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IMPROVING DESIGN AND OPERATION OF STEAM BASED TURMERIC COOKING PROCESS

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ABSTRACT

In large scale turmeric boiling the conventional plants is used with multiple cooker and boiler assembly placed on trolley. The plant is provided with furnace, condensate extraction mechanism, packed pressure vessels and mobile plant. Here in boiling, the turmeric rhizomes are placed in the cooker and the steam is supplied from the boiler to the pressure cooker and the turmeric is boiled. In traditional plants the boiling is done without maintaining the pressure in the vessel, so the boiling is inefficient. Along with that the leakage problems related with pressure vessel gives rise to heat loss. Overall the losses are much more and the process is not optimized. The efficiency of the actual processing plant is 13.19% which is very less. This is due to the lot of losses from every part of plant. The losses are very hard to control in minimum cost. So the objectives of this project are Reduce cooking time, Recycle condensate, Reduce labor effort and cost, Reduce fuel consumption and Reduce heat losses.

Keywords-cur cumin percentage, pressure vessel design and analysis, low cost insulation, condensate recycling, heat recycling.

I. INTRODUCTION

India is leading with 90% of turmeric production in the world with 1, 37,000 ha of area (www.indianspices.com). Being a spice cash crop, medicinally and industrially important, the area under turmeric is increasing in Maharashtra with a production of 8220 tones of turmeric from 6644 ha of area June, 2008. Primary processing of turmeric is still being done with traditional means leading to many losses and difficulties. Farmers use open shallow metal (Mild Steel) pan for turmeric boiling on open fire furnace. Water is added up to 3/4 of the heap height in the pan and covered by gunny bags or plastered. This conventional process of turmeric is heap height in the pan and covered by gunny bags or plastered. This conventional process of turmeric is time consuming, hazardous and less fuel efficient. To minimize processing time and hazardous associated with the conventional boiling plant; a steam based design is popular in the market from last 10 years. All the farmers are invariably using steam based turmeric processing on rental basis. The present design has evolved over last few years but still there are gaps in the areas of fuel economy, labor efforts and convenience of operation.

The present project work will target towards reducing these gaps with science and engineering principles.

II. OBJECTIVES OF THE STUDY

For increasing overall efficiency of turmeric cooking plant, some modifications in plant is necessary. Pump, blower, condensate storage tank and insulation is required for modifications as shown in figure 2. Heat losses from chimney can minimize with help of blower. This arrangement acts as heat exchanger, so hot air will provide to furnace. Condensate removed from cooking vessel is stored in condensate storage tank and recycle it with help of pump.

1. Pressured cooking

The lab study using pressure cooker indicates reduction in cooking time of turmeric; this can lead to high production rate and reduced fuel consumption. The present turmeric boiler produces steam at 3-4 bar (g) pressure and turmeric cooker operates at less than 0.5 bar (g) pressure (as this is Open to atmosphere). Based on design of cooker (thickness 3 mm and hoop stress 68 N/mm2) raw

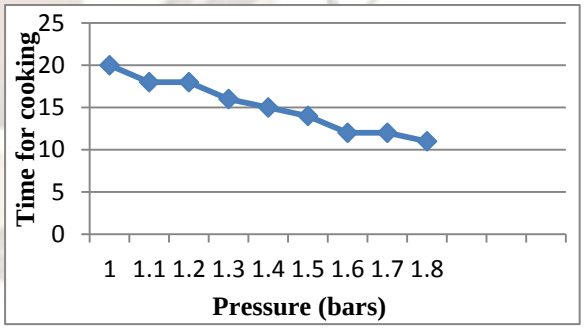

FIG 1.GRAPH FOR TIME Vs PRESSURE

turmeric rhizomes is cooked at 2 bar pressure without affecting on cur cumin percentage (this is generally 1.2 for good quality of turmeric) and safety of cooking vessel. A pressure gauge and a safety valve is installed on present cooker to operate the same at 2 bar (g) safely.

2. Condensate recycling

The condensate generated from cooking is recycled to boiler using feed water pump. The recycling will ensure good water quality (no scale forming salts) at 50 ºC feed to boiler. This is not only recycle heat from water but also reduce scaling potential in boiler (lead to improvement in life and reduce heat transfer barrier of boiler). The automatic condensate recycling requires level sensor.

