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STUDY OF DESIGN AND DEVELOPMENT OF TURMERIC PROCESSING UNIT: A REVIEW.

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ABSTRACT
India is one of the leading countries in production of raw turmeric and other sub products related to turmeric. 76 % of the world turmeric production is in India. The common practices among turmeric growers for turmeric cooking are traditional methods, which involves cooking and drying. The basic principle is boiler is used for cooking of turmeric in pressure vessel and after that hot air is used for drying of turmeric. In conventional method time required of this entire process is about 15 days, and it is less efficient. [8] [5] There is need to develop design of boiler and pressure vessel and also dryer. Also some safety precautions are required to include. This paper reviews properties of turmeric and conventional method of turmeric processing and design analysis of boiler, pressure vessel, and dryer.

INTRODUCTION
India is one of the leading countries in production of raw turmeric and other sub products related to turmeric. Turmeric is used as condiment, dye, drug and cosmetic in addition to its use in religious ceremonies. Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtra, Assam are some of the important states cultivating turmeric, of which, Andhra Pradesh alone occupies 38.0% of area and 58.5% of production. During 2013-2014, the country produced 12.29 lakh tones of turmeric from an area of 2.34 lakh ha. Some of the popular cultivars are Duggirala, Tekkurpet, Sugandham, Salem, Alleppe and prabha. [8] Turmeric contains protein (6.3%), fat (5.1%), minerals (3.5%), carbohydrates (69.4%) and moisture (13.1%). The essential oil (5.8%) obtained by steam distillation of rhizomes (Kapoor, 1990) Curcumin (diferuloylmethane) (3–4%) is responsible for the yellow colour, curcumin II (6%) and curcumin III (0.3%) [1] [2]

Table No. 1: Variability in biochemical composition of different turmeric. [4] [6] [7]

SR.NO.	Varieties/ Germplasm	Moisture content (%)	Mineral Content (%)	Curcumin content (g/100g)	Essential oil content (%)
1.	NDH-7	11.66	5.30	5.30	7.50
2.	NDH-8	10.83	5.16	4.50	8.19
3.	NDH-45	10.26	5.03	3.70	3.32
4.	NDH-68	10.53	4.69	5.50	3.91
5.	NDH-69	10.83	4.94	4.60	8.14
6.	NDH-86	9.60	3.93	4.10	7.60
7.	NDH-88	11.80	4.47	4.90	7.41
8.	NDH-116	12.20	4.59	5.10	5.44
9.	NDH-1	9.41	5.12	5.90	6.44
10.	Prabha	11.42	4.63	5.30	4.81

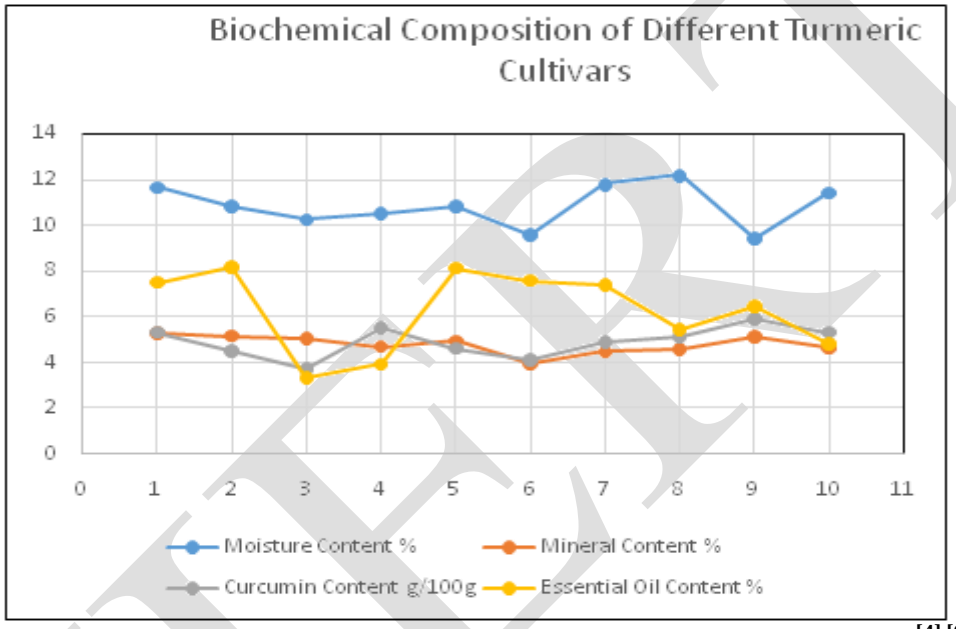

Figure. 1: Variability of biochemical composition of different turmeric [4] [6] [7]

CONVENTIONAL METHOD OF TURMERIC PROCESSING

The harvested turmeric rhizomes before entering into the market is converted into a stable commodity through a number of post-harvest processing operations like boiling, drying and polishing.

