DETAILED PROJECT REPORT
ON
WASTE HEAT RECOVERY
(JAGADHRI BRASS & ALUMINIUM CLUSTER)

Bureau of Energy Efficiency

Prepared By

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ISTSL

WASTE HEAT RECOVERY SYSTEM FOR COKE FIRED PIT FURNACES (BRASS MELTING)

JAGADHRI BRASS AND ALUMINIUM CLUSTER

BEE, 2010

Detailed Project Report on Waste Heat Recovery System for Coke Fired Pit Furnaces (Brass Melting)

Brass & Aluminium SME Cluster, Jagadhri, Haryana (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: **JAG/MET/GAS(A)/01**

For more information

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Zenith Energy Services Pvt. Ltd.

Hyderabad

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Lists of Abbreviations

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

EXECUTIVE SUMMARY

Zenith Energy Services Pvt. Ltd. is executing BEE-SME program in Jagadhri Brass & Aluminium Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Jagadhri is renowned for the brass utensils, sheets, coils, strips and also Aluminium & Stainless steel utensils, there are about 150 to 200 brass and aluminium industries in the cluster. The brass & copper sheets, strips, coils and aluminium utensils produced in Jagadhri cluster are renowned in the country. Majority of the industries have been in operation for the last 15 to 30 years. The main raw materials are brass, copper and aluminium scrap is being procured from local agents.

The major Energy forms used in the cluster are electricity and fuels like Coke, Wood, and Furnace Oil etc. Electricity is used for driving the prime movers of pumps, fans, drives, rolling machine motors, induction and annealing furnaces and for lighting. Coke and Furnace oil is used for brass and aluminium melting in Pit Furnaces. Wood is used as a fuel in Annealing furnaces.

The cost of energy as a percentage of manufacturing cost varies anywhere between 3 to 5%, which includes electrical as well as thermal. Majority of the industries located in Jagadhri uses coke and furnace oil as energy in process for pit melting and a very few units are using electricity for wood Gasifiers for melting. Pit melting process requires large amount of thermal energy, inducing a high share of energy cost. The energy cost is next to the raw materials cost.

This DPR is prepared for installation of Waste Heat Recovery System in Pit Furnaces for brass melting units for reducing coke consumption. The DPR highlights the details of the study conducted for assessing the potential for possible coke 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:

S.No	Particular	Unit	Value
1	Project cost	`(in Lakh)	0.50
2	Fuel saving(coke)	tonne/year	7.2
3	Monetary benefit	` (in Lakh)/year	1.58
4	Simple payback period	year	0.32
5	NPV	` (in Lakh)	4.06
6	IRR	%age	224.24
7	ROI	%age	40.43
8	Average DSCR	Ratio	9.31
9	Estimated CO_2 reduction	tCO_2/year	11
10	Process down time	days	Nil

The projected profitability and cash flow statements indicate that the project implementation i.e. installation of Waste Heat Recovery System will be 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 29 selected SMEs clusters. Jagadhri Brass & Aluminium 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:

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.

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

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.

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

Jagadhri is renowned for the brass utensils, sheets, coils, strips and also Aluminium & Stainless steel utensils, there are about 175 brass and aluminium industries in the cluster. The brass & copper sheets, strips, coils and aluminium utensils produced in Jagadhri cluster are renowned in the country. The main raw materials are brass, copper and aluminium scrap is being procured from local agents.

The cost of energy as a percentage of manufacturing cost varies anywhere between 3 to 5%. Majority of the industries located in Jagadhri uses coke and furnace oil as energy in process for pit melting and a very few units are using electricity for wood gasifiers for melting. Pit melting process requires large amount of thermal energy, inducing a high share of energy cost. The energy cost is next to the raw materials cost.

1.1.1 Production process

The main process operation for aluminium melting and products manufacturing adopted in cluster units are as follows:

Brass Melting

Pit Furnace is a common type of furnace used in all cluster units for melting the scrap brass in the crucibles. Furnace oil is used as fuel. The pit furnace is a circular pit lined with refractories and the crucible is inserted in the furnace and Furnace oil is feeded underneath and sides of the pit furnace. The outer side of the furnace is lined with red bricks. The normal time for each batch of melting is two and half hours and subsequently the batch time reduces by about 20 minutes to 30 minutes than the initial batch.

Annealing

Different types of Annealing process are used in the cluster:

a) Electric annealing

b) Wood fired annealing

c) Oil fired annealing

The temperature required for annealing and re-heating the brass billets is 600 to 650 ^{o}C and Aluminium billets is 400-450 ^{o}C. The brass & aluminium sheets, billets and brass coils are heat treated for about 10 to 12 hours in a day.

Electric annealing

The brass sheets are heat treated for about 5 to 6 hours in a day by electrical energy and the production capacity of the annealing furnace in the cluster units is varying from 1000 kg to 3000 kg per batch. The annealing furnace is bogie type furnace fabricated with steel body and the inside of the furnace is constructed with the refractory bricks and insulation materials.

Wood fired annealing

Wood Fired Annealing Furnace is a common type of annealing furnace found in the cluster and is normally installed in smaller and medium size units. The wood fired furnace is used for heat treatment of the brass and aluminium sheets and circles and also reheating of the billets before hot rolling. The wood is used as fuel and the production capacity of the wood fired furnace in the cluster units is varying from 2000 kg to 4000 kg per batch. The annealing furnaces are of very old design and are constructed with red bricks and only the hearth of the furnace is constructed with the refractory bricks. The design of the annealing furnace is more or less identical in all cluster units.

