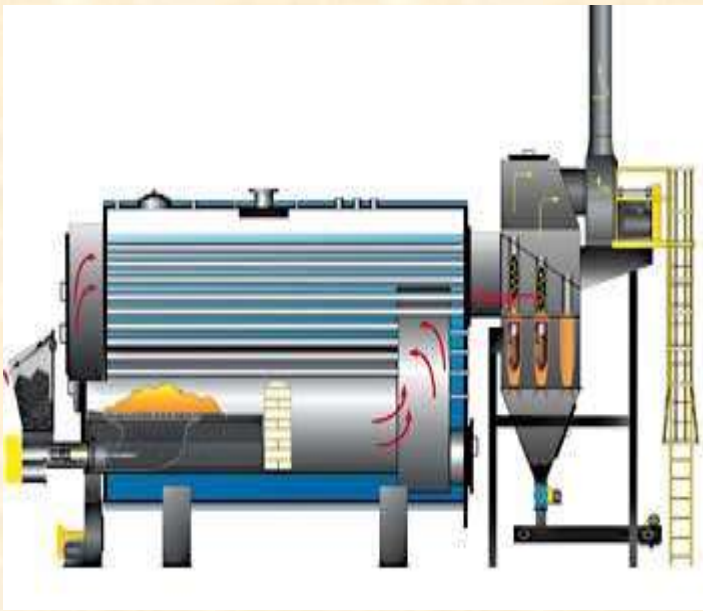
DETAILED PROJECT REPORT
ON
CONDESATE RECOVERY SYSTEM
IN 24 TPB DRYERS
(WARANGAL RICE MILLING CLUSTER)





Bureau of Energy Efficiency

Prepared By

CONDENSATE RECOVERY SYSTEM (24 TPB DRYERS)

WARANGAL RICE CLUSTER

BEE, 2011

Detailed Project Report on Condensate Recovery System in 24 TPB Dryers

Rice Milling SME Cluster, Warangal, Andhra Pradesh (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: **WRG/RICE/CRS/15**

For more information

Bureau of Energy Efficiency (BEE)

(Ministry of Power, Government of India)

4th Floor, Sewa Bhawan

R. K. Puram, New Delhi – 110066

Telephone +91-11-26179699

Fax +91-11-26178352

Websites: www.bee-india.nic.in

Email: jsood@beenet.in/

pktiwari@beenet.in

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Dr. Ajay Mathur, Director General, BEE

Smt. Abha Shukla, Secretary, BEE

Shri Jitendra Sood, Energy Economist, BEE

Shri Pawan Kumar Tiwari, Advisor (SME), BEE

Shri Rajeev Yadav, Project Economist, BEE

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APITCO Limited

Hyderabad

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List of Abbreviations

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

EXECUTIVE SUMMARY

Bureau of Energy Efficiency (BEE) appointed Andhra Pradesh Industrial Technical Consultancy Organisation Limited as the executing agency for Rice Milling Cluster of Warangal under BEE's SME programme. Under this project, the executing agency carried out studies in the Rice Milling cluster of Warangal. Out of a total of 110 rice mills, study was conducted in 30 units. Preliminary audits were done in all the 30 units whereas detailed energy audits were conducted in 30 of these units.

This DPR will provide an overview of Condensate Recovery system. The dryer uses preheated air at 70^0C – 80^0C for drying the parboiled paddy. The moisture content of the paddy is reduced from 25% to 13%.This has a heat exchanger to heat air. There is a blower delivering air which passes through the heat exchanger, and the hot air is delivered to the drier. Energy Saving Opportunity: The condensate from the dryers could well be flashing away which represents heat loss that is recoverable. High pressure condensate is at almost the same pressure as same pressure as steam and contains around 15 to 20% heat of fuel. This heat if recovered shall reduce fuel consumption to the extent of 20%.

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)	4.12
2	Rice Husk saving	Tonne/year	140.1
3	Monetary benefit	` (in Lakh)/year	2.52
4	Simple payback period	years	1.63
5	NPV	` (in Lakh)	5.55
6	IRR	%	45.43
7	ROI	%	27.30
8	DSCR	Ratio	2.61
9	CO2 emission reduction	Tonnes	58.04
10	Procurement and implementation schedule	Week	14

The projected profitability and cash flow statements indicate that the project implementation i.e. installation of efficient boiler will be financially viable and technically feasible solution for the cluster.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 29 selected SMEs clusters. Warangal Rice milling unit 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

1.1.1 Brief Introduction about Cluster

Andhra Pradesh historically called as rice bowl of India has 77 % of cultivated land under paddy cultivation and produces around 17 million tones of rice. There are around 6000 rice milling units are established in the sate, out of which 408 registered rice mills are with in Warangal district to process the produced paddy. Due to high concentration of many rice mills in Warangal district, the Warangal district rice milling units are considered for BEE –SME Program. The rice mill units in Warangal district are formed association namely The Warangal District Rice Milling Welfare Association and have around 408 rice millers are registered. Warangal is well known for rice milling industry and about 110 rice mills are in and around Warangal town.

These rice mills owners are procured the paddy from different sources and processed in these rice mills. The final product i.e. rice from these mills is supplied to Food Corporation of India (FCI), other marketing channels for selling. These units are in operation since 10-15 years and most of rice mills are family owned. Majority of the units generally operate for one shift a day but some run for two shifts both raw rice and parboiled rice mills. Rice processing is seasonal in nature and has two main seasons in a year depending on the paddy availability. First season is during April- May and paddy available during this season is fit for the production of boiled rice whereas the paddy available during the second season (November-January) is used mainly for raw rice production.

The major equipments employed in a typical rice mills are rubber shellers, polishers, dryers, whiteners, boilers, elevators, air compressors, motors, etc which are operated by power from the State Electricity Board (SEB). DG sets are operated when power off situation by the SEB. The major fuel used in the cluster is rice husk which is generated in the rice mills as a waste after process the paddy. The rice husk is used in boilers as a fuel for generating the steam which is required for different process in parboiled rice mills. Surplus rice husk from these rice mills is sold to outside buyers.

1.1.2 Existing production process & Technology

The product i.e. Rice is produced by processing the paddy in mill by removing the husk. There are two types of paddy processing technologies as discussed below:

Raw Rice Mills: Paddy procured from different sources is dried & then sent for milling without any other process.

Parboiled Rice Mills: The procured paddy from different sources is first sent to partial

cooking with the help of steam and then dried with help of air dryers. The steaming of paddy is two types: 'Once steamed paddy', and 'Twice steamed Paddy'. After steaming the paddy, it is sent to the driers for drying, then after it is sent for milling operations. The drying of paddy is of two types, Open Dryers and Closed Dryers. The dried paddy from dryer is then sent to the milling process which is similar to the raw rice processing.

Process description and flow: The paddy received from the farmers contains around 20 % moisture and also contains lot of foreign matter. In order to maintain a uniform moisture level of 12 %, the paddy is passed through a cleaner cum drier to reduce moisture and remove foreign particles. Grading and cleaning operation would involve removal of moisture and foreign material. The cleaned and dried paddy is stored for milling. The dried paddy is again passed through a secondary cleaning system to remove the foreign particles; stones etc are remained in preliminary cleaning. The cleaned paddy is de husked in huller mill with the help of rubber roll hullers. The husk thus separated is either sold or sent to the boiler section for use as fuel. The de-husked paddy is passed through table separators and then to polishing section. In the polishing section the thick brown layer of the paddy is removed with polishers/whiteners. The thick brown layer thus removed by the polishers/ whitener is called bran and this will be used in the solvent extraction plant as raw material. The polished rice is then passed through sieves to remove brokens. The broken rice obtained is put for sale in packed condition. The unbroken polished rice finally passes through sorters to remove discolored rice and then sent for packing.

- Pre Cleaning: Removing all impurities and unfilled grains from paddy
- De-stoning: Separating small stones from paddy
- Parboiling (Optional): Helps in improving the nutritional quality by gelatinization of starch inside the rice grain. It improves the milling recovery percent during deshelling and polishing / whitening operation
- De-Husking: Removing husk from paddy
- Husk Aspiration: Separating the husk from brown rice/ unhusked paddy
- Paddy Separation: Separating the unhusked paddy from brown rice
- Whitening: Removing all or part of the bran layer and germ from brown rice
- Polishing: Improving the appearance of milled rice by removing the remaining bran particles and by polishing the exterior of the milled kernel
- Length Grading: Separating small and large broken from head rice

- Blending: Mixing head rice with predetermined amount of broken, as required by the customer
- Weighing and bagging: Preparing the milled rice for transport to the customer
- The flow diagram of the various unit operations are as follows:

1.2 Energy performance in existing system

1.2.1 Fuel consumption

Average fuel and electricity consumption in a typical unit is given in Table 1 below:

Table 1 Average fuel and electricity consumption

Type	Capacity (TPH)	No. of Units	Electrical Energy kWh / Yr	Production MT/Yr	Fuel Cons. MT/Yr
Type-1 Raw Rice Mills	1	24	2225283	57600	-
	2	49	5431820	235200	-
	Sub-Total	**73**	**7657104**	**292800**	**-**
Type-2 Par-boiled Rice Mills	2	1	129454	4800	1272
	3	10	2036309	72000	15600
	4	24	7824060	230400	44928
	Sub Total	**35**	**9989824**	**307200**	**61800**
	Total	**108**	**17646928**	**600000**	**61800**

1.2.2 Average annual production:

The annual production of raw rice and parboiled rice for various capacities is briefed here. It is clearly depicted in the **Table No 2 & Table No 3**

Type-1: Raw Rice Milling: From the annual production in raw rice mill units for different capacities it is seen that for a 1 TPH capacity, the annual production is 57600 MT/Yr from 24 units, whereas for a 2 TPH capacity the annual production is 235200 MT/Yr form 49 units. **Table 2** illustrates the annual production of raw rice mill based on capacity of production.

