

1.2.1 Fuel and electricity consumption

The machine tool industries in this cluster use electricity from grid to meet their electrical energy requirement. Some of the industrial units having the backup power generator (Diesel Based) to meet the demand in case of grip power supply failure or scheduled power cut from the grid. The main and primary energy for machine tool industries is the electricity for operation of production and utility services. In manufacturing of some category of products, heat treatment process required to achieve the desired material properties. In heat treatment units of the clusters, which are very few in numbers (only 14 %) are using electricity as the main source of energy even in the process of heat treatment, which is usually outsourced. The percentage segregation of used energy in the cluster is given in figure 1.2, which reveals that the 95.9% of energy used in the cluster is drawn from the Bangalore Electricity Supply Company Limited (BESCOM) grid whereas only 4.1% of total energy required is being generated by thermal energy (High Speed Diesel) using DG sets.

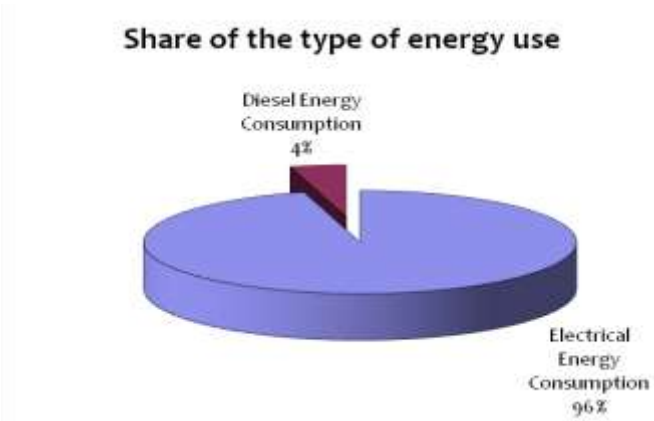


Figure 1.2: Share of Energy Type used in the Machine Tool Units

1.2.2 Average production

Production capacity of machine tool units in Bangalore cluster depends on the type of product being produced in unit. Production capacity of machine tool units in Bangalore

cluster is in the range of 1500 kg per Annum –1050000 kg per Annum. The following figure shows the classification of machine tool units in Bangalore cluster based on production capacity. The production capacity as the weight of the metal removed in case of components, accessories and SPM making industries. In case of Heat treatment, weight of the material treated has been considered as the production capacity. The above methodology is adopted as major energy is spent towards removing the metal, as per the specifications of the product, while carrying out jobs such as milling, turning, grinding and drilling. In case of heat treatment units, major energy is spent in the heat treatment furnaces. Hence, the weight of material processed is taken as production capacity.

1.2.3 Specific energy consumption

The specific energy consumption depends on the final product being manufactured by the machine tool units; therefore SEC has been classified according to the types of products produced in the cluster. Details of the SEC depending on the type of products is shown in the following table

Table 1.1 Energy Consumption Pattern of Machine Tools Cluster

Type of units	Specific Energy Consumption, GJ/Tonne	Specific Energy Consumption, kWh/Tonne
Components	24.8	6472
Accessories	19.7	5118
Machines	2.2	600
Heat Treatment	64.2	15057
Average	27.7	6811.8

1.3 Identification of technology/equipment

1.3.1 Description of technology/equipment

In a machine tools unit, the electricity cost is about 5% of total cost and the rest of it is the cost of raw material (metals) that would be drawn. However, the electricity cost is still about Rs. 10.36 lakh. Any technology that saves even 10% could provide substantial incentives to the units. Compressed air used in the machine tools cluster is mainly used instrumentation air for the CNC machines. The typical air compressors used at present in the machine tools unit are reciprocating type receiver mounted type designed for 10 kg/cm^2 (g). Most of the compressors are designed for 40 CFM in the units for machine tools cluster; some of the units are using two compressors also if the air requirement is more than the 40 CFM. The technical specification of Existing compressor used in the machine tools units of the cluster are shown in Table 1.2 below.

Table 1.2 Typical specifications of present Air Compressor

S. No.	Parameters	Detail
1	Manufacturer	KG Khosla, ELG
2	Capacity	15 HP
3	Designed	Free Air Delivery 40 CFM
4	Operation	Continuous
5	Associated Motor type	Induction motor
6	Voltage ratings	415 V +/- 10 V, 3 Phases, 50 Hz +/- 5%.
7	Maximum Pressure	10 kg/cm^2 (g)
8	Maximum Receiver Pressure	12 kg/cm^2 (g)
9	Air Receivers Capacity	500 Liter

Performance study of compressor system was conducted during the detailed energy use and technology audit studies in various machine tools units of the cluster, it was observed that most of air compressors installed are old, reciprocating and actual FAD of the air compressor is low than the rated FAD. The performances of various air compressors installed in the cluster units were evaluated and the details are furnished in present Annexure 1.

Table 1.3 The existing operational parameter of the compressor system

S. No.	Parameters	Detail
1	Designed FAD	40 CFM
2	Actual FAD	27.3 CFM
3	Volumetric Efficiency	68 %
4	Power Consumed	8.4 kW
5	Operating Pressure	8.5 kg/cm^2 (g)
6	Specific Energy Consumption	0.307 kW/CFM

From energy use and technology gap audit studies in various units of the cluster, the following were identified:

- The out of the air compressors are low than the rated output of the air compressors, this may be due leaky valves, worn out parts of the air compressors such as cylinder piston assembly, etc.
- The air compressors are of reciprocating type and hence the output of the air compressors deteriorates rapidly.
- Set pressure is higher (8.5 kg/cm2 (g)) than the required pressure (6.9 kg/cm2 (g))

to operate the pneumatic instruments of the CNC machines in the machine tools units.

- High power consumption due to old technology type system.

From the above mentioned analysis it is clear that the performance of the present old reciprocating air compressors is poor in terms of Energy, Environment and social aspects and consuming more power. Based on above facts, the present inefficient air compressors to be replaced with new energy efficient screw air compressors for better performance and reducing electricity consumption.

1.3.2 Role in process

The air compressors are one of the most important utility systems of the machine tools units as compressed air used in pneumatic control system of the CNC machine. The required pressure for operating pneumatic control system of the CNC machine is 6.9 kg/cm^2(g)). The required input air line size is 1/2" ID (12.7mm) for most machines. The exceptions are the 40-taper VF-1 thru VF-11 machines, which require a 3/8" ID (9.5mm) air line. The recommended method for attaching the air hose is directly to the barb fitting on the back of the machine, secured with a hose clamp. If a quick coupler is desired, use a 3/8" (9.5mm) coupler for the 3/8" air hose, or a 1/2" (12.7mm) coupler for the 1/2" air hose. All CNC models require 4 SCFM (1.89 liters per second). For mills equipped with the auto air gun option, 10 SCFM (4.72 liters/sec.) will be required for the machine. The auto air gun consumes an additional 6 SCFM (2.83 liters/sec.). The air requirements should be supplied by at least a 2-HP compressor with a minimum 20-gallon tank for one CNC machine. It is important that In order to operate the machine properly if the air nozzle is used during pneumatic operations, the air flow will need to be increased as outlined in the previous note.

