2.1 THERMOSTRUCTURAL ANALYSIS AND DESIGN RELEVANT TO PRESSURE VESSEL:

To design a blancher for turmeric processing, a design process is carried out with conventional design process. The different softwares were studied for software design of the blancher.

Nilangan Mukherjee and P.K. Sinha (1994) focused on the study of finite element analysis used to design a three dimensional thermostructural analysis of multidirectional fibrous composite plates. A set of simple thermo elastic constitutive relations are developed for a general n-directional fibrous composite. A typical multidirectional unit cell is assumed to consists of several unidirectional composite blocks. The present material model is next used to analyse the thermostructural problem employing the finite element method. A quadratic isoperimetric brick element is used to discretize both thermal and structural fields. The material model is validated against an existing ideological model based on the laminate theory. Results reveal the effect of fibre directionally on several thermostructural parameters.

The authors focused on the finite element formulation, employing a twenty noded isoperimetric brick element is used to investigate the thermostructural problem. The material and finite element models, when compared with existing analytical and experimental results, reveal fair agreement.

Enver Murad and Ursel Wangner [Clays and clay minerals, the firing process (1998)], focused on the changes in iron valence and iron site geometry, when clays and clay minerals are heated and allows a distinction to be made between paramagnetic and magnetically ordered phases. Mossbauer spectra can thus
reveal the extent of iron retention in silicate structures upon heating, the identity of iron oxides initially present or formed during the heating process and their transformations and the character of the atmosphere under which heating was carried out. This makes Mossbauer spectorscopy the most effective tool for the characterization of changes induced by heating phyllosicliactes and iron oxides. In the present review the authors presented the thermal behavior of clay minerals and clays. The firing behaviour of clays of complex mineralogy can usually be adequately well approximated in the temperature range in which dehydroxylation takes place by summing up the variations, in Mossbauer parameters of the individual minerals. Mossbauer spectra of such products can help to assess the conditions under which firing took place. The materials, all fits to spectra of heated samples must be physically sound, i.e. they should never involve more components then are justified by the quality of the spectra or the maximum possible contributions from the sample. By retaining fitting models of the original samples throughout the range of temperatures, thus facilitating the comparison of data and the observations of changes induced by heating.

Junbom Kim, T.V. Nguyen and R.E. White (Oct. 1992) focused on thermal mathematical modeling of a multi cell common pressure vessel nickel hydrogen battery. A two dimensional and time dependent thermal model of a multi cell common pressure vessel nickel hydrogen battery was developed. A finite element solver called PDE was used to solve this model. The model was used to investigate the effects of various design parameters on the temperature profile within the cell. The results were used to help and find a design that will yield an acceptable temperature gradient inside a multi cell CPV nickel hydrogen battery. Steady state constant heat generation rate and a time dependent heat generation rate were solved. It is found that the effect of porosity of the diffusion screen, platinum electrode, separator and observer on the maximum temperature is found to be insignificant. Comparison of contour plots between cells with and without a heat fin shows a definite necessity for a heat fin to reduce the temperature gradient inside the cell and avoid the possibility of electrolyte redistribution. Two heat fin materials, copper and
aluminum are compared and copper shows better results. The maximum temperature inside the cell is found to be linearly proportional to the number of modules between the heat fins and the heat generation rate. It is found that for the configuration investigated here, 59 minutes are needed to reach 59% of the steady state temperature. The model could be modified to investigate the temperature behavior of different cell geometries and different thermal and physical values of cell component materials.

Zarkostevamovie, Gradimir, Nenad Radojkovie (Feb. 17, 2002), focused on an iterative procedure for sizing shell and tube heat exchangers according to prescribed pressure drop. The thermo-hydraulic calculation and the geometric optimization for shell and tube heat exchangers on the basis of CFD technique have been carried out. Modeling of shell and tube heat exchanges for design and performance evaluation is now an established technique used in industry. In this review, a numerical study of three-dimensional fluid flow and heat transfer in a shell and tube model heat exchanger is described. Three different turbulent models were used for the flow processes, to calculate velocity, pressure, heat flow rate and temperature distributions. It can be seen that higher heat flow rate was obtained by calculations with the third turbulence model. The Chen-Kim modification of K-ε turbulence model gives the most accurate velocity field than turbulence model of constant eddy viscosity or standard K-ε turbulence model, where K is kinetic energy and ε is dissipation rate. The flow process has an important effect on heat transfer. An optimal flow distribution can result in a higher heat transfer rate and lower pressure drop, hence flow distribution is an essential step in heat exchanger design. It can be predicted by CFD technique for both existing and newly developed heat transfer equipment.