Table 2 Average annual productions in raw rice mills

Capacity (TPH)	Processing Methodologies	Number of Units	Annual Production (MT/Yr)
1	Raw Rice Mill	24	57600
2	Raw Rice Mill	49	235200

Type-2: Parboiled Rice Milling: From the annual production in parboiled rice mill units for different capacities, it is seen that for a 2 TPH capacity the annual production is 4800 MT/Yr from 1 unit, whereas for a 3 TPH capacity the annual production is 72000 MT/Yr

from 10 units and 4 TPH is 230400 MT/Yr from 24 units. **Table 3** illustrates the annual production details of parboiled rice mills based on capacity of production.

Table 3 Average annual production in Parboiled rice mills

Capacity (TPH)	Processing Methodologies	No of Units	Annual Production (MT/Yr)
2	Parboiled Rice Mill	1	4800
3	Parboiled Rice Mill	10	72000
4	Parboiled Rice Mill	24	230400

The annual production from these rice mills is dependent on the availability of the paddy. The paddy is available during two seasons in a year i.e. First season is during April- May and paddy available during this season is fit for the production of boiled rice whereas the paddy available during the second season (November-January) is used mainly for raw rice production.

1.2.3 Specific energy consumption

Specific energy consumption both electrical and thermal energy per m^2 or MT of production for different type of Rice mills are furnished in Table 4 below:

Table 4 Specific energy consumption

Type	Capacity (TPH)	No. of Units	Production MT/Yr	Sp. Power Cons. kWh/T	Sp. Fuel Cons. kg/T
Type-1 Raw Rice Mills	1	24	57600	38.63	-
	2	49	235200	23.09	-
	Sub-Total	**73**	**292800**	**26.15**	**-**
Type-2 Par-boiled Rice Mills	2	1	4800	26.96	265
	3	10	72000	28.28	216
	4	24	230400	33.95	195
	Sub Total	**35**	**307200**	**32.51**	
	Total	**108**	**600000**		

1.3 Existing Technology / Equipment

1.3.1 Description of existing technology

In parboiled rice mills, electricity cost is about 25 to 30% of total cost and the rice husk consumption cost in boiler is about 70 to 75% of total energy consumption cost in a unit. Hence, about 60 to 70% of total energy cost in parboiled rice mills plant is in the boiler only. The boiler is the steam-generating equipment. Husk is burned in the furnace and the heat of combustion is transferred to evaporate water inside the boiler. This steam is used to soaking, cooking and drying the paddy.

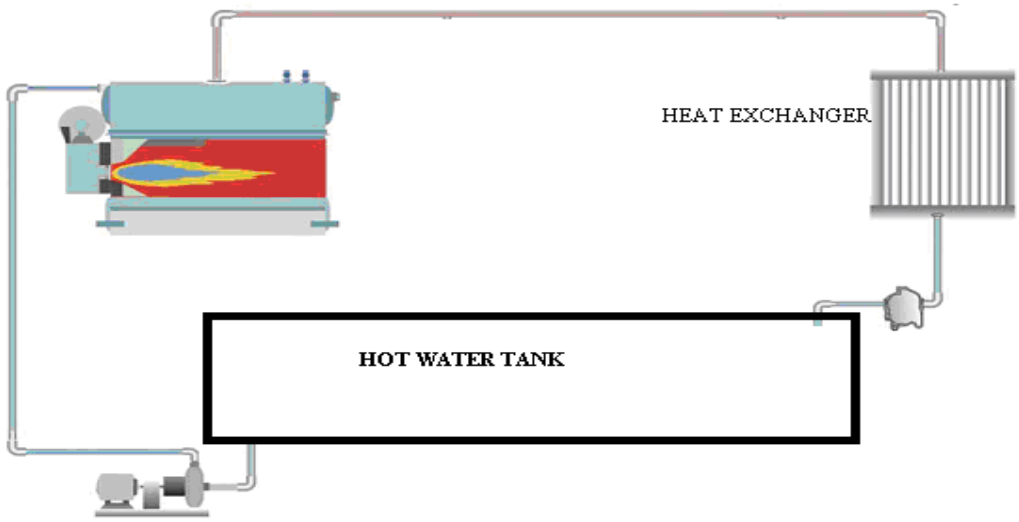


Figure 1: Schematic diagram of a typical dryer without condensate recovery system

In Warangal cluster the boilers are using Pneumatic over Feed (POF / POS) – The fuel is pneumatically lifted and fed from the top and is burnt over specially designed fire bars. Solid fuels like Rice husk can also be burnt using an ID fan additionally. All parboiled rice mills in Warangal Cluster not installed any condensate heat recovery system from the flue gas. It was observed that the condensate from the dryer heat exchanger out let was leaving at temperature of 90 ^{0}C - 60 ^{0}C. This temperature can be recovered by installing the condensate recovery system.

Table 5 Boiler specifications:

Components	Different Parts	Detail
Capacity		3000 kg/hr
Type	Shell & Tube	IS 2062
	Fully Wet Back	
	Three Pass	
Fuel		Rice Husk
Bed	Grate Bars	Alloy CI
Feeder	Vibratory or Screw	Constant speed motor
Firing system	Front door/ Top	SA 106 Gr.B
Furnace	Internal	IS 8 (50% Alumina)
Working Pressure		10.54 kg/cm2
Material of Construction	Tubes	BS 6323 ERW
	Shell	SA 106 Gr.B
	Chimney	M.S
Fabrication		Shop as well as Site Fabrication

Demand and Energy charges

At Warangal, electrical connection is taken from Andhra Pradesh Northern Power Distribution Company Limited at the following tariff rates:

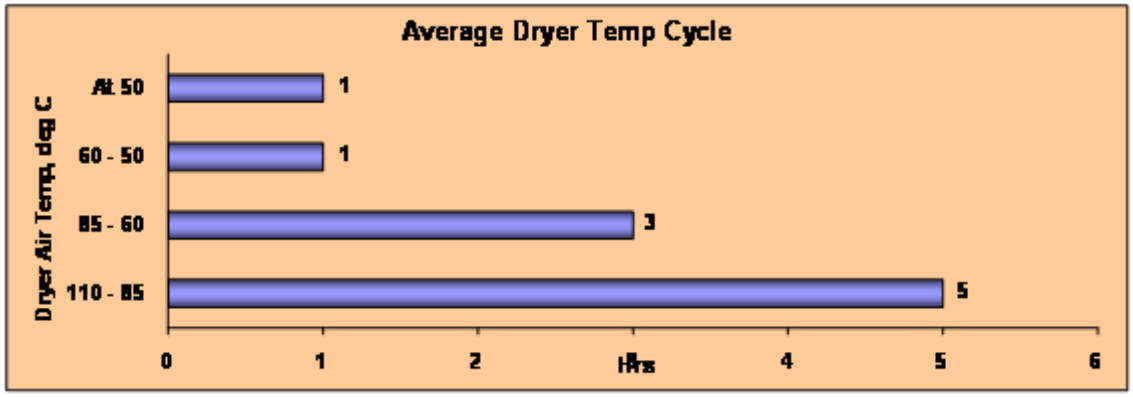
H.T Loads					
S. No	**Type of Connection**	**Category**	**Type of Consumers**	**Fixed/ Demand Charges**	**Energy Charges Ps/Unit**
1	HT	Category -1	Industrial General(Hotels, Hospitals, Restaurants, Clubs, Theaters, Cinemas Railway Stations)		
			132 kV and above	250/KVA/ Month	270
			33 kV	250/KVA/ Month	295
			11 kV and below	250/KVA/ Month	320
			Fans & Lighting Colony Consumption		440

If in any month the Recorded Maximum Demand (RMD) of the consumer exceeds his contracted demand with Licensee, the consumer will pay the following charges on excess demand and energy.

Excess RMD over CMD	**Demand Charges on Excess Demand**	**Energy Charges on Excess Energy**
100 to 120 %	2 times of normal charge	Normal
Above 120% and up to 200%	2 times of normal charge	1.5 times of normal charge
More than 200%	2 times of normal charge	2 times of normal charge
Excess demand and energy shall be computed as follows :- Excess Demand = (RMD – CMD) if RMD is more than CMD with Licensee Excess Energy – (Excess Demand/RMD) X Recorded Energy.		

1.3.2 Role in Process

The dryer uses preheated air at 70^{o}C – 80^{o}C for drying the parboiled paddy. The



moisture content of the paddy is reduced from 25% to 13%.This has a heat exchanger to heat air. There is a blower delivering air which passes through the heat exchanger, and the hot air is delivered to the drier. Energy Saving Opportunity: The condensate from the dryers could well be flashing away which represents heat loss that is recoverable.

A typical graph of drying cycle is as shown below:

1.4 Baseline establishment for existing technology

1.4.1 Design and operating parameters

Rice husk Consumption in boiler depends on the following parameters.

- Mass flow rate of feed water
- Steam temperature
- Mass flow rate of steam
- Calorific value of fuel
- Moisture in rice husk
- Combustion air flow
- Feed water temperature
- Temperature of combustion air
- Percentage combustible in ash
- Inlet air temperature in ºC (Ta)
- GCV of ash in kcal/kg
- Flue gas temperature in ºC (Tf)
- Ultimate analysis of fuel (H_2, O_2,S, C, moisture content, ash content)
- Percentage of oxygen or CO_2 in the flue gas
- Ambient temperature in ºC (Ta) & humidity of air in kg/kg of dry air.

