REPLACING EXISTING NON- IBR BOILER WITH IBR PRESSURE BOILER

(***For Vellore Rice Mill Cluster***)

I. Cluster Brief

Paddy is the principal crop extensively cultivated in Tamil Nadu and accounts for the third of total gross cropped area and nearly 60% of irrigated area in Tamil Nadu. Rice is a product of milling of paddy hence rice milling is an important activity in Tamil Nadu. In 2015-16, the State produced 75.2 million tons of rice accounting for about two- thirds of the total production of the food grains in the state. Yield-wise, Tamil Nadu ranked second in rice at National level.

The Vellore cluster rice mills are concentrated in areas Arni (Tiruvannamalai District), Arcot and Vellore (Vellore District). Vellore is an old cluster as the mills have been operating since 1950's and a majority of these old mills are still in operation today. Periodically, new rice mills have been added in the cluster.

The Vellore cluster has about 340 rice mills spread across the areas of Arni (Tiruvannamalai District) and Arcot & Vellore (Vellore District). Out of this, about 150 rice mills are located in Arni and nearby villages Arunagiri Road, Sevoor, Rattinamangalam, Chepet Road, Vazhapandal Road and Vandhavaasi Road within a radius of five km. The remaining 190 mills are concentrated in Arcot, Vellore, Gudiatham, Arakkonam and Walajpet. The rice mills of the cluster have been in operation for the past five decades.

The Arni Paddy and Rice Merchants Association is the representing Association of the rice mills, which was established in the year 1974.

II. Existing practice

Boilers are one of the important equipment of the rice milling industry in thermal energy section and are used for steam generation for cooking of paddy by direct injection of steam in the cooker/bottle. Steam is also used in dryer for drying in the units where IBR pressure Boiler is available. In the units, where the Non –IBR Boiler is used, the thermal energy required for the Dryer operation is provided by direct firing of fuel in the Dryer. The major types of fuels used in the Boiler and Dryer are GN shell, Wood and Rice husk.

Non-IBR Boiler

It has been observed that about 45-50% of the Rice mill units are using inefficient Non- IBR Boilers for steam generation whose efficiency is very low. The boiler is locally fabricated and do not have name plate details on it. The boiler is of fire tube, natural draft, wood fired and manually fired boiler. Most of these boilers do not have Pressure and Temperature gauges installed. These boilers are operated for about 4 to 5 hours in a day and steam generated at 1-2 kg/cm^2 is used for paddy cooking by directly injecting the steam in the cooker.

From energy use and survey conducted in various Rice Mill industries in Vellore Rice Mill cluster, the following were identified:

- Energy efficiency improvement opportunities
- Environment and working conditions improvement
- Operational & maintenance practices in conventional boiler

Technology gaps in wood fired inefficient boilers are identified and described in details below:

Poor heat transfer efficiency: The present boiler is of single pass system. The heat transfer is poor due to low heat transfer area and short contact time between flue gas and water and hence leads to inefficiency and high flue gas losses. Many times due to delay in periodical removal of ash deposits in the boiler, the heat transfer drops significantly leading to poor output and drop in efficiency.

Heat loss from charging door: The fuel charging door remains more or less open during the entire operation due to various reasons; those are human error and non-compatibility of wood logs in combustion chamber or Grate is not designed to accommodate wood log size and vice versa.

No waste heat recovery

The waste heat recovery (WHR) system is not available in these smaller sized boilers. There exists enormous potential in flue gases of the boiler as the temperature of the flue gases would be high as the boiler is of single pass system. The high temperature flue gas is vented to the atmosphere without any waste heat recovery.

Low loading of the boiler: The capacity utilization of the boiler is low and hence considerable reduction in thermal efficiency of the boiler.

No control on fuel firing

In the existing boiler, there is no control over fuel firing in combustion chamber.

Poor insulation on boiler: The surface temperature of the boiler is high due to poor insulation leading to high radiation losses.

From the above mentioned analysis it is clear that the performance of the existing conventional boiler is poor in terms of energy, environment and social aspects. Based on above facts, the present inefficient Boiler is to be replaced with new energy efficient Boiler.

In addition to above mentioned facts, it is pertinent to note that wherever the Non-IBR Boiler is being used, the thermal energy required for the drying operation is catered by Direct Fuel Fired Dryer. The efficiency of this dryer is as low as 25-50% based on the operating condition. Hence there is a need to change the inefficient direct fired dryer with the LSU Port dryer to utilize the steam from the IBR Boiler. The two technologies namely IBR Boiler and LSU Port Dryer complement each other and should be implemented as a package.