Resat Selbas, Onder Kizilkan, Marcus Reppich, (2006), focus on the design and estimation of the minimum heat transfer area required for heat exchanger. The genetic algorithms has been successfully applied for the optimal design of shell and tube heat exchangers by varying the design variables, outer tube diameter, tube
layout, number of tube passes, outer shell diameter and baffle cut. LMTD method is used to determine the heat transfer area for a given design configuration.

This paper demonstrates successful application of genetic algorithm for the optimal design of shell and tube heat exchangers. Approximate design methods for heat exchangers have been investigated and a generalized procedure has been developed to find the minimum heat exchanger area. The study provides more flexibility to the designer to provide significant improvement in the optimal design compared to the traditional designs.

Yan Li, Xiumin Jaing, Xiangyong Huang, Jigang Jia, Jianhi Tong (2007), focused on the flow field and the heat transfer characteristics of a shell and tube heat exchanger for the cooling of syn gas. The pressure, temperature distribution and local heat transfer rate are studied under the effect of syn gas.

In this paper a three dimensional numerical simulations for syn gas coolers with different baffle configuration and working condition are performed to reveal the effects of baffle configurations and working condition on the heat transfer and pressure drop characteristics. The higher operation pressure can improve the heat transfer however brings bigger pressure drop because of different mass flow rate. The components of the syn gas significantly affect the pressure drop and the heat transfer. The heat transfer increases with higher H$_2$O percentage and lower H$_2$ percentage. The pressure drop increases with higher CO$_2$ percentage and lower H$_2$ percentage. The arrangement of baffles influences the fluid flow. Shortening the height of the baffles, decreasing the number of the baffles, can decrease the resistance effectively.

S.K. Das, K.M. Godiwala, S.P. Mehrotra (2006), focused on the erosion behavior of fly ash particles entrained in the flue gas from boiler furnaces in coal fired power stations can cause serious erosive wear on steel surfaces along the flow path. Such erosion can significantly reduce the operational life of the boiler components. A mathematical model embodying the mechanisms of erosion on behavior, has been developed to predict erosion rates of coal fired boiler components.
at different temperatures. Various grades of steel used in fabrication of boiler components and published data pertaining to boiler fly ash have been used for the modeling. The model incorporates high temperature tensile properties of the target metal surface at room and elevated temperatures and to predict the erosion rate of various grades of steel. The calibrated model will be useful for erosion analysis of boiler components. It is seen that the erosion rates on steel surfaces subjected to steam of fly ash particles vary with the particle impingement angle. All the steel grades investigated in this study show increase in erosion rates with temperature, with ash particle, impact velocity and ash particle impact angle.

G.A. Dreister (2006), focused on highly efficient tubular heat exchanger surfaces. A critical analysis of the up to date methods for evaluation of the efficiency of heat transfer enhancement in channels is presented for enhancing the heat transfer during condensation. It is suggested to use turbulizers or ribs destroying the condensate film, non wettable coating, liquid stimulants for inducing drop wise condensation, swirling of flow or rotation of the heat transfer surface. The modern methods and design of the tubular heat exchangers are presented in this review. The heat transfer enhancement during boiling and condensation are also studied and reviewed. The best results concerning heat transfer enhancement under film boiling and in expanding the regions of nucleate boiling are obtained by the application of annular turbulizers, low heat conduction coatings and jet systems. Among all the methods investigated of heat transfer for enhancement during condensation, probably the best results are provided with the use of tubes with annular turbulizers.

H.A. Navarro and L.C. Cabezas-Gomez (Dec. 2007) focused on a mathematical model for cross flow heat exchanges with complex flow arrangements for determining \( e \)-NTU relations is presented. The model is based on the tube element approach, according to which the heat exchanger outlet temperatures are obtained by discretizing the coil along the tube fluid path. In each cross section of the element, tube side fluid temperature is assumed to be constant because the heat capacity rate ratio \( C^* = \frac{C_{\text{min}}}{C_{\text{max}}} \) tends toward zero in the element. Thus temperature is controlled by effectiveness of local element corresponding to an
evaporator, or a condenser type element. The model is validated through comparison with theoretical algebraic relations for single pass cross flow arrangements with one or more rows. Very small relative errors are obtained showing the accuracy of the present model. e-NTU curves for several complex circuit arrangements are presented. The model developed represents a useful research tool for theoretical and experimental studies on heat exchanger performance. Effectiveness values were estimated for cross flow heat exchangers with complex flow arrangements. For the cases analyzed, a maximum difference about 10% was noted between effectiveness model prediction and those based on theoretical formulae.

A.D. Efanov, A.P. Sarokin, E.F. Ivanov (2007), focused on the experimental investigations into hydrodynamics and heat transfer during the boiling of an eutectic sodium-potassium alloy in a system of two parallel channels that stimulate the operating conditions of channels in a typical fast-neutron reactor. The study of thermal and hydraulic characteristics of a shell and tube water heater equipped with dimpled heat transfer tubes to enhance heat transfer.