Electricity requirement in the parboiled rice mill depend on production .Detail of rice husk consumption in parboiled rice mills is given in table 6 below.

Table 6 Electricity, Rice husk and diesel consumption

S. No.	Energy Type	Unit	Value	
			Min	Max
1	Electricity	kWh/year	307938	403824
2	**Rice Husk**	**MT/year**	**1950**	**2980**
3	Diesel	Liters/year	800	1200

Baseline			
S. no.	Parameters	Unit	Value
1	Boiler Capacity	TPH	3
2	Enthalpy of feed water @ 80 C and normal pressure	kcal/kg	80
3	Enthalpy of steam @ 110 C temp 10.5 bar pressure	kcal/kg	643.9
4	Heat required	kcal/hr	1691700

Baseline			
S. no.	Parameters	Unit	Value
5	Efficiency of existing boiler with older firing technique	%	60
6	Heat Input	kcal/hr	2819500
7	Rice Husk required (calorific value 3200 kcal/Kg)	Kg/hr	881.1
8	Rice Husk required Annually (@ 12hrs/day and 280 days/annum)	tonne/Annum	2960

1.4.2 Operating efficiency analysis

Operating efficiency of the boiler is found to be range of 45% to 72% .Specific energy consumption in the boiler is given in Annexure 1.

Table 7 Operating efficiency analysis for rice husk

S.No.	Type of Fuel	Unit	Specific Fuel Consumption	
			Min	Max
1	Rice Husk	Kg /MT	174	320

The operating efficiency of boiler is determined by indirect method. It includes the principal losses that occur in the boiler. Detailed parameters and calculations used for operating efficiency evaluation of boiler efficiency are given in the Annexure 1.

1.5 Barriers in adoption of proposed equipment

1.5.1 Technological barrier

In rice milling cluster at Warangal, overall technical understanding on rice manufacturing is good and is rapidly increasing. Some unit's prime equipments like rubber Sheller, whitener, polisher etc are imported from Japan and China. There is no separate electrician in each unit. In case, any problem occurs in the milling section and boiler section, the plant should be shutdown for one day. However, the first change is still a challenge, upon success, later on duplication and adaptation is extremely common in the cluster. The technologies need to be demonstrated within the cluster. While carrying out the audits and presenting the energy audit reports to the units, in the discussion with the plant owners, many of them agreed with many of the identified energy saving measures and technologies but they demanded demonstration of the energy saving technologies in any plant and thereafter they have readiness to follow.

1.5.2 Financial barrier

Availing finance is not a major issue. Among the SME's, the larger units, if convinced, are capable of either financing themselves or get the finance from their banks. The smaller units will require loan at comfortable rates and other support to raise the loan. However, as most of them have been able to expand their setup and grow, there is a

readiness to spend for energy efficiency technologies which have good returns. Energy Efficiency Financing Schemes such as that of SIDBI's, if focused on the cluster, will play a catalytic role in implementation of identified energy conservation projects & technologies. The cluster has significant potential of co-generation by using biomass (rice husk) and solar technologies. However, though there are good returns, this project is highly capital intensive and requires support of policy as well as innovative financial mechanisms. Initiative has already been taken by some of the units to install rice husk based co-generation. Clean Development Mechanism (CDM) needs to be duly applied to generate additional cash flow to further improve the returns from the project.

1.5.3 Skilled manpower

At Warangal rice mill cluster, availability of skilled manpower is one of the limitations. Number of rice mill units has grown fast as compared to the availability of skilled manpower. Two to three local electrical persons available at Warangal takes care of about 15 to 20 Rice mill units. For major equipments like polisher, whitener, capacitors banks status checking, boiler section and remaining motors in the unit etc. Maintenance or the repair work of these equipments is take care by the equipment suppliers themselves. Local technical persons at Warangal take care of most of the matters. The units have age-old inefficient practices and well-experienced non-qualified staff in these industries. Even if the qualified staff joins for the sake of experience it jumps to other big industry after getting sufficient experience this is because of low pay packages. These are the major barriers in the technological development of the SME's. Specialized and focused training of the local service providers on better operation and maintenance of the equipments, importance of the energy and its use and energy conservation measures will improve awareness among the unit owners and workforce. Original equipment suppliers should also participate in these programs.

1.5.4 Any other barrier

Many of the new technology provider's (especially some foreign technology leaders) have not shown keen interest in implementation of their new innovative technologies. This appears to be because of fear of duplication. The service providers for the Warangal cluster are available in the radius of 150 to 200 kms and are mainly from important cities such as Vijaywada and Hyderabad. Warangal is well connected by intercity train service and highways to both the cities. Few of the service providers have their activities in Warangal. More than fifty service providers of technologies for energy efficiency improvements are located in these cities.

2. PROPOSED EQUIPMENT FOR ENERGY EFFICIENCY IMPROVEMENT

2.1 Description of proposed equipment

2.1.1 Detailed of proposed equipment

The steam is used for indirect heat transfer in heat exchanger it gives off its latent heat (useful heat) to process and converts itself into liquid form known as condensate. This high pressure condensate when released to atmospheric pressure can no longer hold high heat content. The excess heat is released as flash steam. High pressure condensate is at almost the same pressure as same pressure as steam and contains around 15 to 20% heat of fuel. This heat if recovered shall reduce fuel consumption to the extent of 20%. In addition to the fuel savings, boiler quality water is also recovered, and is used in boiler .This has effect of water and water treatment chemicals. Further good quality boiler feed water reduces the blow down losses resulting in fuel savings. To summarize, the efficient condensate recovery system will ensure.

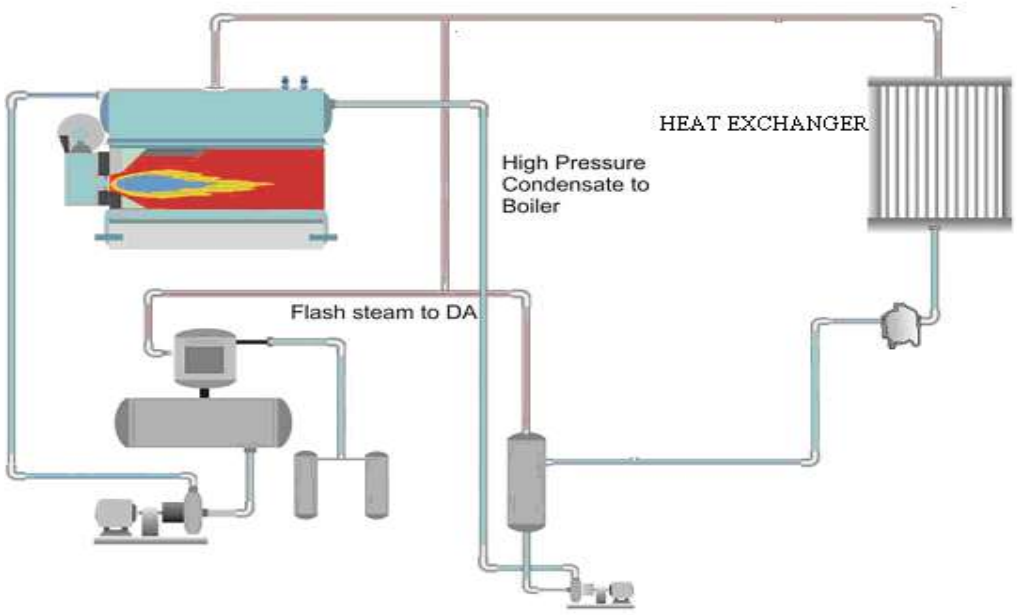


Figure 2: Schematic diagram of a typical dryer with condensate recovery system

Table 8 Detail design of Condensate Recovery System (CRS)

Parameter	With Out CRS (Existing)	With CRS (New)
Feed Water Temperature	Low	High
Quality of boiler feed water	Poor	Good
Blow down losses	High	Low
Water Treatment losses	High	Low

For implementation of the proposed technology as per the following modifications are required in existing boiler.

1 Civil foundations for total system.

2 Pipe line for heat exchanger outlet to feed water tank.

3 Power/control cables.

4 Any changes / relocation of equipments / structural members to install this kit considering actual boiler house layout.

2.1.2 Equipment/technology specifications

Detailed specifications of condensate recovery system (CRS) are furnished in Annexure 7.

Product Features

Condensate recovery system is an integrated system comprising of a Flash Steam Generator, Steam operated Condensate Transfer Pump and a Deareator Unit with immersion tube and Low cost heating.

2.1.3 Suitability or Integration with existing equipment

This system recovers efficiently flash steam, hot condensate and feed them to the feed water tank through a well designed Deareator unit with immersion tube. The efficiency of boiler improvement is 2 to 5%. The following are the reasons for selection of this technology.

- It will reduce the total operating energy cost of the plant.
- It reduces the GHG emissions.
- Minor modification in existing feed water system.
- Soaking, cooking and drying process are major thermal energy consumers.

2.1.4 Superiority over existing system

Among existing boiler used in India, boilers based on bubble bed combustion is one of the design having lowest specific energy consumption. The revenue generation will increase after implementation of this project and makes this project more financially feasibility.

2.1.5 Availability of technology /equipment

Suppliers of this technology are available at local as well international level very easy. Even most of the suppliers took initiative and interacting with the parboiled rice mill owners for creating the awareness of use of this technology at parboiled rice mills.

2.1.6 Source of equipment

This technology is already implemented and operation in most of the parboiled rice mills in India. Though it is not a very popular technique in parboiled rice mill industry in Warangal cluster, but it is one of the most fuel efficient technologies available.

2.1.7 Service providers

Details of technology service providers are shown in Annexure 6.