Oil fired annealing furnace

The brass coils is heat treated for about 8 to 10 hours in a day. The furnace oil is used as fuel and the production capacity of the oil fired bell furnace in the cluster units is varying from 3000 kg to 4000 kg per batch. The annealing furnaces are bell type furnace fabricated with insulation steel drum and asbestos. The design of the bell annealing furnace is more or less identical in all the coil plant units.

Rolling

Different types of rolling process are used in the cluster:

a) Hot rolling

b) Cold rolling

Hot Rolling

The primary function of the Hot rolling is to reheat aluminium billets or hot casted billets nearly to their melting point, then roll them thinner and longer sheets through rolling machine driven by motors having capacity around 60 to 100 HP and annealing up the lengthened brass or aluminium sheets and used for the next process.

Cold Rolling

Cold rolling is carried out to allow desirable metal qualities that cannot be obtained by hot working such as eliminating shrinkage errors for higher dimensional accuracy of the metal. Furthermore, to have smoother surface of the final products, enhance strength and hardness. As such, the metal must be heated from time to time (annealed) during the rolling operation to remove the undesirable effects of cold working and to increase the workability of the metal.

Shearing

In the shearing process, the sheets are cut to required size out of larger sheets such as roll sheets. Shears are used as the intermediate or finished step in preparing for cold rolling or circle cutting processes.

Pressing

Pressing is a metal forming process in which sheet metal is stretched into the desired part shape. A tool pushes downward on the sheet metal, forcing it into a die cavity in the shape of the desired part. The tensile forces applied to the sheet cause it to plastically deform into a utensil-shaped part. Pressing is most effective with ductile metals, such as aluminum, brass, copper, and mild steel. Examples of parts formed with Pressing include milk tanks, cans, cups, kitchen utensil sinks, pots and pans.

The Pressing processes machine either in cam or hydraulic type is used having capacity 25 HP to 63 HP motors.

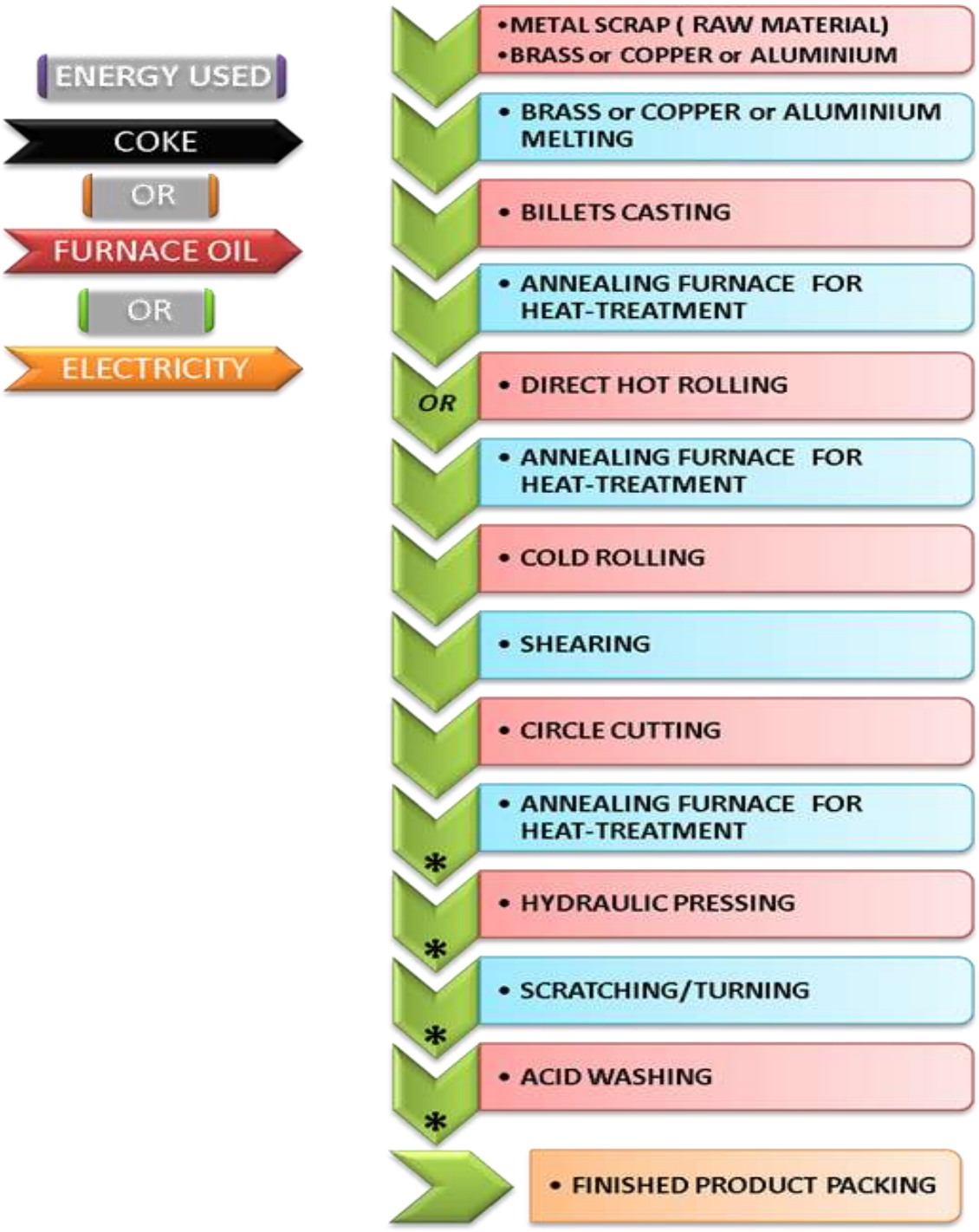


Figure 1.1: General Process Flowchart

For Product / Utensils Manufacturing

1.2 Energy performance in existing situation

1.2.1 Fuel and electricity consumption of a typical unit

The main energy forms used in a typical unit in the cluster are electricity, coke, furnace oil and wood. Electricity is used for driving the prime movers of blowers, hot and cold rolling machines, shearing machines and press. Coke is used as fuel in Pit Furnaces for brass melting and wood is used as fuel for annealing furnaces. The energy consumption of a typical unit in the cluster having pit furnace for brass melting is furnished in Table 1.1 below:

Table 1.1: Energy consumption of a typical unit (Ahuja Metal Industries)

S.No	Details	Unit	Value
1	Coke Consumption	tonne/annum	96
2	Grid Electricity consumption	MWh/annum	170
3	Wood Consumption	tonne/annum	240

1.2.2 Average production by a typical unit in the cluster

The average production in a year in a typical unit is 720 tonne.

1.2.3 Specific Energy Consumption

The main energy forms used in the brass processing units are electricity, furnace oil and wood. The Specific energy consumption for electrical and thermal energy per tonne or kg of Production for a typical unit is furnished in Table 1.2 below:

Table 1.2: Specific energy consumption for a typical unit (Ahuja Metal Industries)

S. No.	Type of Fuel	Units	Specific Energy Consumption
1	Coke consumption	tonne/ tonne of production	0.133
2	Grid Electricity consumption	MWh/ tonne of production	0.236
3	Wood consumption	tonne/ tonne of production	0.333

Equipment wise Specific Energy Consumption

The specific energy consumption of the equipments used in the Jagadhri Aluminium & Brass Industries is given in Table 1.3 below wherever possible.

Table 1.3 Equipment wise Specific Energy Consumption

S.No.	Equipments	Minimum SEC	Maximum SEC	Average SEC (for whole cluster)
1	Pit Furnace	0.110	0.150	0.130
2	Annealing Furnace	0.150	0.260	0.205

1.3 Existing technology/equipment

1.3.1 Description of existing technology

Pit Furnace is a common type of furnace used in all cluster units for melting the scrap brass in the crucibles. Coke is used as fuel and the production capacity of the pit furnace in the cluster units is 600 kg per batch. Normally about 4 to 5 batches are produced in a day. The furnace is operated on single shift basis normally 12 hours.

The temperature required for brass melting in pit furnaces is 1050 ^{o}C to 1100 ^{o}C. The brass melting is carried out in crucibles. During energy audit studies, it is observed that, the waste flue gases from the crucible furnace is found to be 500 ^{o}C to 600 ^{o}C and is vented to the atmosphere without any heat recovery.

1.3.2 Its role in the whole process

The pit furnace is used for melting the brass scrap. The number of melting batches varies as per the production requirement.

1.4 Establishing the baseline for the equipment to be changed

1.4.1 Design and operating parameters

The main energy forms used for pit furnace are coke. Electricity is also used in small quantities for operation of blower for supplying combustion air. The pit furnace is constructed by the in house workers and doesn't have name plate details. The coke consumption depends on the following parameters such as quantity of brass to be melted, temperature required, furnace oil heat value and design of the pit furnace. The operating parameters of the pit furnace collected for a typical unit during the field visit is furnished in Table 1.4 below:

Table 1.4 Details of Operating parameter

S. No.	Particular	Units	Value
1	Capacity of the pit furnace	kg/ batch	600
2	Quantity of brass melted	kg/ batch	600
3	Average Furnace oil consumption	kg/batch	80
4	Melting temperature measured	°C	1021
5	Temperature of waste flu gas	°C	500 – 550
6	Quantity of unburnt fuel left after the process	kg/batch	20

1.4.2 Coke & Electricity consumption and Operating Efficiency

The operating efficiency of the pit furnace in various units had been evaluated during energy use and technology audits using coke as fuel for brass melting. The efficiencies of the pit furnaces are found to be in the range of 8% to 15% in various units of the cluster. The details of furnace oil consumption, electricity consumption, efficiencies and energy cost involved for brass melting per kg for pit furnaces in 3 typical units is furnished below in Table 1.4 below:

Table 1.4 Energy Consumption & Efficiency of three typical units in the cluster

S. No	Name of the unit	Fuel Consumption (tonne/annum)	Electricity Consumption (MWh/annum)	Efficiency of pit furnace (% age)	Waste heat recovery
1	Ahuja Metal Industries	96	170	11.4	No
2	Usha Enterprises	57	159	11.0	No
3	Arun metals	120	159	10.8	No

1.5 Barriers for adoption of new technology/equipment

1.5.1 Technological Barriers

The major technical barriers that prevented the implementation of the waste heat recovery system for pit furnaces in the cluster are:

- Though, number of units had been implemented induction furnace, the implementation was limited bigger size units and was penetrated in the smaller size units, this may be lack of awareness of the technology among small unit owners

- Lack of knowledge of the technical benefits of the induction furnace in smaller units
- Majority of the owners of the cluster are more focused on the successful implementation of the proposed technology in the cluster before going to implement it as so far, no unit had been implemented Induction furnace.

1.5.2 Financial Barrier

- Though, many SME owners are interested to install induction furnace for brass melting, but due to high initial investment, SME owners could not implement in the cluster.
- Further, lack of awareness about the losses occurred due to waste heat and monetary benefit of the Induction furnace is also one of the major barrier that prevented implementation of the waste heat recovery system.
- Energy Efficiency Financing Schemes such as SIDBI's, if taken up in the cluster, many SME owners will come forward to up taken up the technology due to financial attractiveness of the technology.