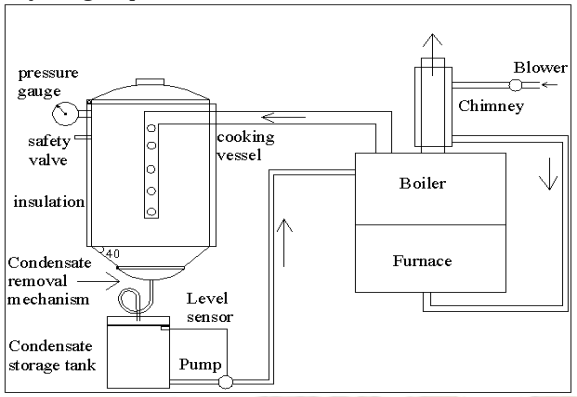

Fig 2. Layout of overall project work

3. Hot air recycling

Use of for pre heating air blower is used for generating force draft for solid fuel combustion. The air generated in blower is preheated using boiler flue gas chimney, where chimney is installed with vertical fins on external surface. This will improve efficiency of boiler and ultimately reduce fuel consumption.

1. Insulation

The cooking vessel with a GI (Galvanized Iron) sheet cover, this will create air gap between cooking vessel and cover. The air gap is filled with low cost insulation material like wood chips or bagass.

III. PRESSURE VESSEL DESIGN AND ANALYSIS

The pressure time relation graph got from the experiments, it shows that the time duration required for the cooking decreases with the increase in pressure.

$$\sigma = \frac{tensile\ strength}{factor\ of\ safety}$$

$$\sigma = \frac{PD}{2t}$$

$$t = 1.47\ mm$$

Assume corrosion allowance is 1.5 mm

Hence thickness of pressure vessel **≈ 3 mm.**

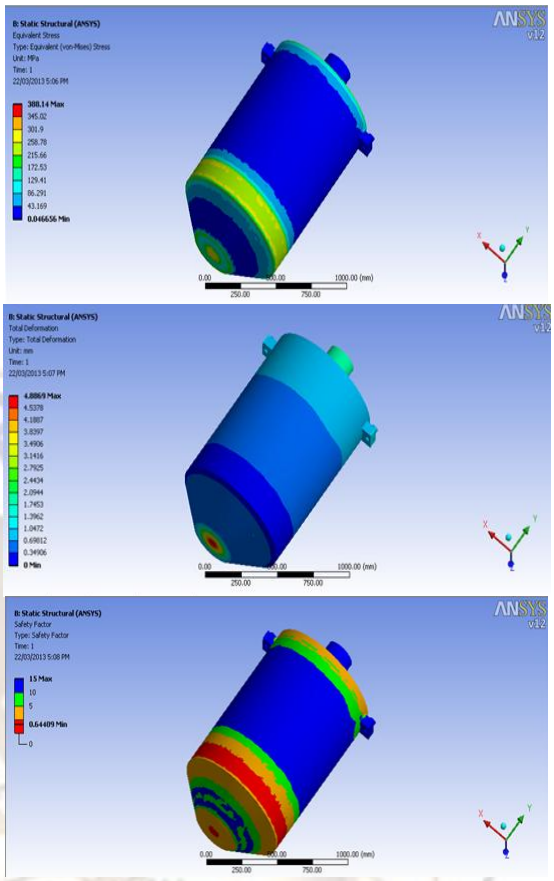

FIG 3.Stress, Deformation and F.O.S. results

2. RESULT TABLES

Hot air recirculation	Without blower	With blower
Mass of wood for steam generation	50 kg	40 kg
Outlet water temperature	70 ^{0}C	75^{0}C
Furnace temperature	865^{0}C	945^{0}C
Chimney temperature	260^{0}C	237^{0}C
Exhaust temperature	384^{0}C	362^{0}C
Ash temperature	500-700^{0}C	470-600^{0}C
Time for steam generation	1 hr.10min.	40min.

Condensate recycling	Without pump	With pump
Remaining water in boiler	1200 lit.	900 lit.

Pressurized cooking	Without pressure	With pressure
Weight of turmeric rhizomes	304 kg.	309 kg.
Cooker temperature	99^0C	102^0C
Temperature of boiled turmeric	-	68-79^0C
Time required per cooker	30 min.	17 min.

Insulation	Without insulation	With insulation
Volume of condensate	2.5 lit.	2.7 lit.
Condensate temperature	86^0C	91^0C
Cooker temperature	98^0C	102^0C

IV. CONCLUSION

By using concept of pressured cooking, time for cooking turmeric rhizomes is reduced from 30 min. to 17 min. And quality of turmeric is also maintained (cur cumin) percentage.

Efficiency of cooking plant (especially boiler) is increased by recycling condensate with help of pump. Automatic feeding of condensate reduces the manpower.

By connecting chimney's outer shell and furnace the heat is exchanged, so time required for steam generation is reduced from 1 hr.10 min. to 40 min. Wood required to create steam is reduced so ultimately efficiency of cooking plant is increased.

The overall efficiency of turmeric cooking plant is approximately doubled of previous cooking plant.

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