2.1.8 Terms and Conditions in sales of equipment

Scope of supply, terms and conditions differ from equipment suppliers. Further details of terms and condition are also shown in Annexure 7.

2.1.9 Process down time

Process down time of the boiler is about 3 to 4 weeks after all material reached site and fuel feeding line / fuel storage modified when boiler is working (Keeping existing system working).

2.2 Life cycle assessment and risks analysis

Life of the equipment is about 8-10 years. No need to any further huge modification after one time technology changes, in case of risk analysis there is a need of proper training of boiler operator for new combustion system.

2.3 Suitable unit /Plant for implementation of proposed technology

Suitable unit for implementation of this technology are parboiled rice mills having the production capacity of about 24tonnes/batch dryers.

3. ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY

3.1 Technical benefit

3.1.1 Fuel savings

Rice husk consumption in the parboiled rice mills will reduce the after implementation of the technology. Project implementation will lead to save about 140.1 T rice husk per year.

3.1.2 Improvement in product quality

There would be no direct impact in product quality, but fuel consumption would be lower hence increasing the efficiency of the boiler.

3.1.3 Improvement in production

There would be no direct impact in production; the lower fuel consumption using this technology will reduce the operational cost of the finished product.

3.1.4 Reduction in raw material

Raw material consumption is same even after the implementation of proposed technology.

3.1.5 Reduction in other losses

Heat loss is only loss covered by this technology; heat recovery from the condensate will reduce the overall fuel consumption.

3.2 Monetary benefits

Rice husk Savings in boilers using CRS is about 140.1 Metric tons per year. Savings due to the recovered heat from steam and availability of preheated condensate water for boiler operation thus increase in efficiency of the boiler by 2 to 5%. Hence total monetary benefit due to implementation of this project will be about ` 2.52 lakhs

3.3 Social benefits

3.3.1 Improvement in working environment

Lesser the fuel required so extra space could be recovered and used for another applications.

3.3.2 Improvement in skill set of workers

Boiler operator skills definitely are improved. As the training will be provided by equipment suppliers which improve the technical skills of manpower required for operating of the equipment and also the technology implementation will create

awareness among the workforce about energy efficiency and energy savings.

3.4 Environmental benefits

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

There are significant reductions to be achieved in Green House Gas emission by adoption of bubbling bed firing technology. This project results in reduction of about 58.04 tCO2 reductions per year. The other benefits include, decrease in particulate pollution levels in boiler and surrounding area.

3.4.3 Reduction in other emissions like Sox

No such harmful emissions, during the course of using rice husk as fuel.

4. IMPLEMENTATION OF NEW EFFICIENT TECHNOLOGY

4.1 Cost of technology implementation

4.1.1 Cost of technology

The Detailed cost of the Condensate recovery system for 24 TPB dryer systems is listed in the table below.

Table 9 Cost of equipment

S. No	Particular	Unit	Value
1	Condensate Recovery Pump (TACTS300i Plus)	`	162500
2	Flash Vessel (TAFS200)	`	74480
3	Deareator (TADIT 150)	`	52380
4	Cost of civil work	`	50000
5	EPC cost	`	16968
6	***Total cost***	`	***356328***

Table 10 Other Charges (Taxes & Misc. Charges)

S. No	Particular	Unit	Value
1	Consultancy	`	10000
2	Packaging and Forwarding 3%	`	8681
3	CST 2%	`	5787
4	Taxes on Consultancy 10.5%	`	1050
5	Excise 10.3%	`	29804
6	***Total***	`	***55322***

Total cost of the proposed system is ` 4.12 lakh

4.2 Arrangement of funds

4.2.1 Entrepreneur's contribution

Proposed financing of Condensate Recovery System 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

Profitability and cash flow statements have been worked out for a period of 8 years. The Financials have been worked out on the basis of certain reasonable assumptions, which

are outlined below.

The project is expected to achieve monetary savings of ` 2.52 lakh per anuuam.

- The Operation and Maintenance cost is estimated at 2% of cost of total project with 5% increase in every year as escalations.
- Interest on term loan is estimated at 10%.
- Depreciation is provided as per the rates provided in the companies act.

Considering the above mentioned assumptions, the net cash accruals starting with ` 1.84 lakhs in the first year operation and gradually increases to `9.91 lakhs at the end of eighth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ` 4.12 lakhs and monetary saving is ` 2.52 lakhs hence, the simple payback period works out to be 1.63 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10% works out to be ` 5.55 lakh.

4.3.4 Internal rate of return (IRR)

The after tax IRR of the project works out to be 45.43%. Thus the project is financially viable.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 27.30%.

Financial indicator of proposed technology is furnished in Table 11 below:

Table 11 Financial indication of proposed technology/equipment

S.No	Particulars	Unit	Value
1	Simple Pay Back period	Month	20
2	IRR	% age	45.43
3	NPV	lakhs	5.55
4	ROI	% age	27.30
5	DSCR	Ratio	2.61

4.4 Sensitivity analysis

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

- Optimistic scenario (Increase in fuel savings by 5%)
- Pessimistic scenario (Decrease in fuel savings by 5%)

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

Details of sensitivity analysis at different scenarios are shown in Table 12 below:

Table 12 Sensitivity analysis at different scenarios

Scenario	*IRR* %	*NPV* ` in lakh	*ROI* %	*DSCR*
Normal	45.43	5.55	27.30	2.61
5% increase in fuel Saving	48.29	6.04	27.45	2.74
5% decrease in fuel Saving	42.55	5.07	27.13	2.48

4.5 Procurement and implementation schedule

Procurement and implementation schedule for proposed project is about 14 weeks process down time is shown in the table 13 and rest 10 weeks are for order placement and delivery.

Table 13 Procurement and implementation Schedule

S. No	Activities	Weeks			
		1	2	3	4
1	Foundations & Civil Work				
2	Erection & Commissioning of CRS system				
3	Piping & Insulation				
4	Testing & Trial				
5	On site operator training				

Annexure – 1: Energy audit reports used for establishing

The results of 5, 4TPH boiler detail energy audit with efficiency is given below

Audit No. 1

S. No	Parameter	Unit	Value
1	Boiler Capacity	TPH	4
2	Feed water temperature (T1)	^{0}C	60
3	Enthalpy of feed water(h2)	kcal/kg	60
4	Process steam pressure (P)	kg/cm2	10.5
5	Inlet steam temperature (T2)	^{0}C	110
6	Steam Enthalpy at steam turbine inlet(h1)	kcal/kg	643.9
7	Mass Flow rate of fuel (mf)	kg/h	763
8	% Hydrogen in fuel	%	5.70
9	% Carbon in fuel	%	38.5
10	% Oxygen	%	38.5
11	% Nitrogen	%	0.5
12	% Sulphur	%	0
13	G.C.V	Kcal/kg ^{0}C	3600
14	Moisture in fuel	%	10
15	Ash in fuel	%	15
16	G.C.V of Bottom Ash	Kcal/kg ^{0}C	900
17	G.C.V of Fly Ash	Kcal/kg ^{0}C	650
18	Ratio of bottom Ash to Fly Ash		80:20
19	Percentage of oxygen in flue gas	%	7
20	Flue gas temperature	^{0}C	210
21	Ambient Temperature	^{0}C	30
22	Humidity of air	kg/kg of dry air	0.018

Efficiency of Boiler

Based on the measured data the boiler efficiency is calculated and presented below

Efficiency Calculation			
S. No	Heat Loss Description	GCV Based	
		kCal/kg	%
1	Loss due to heat in dry flue gases	715	19.9%
2	Loss due to physically bound moisture in fuel	60	2.0%
3	Loss due to chemically bound moisture from burning of hydrogen	386	10.7%
4	Loss due to un-burned carbon in ash	64	1.8%
5	Loss due to formation of CO	0.1	0.0%
6	Loss due to radiation & convection (Unmeasured)	108	3.0%
	Total Heat Loss	**1333**	**37**
	Efficiency	**63%**	

Audit No. 2

S. No	Parameter	Unit	Value
1	Boiler Capacity	TPH	4
2	Mass Flow rate of steam (ms)	kg/h	4000
3	Feed water temperature (T1)	^{0}C	65
4	Process steam pressure (P)	kg/cm^2	10.5
5	Inlet steam temperature (T2)	^{0}C	110
6	Mass Flow rate of fuel (mf)	kg/h	685
7	% Hydrogen in fuel	%	7.50
8	% Carbon in fuel	%	38.5
9	% Oxygen	%	29.5
10	% Nitrogen	%	0.5
11	% Sulphur	%	0
12	G.C.V	Kcal/kg ^{0}C	3600
13	Moisture in fuel	%	8
14	Ash in fuel	%	16
15	G.C.V of Bottom Ash	Kcal/kg ^{0}C	900
16	G.C.V of Fly Ash	Kcal/kg ^{0}C	650
17	Ratio of bottom Ash to Fly Ash		80:20
18	Percentage of oxygen in flue gas	%	7.5
19	Flue gas temperature	^{0}C	180
20	Ambient Temperature	^{0}C	30
21	Humidity of air	kg/kg of dry air	0.018

Efficiency of Boiler

Based on the measured data the boiler efficiency is calculated and presented below.