BOILING:

Boiling is the first post-harvest operation to be performed at the farm level which involves cooking of fresh rhizomes in water until soft before drying. Boiling destroys the vitality of fresh rhizomes, avoids the raw odour, reduces the drying time and yields uniformly coloured product. In the traditional method, a vessel made of galvanized iron sheet is used for turmeric boiling. Boiling is considered complete by pressing a pointed stick in to the rhizomes with slight pressure. The other indications of the completion of boiling process are softness and easy breaking of rhizomes when pressed between the fore finger and thumb and a yellow interior instead of redone. An effective cooking time of 45 to 60 minutes for fingers and 90 minutes for mother rhizomes is considered essential. Overcooking and under cooking are found to affect the quality of the rhizome. Steam pressure in boiler is 1.05 Kg/ $cm^{2.}$ Temperature is 100°C± 10 °C. [5]

DRYING*:*

The cooked fingers are dried in the sun by spreading in 5-7 cm thick layers on the drying floor. A thin layer is not desirable, as the colour of the dried product may be adversely affected. During night time, the material should be heaped or covered. It may take 10-15 days for the rhizome to become completely dry. Turmeric

should be dried on clean surface to ensure that the product does not get contaminated by extraneous matter. Care should be taken to avoid mould growth on the rhizomes. Rhizomes are turned intermittently to ensure uniformity in drying. [5]

Table No. 2: Curcumin content in the rhizomes [3]

Nature of turmeric rhizomes	Curcumin content, percent
Raw 2.3	2.3
Boiled	6.2
Dried	5.9

POLISHING AND COLOURING:

Dried turmeric has poor appearance and rough dull outer surface with scales and root bits. The appearance is improved by smoothening and polishing the outer surface by manual or mechanical rubbing. Polishing is done till the recommended polish of 7-8% is achieved. Usually 5 to 8%of the weight of turmeric is the polishing wastage during full polishing and 2 to 3% during half polishing. In an improved method, polishing is done by using hand operated barrel or drum mounted on a central axis, the sides of which are made of expanded metal screen. When the drum filled with turmeric is rotated, polishing is effected by abrasion of the surface against each other as they roll inside the drum. [5]

CLEANING, GRADING, PACKING AND STORAGE:

Turmeric of commerce is described in three ways:

1. Fingers: These are the lateral branches or secondary 'daughter' rhizomes which are detached from the central rhizome before curing.Fingers usually range in size from 2.5 to 7.5 cm in length and may be over 1 cm in diameter.
2. Bulbs: These are central 'mother' rhizomes, which are ovate in shape and are of shorter length and having larger diameter than the fingers.
3. Splits: Splits are the bulbs that have been split into halves or quarters to facilitate curing and subsequent drying.

Turmeric being a natural produce, is bound to gather contaminants during various stages of processing. The spice is also cleaned to remove such foreign materials. A sifter, destoner, and an air screen separator will help remove materials such as stones, dead insects, excreta, and other extraneous matter. Cleaned and graded material is packed generally in new double burlap gunny bags and stored over wooden pallets in a cool, dry place protected from light. The stores should be clean and free from infestation of pests and harbourage of rodents. It is not recommended to apply pesticides on the dried/polished turmeric to prevent storage pests. [5]

DESIGN AND RESULTS

In order to improve the rhizomes quality and to improve the overall process, new improved fire tube boilers with insulation is used to reduce the loss of energy. The pressure vessels are also provided with same insulation, so as to improve cooking time.

For drying, various drying methods had been studied. The various methods are as follows,

- Vacuum Drying.
- Microwave Drying.
- Solar Drying.
- Freeze Drying.

As vacuum, freeze and microwave drying need external supply for its working. Therefore it is not feasible for the farmers to use electricity. Solution for this problem was solar drying. In solar drying, an active type flat plate collector is used to heat the air, and that air is allowed to flow over turmeric by using a centrifugal blower.

The fire tube boiler is designed by using the theories of fired pressure vessels as well as the IBR norms of small boilers for industrial purpose. And the cooking vessels are designed form the theories of unfired pressure vessels.