III. Proposed technology:

The proposed package consists of two technologies namely:

1. IBR Pressure Boiler
2. Steam operated LSU Port Dryer (Technology is already approved)

The first part of the project activity is the replacement of present Non-IBR boiler with new energy efficient IBR Boiler. The second part is replacement of existing Direct Fired Fluidized Bed Dryer with new LSU Port using steam.

The new multi fuel fired boiler is a packaged, horizontal 3 pass solid fuel boiler fully wet back. The efficiency of the present boiler installed is of low efficiency (40-50) and efficiency of the new boiler is the range of 70% under ideal operating conditions. Replacing the present Boiler with new energy efficient boiler will reduce fuel consumption and reduces production cost. The typical capacity of Boiler that would be required in the cluster is 2 TPH and 4 TPH Boiler. However actual boiler capacity can be finalized based on the steam requirement of the process of the individual unit. This type of boiler is of forced draft and suitable for firing all kinds of solid fuels with minor modifications. These boilers are manually fired and designed for easy operation and maintenance. Following are its main features:

- Packaged shell type with an internal furnace. No external refractory furnace.
- Boiler works automatically based on set pressure, continuously automatic fuel feeding and hence less manpower is required.
- Higher combustion efficiency
- Quick steaming and no need for frequent ash removal from the furnace.
- The Grate/Fluidized and ash ports for fuel feeding and ash removal
- Refractory for better radiation
- Control panel with fuse, temperature controls and pressure switches and other safety interlocks.
- Insulation and mild steel cladding

Comparison of Inefficient boiler with Energy efficient boiler

S.No.	Parameter	Existing Non-IBR Boiler	Energy Efficiency IBR Boiler
1	Fuel consumption	High	Low
2	Environment pollution	High (due to more fuel consumption)	Low (Complete combustion & less fuel consumption)
3	Operational cost	High	Low
4	Availability of local service providers	Yes	Yes
5	Draught system	Natural	Forced
6	Fuel combustion	Partial(due to inefficient combustion chamber design)	Complete
7	Waste heat recovery	No	Yes
8	Radiation losses	More due to lack of proper insulation	Less
9	Utilization of heat	Less (Single/two pass system)	Maximum (three pass system)
10	Capacity utilization	Low	Optimum

Technical specification of new boiler

S. No	Parameter	Unit	Type
1	Boiler Type	-	Multi tubular 3 pass
2	Fuel used	-	Paddy Husk
3	Combustion draft	-	Forced
4	Condition of steam	-	Saturated
5	Capacity	TPH	1/2/3/4
6	Efficiency	%	70 +/-2

7	Working Pressure	Kg/cm^2	10.54
8	Fuel feeding	-	Top
9	Fans	-	FD and PA

IV. Envisaged savings from the replacement of Non-IBR Boiler with Energy Efficient IBR Boiler

Under this scheme, the envisaged savings is estimated as stated below

A. Savings in the fuel consumption due to replacement of existing inefficient Direct Fired Dryer with LSU Port dryer

B. Savings in the fuel consumption due to reduction in the cost of steaming operation by use of IBR Boiler.

C. Savings due to reduction in Broken Rice quantity

A. Savings due to the replacement of Direct Fired Fluidized Bed Dryer with LSU Port Dryer

Parameters	FBD Dryer	Unit
Expected Fuel consumption for the drying requirement	2500	Kg/batch
Dryer Thermal Efficiency #	31.1	%
Expected Batch per annum	240.0	Batches
Total Fuel consumption	600000.0	Kg/annum
Total Fuel cost	21.0	Lakhs/annum

Dryer efficiency subjected to change based on the operating parameters.

Parameters	LSU Port Dryer using Steam heating	Unit
Expected LSU Port Thermal Efficiency	65.0	%
Heat required per batch	3037292.3	Kcal/batch
Equivalent Steam required per batch	6.0	MT/batch
Boiler Efficiency	70.0	%
Fuel Consumption per batch	1411.6	Kg/batch
Total Batch per annum	240.0	Nos.
Total Fuel consumption	338772.6	Kg/annum
Total Fuel cost	15.2	Lakhs/annum
Savings per annum	5.8	**Lakhs/annum**