Efficiency Calculation			
S. No	Heat Loss Description	GCV Based	
		kCal/kg	%
1	Loss due to heat in dry flue gases	390	10.8
2	Loss due to physically bound moisture in fuel	52	1.7
3	Loss due to chemically bound moisture from burning of hydrogen	436	12.1
4	Loss due to un-burned carbon in ash	68	1.9
5	Loss due to formation of CO	0.1	0.0
6	Loss due to radiation &convection (Unmeasured)	108	3.0
	Total Heat Loss	**1053**	**29**
	Efficiency	**70.7**	

Audit No.3

S. No	Parameter	Unit	Value
1	Boiler Capacity	TPH	4
2	Mass Flow rate of steam (ms)	kg/h	4000
3	Feed water temperature (T1)	^{0}C	60
4	Enthalpy of feed water(h2)	kcal/kg	60
5	Process steam pressure (P)	kg/cm^2	10.5
6	Inlet steam temperature (T2)	^{0}C	110
7	Steam Enthalpy at steam turbine inlet (h1)	kcal/kg	643.9
8	Mass Flow rate of fuel (mf)	kg/h	822
9	% Hydrogen in fuel	%	5.70
10	% Carbon in fuel	%	38.5
11	% Oxygen	%	38.5
12	% Nitrogen	%	0.5
13	% Sulphur	%	0
14	G.C.V	Kcal/kg ^{0}C	3600
15	Moisture in fuel	%	8
16	Ash in fuel	%	16
17	G.C.V of Bottom Ash	Kcal/kg ^{0}C	1000
18	G.C.V of Fly Ash	Kcal/kg ^{0}C	650
19	Ratio of bottom Ash to Fly Ash		80:20
20	Percentage of oxygen in flue gas	%	7
21	Flue gas temperature	^{0}C	210
22	Ambient Temperature	^{0}C	30
23	Humidity of air	kg/kg of dry air	0.018

Efficiency of Boiler

Based on the measured data the boiler efficiency is calculated and presented below.

Efficiency Calculation			
S No	Heat Loss Description	GCV Based	
		kCal/kg	%
1	Loss due to heat in dry flue gases	714	19.8%
2	Loss due to physically bound moisture in fuel	53	1.8%
3	Loss due to chemically bound moisture from burning of hydrogen	386	10.7%
4	Loss due to un-burned carbon in ash	68	1.9%
5	Loss due to formation of CO	0.1	0.0%
6	Loss due to radiation & convection (Unmeasured)	108	3.0%
	Total Heat Loss	**1355**	**100%**
	Efficiency	**63.1%**	

Audit No.4

S. No	Parameter	Unit	Value
1	Boiler Capacity	TPH	3
2	Mass Flow rate of steam (ms)	kg/h	3000
3	Feed water temperature (T1)	^{0}C	55
4	Process steam pressure (P)	kg/cm^2	10.5
5	Inlet steam temperature (T2)	^{0}C	110
6	Mass Flow rate of fuel (mf)	kg/h	540
7	% Hydrogen in fuel	%	7.00
8	% Carbon in fuel	%	38.5
9	% Oxygen	%	28.5
10	% Nitrogen	%	0.5
11	% Sulphur	%	0
12	G.C.V	Kcal/kg ^{0}C	3600
13	Moisture in fuel	%	9
14	Ash in fuel	%	16
15	G.C.V of Bottom Ash	Kcal/kg ^{0}C	900
16	G.C.V of Fly Ash	Kcal/kg ^{0}C	650
17	Ratio of bottom Ash to Fly Ash		80:20
18	Percentage of oxygen in flue gas	%	9
19	Flue gas temperature	^{0}C	200
20	Ambient Temperature	^{0}C	30
21	Humidity of air	kg/kg of dry air	0.018

Efficiency of Boiler

Based on the measured data the boiler efficiency is calculated and presented below.

Efficiency Calculation			
S. No	Heat Loss Description	GCV Based	
		kCal/kg	%
1	Loss due to heat in dry flue gases	1205	33.5
2	Loss due to physically bound moisture in fuel	59	2.00
3	Loss due to chemically bound moisture from burning of hydrogen	413	11.5
4	Loss due to un-burned carbon in ash	68	1.9
5	Loss due to formation of CO	0.1	0.0
6	Loss due to radiation &convection (Unmeasured)	108	3.0
	Total Heat Loss	1853	51
	Efficiency	49%	

Audit No.5

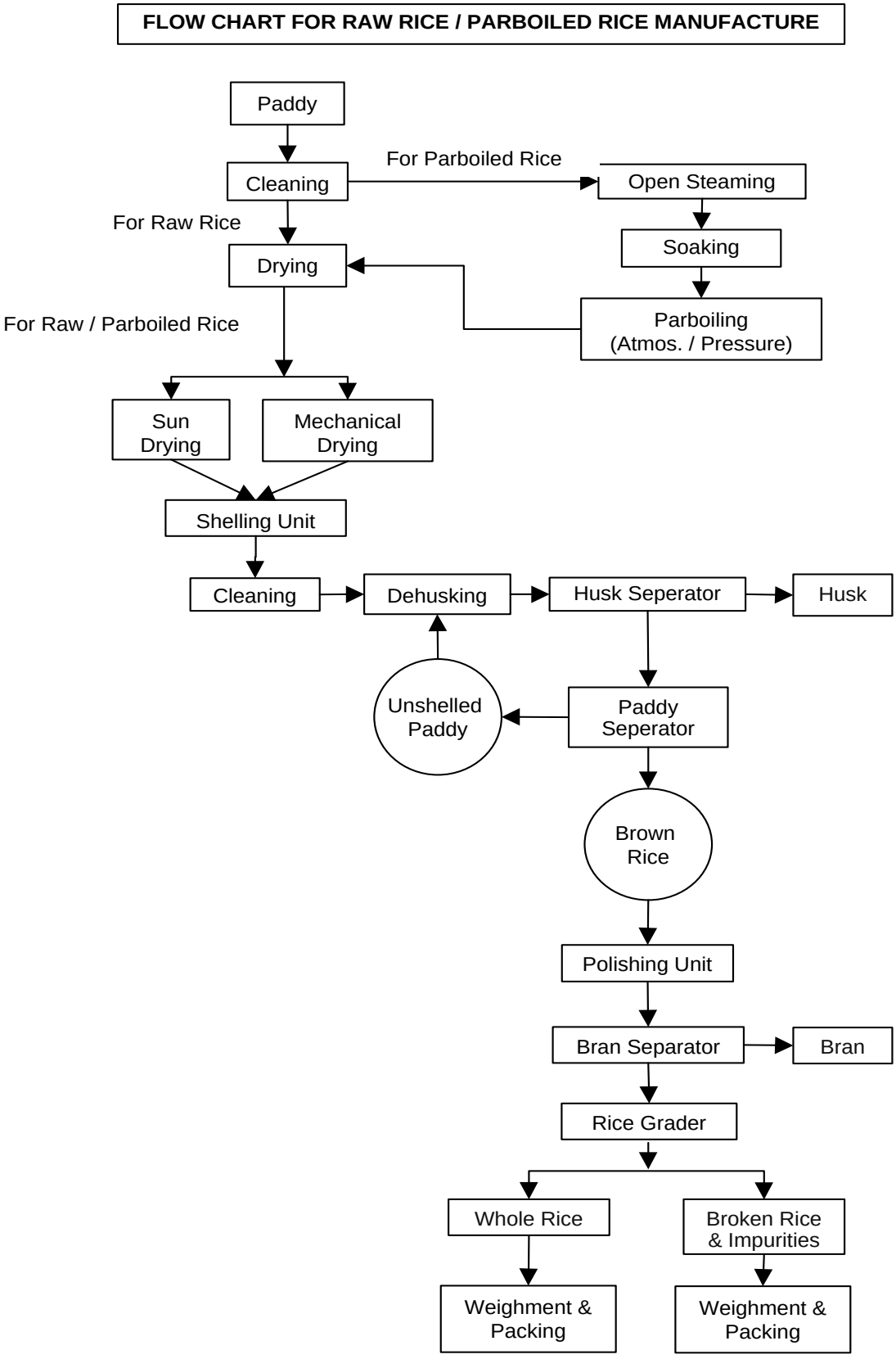
S. No	Parameter	Unit	Value
1	Boiler Capacity	TPH	4
2	Mass Flow rate of steam (ms)	kg/h	4000
3	Feed water temperature (T1)	^{0}C	60
4	Enthalpy of feed water(h2)	kcal/kg	60
5	Process steam pressure (P)	kg/cm^2	10.5
6	Inlet steam temperature (T2)	^{0}C	110
7	Steam Enthalpy at steam turbine inlet(h1)	kcal/kg	643.9
8	Mass Flow rate of fuel (mf)	kg/h	855.2
9	% Hydrogen in fuel	%	5.70
10	% Carbon in fuel	%	38.5
11	% Oxygen	%	38.5
12	% Nitrogen	%	0.5
13	% Sulphur	%	0
14	G.C.V	Kcal/kg ^{0}C	3600
15	Moisture in fuel	%	8
16	Ash in fuel	%	15
17	G.C.V of Bottom Ash	Kcal/kg ^{0}C	900
18	G.C.V of Fly Ash	Kcal/kg ^{0}C	650
19	Ratio of bottom Ash to Fly Ash		80:20
20	Percentage of oxygen in flue gas	%	7
21	Flue gas temperature	^{0}C	200
22	Ambient Temperature	^{0}C	30
23	Humidity of air	kg/kg of dry air	0.018

Efficiency of Boiler

Based on the measured data the boiler efficiency is calculated and presented below.