BOILER SPECIFICATIONS:

Type	Fire-tube Boiler.
Capacity	60 lit.
Operating Pressure	1.2 bar.
Steam Temperature	120^0 C.
Insulation	Glass fiber 8mm thick.

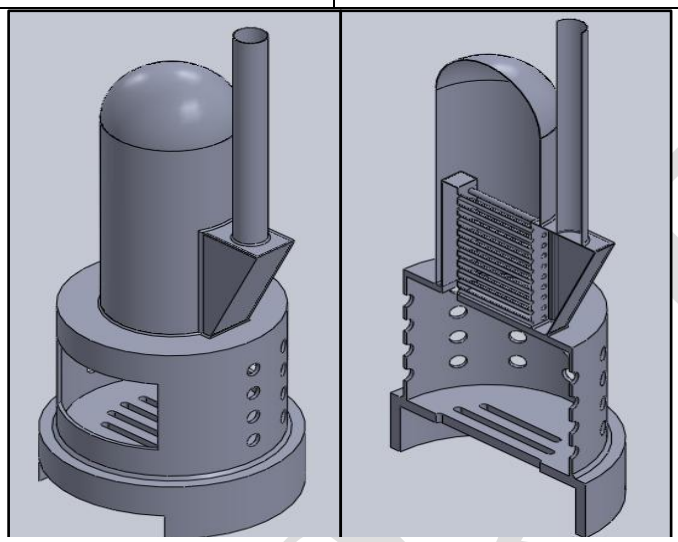

Figure No. 2: Design of Boiler.

Boiler Analysis for both structural stress as well as temperature distribution is given below.

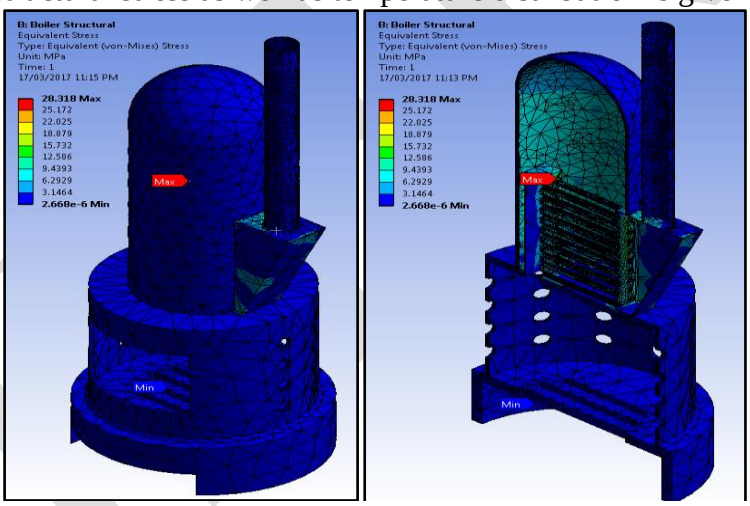

Figure No. 3: Stress Analysis of Boiler.

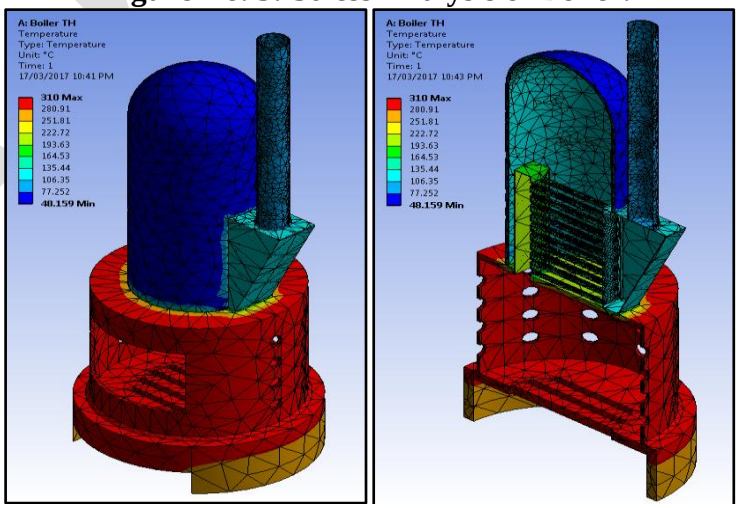

Figure No. 4: Temperature Distribution Analysis of Boiler.