B. Savings in steaming operation due to use of IBR Pressure Boiler

Parameters	Values	Units
Energy required for steaming one MT of paddy	21000	kcal/MT
Batch Size	15.2	MT
Energy requirement per Batch	319200	kcal/batch
Estimated Steam requirement in Non- IBR Boiler	738.9	Kg/batch
Estimated Fuel consumption in Non-IBR Boiler	310.6	Kg/batch
Total Batch per annum	240	Batch/annum
Fuel consumption in Non-IBR Boiler	74.5	MT/annum
Fuel Cost per annum	3.6	Lakhs
Steam requirement in IBR Boiler	613.8	Kg/batch
Fuel consumption in IBR Boiler	160.5	Kg/batch
Total Batch per annum	240.0	Batch/annum
Fuel consumption in IBR Boiler	38.5	MT/annum
Fuel Cost per annum	1.7	Lakhs
Savings per annum	**1.9**	**Lakhs**

C. Savings due to reduction in Broken Rice quantity by using steam for drying

From the survey conducted in Arani cluster and discussions had with the Mill Owners during the Energy Audit study, it is clear that the drying operation plays a vital role in the Broken Rice quantity in addition to several other factors such as quality of paddy grain, improper soaking and steaming operation, Relative humidity & moisture, adjustment in the Mill machineries etc. The present broken rice percentage in the Direct-Fuel fired dryer mill is around 5 kg per batch of paddy, whereas it can be brought down to 3.5 kg per batch in the case of LSU Port Dryer. The saving estimation due to the reduction in the Broken Rice quantity is given below:

Parameters	Values	Units
Present Broken Rice quantity per bag of paddy in Direct Fuel Fired Dryer	5	kg/bag of paddy
Revised Broken Rice quantity per bag of paddy by using steam for drying	3.5	kg/bag of paddy
Reduction in Broken rice quantity contributing to additional Rice quantity	1.5	kg/bag of paddy
	300	kg/batch
	72000	kg/annum
Prevailing price of Rice	50	Rs./kg
Prevailing price of Broken Rice	25	Rs./kg
Net value realized due to additional Rice quantity	25	Rs./kg
Monetary savings per annum	**15.3**	**Lakhs/annum**

Total savings due to replacement of Non-IBR Boiler with EE IBR Boiler (A+B+C)	22.9	Lakhs/annum

Parameters	Units	Values
Annual fuel saving (one unit)	t/y	261
Annual thermal energy saving (one unit)	MJ/y	4370184
Annual fuel saving (considering 25% replication)	t/y	6525
Annual CO_2 emission saving (one unit)	tCO_2/yr	435
Annual CO_2 emission saving (considering 25% replication)	tCO_2/yr	10882
Estimated investment in technology (one unit)	Rs in Lakh	60
Estimated investment in technology Considering 25% replication (assuming price down due to demand aggregation)	Rs in Lakh	1500
Total Investment	million USD	2.14
Total energy savings (in 10 years)	TJ	43.70
Annual CO_2 emission saving (in 10 years)	tCO_2/yr	108818

V. Replication Potential

Based on the discussion with associations, units, sample survey and energy audits, it is estimated that the technology has a replication potential of 25% in the cluster.

VI. Benefits of the New Technology

- Reduced fuel consumption
- Faster steam generation
- Reduced radiation losses due to better insulation and refractory lining and due to better design of the grate
- No frequent cleaning of the bars for removal of ash
- Waste heat recovery system for pre-heating boiler feed water
- Reduction in Broken Rice percentage

VII. Availability of the technology

There are manufacturers available in India and many of them have their base in Chennai. The following are the list of technology providers along with the contact details.

1. Thermax India Ltd.
   Thermax Ltd. - Small Boilers
   Heating SBU (C&H)
   D-13 MIDC Indl. Area, Chinchwad,
   R D Aga Road,
   Pune 411019.
   Contact Person: Hiten Gupta
   Tel: +91-9881749649; Email: hitendra.gupta@thermaxglobal.com

2. Maxtherm (India) Private Limited
   Maxtherm Boilers (Pvt) Ltd
   # 2/12, T.S.Krishna Nagar,
   Anna Nagar West Extn.,
   Chennai -600 050. Tamilnadu, INDIA
   Contact Details: (+91) 044 4380 6882; sales@maxthermboilers.com

3. Prime Thermals
   P214, C I T Road, Beliaghata, Beliaghata, Subhas Sarobar Park, Phool Bagan, Beleghata, Kolkata, West Bengal
   primethermals@gmail.com; +91-97486-38845

4. Titan Enterprises
   Sf No: 479/6, New Agravaram, Ranipet, Agravaram, Bhel Road, Vellore – 632405
   Contact Details: (+91) 9865587756

VIII. Effect on the process

This technology will increase the quality of the rice production and will increase the existing production capacity.