Efficiency Calculation			
S. No	Heat Loss Description	GCV Based	
		kCal/kg	%
1	Loss due to heat in dry flue gases	1086	30.2
2	Loss due to physically bound moisture in fuel	53	1.8
3	Loss due to chemically bound moisture from burning of hydrogen	336	9.3
4	Loss due to un-burned carbon in ash	64	1.8
5	Loss due to formation of CO	0.1	0.0
6	Loss due to radiation & convection (Unmeasured)	108	3.0
	Total Heat Loss	**1647**	**46**
	Efficiency	**54.2**	

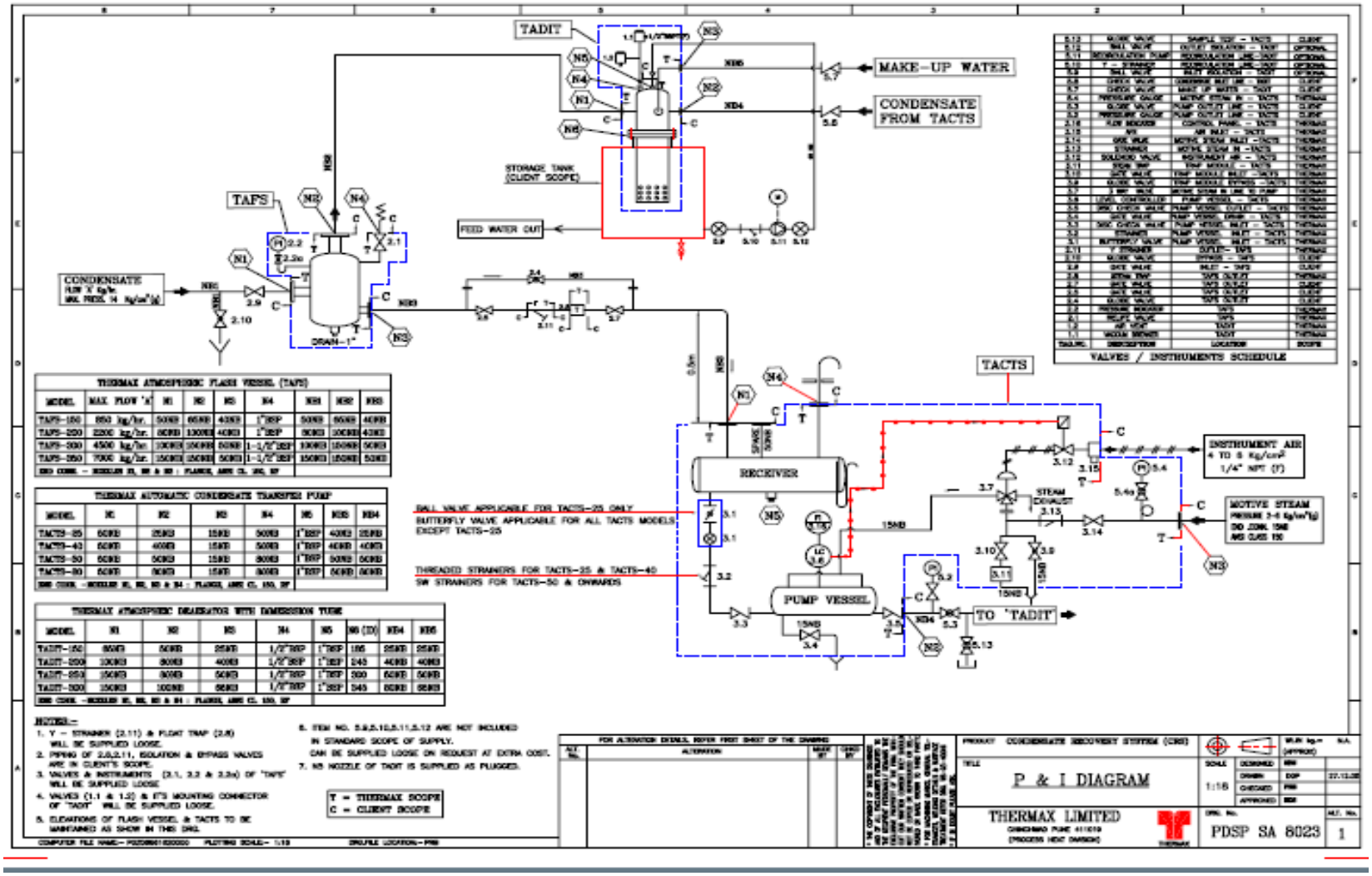
Annexure – 2: Process flow diagram



Annexure – 3: Detailed technology assessment report

Parameter	Units	Value
Total enthalpy of steam at 10 bars	kcal/kg	672
Condensate quantity	kg/hr	1400
Condensate pressure	kg/cm^2	10.5
Low pressure process steam pressure	kg/cm^2	3.5
Sensible heat of condensate at 10 bars	kcal/kg	182.45
Sensible heat of condensate at 3.5 bars	kcal/kg	139.8
Latent heat of condensate at 3.5 bars	kcal/kg	653.5
Boiler Efficiency (on GCV / Solid, NCV / Liquid)	%	75
Fuel used in boiler		Rice Husk
Calorific Value of Fuel	kcal/kg	3100
Condensate Return temperature after flashing	^0C	85
Make-up water temperature	^0C	30
Cost of fuel	`/kg	1.80
Flash Steam Pressure	kg/cm^2	0.5
Daily boiler working hours	hrs	12
Annual operating days	days	280
Flash Steam Calculations		
Flash Steam Generation	%	6.53
Amount of Flash	kg/hr	91.42
Heat from Flash steam	kCal/kg	672
Total heat saving	Kcal/day	737211
Calorific Value of Fuel	kCal/kg	3200
Fuel saving through Flash steam	Kg/day	230.4
Fuel saving through Flash steam	Tonne/Year	64.5
Monitory savings	`/annum	116,111
Condensate Calculations		
Quantity of Condensate after flashing	Kg/hr	1308.58
Base line feed water Temperature	^0C	25
Temperature of Condensate fed to the boiler	^0C	80
Heat recovery potential from condensate	Kcal/kg	55
Heat recovery potential from condensate	Kcal/day	863663
Fuel saving through Condensate recoverable heat	Kg/day	270
Fuel saving through Condensate recoverable heat	Tonne/Year	75.6
Annual monetary savings	`	136080
Total Annual Saving	`	252,191
Cost of CRS System	`(in lakh)	4.12
Payback Period	year	1.63

Annexure – 4: P& I Diagram for CRS System



Annexure – 5: Detailed financial analysis

Assumption

Name of the Technology	Condensate Recovery System		
Rated Capacity	*24 TPB*		
Details	*Unit*	*Value*	*Basis*
Installed Capacity	TPB	24	Feasibility Study
No of working days	Days	280	Feasibility Study
No of Operating Hours per day	Hrs./day	12	Feasibility Study
Proposed Investment			
Plant & Machinery	` (in lakh)	2.89	
Civil work, Cabling & panel	` (in lakh)	0.50	
EPC cost	` (in lakh)	0.17	
Misc. cost(consultancy)	` (in lakh)	0.55	
Total Investment	` (in lakh)	4.12	Feasibility Study
Financing pattern			
Own Funds (Equity)	` (in lakh)	1.03	Feasibility Study
Loan Funds (Term Loan)	` (in lakh)	3.09	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	2.00	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Monetary Saving	Tonne/Annum	140.1	
Annual production cost	`/Tonne	1800	
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	3.09	0.24	2.85	0.36
2	2.85	0.48	2.37	0.26
3	2.37	0.52	1.85	0.21
4	1.85	0.60	1.25	0.16
5	1.25	0.75	0.50	0.10
6	0.50	0.50	0.00	0.01
		3.09		

WDV Depreciation (`in lakh)

Particulars / years	1	2
Plant and Machinery		
Cost	4.12	0.82
Depreciation	3.29	0.66
WDV	0.82	0.16

Project Profitability (`in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Revenue through Savings								
Total Revenue (A)	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52
Expenses								
O & M Expenses	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12
Total Expenses (B)	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12
PBDIT (A)-(B)	2.44	2.44	2.43	2.43	2.42	2.42	2.41	2.41
Interest	0.36	0.26	0.21	0.16	0.10	0.01	-	-
PBDT	2.08	2.17	2.22	2.27	2.33	2.40	2.41	2.41
Depreciation	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
PBT	1.87	1.96	2.00	2.05	2.11	2.18	2.19	2.19
Income tax	-	0.51	0.75	0.77	0.79	0.82	0.82	0.82
Profit after tax (PAT)	1.87	1.44	1.25	1.28	1.32	1.37	1.37	1.37

Computation of Tax (`in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Profit before tax	1.87	1.96	2.00	2.05	2.11	2.18	2.19	2.19
Add: Book depreciation	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Less: WDV depreciation	3.29	0.66	-	-	-	-	-	-
Taxable profit	(1.21)	1.51	2.22	2.27	2.33	2.40	2.41	2.41
Income Tax	-	0.51	0.75	0.77	0.79	0.82	0.82	0.82

Project Balance Sheet (`in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Liabilities								
Share Capital (D)	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
Reserves & Surplus (E)	1.87	3.31	4.55	5.83	7.15	8.52	9.89	11.27
Term Loans (F)	2.85	2.37	1.85	1.25	0.50	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	5.74	6.70	7.43	8.11	8.68	9.55	10.92	12.29
Assets								
Gross Fixed Assets	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12
Less: Accm. Depreciation	0.22	0.43	0.65	0.87	1.09	1.30	1.52	1.74
Net Fixed Assets	3.90	3.68	3.46	3.25	3.03	2.81	2.59	2.38
Cash & Bank Balance	1.84	3.02	3.96	4.86	5.65	6.73	8.33	9.91
Total Assets	5.74	6.70	7.43	8.11	8.68	9.55	10.92	12.29
Net Worth	2.90	4.34	5.58	6.86	8.18	9.55	10.92	12.29
Dept equity ratio	2.77	2.30	1.80	1.21	0.48	0.00	0.00	0.00

Project Cash Flow (`in lakh)