1.4 Benchmarking for existing specific energy consumption

The baseline data has been established based in the energy audits conducted in a total number of 30 machine units out of which 20 were preliminary audits and 10 were detailed audits. The total production cost estimated based on the various technology dependent cost of production of these units.

The typical air compressors used at present in the machine tools unit are reciprocating type receiver mounted type designed for 10 kg/cm2 (g). Most of the compressors are designed for 40 CFM in the units for machine tools cluster; some of the units are using two compressors also if the air requirement is more than the 40 CFM. A typical machine tools unit has an air compressor of 15 HP for a typical 3 – 4 CNC machine installation. The average operational period of the air compressor in a typical machine tools cluster was estimated to be 12 hours in a day. The annual operating hours of a compressor in

machine tool unit was estimated to be about 4200 hours per year. The compressed air is generated 8 kgs/cm2 to10 kgs/cm^2 and is used for CNC machine. The minimum air pressure required for the CNC machine as per the CNC machine supplier recommendation is 6.9 kgs/cm^2. Maximum volumetric efficiency of a 40 CFM reciprocating type air compressor was measured to be 68% of the rated capacity. Electricity requirement to for annual operation of the compressed air system in the typical machine tools cluster is estimated to be which also depends on the number of CNC machines installed in the plant and production. Detail of electricity consumption in compressed air system of a typical machine tools unit is given in Table 1.4 below:

Table 1.4 Energy Consumption Pattern in Compressor of a typical Machine Tools unit

S. No.	Energy Type	Unit	Value
1.	Electricity Consumption	kWh/year	70917

1.4.1 Operating efficiency analysis

To determine the Energy use and technical study, individual units were identified within different locations of the Bangalore Machine Tools clusters in Bangalore district. It is integral to target different units in the clusters as it accounts for deviations in type of prudcts, job properties, sourcing of raw materials, and variations in manufacturing and housekeeping operations. The overall step by step methodology followed for Energy use and technical study is as below:

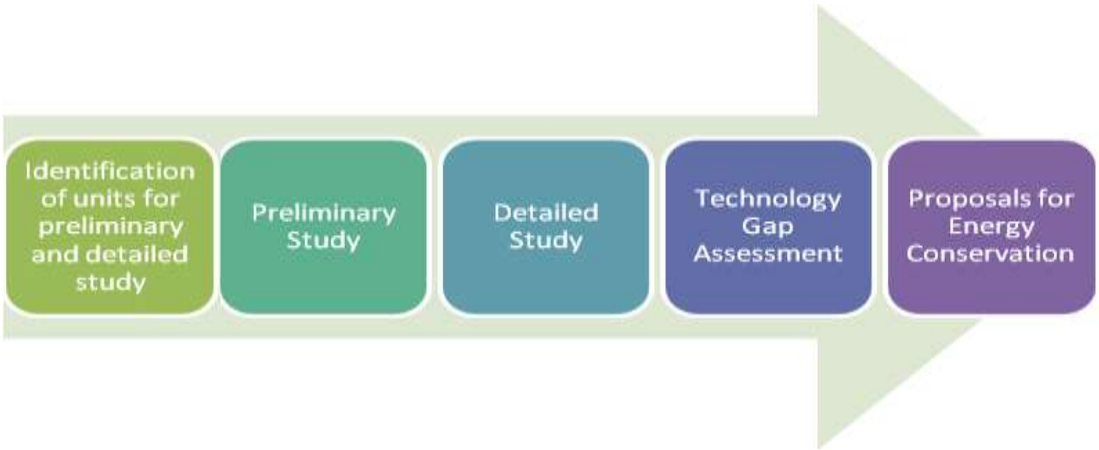


Figure 1.3 Energy auditing methodology

Preliminary energy study

The preliminary study is the first stage in conducting an energy and technology assessment of the machine tools manufacturing units in the cluster. The aim

of the preliminary study is collecting information relating to production, machinery and energy use to get an overview of energy sources, raw materials, processes involved, etc of the units within the cluster. Preliminary energy studies were conducted at 30 machine tools manufacturing units in the Bangalore cluster and the time taken for each study was 1 – 2 days.

Detailed energy study

Detailed energy studies are conducted to get an in depth break up of energy usage of each of the associated processes in the machine tools manufacturing. It covers the quintessential steps in preliminary study and provides a thorough analysis of the functioning of units. Since electricity is the main source of energy used, there are some guidelines which need to be maintained while analyzing and measuring the electricity consumption pattern of the individual unit.

1.4.3 Specific fuel and electricity consumption

The main and basic energy used in the manufacturing process of machine tools is electricity in this unit. The liquid fuel (HSD) energy is mainly using to operate the diesel power generators during the power cut/non-availability of the electrical power from state electricity board.

1.5 Barriers for adoption of proposed technology/equipments

1.5.1 Technological Barrier

Technology obsolescence in the machine tool business is extremely rapid. Product lifecycles are declining and currently average life cycle is no more than 3 years! Thus, in a globalized India, SMEs have been and will continue to face challenges they have not seen before. In the past, most of the products have been a result of 'Reverse Engineering'. Unlike the Japanese and Koreans, the Indian manufacturers have not graduated to the next level of 'Improving' the technology of reverse engineered products. Thus, product technology obsolescence is a major issue facing the Bangalore machine tools industry today.

There is a definitive void in development and existing facilities for Research and Development in this sector. Institutes in the past have been integral in facilitating technology transfers and improvement in the machine tools manufacturing cluster all over India, However there is need for continuous Research and Development associated processes.

1.5.2 Financial Barrier

The restricted availability and the inability to raise resources are common to all types of small businesses. However, the machine tools sector, by its very nature, is a high financial

outlay driven business. Average product costs are greater, gestation period of investments – longer, time to market – higher and a purchasing system – not yet fully matured. All this means greater, than most other businesses, financial resource requirement. This, in turn, puts the machine tool SMEs in a particular disadvantage.

1.5.3 Manpower Skill

Machine downtime ranged from 1 percent to as high as 20 percent in some cases. Labour efficiency ranged between 60 percent to 95 percent. Lower labour efficiency and labour utilization has manifested in lower employee productivity. Labour utilization has been lower as compared to other sectors because of surplus labour since only 26 percent of the companies have undergone downsizing and lack of awareness of productivity methodologies.

Only 65 percent of the companies used CNC or NC machines because most of the smaller players get almost 95 percent of their products outsourced and they only do assembling. In fact, as high as 17 percent of the companies get 100 percent of the manufacturing activities subcontracted. However, on an average 75 percent of the companies subcontracted some amount of their manufacturing. The subcontracting was mainly done due to capacity constraints followed by cost considerations.