PRESSURE VESSEL SPECIFICATIONS:

Type	Vertical Pressure Vessel
Capacity	36 lit.
Operating Pressure	1.0135 bar.
Operating Temperature	103^0 C to 107^0 C.
Insulation	Glass Fiber 8mm thick.

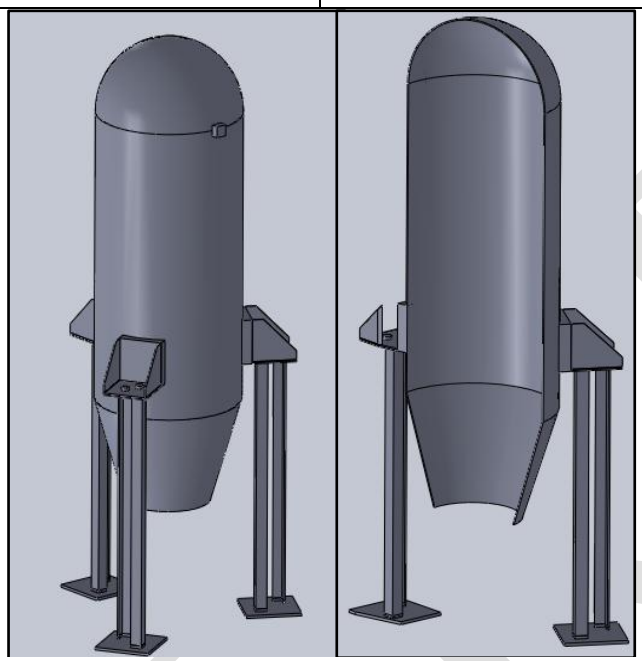

Figure No. 5: Design of Pressure Vessel.

Pressure Vessel Analysis for both structural stress and temperature distribution is as follows,

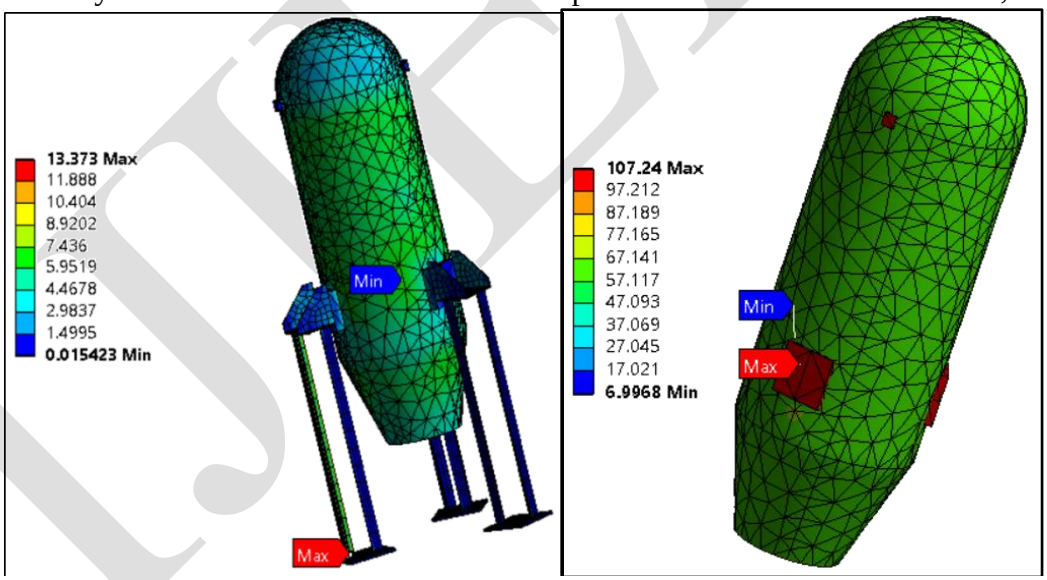

Figure No. 6: Pressure Vessel Stress & Temperature Distribution Analysis.