Particulars / Years	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Sources									
Share Capital	1.03	-	-	-	-	-	-	-	-
Term Loan	3.09								
Profit After tax		1.87	1.44	1.25	1.28	1.32	1.37	1.37	1.37
Depreciation		0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Total Sources	4.12	2.08	1.66	1.46	1.50	1.54	1.59	1.59	1.59
Application									
Capital Expenditure	4.12								
Repayment of Loan	-	0.24	0.48	0.52	0.60	0.75	0.50	-	-
Total Application	4.12	0.24	0.48	0.52	0.60	0.75	0.50	-	-
Net Surplus	-	1.84	1.18	0.94	0.90	0.79	1.09	1.59	1.59
Add: Opening Balance	-	-	1.84	3.02	3.96	4.86	5.65	6.73	8.33
Closing Balance	-	1.84	3.02	3.96	4.86	5.65	6.73	8.33	9.91

Calculation of Internal Rate of Return

Particulars / months	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit after Tax		1.87	1.44	1.25	1.28	1.32	1.37	1.37	1.37
Depreciation		0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Interest on Term Loan		0.36	0.26	0.21	0.16	0.10	0.01	-	-
Cash outflow	(4.12)	-	-	-	-	-	-	-	-
Net Cash flow	(4.12)	2.44	1.92	1.68	1.66	1.63	1.60	1.59	1.59
IRR	45.43%								
NPV	5.55								

Break Even Point (`in lakh)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Variable Expenses								
Operation & Maintenance Exp (75%)	0.06	0.06	0.07	0.07	0.08	0.08	0.08	0.09
Sub Total (G)	0.06	0.06	0.07	0.07	0.08	0.08	0.08	0.09
Fixed Expenses								
Operation & Maintenance Exp (25%)	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
Interest on Term Loan	0.36	0.26	0.21	0.16	0.10	0.01	0.00	0.00
Depreciation *(H)*	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Sub Total (I)	0.59	0.50	0.45	0.40	0.34	0.26	0.24	0.25
Sales (J)	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52
Contribution (K)	2.46	2.46	2.45	2.45	2.45	2.44	2.44	2.44
Break Even Point (L= G/I) (%)	24.15%	20.42%	18.52%	16.26%	13.79%	10.58%	10.04%	10.11%
Cash Break Even {(I)-(H)} (%)	15.32%	11.58%	9.66%	7.40%	4.91%	1.69%	1.13%	1.19%
Break Even Sales (J)*(L)	0.61	0.52	0.47	0.41	0.35	0.27	0.25	0.26

Return on Investment

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Net Profit Before Taxes	1.87	1.96	2.00	2.05	2.11	2.18	2.19	2.19	16.55
Net Worth	2.90	4.34	5.58	6.86	8.18	9.55	10.92	12.29	60.62
ROI	27.30%								

Debt Service Coverage Ratio

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Cash Inflow									
Profit after Tax	1.87	1.44	1.25	1.28	1.32	1.37	1.37	1.37	8.52
Depreciation	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	1.30
Interest on Term Loan	0.36	0.26	0.21	0.16	0.10	0.01	0.00	0.00	1.10
Total (M)	2.44	1.92	1.68	1.66	1.63	1.60	1.59	1.59	10.92

Debt

Interest on Term Loan	0.36	0.26	0.21	0.16	0.10	0.01	0.00	0.00	1.10
Repayment of Term Loan	0.24	0.48	0.52	0.60	0.75	0.50	0.00	0.00	3.09
Total (N)	0.60	0.74	0.73	0.76	0.85	0.51	0.00	0.00	4.19
Average DSCR (M/N)	2.61								

Annexure – 6: Detailed of technology service providers

S. No	Name of Service Provider	Address	Contact Person and No
1	**THERMAX LIMITED**	6-3-649,NALANDA COMPLEX, SOMAJIGUDA,HYDERABAD-500082,INDIA TEL: (040) 23310254 Fax : (40) 23312335	Mr. Hareesh Raman E-mail :hareesh.raman@thermaxindia.com Mobile: +91 8008889421
2	**CHEEMA BOILER LIMITED**	Flat #301B,Naga Sai Nivas Sreenivasa Nagar (E) S.R. Nagar, Hyderabad-500 038,INDIA TEL: +91 (040) 66821160 Fax :+91 (40) 66821161	Mr. Narsimham Ganti E-mail :Cheemahyd@cheemaboilers.com Mobile: +91 9849695585

Annexure – 7: Quotations of Techno-commercial bids for new Technology/equipment

TECHNO - COMMERCIAL OFFER

FOR

CONDENSATE RECOVERY SYSTEM & VALVES

Offer No: C&H/ SSBU/FEMS/HR/10-11/1
Rev. No: 0

Submitted by

FACILITY ENERGY MANAGEMENT SOLUTIONS GROUP
COOLING AND HEATING DIVISION- SERVICES SBU
THERMAX LIMITED
INDIA

Contact person	Hareesh Raman
Phone No.	+918008889421
E-mail ID	vk@thermaxindia.com,hareesh.raman@thermaxindia.com,haresaran123@gmail.com

ANNEXURE –I - An Overview of the Proposed System

THERMAX CONDENSATE RECOVERY SYSTEM (TCRS)



Condensate is formed when steam liberates heat and converts from vapor to liquid phase. The condensate is relatively pure compared to most water sources. Condensate is an excellent source of feed water for boiler. Since condensate has low TDS, concentration of TDS in boiler feed water is substantially lower, which results in a reduction of heat lost through blow-down, which reduces the amount of heat, required to maintain operating pressures.

Condensate has a fair amount of heat. For example, condensate at 3.5 Kg cm2 (g) contains approximately 144 kcal of heat per kg of condensate. If this hot water is fed to the boiler, the amount of heat required to heat it back to the saturation temperature of the boiler reduces. This means that the fuel consumption of the boiler will reduce. As a thumb rule, every 6 ° C rise in feed water temperature leads to an improvement in thermal efficiency by 1%.

Thermax's Condensate Recovery System is an integrated system comprising of a Flash Steam Generator, Steam Operated Condensate Transfer Pump and a De-aerator with immersion tube

SALIENT FEATURES OF NEW TACTS SERIES (TACTS ^{plus} AND TACTS ^{ultra})

- High availability due to **zero moving parts.**
- High motive inlet pressure up to 10 bar for TACTS ^{ultra} series. No need of pressure reducing valve/ station till 10 bar where low pressure steam is not available, hence saving of installation cost
- High discharge of condensate of 50 liters per stroke
- High condensate temperature return- No cavitational issues over electrical pumps

- Skid mounted unit – Easy to install
- CE approved conductivity based level controller (a stringent quality & design process followed in European market, to ensure safe operation)
- A large LED display with 8 digits flow totaliser to display the total volume displaced up to 99999 m3. This does not require resetting the totaliser for 2 – 3 years.
- Flow totaliser designed with SMPS power supply can work with wide voltage variation from 90 to 270V
- Weather proof IP 65 design – suitable for outdoor installations
- Energy efficient pump – Steam trap drain and pump vent taken back to the receiver tank to minimize vent losses and save precious fuel

THERMAX ATMOSPHERIC FLASH VESSEL (TCRS)



After the process and trap, high pressure condensate is collected into this vessel through condensate pipeline. Condensate is then flashed here by the method of volume expansion and flash steam is recovered totally, whereas pure condensate settles down at the bottom portion of the vessel. This flash steam contents high energy/enthalpy in terms of latent heat. From this vessel the flash steam is taken to the feed water service tank where it releases the total latent heat into the cold make-up water. Pure condensate is taken into the feed water service tank through Condensate Pump

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ANNEXURE- II TECHNICAL SPECIFICATIONS

FLASH VESSEL

S.No	Description	Units	Value
1	Condensate Flow	Kg/hr	4500
2	Flash Steam	Kg/hr	450
3	Size	Mm	200
4	Model		TAFS 200

CONDENSATE PUMP

S.No	Description	Units	Value
1	Condensate Flow (Max)	Kg/hr	4500
2	Motive Steam Pressure	Kg/cm2 g	8
3	Back Pressure (Estimated)	Kg/cm2 g	2
4	Model		TACTS PLUS 500i

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ANNEXURE- III SCOPE OF SUPPLY

For TAFS:-

S.No	Item Description	Make	Quantity
1	Flash Vessel	Thermax	1
2	Pressure Gauge	Gluck	1
3	Safety Valve	Associated Engineers	1
4	Y- Strainer	Thermax	1
5	Float Trap	Thermax	1

For CONDENSATE TRANSFER PUMP:-

S.No	Item Description	Make	Quantity
1	Atmospheric Condensate Receiver	Thermax	1
2	Pump Inlet Isolating Valve,	Thermax	1
3	Pump Inlet Isolating Strainer	Thermax	1
4	Pump Inlet Wafer Check Valve	Thermax	1
5	Condensate Return Pump (MS) with level control assembly & digital flow meter, trap assembly, condensate flow indicator.	Thermax	1
6	Pump Outlet Wafer Check Valve	Thermax	1

ANNEXURE – IV: Exclusions

- Civil, Mechanical, structural modification if any.
- Any piping modifications at site
- Power/control cables.
- Air and Electricity required for the operation.
- Any other things which are not specifically mentioned in the offer.