1.5.4 Vendor Linkages:

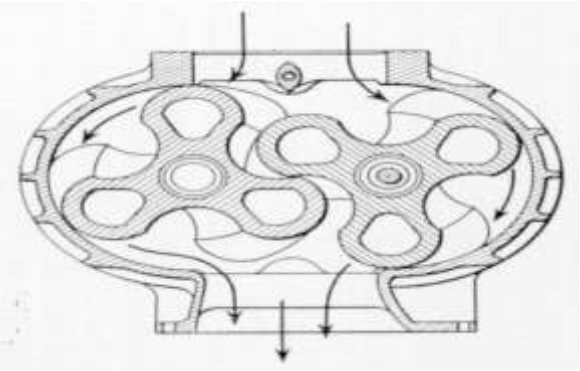
No other business requires such complex level of vendor linkages as the machine tools. For materials, electrical, electronics, hydraulics, pneumatics, metallurgy, tribology, measurement controls – the list of myriad technology linkages is endless. This requires exceptional networking capabilities and plenty of time to be spent by owner of accompany/CEO himself.

2 TECHNOLOGY OPTION FOR ENERGY EFFICIENCY IMPROVEMENTS

2.1 Detailed description of technology selected

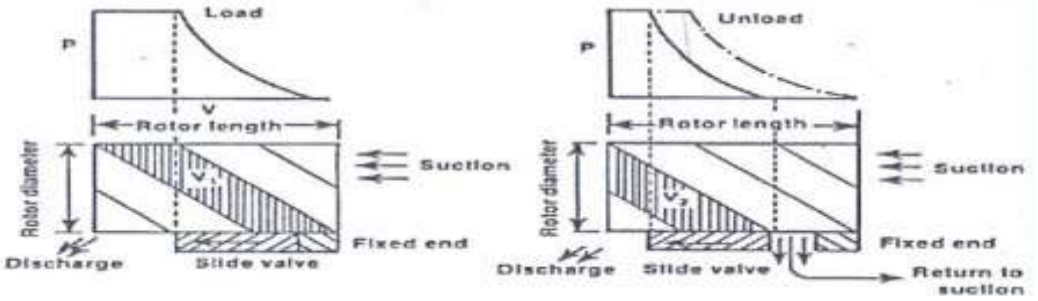
2.1.1 Description of technology

Due to its pulsation free operating characteristic, a screw compressor is usually the best solution where impact sensitive material is being handled. The screw compressor principle is well proven and involves two meshing and non-contacting helical screws. Low wear rates, as well as 100% oil free air, are the main advantage of this compressor type. The compression chamber of a screw compressor does not require oil or grease for lubrication. All lubricated components, such as bearings, are outboard and are easily accessed.



Precision machining of the rotor profile is critical to reliable operation of this compressor type. Even the smallest defect can affect the balance of the machine and cause extensive wear, or even total failure. For this reason, Gardner Denver Wittig is dedicated to perfection of manufacture and robust rotor bearing support. The principle for a rotating displacement compressor a screw was developed during the 1930s, when a rotating compressor with a high capacity and stable flow in varying conditions was required. The screw element's main parts are the male and female rotors, which move towards each other while the volume between them and the housing decreases. Each screw element has a fixed, integrated pressure ratio that is dependent on its length, the pitch of the screw and the form of the discharge port. To attain the best efficiency the pressure ratio must be adapted to the required working pressure.

The screw compressor is not equipped with valves and has no mechanical forces that cause unbalance. This means it can work at a high shaft speed and combine a large flow rate with small exterior dimensions. An axial acting force, dependent on the pressure difference between the inlet and outlet, must be taken up by the bearings. The screw, which originally was symmetrical, has now been developed in different asymmetrical helical profiles.



2.1.2 Technology specification

The energy efficient screw compressor with capacity control mechanism and retrofitting of VFD to optimization of the air delivery as per the demand of the unit has recommonded after the study of operational need of the compressed air in the plant. Detailed technical specifications of 60 CFM (11 kW) energy efficient screw compressor is furnished in Table 2.1 below:

Table 2.1 Equipment Speciation

S. No.	Parameter	Detail
1.	Manufacturer	ELGI
2.	Model	E11 – 8.5
3.	Maximum Operating Pattern	8 kg/cm^2 (g)
4.	FAD (Maximum)	60 CFM (Variable Controller)
5.	Power Consumption	11 kW
6.	Dimensions	1475 X 800 X 1150 (l X b X h)
7.	Voltage rating	415 V +/- 10 V, 3 Phase, 50 Hz +/- 5%.

The other features of the proposed technology are

Energy Efficient:

Power saving air end made under a joint technology agreement with the Center for Positive Displacement for compressors of City University,London.

Optimal capacity control:

Varion intake valve installed at the compressor inlet optimally controls capacity during start up; operation and shutdown.

Direct drive for transmission efficiency:

Unlike belt-driven compressors; where slipping of the V Belt causes power losses and decreased efficiency, Elgi's direct drive ensures efficient power transmission and constant FAD throughout life.

Superior Air Quality:

Oil separation by impact and deceleration enables efficient separation of air and oil, with minimum pressure drop. The Oil carry-over level is consistently less than 2 PPM. ELGI guarantees* this process for the life of the compressor.

99% bulk water free:

ELGI custom-designed centrifugal moisture separator removes over 99% of bulk water from the compressed air; so your end use equipment and tools are less prone to corrosion and have a longer life.

Maintenance Friendly: Durable:

Powder coated for corrosion-resistance and streamlined looks. User friendly ' Solid state

MIMIC annunciation panel for easy fault diagnostics. (Optional microprocessor-based control using industry standard PLC);

Reliable:

Tropicalised to perform at varying ambient temperatures and humidity, Dust protection with heavy duly suction filter ensures efficient filtration and increases life of air end. Reliable safety and interlocking devices

2.1.3 Suitability or integration with existing process

The air compressor is one of the critical and most energy intensive equipment in Bangalore Machine Tools cluster. Based on the detailed energy audits conducted for various air compressors installed in the cluster units, the performance of the air compressors are found to be low and volumetric efficiency is found to be 60% to 75% only due to more wear and tear of the air compressors and worn out parts of the air compressor and further, the output of the reciprocating air compressors deteriorates fastly due to more wear and tear.

Whereas, the new energy efficient screw air compressors will have constant output throughout the life time due to less moving parts and the operation and maintenance cost for screw compressors is less. Although the rotary screw compressor initial purchase cost is greater than a reciprocating compressor, those in the 10-30 hp range are becoming popular. One reason is they come as a complete package. In most cases rotary screw compressor packages are equippedwith a starter, after cooler, and compressor controller with diagnostic capability as standard equipment.

Rotary screw compressors are available in smaller sizes ranging from 5-30 hp. One advantage over reciprocating compressors of the same horsepower is they operate at cooler temperatures. Screw compressors are designed to run at 100% duty cycle and, due to low oil carryover, provide good quality compressed air.

The following are the reasons for selection of screw air compressors:

- Screw air compressors will reduce electricity consumption and will reduce the total operating energy cost of the rice mill
- The output of the screw compressors will remain constant during the life time of the

equipment and output doesn't deteriorate rapidly.

- Variable speed drive for variable volume mechanism can be integrated with the system which leads to efficient operation of compressed air system.