DRYER SPECIFICATIONS*:*

Collector Area	137308.46 mm^2
Centrifugal Blower	
Power	0.11 KW
Voltage	230 V
Motor Speed	2520 rpm

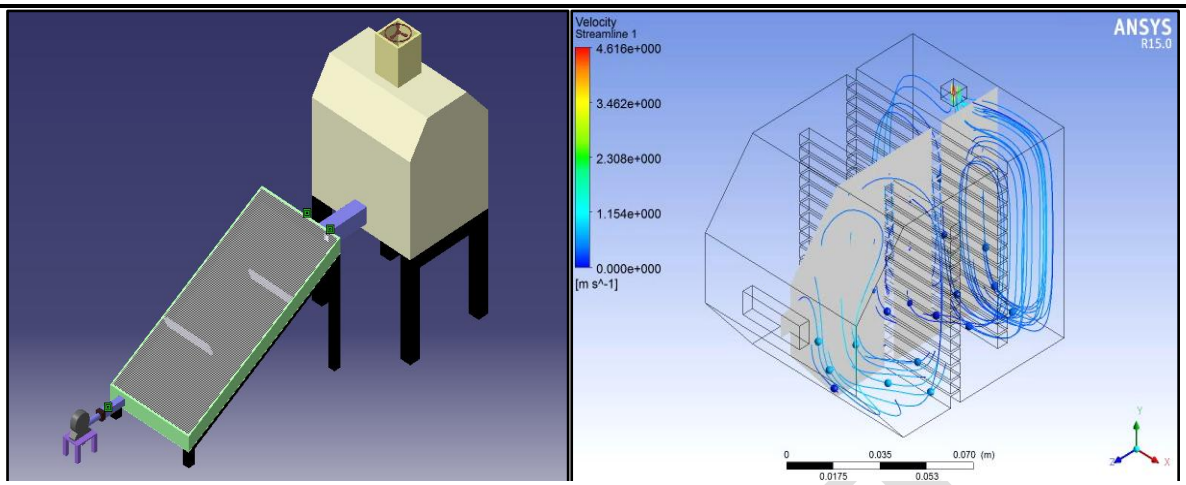

Figure No. 7: Designed and Flow Simulation of Dryer.

COMPARISON:

Points of comparison,

- Heat losses in case of new design is less as compared to that of old conventional method.
- The cooking time for turmeric is reduced a up to 10min. And the drying time is reduced from 15 days to 5 days.
- As the boiler and pressure vessels are designed using IBR norms, therefore they are safe to use as compared to that of conventional boilers.
- The boilers used in conventional method cooking are of various shapes such as square, rectangle therefore stress concentration is more at its edges. In new improved design, boiler has a cylindrical body.
- Conventional boilers and pressure vessels are made up of corrosive materials, hence it reduces the life of the plant. Solution against corrosion is to use stainless steel sheets.

CONCLUSION:

Literature review of above study concludes various properties and conventional method used for turmeric processing. The conventional methods for post-processing uses boilers and cookers which are designed without any engineering and mathematical background. Due to which, the boilers and pressure vessels are very bulky and heat losses are more. After designing this system the heat losses are reduced, and the drying time is reduced to 3 to 4 days.

REFERENCES:

1) Abbasi, F.M., M.A. Sagar, M. Akram and M. Ashraf. 1995. *Agronomic and quality traits of some elite rice genotypes. Pak. J. Sci. Ind. Res., vol. 38 pp. 9-10.*

2) Comparisons of Bioactive *Compoundsin Different Cultivars of Turmeric Grown in Eastern U.P.by SunitaKumari, Pratibha Singh and R.N.Kewat,Volume 4, Issue 8, August 2014 1 ISSN 2250-3153.*

3) *Development of high efficient combustion system for turmeric boiling, by*:J. Gitanjali*, p. Venkatachalam and p. Subramanian, July-September 2014.

4) Fattepurkar, S.C.; Damame, S.V. and Ghadge, S.N. *Chemical composition of finger rhizome of Curcuma aromatic L. and Curcuma longa L. Asian journal of Experimental Chemistry, vol. 4, No. 1, 2009, Pp 84-86.*

5) *ICAR- Indian Institute of Spices Research*, By:Jayashree E, Kandiannan K, Prasath D, Sasikumar B, Senthil Kumar CM, Srinivasan V, Suseela Bhai R and Thankamani CK, November 2015.Pg.1, 9-12.

6) Lokhande, S. M., Kale, R. V., Sahoo, A. K., and Ranveer, R. C. *Effect of curing and drying methods on recovery, curcumin and essential oil content of different cultivars of turmeric (Curcuma longa L.) International Food Research Journal, Vol.20, No.2, 2013, pp745-749.*

7) Souza, C. R. A. and Gloria, M. B. A. *Chemical analysis of turmeric from Minas Gerais, Brazil and comparison of methods for flavour free oleoresin. Brazilian Archives of Biology and Technology, Vol.41, No2, 1998, Pp218-224.*

8) *http://www.ncdex.com/downloads/WH_List_10012006.doc.*