B.F. Balunov, M.A. Gotovskii, V.A. Permyakov (2008) shows that the heat transfer on the internal dimpled surface has risen by 60% with their drag increased by a factor of 2%. The expressions and correlations developed in this review are helpful to evaluate the thermal hydraulic characteristics of shell and tube steam water heaters equipped with heat transfer surfaces composed of dimpled tubes and having the same geometrical parameters. It is possible to develop a new shell and tube water-water heaters outperforming the existing plate-type apparatuses in thermal efficiency and operating characteristics.

M.F. Tselishchev, and P.N. Plotnikov [Heat transfer apparatus of steam turbine units (2008)], focused on simulating the rolling of tubes and its effect on the stressed and strain state of the tube sheets used in the heat transfer apparatuses of steam turbine units. The comprehensive calculations and experimental investigations of the stresses occurring in the shell and tube heat transfer apparatus under the effect of tube rolling forces was carried out to estimate the stresses and strain state of the
tube bundle. The proposed model for the strength calculations should be used for all shell and tube heat transfer apparatus, which will allow designers to make them more reliable to design the heat and steam carrying devices.

K. Anbarasu, P. Sampathkumaran, M. Janardhan, S. Yogesh, S. Seetahramu. [Damage assessment of boiler tubes subjected to erosion and corrosion failures by non-invasive technique, (2009)], focused on the incompatible permanent strains in any engineering component caused by the formation of residual stresses due to loading or thermal effect. The stresses tend to increase due to the type of damage occurring in any component such as fatigue, corrosion, erosion or synergistic effect under the influence of environmental conditions. The present investigation highlights about the residual stresses in a typical boiler tube component and to identify the type of damage such as corrosion and erosion have been discussed. Stress levels measured by XRD method tend to decrease with increase in exposure of tubes to corrosion or erosion. MBN parameters on the other hand, shows high readings for the inservice tubes compared to virgin tubes. Hardness profile measurements and microstructural features give good support to the XRD and MBN data. The methods used serve as a quality assurance tool to predict the type of damage that has occurred in the tubes.

Tiebao Yang, Henry Hu, Xiang Chen (2009), focused on the proper temperature control essential for producing superior quality components and yielding high production rates in high temperature manufacturing processes. It is usually very difficult to monitor the local surface temperatures without destructively inserting thermal sensors into them. However, the measurement of cooling water temperature at the coolant outlet is relatively unproblematic, there is a correlation between these two temperatures. Based on the system identification theory, a control oriented linear time invariant model has been developed, which correlates the local die temperature to the cooling water outlet temperature. It is concluded from the review paper that a temperature correlation exists between the coolant and the cooled objects. A model has been developed to correlate die temperature with water
temperature for a water cooled die insert. The results show that, an increase in internal cooling water flow rates reduces the die insert temperatures and the cooling water outlet temperature. As a cooling time extends, both the temperatures tend to approach a steady state. The time for water outlet temperature to reach a steady state is reduced, as the water flow rate increases. The method presented in this paper could provide an alternative approach to predict the die surface temperature. Also it could be applied to design a real time temperature control system.

The thermostructural analysis of weld tubes, vacuum vessels and thermal protection materials were carried by various authors are studied to apply thermostructural analysis on Blancher for turmeric processing plant.

Parul Agrawal, Daniel M. Empey, Thomas H. Squire (2009), focus on the design and analysis work for the heat shields subjected to severe thermal and mechanical loading. Coupled non linear thermal mechanical finite element analysis was conducted to estimate temperature distribution and stress contours for various cases. The temperature distribution and magnitude of the measured strains were also consistent with predicted values. Thermocouple and strain gauge data obtained from the solar tower tests will be used for subsequent analysis and validation of FEM models. The Preliminary analysis is to recommend suitable loads for arrayed coupons in order to achieve higher allowable stress levels in presence of coupled thermal mechanical loads to observe failure modes. The test data was in agreement with model prediction and no catastrophic failure was observed during the test.

G.R. Jinu, P. Sathiya, G. Ravichandran and A. Rathinam (2010), focus on comparison of thermal fatigue behaviour of ASTMA-213 grade T-92 base weld tubes. When the tubes are subjected to alternate heating and cooling in power plant causing them to crack and fail, this phenomenon is referred to as thermal fatigue. In this paper the temperature and strain distributions along the specimen were computed theoretically using ANSYS software for the applied temperature conditions. The study reveals that heating and cooling cause thermal fatigue, initiate
cracks in the tubes. The experimental results were compared with FEM results. FEM has been stimulated as per the designed matrix. The temperature and strain contours for the heated tubes have been obtained to study the effect of thermal behavior. The development of these cracks is due to the temperature variation from high temperature to room temperature during the plant operation during the start up and shut down.