1.5.3 Skilled manpower

The proposed technology does not require any skilled manpower.

1.5.4 Other barrier(s)

No major other barriers were identified.

2. DESCRIPTION OF PROPOSED TECHNOLOGY/EQUIPMENT

2.1 Detailed description of technology/equipment selected

2.1.1 Description of technology

The waste heat recovery system is developed by M/s Zenith Energy Services Pvt. Ltd after intensive research of the in-house engineers and the system is used for pre-heating the charge to be melted. The waste heat recovery system is a portable mesh type container and consists of wheels for comfortable moving on the furnace platform. The brass to be melted in collected in the container and is placed on the pit furnace. The flue gases of the pit furnaces will come in contact with scrap material directly heated the scrap by using the heat available in the flue gases. After completion of the melting process, the portable waste heat recovery system is removed from the system and scrap material heated is charged to the pit furnace for melting.

The waste heat recovery system will have a door for easy charging from the bottom and the sides. The detailed drawings and photograph of the system is provided in the Annexure 4.

2.1.2 Technology /Equipment specifications

The waste heat recovery system is typically a fabrication activity and doesn't contain specifications and is suitable for 600 kg capacity pit furnaces. The detailed technical drawings are furnished in Annexure 4**.** The materials used for the fabrication of the waste heat recovery system are stainless steel and Mild steel sheets of required thickness.

2.1.3 Justification & Suitability of the technology selected

Pit furnaces are the most commonly used furnace in the brass and aluminium melting units in the Jagadhri Cluster industries. The coke and furnace oil is used as fuel for pit furnaces. As per the studies carried out in various units, no single unit has waste heat recovery system in the brass melting units. In many cases, the temperature of the flue gases at the exit of the boilers is found to be varying between 500 ^{o}C to 550 ^{o}C for coke fired and 600 ^{o}C for furnace oil fired pit furnaces.

Installing waste heat recovery system for pre-heating the charge will reduce the fuel consumption by utilizing the heat in waste flue gases. Detailed justification of fuel saving is given at annexure 3.

2.1.4 Superiority over existing technology/equipment

The proposed technology enhances the efficiency of the pit furnaces for the following reasons:

- The precious heat available in the waste flue gases is utilized and thus reduces coke consumption.
- The pre-heating of the charge will considerably reduce the melting time.
- The life of the crucibles increases due to reduction in melting time.
- Reduces thermal pollutants to the atmosphere due to reduction in temperature of waste flue gases

2.1.5 Availability of the proposed technology/equipment

The waste heat recovery system is designed by Zenith Energy Services Pvt Ltd and can be locally fabricated with the local service providers. The detail of the local service provider is furnished in Annexure 7.

2.1.6 Source of technology/equipment for the project

The technology is developed by the Zenith Energy Services Pvt. Ltd.

2.1.7 Service/technology providers

The service providers are available locally.

2.1.8 Terms of sales

Terms of payment

40% Advance with purchase order, 50% running payment along with taxes and duties against proforma Invoice before dispatch and remaining 10% after commissioning and trial

2.1.9 Process down time during implementation

The waste heat recovery system is additional equipment and is portable and no process down time is considered.

2.2 Life cycle assessment and risks analysis

The life of the waste heat recovery system is considered at 5 years.

2.3 Suitable unit in terms of capacity

The waste heat recovery system can be installed in all the brass melting units of various capacities having pit furnaces.

3. ECONOMIC BENEFITS OF NEW ENERGY EFFICIENT TECHNOLOGY

3.1 Technical benefits

3.1.1 Fuel savings per year

Installation of waste heat recovery system for pit furnace will reduce the coke consumption in the pit furnace. Based on the detailed studies undertaken, it is estimated that by upgrading to new Modified Pit Furnaces, coke consumption gets reduced by 7.2 tonne (7.5%) per annum for a typical unit having pit furnaces of 600 kg per batch.

3.1.2 Electricity savings per year

The waste heat recovery system reduces fuel consumption and doesn't reduce electricity consumption and hence electricity savings are not considered.

3.1.3 Improvement in product quality

Installation of waste heat recovery system doesn't have impact on the product quality.

3.1.4 Increase in production

The project activity is waste heat recovery system and heat in the flue gases is used for pre-heating the charge and hence reduces the melting time due to pre-heating hence, the production may improve due to reduction in batch time.

3.1.5 Reduction in raw material consumption

Due to reduction in the batch time and the crucibles can be used for more batches; hence the crucibles consumption may reduce.

3.1.6 Reduction in other losses

There is no significant reduction in other losses.

3.2 Monetary benefits

The installation of waste heat recovery system reduces coke consumption by 7.2 tonne per annum and the monetary savings is estimated at ` 1.58 lakh per annum.

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

The project activity is a waste heat recovery system; hence due to reduction of temperature of waste flue gases, the working environment will improve considerably.

3.3.2 Improvement in skill set of workers

The technology selected for the implementation is new. The technology implemented will create awareness and operation and maintenance of the new technology and hence improves skills of the workers.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

There is no significant impact in effluent generation due to implementation of the project activity.

3.4.2 Reduction in GHG emission such as CO_2, NOx, etc

The major GHG emission reduction source is CO_2. The technology will reduce coke consumption by 7.2 tonne hence, emission reductions are estimated at 11 tonne of CO_2 per annum due to implementation of the project activity.

3.4.3 Reduction in other emissions like SOx

As the project activity reduces furnace oil consumption, the SOx emissions also reduces to some extent.

4. IMPLEMENTATION OF PROPOSED EQUIPMENT

4.1 Cost of technology/equipment implementation

4.1.1 Cost of technology/equipments

Total cost required for fabrication of waste heat recovery system required only ` 0.45 lakh.