2.1.4 Superiority over existing technology

The rotary screw compressor has low leakage levels and low parasitic losses vs. roots type. The supercharger is typically driven directly from the engine's crankshaft via a belt or gear drive. Unlike the Roots type supercharger, the twin-screw exhibits internal compression which is the ability of the device to compress air within the housing as it is moved through the device instead of relying upon resistance to flow downstream of the discharge to establish an increase of pressure. The requirement of high-precision computer-controlled manufacturing techniques makes the screw type supercharger a more expensive alternative to other forms of available forced induction. With later technology, manufacturing cost has been lowered while performance increased.

All supercharger types benefit from the use of an intercooler to reduce heat produced during pumping and compression. A clear example of the technology applied by the twin-screw in companies like Ford, Koenigsegg, Mazda, Mercedes and Mercury Marine can also demonstrate the effectiveness of the twin screw. While some centrifugal superchargers are consistent and reliable, they typically do not produce full boost until near peak engine rpm, while positive displacement superchargers such as Roots type superchargers and twin-screw types offer more immediate boost.

The screw compressors are superior over the existing reciprocating air compressors for the following:

- Low power consumption due to more output during the course of time
- Reduces the GHG emissions
- Less noise
- Low operation and maintenance cost
- Life of the equipment is multifold than the present air compressors

Use of this technology reduces the amount of electricity consumed by the unit. It can amount to savings of the order of 28567 electrical units for the company with paybacks of about 1.93 years. Further, as the cost of electricity is on an upward trend, this is certainly profitable in the long run.

Using variable frequency drive the operating pressure can be precisely controlled. There is no need to maintain a bandwidth as maintained in case of load/no-load control. This leads to reduction in average operating pressure of the compressor hence reduction in power

consumption.

The leakage in the compressed air system is proportional to the operating pressure. Since there is a significant reduction in operating pressure and hence significant reduction in leakage level.

2.1.5 Availability of technology

Energy efficient screw type compressors providers are basically national and multinational companies providing the services in all the cities of the country through the sales offoice or distribution offices. The technology is widely available and lots of national and multinational manufacturers are suppling their products to these industries including the machine tools industry.

2.1.6 Source of technology

This technology is already in use in some machine tools units in the cluster where the production requirment is same. They also got the results of reduction in energy consumption as well as reduction in rejection of material and the technology is running successfully.

2.1.7 Service/technology providers

There are about 3 technology providers are available in the cluster for this system as shown in Annexure-7.

2.1.8 Terms and condition of sales

50% of the charges would have to be paid upfront and the rest along with the taxes would have to be paid while sending the proforma invoice prior to dispatch. Further, the warranty period extends upto 12 months from the point of delivery for any inherent manufacturing defect or faulty workmanship..

2.1.9 Process down time during implementation

As the energy efficient screw type compressors are available with same mechanical dimensions, process down time might be requires 1 days for the installation of the motors.

2.2 Life cycle assessment and risks analysis

Life of the equipment is about 15 years. Risk involves in the installation of proposed project are mainly in getting the size of the compressors and requirement of the air at utilization end. If the demand of the compressed air at utilization end is calculated wrongly and the compressor is oversized, the efficiency would still remain poor. To overcome this issue the variable drives based compressor is recommonded in the DPR. This type of compressor is able to meet efficiency level even during the low demand of the compressed air at utilization end.

2.3 Suitable unit/plant for implementation of proposed technology

Suitable unit for implementation of this technology are machine tools unit having the minimum three CNC machine and Maximum 5 CNC machines installed. The approximate 30 units in the cluster found eligible to adopt this technology.

3 ECONOMIC BENEFITS FROM NEW ENERGY EFFICIENT TECHNOLOGY

3.1 Technical benefits

3.1.1 Fuel saving

Since the primary source of energy in a motor is electricity, the suggested technology does not contribute to fuel savings.

3.1.2 Electricity saving

After implementation of project, the unit would consume about 28567 kWh/yr of less electricity. As the cost of electricity rises, the monetary savings would only rise.

3.1.3 Improvement in product quality

The production will remain the same as in present.

3.1.4 Increase in production

The quality of the product would still remain the same. It shall have no impact on the way tools are drawn but merely make the process more efficient.

3.1.5 Reduction in raw material consumption

Raw material consumption would also remain same even after the implementation of the proposed technology.

3.1.6 Reduction in other losses

Since in the primary mode, the unused energy is dissipated via heat, which can wear out, say, the bearing of the motor more quickly, while motors that are more efficient would increase the longevity of the device. Further, right sized and more efficient motors would require less cooling and thereby reduces the dependence on the cooling apparatus like fans and chilled fluids. Thus, it has more indirect benefits.

3.2 Monetary benefits

The monetary benefits of the unit are mainly due to reduction in the electricity consumption by 28567 kWh/yr. This amounts to monetary savings of ` 142835 per year. A detailed estimate of the saving has been provided in the table 3.1.

Table 3.1 Energy and monetary benefit

S. No.	Parameter	Unit	Value
	Existing System		
1	Actual Air Requirement	CFM	55
2	Active Power Consumption Specific	kW	16.8
3	Energy Consumption	kW/CFM	0.307
4	Annual Operating Hours	Hours/annum	4200

S. No.	Parameter	Unit	Value
5	Annual Electrical Consumption	kWh/annum	70917
	Proposed System		
1	Air Requirement	CFM	55
2	Active Power Consumption	kW	11
3	Specific Energy Consumption	kW/CFM	0.183
4.	Annual Operating Hours	Hours/annum	4200
5	Annual Electrical Consumption	kWh/annum	42350
	Cost Benefit Analysis		
1	Reduction in Specific Power Consumption	kW/CFM	0.124
2	Total Air Delivery generated	CFM	55
3	Annual Operating Hours (12 hrs. X 350days)	Hours/annum	4200
4	Reduction in Electricity Consumption	kWh/annum	28567
5	Rate of Electricity	`/kWh	5
6	Monetary savings due to electricity savings	` /year	142835

3.3 Social benefits

3.3.1 Improvement in working environment

Reduction in electricity consumption would probably not change the working environment apart from making the management happier.

3.3.2 Improvement in skill

The workers would probably not find too much of a difference in the day to day operation of the device. Hence, their skills are probably going to be unaffected.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

As the existing and proposed technology is based on the clean fuel based operation. No effluent generation or reduction will afect.

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

The measure helps in reducing CO2 emission since it demands less electricity off the grid.

An estimate suggests that a saving of 26567kWh/year of electricity reduces 20.566 tonne of CO^2 equivalent per year.

3.4.3 Reduction in other emissions like SOx

As the existing and proposed technology is based on the clean fuel based operation therefore Sulphur is not present in electricity; hence there is no impact on SOX emissions.

4 IMPLEMENTATION OF NEW ENERGY EFFICIENT TECHNOLOGY

4.1 Cost of technology implementation

4.1.1 Cost of technology

The costs of equipments that will be required for Installation of 55 CFM Energy efficient compressor with VFD are provided in Table 4.1 below:

Table 4.1 Cost of equipment

S. No.	Particulars	Cost
1	Cost of 55 CFM screw compressor	` 2,12,000
2	VFD Retro fitment	` 25,000

4.1.2 Other costs

Table 4.2 Cost of civil work and consultancy

S. NO.	Particulars	Cost
1.	Electrical & Utility Expanses & other Charges	` 26,400/-
	Total Twenty Six Thousand and four hundred only	`26,400/-

Total investment in the proposed technology (including equipment cost & other cost) is ` 2.63 lakh.