ANNEXURE – V: Battery limit

Inlet and outlet of flash vessel, condensate pump

ANNEXURE – VI: UTILITY REQUIREMENTS

- 230 V AC +/- 5 % power supply (Stabilized voltage supply) for the condensate transfer pump
- Motive Steam Supply at a pressure of 3 kg/cm2

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ANNEXURE –VII: PRICE, COMMERCIAL TERMS & CONDITIONS

S.No	Item Description	24 TPB	PRICE Rs	36 TPB	PRICE Rs	48 TPB	PRICE Rs
1	Condensate Recovery Pump	TACTS 300i PLUS	162500	TACTS 300i ULTRA	172750	TACTS 400i PLUS	197380
2	Flash vessel	TAFS 200	74480	TAFS 300	104790	TAFS 300	104790
3	Deareator	TADIT 150	52380	TADIT 150	52380	TADIT 150	52380
		Total	**289360**		**329920**		**354550**

Commercial terms and conditions:

- Price : Ex-works, Pune
- Packing & Forwarding : Extra @ 3 %
- Excise Duty : 10.3 % Extra or as applicable
- CST/MST : CST @ 2 % against form "C" or VAT as applicable at the time of delivery.
- Octroi, Freight & Insurance : Extra at actual.
- Delivery : 8 weeks from the date of receipt of the Order & advance.
- Payment terms : 40 % advance along with the order & Balance against Proforma Invoice prior to dispatch.
- Validity : 30 days from the date of this offer.
- Site Modification : To be borne by client
- Supervision Charges of Installation : Rs 10000 plus taxes extra

SALES TERMS & CONDITIONS

PACKING AND FORWARDING:
The equipment shall be packed as per Thermax's standard practice.

OCTROI DUTY AND LOCAL TAXES:
The prices offered by THERMAX do not include Octroi duty/Entry tax (if any), which is payable to the local authorities at destination. Buyer will pay such duties directly while receiving the equipment. In case

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THERMAX is called upon to pay these, Buyer will reimburse the same to Thermax at actual. Alternatively, in case Buyer is exempted from paying Octroi duty, Buyer shall give Thermax suitable "Octroi exemption certificate" prior to dispatch, to enable Thermax clear the consignment without payment of Octroi duty.

VARIATION OR ADDITION IN SCOPE OF SUPPLY:

The scope of Thermax's supply is restricted to as specified in the proposal. Any subsequent addition or alteration will be acceptable to Thermax provided it is convenient to do so and the price and delivery period is suitably revised. Unless such revision is authorized from the Buyer within 15 days of our intimation, Thermax shall be at liberty to suspend further work and recommence it only after fresh negotiation on prices and delivery period. The same will be the case if Thermax is forced to suspend work for more than 15 days at Buyer's specific instructions or lack of instructions.

CHANGES IN WORK OR LAW:

If there is any change in the scope and/or nature of work, during the execution of this project, because of change in Indian Government's ruling or regulations or order, an adjustment in terms including, but not limited to, prices, deliveries, etc. shall be mutually agreed.

Thermax is not obliged to proceed with the changes until Thermax have received the Buyer's written approval of the proposed changes as well as adjustments, if any, in terms of the order.

PRICE VARIATION CLAUSE:

The price quoted in the Price Schedule will vary as per the Price Variation Clause for Boilers & Pressure vessels of Confederation of Engineering Industry (Boilers & unfired pressure vessels Division)

$$P = \frac{PO}{100}\left\{10 + 25\frac{MS}{MSO} + 30\frac{MR}{MRO} + 35\frac{L}{LO}\right\}$$

Where,

P = Price to be charged at the time of delivery.

PO = Price quoted.

MSO = Prices of boiler quality steel charged by SAIL per ton on date of quotation.

MS = Prices of boiler quality steel charged by SAIL per ton at 2/3 rd of the delivery quoted

MRO = Reserve Bank of India Index for wholesale prices for non-electrical under group 'Machinery and Transport' as on date of quotation.

MR = RBI index at 2/3rd of delivery period.

LO = Labour Index (as compiled by local chamber of commerce) two months prior to date of quotation.

L = Labour Index 2 months before the quoted delivery period.

The maximum amount of increase being subject to a ceiling of 10% of the accepted and confirmed price of equipment's ordered where the delivery is less than 15 months.

* Price of boiler quality steel plate is to be accepted as basis for variation even if in a given boiler/equipment this material may not be actually used. For the purpose of this clause, steel tubes would be treated as boiler quality steel

* Labour Index stands for Pune Consumer Price Index Number for working class (new series) with base year January to December, 1961.

DELIVERY:

The detailed Purchase Order comprising of scope, technical specifications and commercial terms shall be released within a maximum period of two weeks from the date of Letter of Intent.
The zero date of the order is the date Thermax receives detailed Purchase Order & advance.
The delivery period mentioned in this proposal is given in good faith based on Thermax's present commitments and is therefore subject to reconfirmation at the time of acceptance of PO.

EXCESS MATERIALS:

Since Thermax shall be sending to site a number of items in spare for smooth and uninterrupted erection and commissioning, such items, which remain unused, will be Thermax's property and will be removed by Thermax.
Any instrument required for performance testing will be brought to the site by Thermax and will be taken back by Thermax after the testing is over.

WARRANTY FOR EQUIPMENT:

Thermax's liability in respect of any defect in or failure of equipment supplied by Thermax or any loss, injury or damage attributable thereto, is limited to making good by replacement or repairs, defects, which appear therein, provided the equipment is operated and maintained in accordance with Thermax's instructions, and arise totally from proved fault in design, materials or workmanship, within a period of 12 months from the date of commissioning of the equipment or 18 months from the date of last invoiced dispatch, whichever is earlier, at the end of which period, all liability on Thermax's part will cease.

This warranty is applicable under the following conditions:

1. Any replacements/repairs required under provisions of the above warranty will be carried out at Thermax's option either at site or at Thermax's works. In the latter case, Buyer will send the defective parts to Thermax works at Buyer's cost & liability.
2. After repairs/replacement, warranty period for the entire equipment including replaced or repaired parts will be limited to the unexpired portion of the total warranty period.
3. For accessories and fittings not manufactured by Thermax, but which form an integral part of the equipment supplied by Thermax, the warranty will be co-terminus with the main equipment, irrespective of the warranty extended by their suppliers.
4. In respect of the equipment where despatch after readiness is delayed due to specific instructions or lack of instructions from Buyer, the warranty will be limited to 18 months from the date of readiness for despatch of equipment as notified by Thermax.
5. Any other party on Thermax's equipment during the warranty period, unless authorized by Thermax in writing, will carry out no repairs or replacements.
6. The warranty obligations will be honored by Thermax provided Buyer have fulfilled obligations under the order relating to release of due payments, etc.

The warranty period does not cover the following:

- Normal wear and tear
- Damages/defects arising out of wrong operation of the equipment by the Buyer and/or arising out of accidents, riots, fire, etc.

DELAYS IN PAYMENT:

Any delay in payment to Thermax beyond the due dates will entitle Thermax to suspend further work under the order without any liability for delay in delivery and/or completion and to receive interest on the outstanding amount for the period of delay at a rate higher by two percent than the bank lending rate prevailing at that time.

CANCELLATION:

Buyer will not unilaterally cancel the order once Thermax accepts it. In the event of the order being cancelled by Buyer with Thermax's consent, Buyer will be liable to pay cancellation charges to Thermax, either proportional to the order period up to the date of cancellation or the actual cost of work completed, whichever is higher, subject to the minimum of 20% of the value of order. Buyer will not have any claim over designs, drawings and materials lying with Thermax, which, after cancellation of order, will become Thermax's property.

Under no circumstances, cancellation of order is acceptable after expiry of 75% of order period.

INTERRUPTIONS:

Should Thermax be subjected to interruption during the execution of the order on account of non- fulfillment of the Buyer's obligations or due to reasons attributable to the Buyer, the terms and conditions of this order shall be re-negotiated and mutually agreed upon. Thermax are not obliged to resume the work until Thermax have received the Buyer's written approval of the re-negotiated terms and conditions.

FORCE MAJEURE:

Thermax shall be under no liability for delay in delivery/completion of work if Thermax or Thermax's subcontractors/suppliers are prevented from discharging Thermax's respective obligations under the order for causes beyond Thermax's reasonable control, including but not limited to war [whether declared or not], invasion, acts of enemies, hostilities, riots, civil commotion, labor disturbance, strikes, lockouts, layoffs, mutiny, insurrection, rebellion, revolution, epidemics, accidents, sabotage, fire, earthquake, floods, Government orders and restrictions, legal enactment's, delay or inability to obtain materials due to change in Import Policy or other statutory restrictions, lack of transport facilities, interruptions/restrictions in power supply, damage to or breakdown of plant, machinery and equipment, etc.

CONSEQUENTIAL DAMAGES:

Neither party shall at anytime be liable to the other for any loss of profits or any similar Indirect damages, howsoever described, incurred or suffered by either party in respect of the project.

ARBITRATION:

In the event of any difference in the interpretation of these terms or dispute arising in executing the order, the same will be resolved by reference to two arbitrators under provision of Indian Arbitration Act, 1940.

JURISDICTION:

Any order arising out of Thermax's present offer will be subject to jurisdiction of Law Courts in Pune.

SECRECY:

All data, specifications and drawings submitted by Thermax as a part of the order are proprietary in nature and will not be passed on by the Buyer to any third party, for whatever reason, without Thermax's written consent.

GOVERNING LAWS:

Indian Laws and Regulation shall govern execution of this project.

GENERAL:

Any condition or other matters pertaining to this offer not expressly stipulated will be a matter of mutual discussions and agreement at the time of accepting the order.

For **THERMAX LTD**

Hareesh Raman
Cooling & Heating Division
Services SBU
Hyderabad.
+918008889421.

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

APITCO Limited
8th FLOOR, PARISRAMA BHAVAN,
BASHEERBAGH, HYDERABAD 500 004
Phones: +91- 040-23237333, 23237981,
Fax: +91-40-23298945
e-mail: hyd1_apitco@bsnl.in
Website: www.apitco.org