4.1.2 Other costs

The erection and commissioning charges for the waste heat recovery system is estimated at ` 0.05 lakh. The details of the item wise cost are furnished in Table 4.1 below:

Table 4.1 Total Project cost

S.No	Particular	Unit	Value
1	Waste heat recovery system	` in lakh	0.45
2	Erection and Commissioning	` in lakh	0.05
3	Investment without IDC	` in lakh	0.50
4	Interest During Implementation	` in lakh	0.00
5	Total Investment	` in lakh	0.50

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 ` 0.13 lakh.

4.2.2 Loan amount

The term loan is 75% of the total project cost, which works out at ` 0.38 lakh.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10.00% which is prevailing interest rate of SIDBI for energy efficiency 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 ` 1.09 lakh in the first year operation and increases to ` 5.78 lakh at the end of eighth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ` 0.50 lakh and monetary savings due to reduction in energy/production cost is ` 1.58 lakh and payback period works out to be 0.32 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10.0% interest rate works out to be ` 4.06 lakh.

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 224.24%. Thus the project is financially viable. The average DSCR works out at 9.31.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 40.43%.

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 monetary savings and decrease. For the purpose of sensitive analysis, two scenarios are considered are.

- Increase in monetary savings by 5%
- Decrease in monetary 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 at different scenario

Particulars	IRR %	NPV ` in lakh	ROI %	DSCR
Normal	224.24	4.06	40.43	9.31
5% increase in fuel savings	234.98	4.29	40.56	9.77
5% decrease in fuel savings	213.47	3.83	40.28	8.85

As can be seen from above, the project is highly sensitive to fuel savings, the debt service coverage ratio works out to be 8.85 times in worst scenario, which indicates the strength of the project.

4.5 Procurement and implementation schedule

The project is expected to be completed 8 days from the date of financial closure and release of work order to the supplier. The detailed schedule of project implementation is furnished in Annexure 6.

ANNEXURES

Annexure 1: Evaluation of furnace efficiency

1) Ahuja Metal Industries

S.No	Parameter	Units	Details
1	Fuel used	---	Coke
2	Quantity of brass melted in the pit furnace in the crucible	kg/day	2400
3	Specific heat of brass	kCal/kg ^{o}C	0.092
4	Initial temperature of brass	^{o}C	30
5	Final temperature of brass (molten metal)	^{o}C	1021
6	Heat output	kCal/day	2,18,812
7	Quantity of coke consumption	kg/day	320
8	Calorific value of coke	kCal/kg	6000
9	Heat input	kCal/day	19,20,000
10	Efficiency	% age	11.4