4.2 Arrangements of funds

Proposed financing for the Installation of Energy Efficient Screw compressor is made considering a debt equity ratio of 3:1, which is normally allowed by financial institutions for financing energy efficiency projects. On the basis of debt equity ratio of 3:1 the promoter's contribution works out to 25% of the project cost and the balance would be term loan from the Bank / FIs.

4.3 Financial indicators

4.3.1 Cash flow analysis

Detail cash flow analysis for new proposed technology is given in Annexure–5.

4.3.2 Simple payback period

The estimated payback period is about 1.84 years.

4.3.3 Net Present Value (NPV)

Net Present Value of new project would work out ` 2.51 lakh.

4.3.4 Internal rate of return (IRR)

The after tax internal rate of return of the project works out to be 35.84 %. 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 26.48 %.

Table 4.4 Financial indicator of proposed technology

Particulars	Unit	Value
Simple Pay Back period	Years	1.84
IRR	%age	35.84
NPV	` in lakh	2.51
ROI	%age	26.48
DSCR	ratio	2.12

4.4 Sensitivity analysis

In different situation energy saving may increase or decrease on the basis of this scenarios a sensitivity analysis in realistic, pessimistic and optimistic has been carried out on the basis of two scenarios as considers.

Fuel saving increase by 5%

Fuel saving decrease by 5%

Table 4.5 Sensitivity analysis

Particulars	IRR	NPV	ROI	DSCR
Normal	35.84%	2.51	26.48	2.12
5% increase in fuel saving	38.44%	2.79	26.69	2.23
5% decrease in fuel saving	33.22%	2.24	26.24	2.00

Assuming all provision and resource input would be similar during economic analysis

4.5 Procurement and implementation schedule

Procurement and implementation schedule for proposed project are shown in Table 4.4 below.

Table 4.5 Implementation Schedule

S. No.	Activities	Weeks				
		1	2	3	4	5
1	Procurement and Delivery					
2	Civil & Electrical Work					
3	Commissioning					

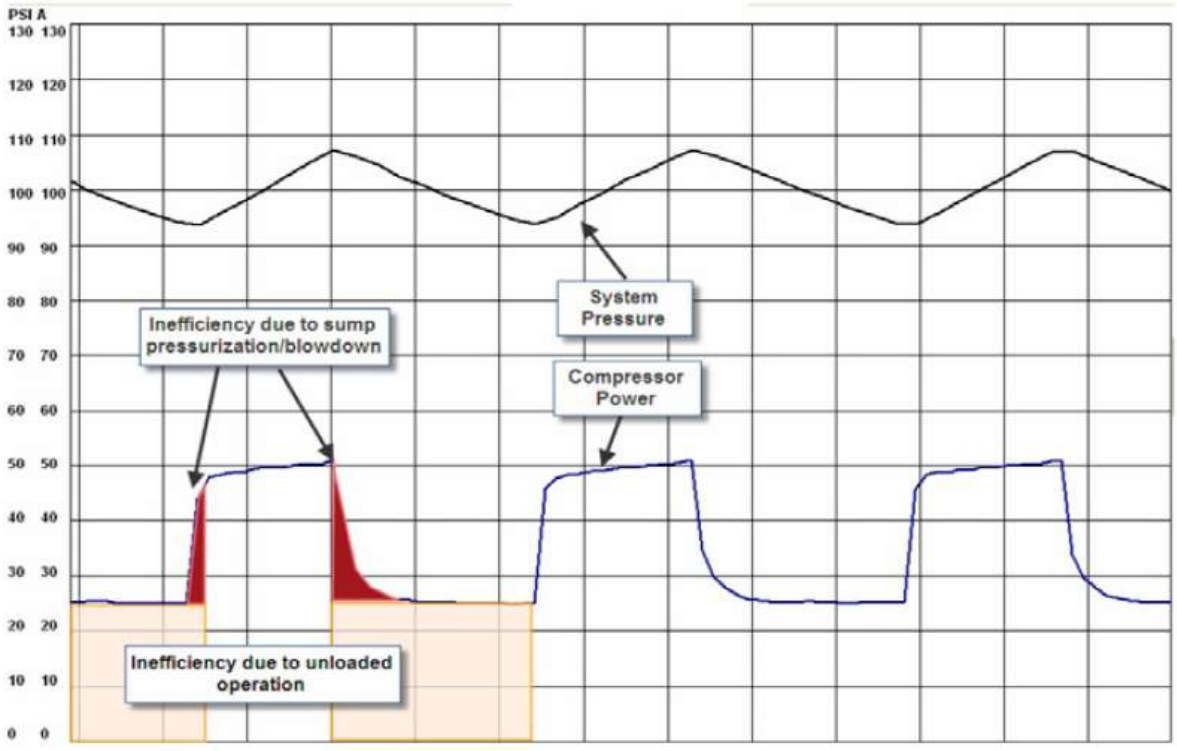
ANNEXURE

Annexure 1: Energy audit reports used for establishing

The results of detail energy audit for machine tools units are given below:

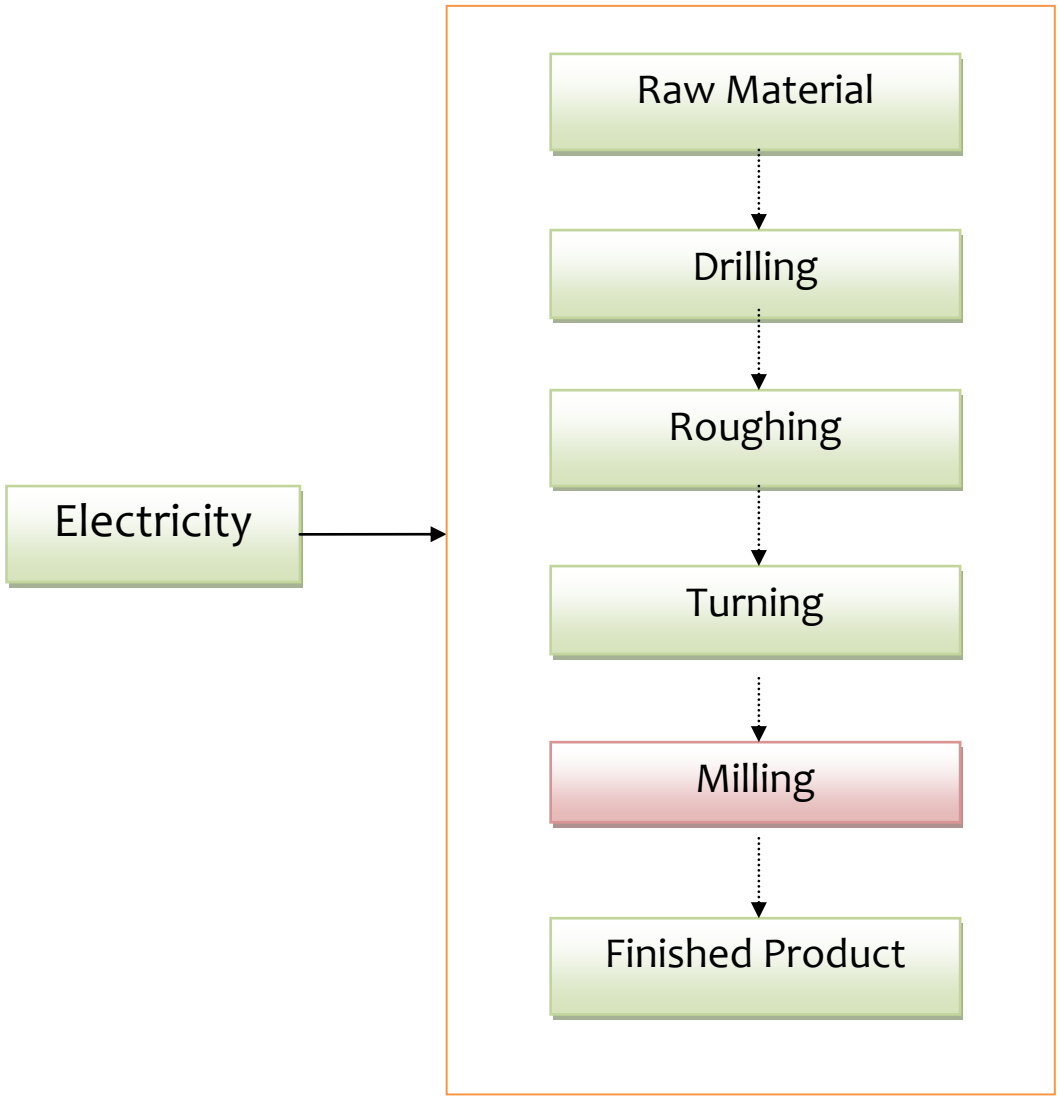
Audit No. 1

S. No.	Parameters	Detail
1	Designed FAD	40 CFM
2	Actual FAD	27.3 CFM
3	Volumetric Efficiency	68 %
4	Power Consumed	8.4 kW
5	Operating Pressure	8.5 kg/cm^2 (g)
6	Specific Energy Consumption	0.307 kW/CFM



Annexure 2: Process flow diagram

Energy Efficient air compressor is retrofitted to machining machine process in machine tools manufacturing units. This will neither a part of the process no machinery.



Annexure 3: Detailed Technology Assessment Report

S. No.	Parameter	Unit	Value
	Existing System		
1	Actual Air Requirement	CFM	55
2	Active Power Consumption Specific	kW	16.8
3	Energy Consumption	kW/CFM	0.307
4	Annual Operating Hours	Hours/annum	4200
5	Annual Electrical Consumption	kWh/annum	70917
	Proposed System		
1	Air Requirement	CFM	55
2	Active Power Consumption	kW	11
3	Specific Energy Consumption	kW/CFM	0.183
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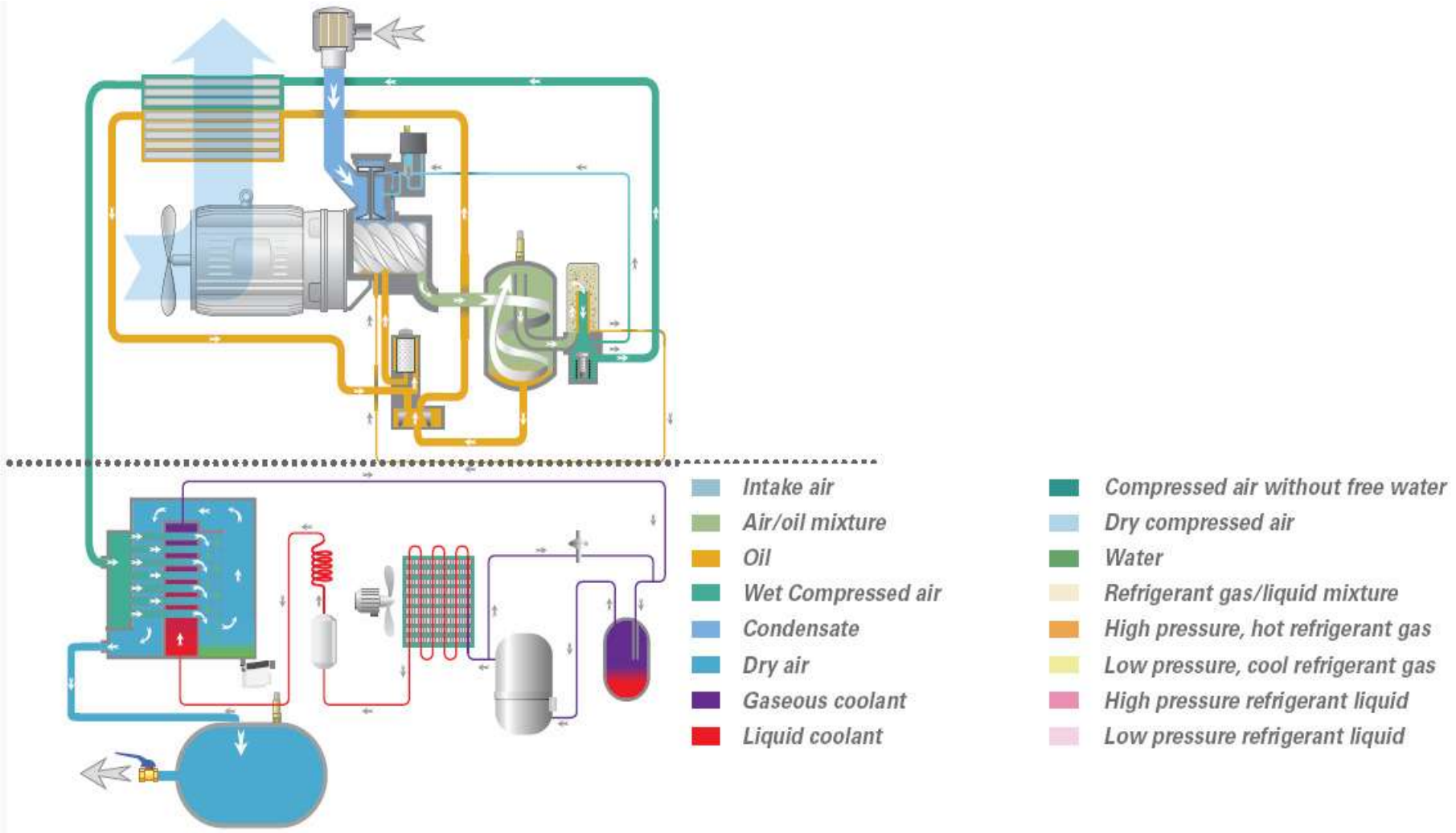
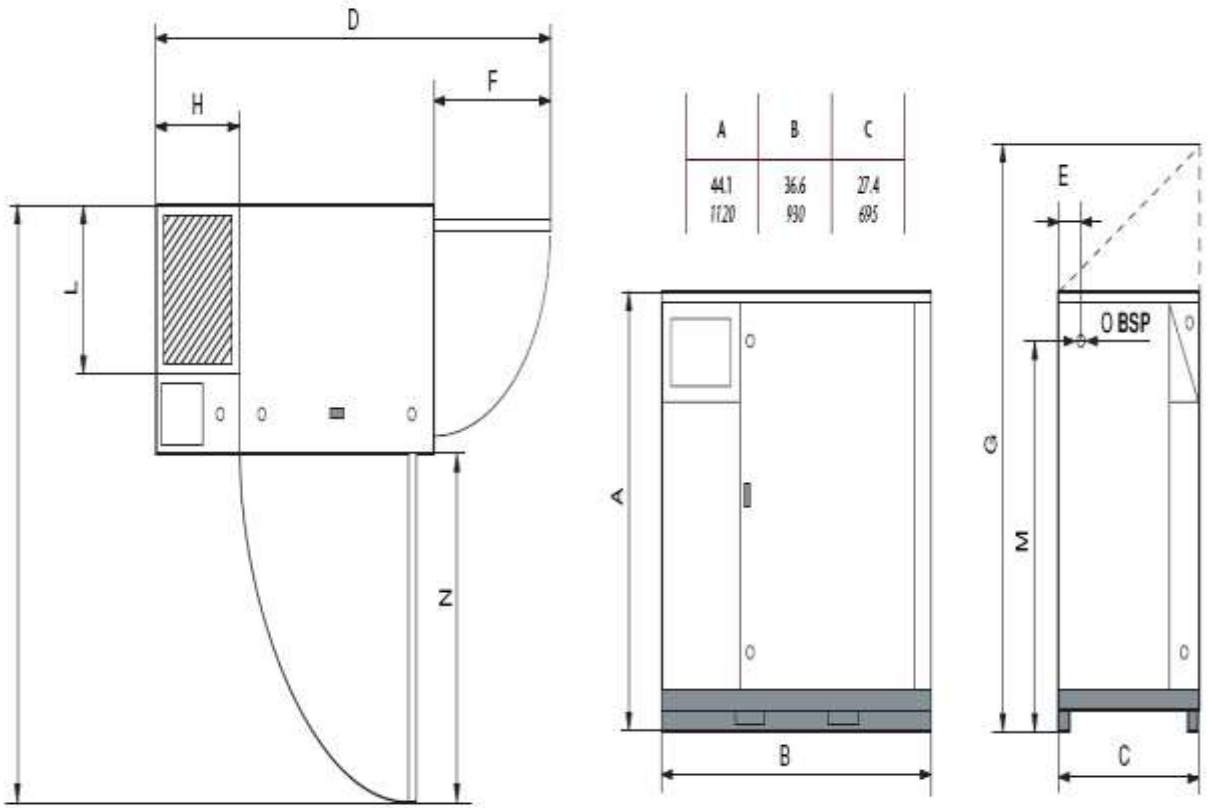
4	Reduction in Electricity Consumption	kWh/annum	28567
5	Rate of Electricity	`/kWh	5.00
6	Monetary savings due to electricity savings	` /year	142835

Annexure 4: Technical Drawing of 60 CFM/15 HP Energy Efficient Screw Type Air Compressor

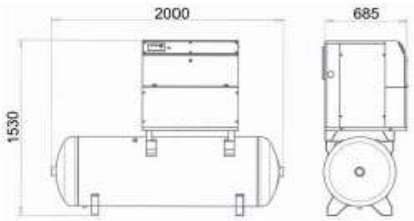




A	B	C
44.1 1120	36.6 930	27.4 695

D	E	F	G	H	I	L	M	N	O
-	3.7 95	-	57.1 1450	15.0 380	-	19.7 500	39.4 1000	-	3/4" BSP

On tank



cm 88x69x81

Annexure – 5 Detailed financial calculations & analysis for financial indicators

Assumption

Name of the Technology	***Energy Efficient Screw Compressor***		
Rated Capacity			
Details	***Unit***	***Value***	***Basis***
Installed Capacity	HP	15	Feasibility Study
No of working days	Days	350	Feasibility Study
No of operating hours per day	Hrs./day	12	Feasibility Study
Proposed Investment			
Plant & Machinery	` (in lakh)	2.12	Feasibility Study
VFD Retrofitment	` (in lakh)	0.25	Feasibility Study
Electricity, Utility expenses & other charges	` (in lakh)	0.26	Feasibility Study
Total Investment	` (in lakh)	2.63	Feasibility Study
Financing pattern			
Own Funds (Equity)	` (in lakh)	0.66	Feasibility Study
Loan Funds (Term Loan)	` (in lakh)	1.98	Feasibility Study
Loan Tenure	years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%age	10.00	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	5.00	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Electricity saving	kWh	28567	
Cost	`/kWh	5.00	
St. line Depn.	%age	5.28	Indian Companies Act
IT Depreciation	%age	80.00	Income Tax Rules
Income Tax	%age	33.99	Income Tax

Estimation of Interest on Term Loan

(`in lakh)

Years	Opening Balance	Repayment	Closing Balance	Interest
1	1.98	0.06	1.92	0.23
2	1.92	0.16	1.76	0.19
3	1.76	0.32	1.44	0.16
4	1.44	0.48	0.96	0.12
5	0.96	0.60	0.36	0.07
6	0.36	0.36	0.00	0.01
		1.98		

WDV Depreciation

Particulars / years	***1***	***2***
Plant and Machinery		
Cost	2.63	0.53
Depreciation	2.11	0.42
WDV	0.53	0.11

Projected Profitability

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Revenue through Savings								
Total Revenue (A)	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
Expenses								
O & M Expenses	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19
Total Expenses (B)	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19
PBDIT (A)-(B)	1.30	1.29	1.28	1.28	1.27	1.26	1.25	1.24
Interest	0.23	0.19	0.16	0.12	0.07	0.01	-	-
PBDT	1.07	1.10	1.12	1.15	1.20	1.25	1.25	1.24
Depreciation	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
PBT	0.93	0.97	0.98	1.02	1.06	1.11	1.11	1.10
Income tax	-	0.23	0.38	0.39	0.41	0.42	0.43	0.42
Profit after tax (PAT)	0.93	0.73	0.60	0.62	0.65	0.69	0.69	0.68

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

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit before tax	0.93	0.97	0.98	1.02	1.06	1.11	1.11	1.10
Add: Book depreciation	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Less: WDV depreciation	2.11	0.42	-	-	-	-	-	-
Taxable profit	(1.04)	0.68	1.12	1.15	1.20	1.25	1.25	1.24
Income Tax	-	0.23	0.38	0.39	0.41	0.42	0.43	0.42