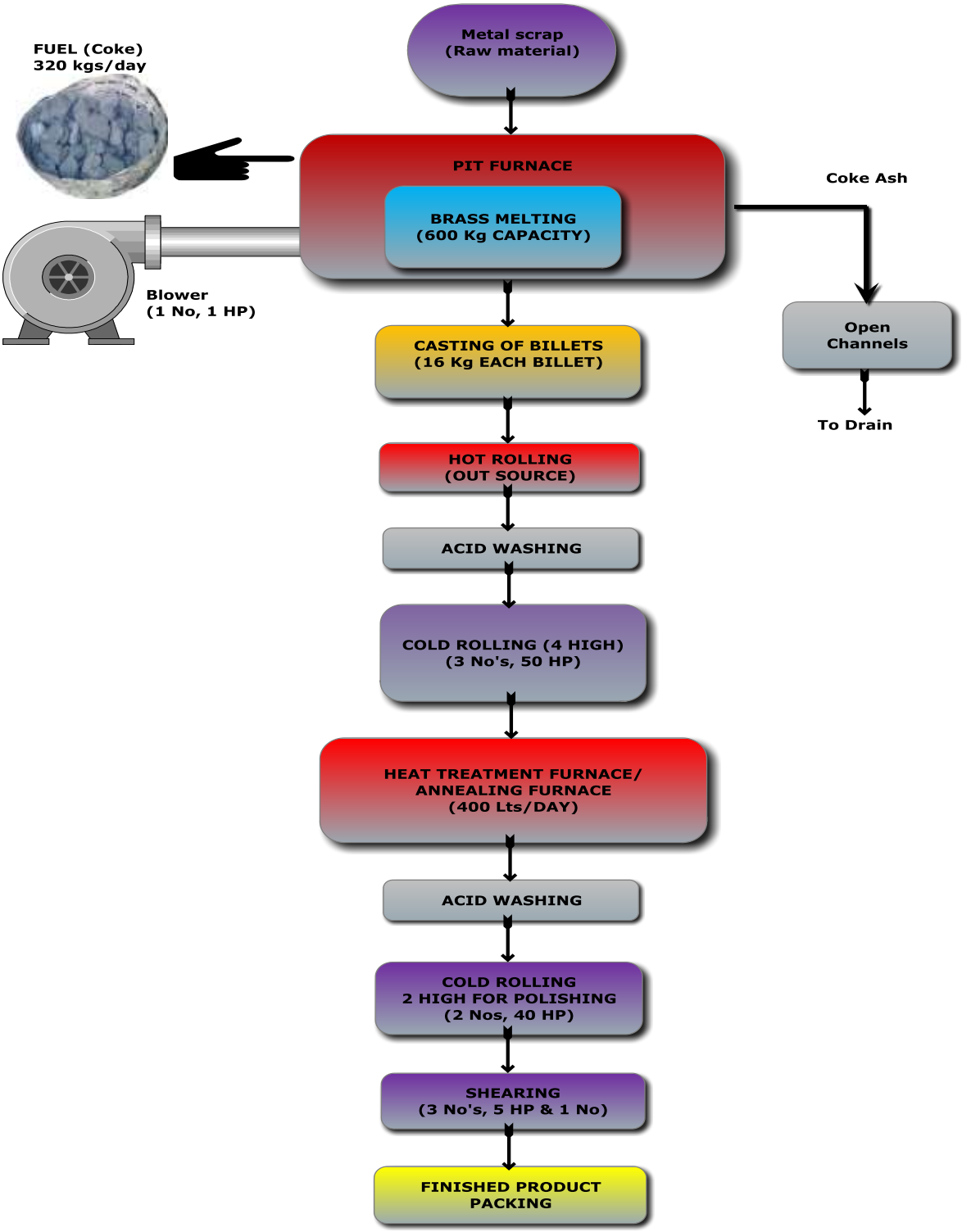
2) Usha Enterprises

S.No	Parameter	Units	Details
1	Fuel used	---	Coke
2	Quantity of brass melted in the pit furnace in the crucible	kg/day	2400
3	Specific heat of brass	kCal/kg ^{o}C	0.092
4	Initial temperature of brass	^{o}C	30
5	Final temperature of brass (molten metal)	^{o}C	1017
6	Heat output	kCal/day	2,17,929
7	Quantity of coke consumption	kg/day	320
8	Calorific value of coke	kCal/kg	6000
9	Heat input	kCal/day	19,20,000
10	Efficiency	% age	11.35

3) Arun metals

S.No	Parameter	Units	Details
1	Fuel used	---	Coke
2	Quantity of brass melted in the pit furnace in the crucible	kg/day	3000
3	specific heat of brass	kCal/kg ^{o}C	0.092
4	Initial temperature of brass	^{o}C	30
5	Final temperature of brass (molten metal)	^{o}C	970
6	Heat output	kCal/day	2,59,440
7	Quantity of coke consumption	kg/day	400
8	Calorific value of coke	kCal/kg	6000
9	Heat input	kCal/day	24,40,000
10	Efficiency	% age	10.81

Annexure 2: Process flow diagram



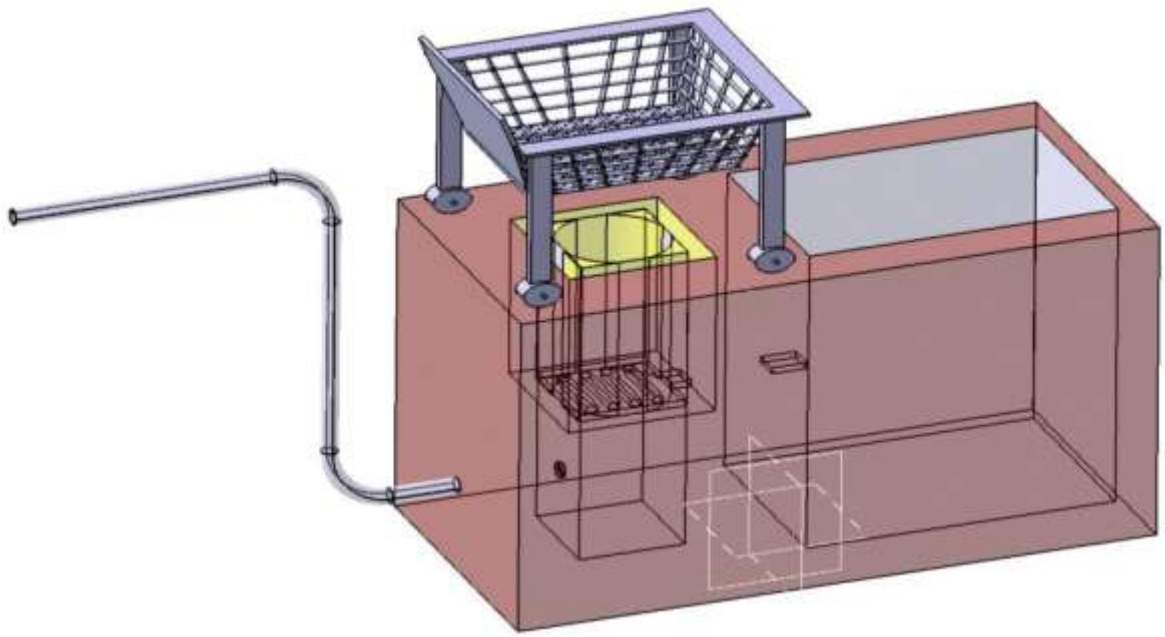
Annexure 3: Detailed technology assessment report- wood gasifier

S No.	Parameters	Unit	Value
1	Quantity of fuel consumption	kg/day	320.0
2	Calorific value of fuel	kcal/kg	6,000
3	Efficiency	%	11.40
4	Oxygen measured	%	5.2
5	Carbon dioxide measured	%	6.4
6	Excess air	%	33.12
7	Theoretical Air required per kg of coke	kg/kg of coke	7.1
8	Quantity of actual air supplied	kg/kg of coke	9.45
9	Quantity of flue gases per day	kgs/day	3345
10	Temperature of flue gases	^{0}C	500
11	Temperature of flue gases after heat recovery	^{0}C	200
12	Temperature difference of flue gases	^{0}C	300
13	Heat exchanger efficiency	%	65
14	Specific heat of flue gases	kcal/kg ^{0}C	0.23
15	Equivalent wood	tons/annum	7.5
16	%saving	%	7.81

The cost benefit analysis of installing waste heat recovery system in pit furnace for brass melting is furnished below