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

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Liabilities								
Share Capital (D)	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Reserves & Surplus (E)	0.93	1.66	2.26	2.88	3.54	4.22	4.91	5.59
Term Loans (F)	1.92	1.76	1.44	0.96	0.36	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	3.50	4.07	4.35	4.50	4.55	4.88	5.56	6.25
Assets								
Gross Fixed Assets	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63
Less: Accm. Depreciation	0.14	0.28	0.42	0.56	0.70	0.83	0.97	1.11
Net Fixed Assets	2.49	2.36	2.22	2.08	1.94	1.80	1.66	1.52
Cash & Bank Balance	1.01	1.72	2.14	2.42	2.61	3.08	3.90	4.72
Total Assets	3.50	4.07	4.35	4.50	4.55	4.88	5.56	6.25
Net Worth	1.59	2.32	2.92	3.54	4.20	4.88	5.57	6.25
Dept equity ratio	2.91	2.67	2.18	1.45	0.54	-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	0.66	-	-	-	-	-	-	-	-
Term Loan	1.98								
Profit After tax		0.93	0.73	0.60	0.62	0.65	0.69	0.69	0.68
Depreciation		0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Total Sources	2.63	1.07	0.87	0.74	0.76	0.79	0.83	0.83	0.82
Application									
Capital Expenditure	2.63								
Repayment of Loan	-	0.06	0.16	0.32	0.48	0.60	0.36	-	-

Total Application	2.63	0.06	0.16	0.32	0.48	0.60	0.36	-	-
Net Surplus	-	1.01	0.71	0.42	0.28	0.19	0.47	0.83	0.82
Add: Opening Balance	-	-	1.01	1.72	2.14	2.42	2.61	3.08	3.90
Closing Balance	-	1.01	1.72	2.14	2.42	2.61	3.08	3.90	4.72

Calculation of Internal Rate of Return ***`(in lakh)***

Particulars / months	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Profit after Tax		0.93	0.73	0.60	0.62	0.65	0.69	0.69	0.68
Depreciation		0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Interest on Term Loan		0.23	0.19	0.16	0.12	0.07	0.01	-	-
Cash outflow	(2.63)	-	-	-	-	-	-	-	-
Net Cash flow	(2.63)	1.30	1.06	0.90	0.88	0.86	0.84	0.83	0.82
IRR	35.84%								
NPV	2.51								

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Variable Expenses								
Operation & Maintenance Exp (75%)	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14
Sub Total (G)	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14
Fixed Expenses								
Operation & Maintenance Exp (25%)	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05
Interest on Term Loan	0.23	0.19	0.16	0.12	0.07	0.01	0.00	0.00
Depreciation *(H)*	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Sub Total (I)	0.40	0.36	0.34	0.30	0.25	0.19	0.18	0.19
Sales (J)	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
Contribution (K)	1.33	1.32	1.32	1.31	1.31	1.30	1.30	1.29
Break Even Point (L= G/I) (%)	30.23%	27.12%	25.69%	22.75%	18.91%	14.70%	14.14%	14.38%
Cash Break Even {(I)-(H)} (%)	19.76%	16.62%	15.15%	12.16%	8.28%	4.02%	3.40%	3.59%
Break Even Sales (J)*(L)	0.43	0.39	0.37	0.32	0.27	0.21	0.20	0.21

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Net Profit Before Taxes	0.93	0.97	0.98	1.02	1.06	1.11	1.11	1.10	8.28
Net Worth	1.59	2.32	2.92	3.54	4.20	4.88	5.57	6.25	31.26
ROI	26.48%								

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Cash Inflow								
Profit after Tax	0.93	0.73	0.60	0.62	0.65	0.69	0.69	0.68
Depreciation	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Interest on Term Loan	0.23	0.19	0.16	0.12	0.07	0.01	0.00	0.00
Total (M)	1.30	1.06	0.90	0.88	0.86	0.84	0.83	0.82

Debt

Interest on Term Loan	0.23	0.19	0.16	0.12	0.07	0.01	0.00	0.00
Repayment of Term Loan	0.06	0.16	0.32	0.48	0.60	0.36	0.00	0.00
Total (N)	0.29	0.35	0.48	0.60	0.67	0.37	0.00	0.00
Average DSCR (M/N)	2.12							

Annexure – 6: Details of procurement and implementation plan

S. No.	Activities	Weeks				
		1	2	3	4	5
1	Procurement and Delivery					
2	Civil & Electrical Work					
3	Commissioning					

Annexure – 7 Details of technology/equipment and service providers

Name of Organization	***Communication Address***	***Contact No.***
M/s Arempee Compressors P Ltd.	M/s Arempee Compressors P Ltd. Coimbatore Tamil Nadu	A Pravin Head New Development 09626251524

Annexure – 8 Quotations or Techno-commercial bids for new technology/equipment

PART I – Technical Offer

OFFER No. Technical /RMP -161C/10-11 dated: 01.02.2011

ROTAR 15 E 500 C compressed air unit – Volt 400 3 ph 50Hz

around-the-clock operation – oil and air cooled

DIMENSIONS AND WEIGHT

OPERATING DATA

Max. operating pressure	bar	10
Free air delivered (according to ISO 1217) at 7 – 9 – 12 bar	l/min	1,490
	Cfm	60
Installed power	kW - HP	11 - 15
Max. power absorption	A	24.5
Voltage	V/Ph/Hz	400/3/50
Auxiliary voltage	V/Hz	230-24/50
Motor protection degree		IP 55
Motor insulation class		F
Max. final air overheating	°C	13
Fan capacity	cu.m/h	2,000
Loss of heat	kJ/h	37,600
Lubricant	l	5
Topping-up	l	1
Oil residues in air	mg/cu.m	4
Min.- max. room temperature	°C	5 - 50
Noise level (according to PNEUROP PN8NTC2.2)	dB(A)	71
Air outlet connector	bsp	¾"

PART – II

COMMERCIAL OFFER

OFFER No. **Commercial/RMP -161D/10-11** dated: **01.02.2011**

1) **FINI – RMP semi Automatic Analog Electrical Control Screw Air Compressor model 15 E 500 producing 52.5 Cfm with 500 Ltr. Air Receiver, Motor and standard accessories..... Rs. 1,85,000/-**

COMMERCIAL TERMS & CONDITIONS : :

1) **Prices : Discounted,** Ex-works, Coimbatore
2) **P/F : 2.5% Extra**
3) **Taxes & Duties** (a) 10.3% Extra ,
   (b) CST 2% against 'c' form (or) Vat 4%
   Validity : 30 days
4) **Delivery :** Within 30 days from the date of receipt of confirmed order
5) **Payment :** 35% in advance balance against Proforma Invoice prior to dispatch.
6) **Transit Insurance & Freight:** Shall be in your account & Freight will be to –pay borne by you at actual.
7) **Commissioning :** Commissioning charges will cost Extra with First Fill of Oil at FOC
8) **Warranty:** 18 months from the date of supply (or) 12 months from the date of commissioning whichever is earlier against manufacturing defects.

NOTE: Inter connecting pneumatic pipelines, air pipe lines, wiring & civil works will be your works scope and not our scope.

Kindly place the order in the name of **M/s Arempee Compressors P. Ltd., Coimbatore**

For Arempee Compressors P. Ltd.,,

A.Pravin
Head New Development
096262-51524

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(Ministry of Power, Government of India)
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