S.No	Parameter	Units	Details
1	Present quantity of Brass melting per batch	kg/batch	600
2	Coke consumption per batch	kg/batch	80
3	Cost of Coke	` /kg	22
4	Coke consumption per day (4 batch)	kg/batch	320
5	No of working days	Days/ annum	300
6	Present coke consumption	tonnes/annum	96
7	Proposed saving of coke on modified furnace	% age	7.5
8	Coke savings per annum	tonne/annum	7.2
9	Proposed coke consumption	tonne/annum	89
10	Monetary savings per annum	` in lakh	1.58
11	Investment	` in lakh	0.51
12	Payback period	Year	0.32
13	60% of carbon content in coke	tonne/annum	4.32
14	CO_2 emission reduction	tonne/annum	11

Annexure 4: Technical drawings of the waste heat recovery system



Annexure 5: Detailed financial calculations & analysis

Assumptions

Name of the Technology	**Waste Heat Recovery System - Brass Melting**		
Rated Capacity	**NA**		
Details	***Unit***	***Value***	***Basis***
No of working days	Days	300	
No of Shifts per day	Shifts	1	(Assumed)
Proposed Investment			
Waste Heat Recovery System - Brass Melting	` (in lakh)	0.45	
Erection and commissioning	` (in lakh)	0.05	
Investment without IDC	` (in lakh)	0.50	
Interest During Implementation	` (in lakh)	0.00	
Total Investment	` (in lakh)	0.50	
Financing pattern			
Own Funds (Equity)	` (in lakh)	0.13	Feasibility Study
Loan Funds (Term Loan)	` (in lakh)	0.38	Feasibility Study
Loan Tenure	years	3.00	Assumed
Moratorium Period	Months	3.00	Assumed
Repayment Period	Months	39.00	Assumed
Interest Rate	%age	10.00%	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	10.00	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Coke savings per annum	Tons/ annum	7.2	
Cost	tons	22000	
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 lakhs)**

Years	*Opening Balance*	*Repayment*	*Closing Balance*	*Interest*
1	0.38	0.04	0.34	0.03
2	0.34	0.12	0.22	0.03
3	0.22	0.16	0.06	0.02
4	0.06	0.06	0.00	0.00
		0.38		

WDV Depreciation **(` in lakhs)**

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	0.50	0.10
Depreciation	0.40	0.08
WDV	0.10	0.02

Projected Profitability (` in lakhs)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*
Revenue through Savings						
Fuel savings	1.58	1.58	1.58	1.58	1.58	1.58
Total Revenue (A)	1.58	1.58	1.58	1.58	1.58	1.58
Expenses						
O & M Expenses	0.05	0.05	0.06	0.06	0.06	0.06
Total Expenses (B)	0.05	0.05	0.06	0.06	0.06	0.06
PBDIT (A)-(B)	1.53	1.53	1.53	1.53	1.52	1.52
Interest	0.03	0.03	0.02	0.00	-	-
PBDT	1.50	1.50	1.51	1.53	1.52	1.52
Depreciation	0.03	0.03	0.03	0.03	0.03	0.03
PBT	1.47	1.48	1.49	1.50	1.50	1.49
Income tax	0.37	0.48	0.51	0.52	0.52	0.52
Profit after tax (PAT)	1.10	0.99	0.97	0.98	0.98	0.98

Computation of Tax (` In lakh)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*
Profit before tax	1.47	1.48	1.49	1.50	1.50	1.49
Add: Book depreciation	0.03	0.03	0.03	0.03	0.03	0.03
Less: WDV depreciation	0.40	0.08	-	-	-	-
Taxable profit	1.10	1.42	1.51	1.53	1.52	1.52
Income Tax	0.37	0.48	0.51	0.52	0.52	0.52

Projected Balance Sheet

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*
Liabilities						
Share Capital (D)	0.13	0.13	0.13	0.13	0.13	0.13
Reserves & Surplus (E)	1.10	2.09	3.06	4.05	5.02	6.00
Term Loans (F)	0.34	0.22	0.06	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	1.56	2.44	3.25	4.17	5.15	6.13
Assets	**1**	**2**	**3**	**4**	**5**	**6**
Gross Fixed Assets	0.50	0.50	0.50	0.50	0.50	0.50
Less: Accm. Depreciation	0.03	0.05	0.08	0.11	0.13	0.16
Net Fixed Assets	0.47	0.45	0.42	0.39	0.37	0.34
Cash & Bank Balance	1.09	1.99	2.83	3.78	4.78	5.78
TOTAL ASSETS	1.56	2.44	3.25	4.17	5.15	6.13
Net Worth	1.22	2.22	3.19	4.17	5.15	6.13
Dept equity ratio	2.72	1.76	0.48	0.00	0.00	0.00

Projected Cash Flow:

Particulars / Years	*0*	*1*	*2*	*3*	*4*	*5*	*6*
Sources							
Share Capital	0.13	-	-	-	-	-	-
Term Loan	0.38						
Profit After tax		1.10	0.99	0.97	0.98	0.98	0.98
Depreciation		0.03	0.03	0.03	0.03	0.03	0.03

Total Sources	0.50	1.13	1.02	1.00	1.01	1.01	1.00
Application							
Capital Expenditure	0.50						
Repayment of Loan	-	0.04	0.12	0.16	0.06	-	-
Total Application	0.50	0.04	0.12	0.16	0.06	-	-
Net Surplus	-	1.09	0.90	0.84	0.95	1.01	1.00
Add: Opening Balance	-	-	1.09	1.99	2.83	3.78	4.78
Closing Balance	-	1.09	1.99	2.83	3.78	4.78	5.78

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

Particulars / year	***0***	***1***	***2***	***3***	***4***	***5***	***6***
Profit after Tax		1.10	0.99	0.97	0.98	0.98	0.98
Depreciation		0.03	0.03	0.03	0.03	0.03	0.03
Interest on Term Loan		0.03	0.03	0.02	0.00	-	-
Cash outflow	(0.50)	-	-	-	-	-	-
Net Cash flow	(0.50)	1.16	1.05	1.01	1.01	1.01	1.00
IRR	224.24%						
NPV	4.06						

Break Even Point

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***
Variable Expenses						
Oper. & Maintenance Exp (75%)	0.04	0.04	0.04	0.04	0.05	0.05
Sub Total (G)	0.04	0.04	0.04	0.04	0.05	0.05
Fixed Expenses						
Oper. & Maintenance Exp (25%)	0.01	0.01	0.01	0.01	0.02	0.02
Interest on Term Loan	0.03	0.03	0.02	0.00	0.00	0.00
Depreciation *(H)*	0.03	0.03	0.03	0.03	0.03	0.03
Sub Total (I)	0.07	0.07	0.06	0.04	0.04	0.04
Sales (J)	1.58	1.58	1.58	1.58	1.58	1.58
Contribution (K)	1.55	1.54	1.54	1.54	1.54	1.54
Break Even Point (L= G/I)	4.70%	4.41%	3.65%	2.72%	2.70%	2.76%
Cash Break Even {(I)-(H)}	2.99%	2.70%	1.93%	1.00%	0.99%	1.04%
Break Even Sales (J)*(L)	0.07	0.07	0.06	0.04	0.04	0.04

Return on Investment

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***Total***
Net Profit Before Taxes	1.47	1.48	1.49	1.50	1.50	1.49	8.93
Net Worth	1.22	2.22	3.19	4.17	5.15	6.13	22.08
							40.43%

Debt Service Coverage Ratio

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*Total*
Cash Inflow							
Profit after Tax	1.10	0.99	0.97	0.98	0.98	0.98	4.05
Depreciation	0.03	0.03	0.03	0.03	0.03	0.03	0.11
Interest on Term Loan	0.03	0.03	0.02	0.00	0.00	0.00	0.08
TOTAL (M)	1.16	1.05	1.01	1.01	1.01	1.00	4.23

DEBT

Interest on Term Loan	0.03	0.03	0.02	0.00	0.00	0.00	0.08
Repayment of Term Loan	0.04	0.12	0.16	0.06	0.00	0.00	0.38
Total (N)	0.07	0.15	0.18	0.06	0.00	0.00	0.45
Average DSCR (M/N)	9.31						

Annexure 6: Details of procurement and implementation plan with schedule/timelines

Project Implementation Schedule – Waste Heat Recovery System

S. No.	Activities	Days							
		1	2	3	4	5	6	7	8
1	Procurement of Materials								
2	Fabrications								
3	Trial Runs								

Annexure 7: Details of technology/equipment and service providers with contact nos.

Equipment Details	Source Of Technology	Service/Technology Providers
Waste Heat Recovery System	Local Suppliers Are Available	A.R Engg. Works C-1,682, Jecio Colony, Jagadhri, Haryana – 135003 Tel : 01732-316704, 94166-80705, 93555-80705.

Annexure 8: Quotations or techno-commercial bids for new technology/equipment

TIN : 06741616247

01732-316704
94166-80705
93555-80705

A. R. ENGG. WORKS

Manufacturers of :

BRASS & S.S. BRUSH, ALL TYPE OF FURNACES, DRYERS, SCCUZOR, WASHING MACHINE
FOR BRASS SHEET & COIL MILL, MANUAL & ELECTRICAL CRAINS FITTINGS WORKS
DEALS IN : FIRE BRICKS, REFACTORY PRODUCTS, BURNERS, BLOWERS, ASBESTOS SHEETS ETC.

C-1, 682, JESICO COLONY, JAGADHRI - 135 003 (HARYANA)

Ref. No. ..... Dated 5/4/10

To

Zenith Energy Services (P) Ltd.
Hyderabad (India)

Sub. : Waste Heat Recovery System with Moveable Trolly
(Approx. Trolly Size : 800mm x 800mm x 450mm)

Sir,

We are pleased to quote our rates for the above mentioned Waste Heat Recovery System with Moveable Trolly in reference to your telephonic enquiry dated 04-04-2010 as under :

The complete waste recovery system febricated with :

1. Mild Steel (Angle, Channel, MS Sheet)
2. S.S. Sheet & S.S. Rod
3. 4 Nos. Wheels
4. Nut Bolts & Mill Store Materials etc. will cost **Rs. : 45,000 /-**

(Rupees Fourty five thousand only /-)

The above rates are ex-works Jagadhri. Taxes extra as applicable at the time of delivery. Payment 40% advance, 50% is running payment and balance 10% after commissioning and trial.

Hope you will find our rates as most competitive and will do favour as with your valued order.

Thanking You,

Yours faithfully,
For **A.R. Engg. Works,**

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066
Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352
Websites: www.bee-india.nic.in, www.energymanagertraining.com

Zenith Energy Services Pvt. Ltd
10-5-6/B, My Home Plaza, Masab
Tank HYDERABAD, AP 500 028
Phone: 040 23376630, 31,
Fax No.040 23322517
Website: www.zenithenergy.com

India SME Technology Services Ltd
DFC Building, Plot No.37-38,
D-Block, Pankha Road,
Institutional Area, Janakpuri, New Delhi-110058
Tel: +91-11-28525534, Fax: +91-11-28525535
Website: www.techsmall.com