Prosenjit Santra, Vijay Bedakhale, Tata Ranganath (2009), focused on thermal structural analysis of SST-I vacuum vessel and cryostat assembly using ANSYS. A steady state superconducting tokmak-I (SST-I) is designed to produce a 'D' Shaped double null diverter plasma and operate in quasi steady state. It is designed of SS 304L material to meet the ultra high vacuum requirements for plasma generation and confinement. Due to baking the non uniform temperature pattern on the vessel assembly coupled with atmospheric pressure loading and self weight gives rise to high thermal structural stresses, which need to be analysed in detail. In addition the vessel assembly being a thin shell vessel structure need to be checked for buckling load and baking thermal loads. The geometry of SST-I is modeled for finite element analysis using ANSYS for different loading scenarios, self weight, pressure loading, considering normal operating conditions and off normal loads coupled with baking of vacuum vessel from room temperature 250°C to 150°C, buckling and model analysis for future dynamic analysis. The paper also presents the boundary conditions, thermal and structural analysis loading, thermal structural analysis results of FEA using ANSYS for various load cases. The SST-I assembly under external atmospheric pressure only is safe while thermal stresses at 250°C baking is exceeding the 3sm limit. The thermal stresses at 150°C baking is within the limit. The linear buckling load factor with external pressure only and self weight is 5.88b.

2.2 TURMERIC PROCESSING:

India is the major producer and exporter of turmeric in the world. There are about 60 Turmeric cultivars (Land varieties) available in the country. Some of the

Most of the C. Longa found in India belong to C. Longa var. typica or atypica. The harvested turmeric is washed well to remove the adhering soil, roots are removed, finger and mother Rhizomes are separated. Finger and Mother Rhizomes are boiled separately about 40-60 minutes under slightly alkaline conditions (100 g of sodium bicarbonate or sodium carbonate in 100 Litre of water) in galvanized iron or earthen vessels and sun dried on bamboo mat or clean drying floor for 10-15 days so as to bring down the moisture content to 10%. The dry recovery of curved turmeric varies between 15-30% depending on variety, location and cultural practices. Dried Turmeric is subjected to polishing either manually or machine polish, the polished Rhizomes are made attractive by coloring them with turmeric powders. Throughout the state farmers follow the same method with little difference in increasing or decreasing the number of difficulties and losses.

The traditional method of turmeric processing also uses cowdung extract and lead chromate base for boiling, which was found hazardous to health. In traditional method of turmeric processing there is uneven heating of Rhizomes, there is loss of characteristics of Rhizomes due to chromate base for boiling, uneven heating, carelessness in handling of Rhizomes during loading and unloading of hot Rhizomes.

In traditional method there is loss of fuel, it requires more time to boil Rhizomes for each batch and there is more laborious work which increases the
labour cost. Taking into consideration the above problems, it is required to design a new turmeric processing / boiling unit which reduces loss of heat, reduces time, laborious work and improves quality and quantity of Rhizomes. With the consideration of above problems, a literature survey is made to study the various methods of turmeric processing and to design a new turmeric processing plant which can fulfill the above requirements.

B. Sasikumar [Turmeric, Indian Institute of Spices Research, Kerala, (2001)], focused on the study of various spices of turmeric. B. Sasikumar described on indigenous method of turmeric processing with various steps. The harvested turmeric is washed well to remove the adhering soil, roots, finger and mother Rhizomes are separated, they are boiled separately. The traditional method requires 40-60 minute to boil water and 20 to 30 minutes to boil Rhizomes. Rhizomes after boiling they are sun dried on bamboo mat or clean drying floor for 10-15 days so as to bring down the moisture content to 10%. After drying, the Rhizomes are polished and grinding them to turmeric powder or as emulsion. B. Sasikumar also focused on properties of Rhizomes, applications of turmeric in various fields, turmeric oil, chemical and functional properties and quality specifications.

T. John Zachariah and K. Nirmal babu (1992), focused on the study of storage of fresh turmeric Rhizomes on oleoresin and curcumin contents. The turmeric varieties Suvarna [PCT-8], Saguna (PCT-13) and Sudarshana (PCT-14), were harvested and stored for a period of nine months. Samples were analyzed for curcumin and oleoresin at monthly intervals. Curcumin and oleoresin levels were not affected by storage. The marginal increase in these constituents like Carbohydrates get progressively depleted with the progress of sprouting and growth of the sprout. The distribution of curcumin in mother Rhizomes and fingers are also discussed. The author came to the conclusion that the level of curcumin as well as oleoresin remains more or less steady in the Rhizomes during storage. The mother Rhizomes has more curcumin than primary and secondary fingers. This difference is due to the difference in the pattern of synthesis and storage in these verities.
Li - Lang and Leo - Xue Gang of South-West University of Science and Technology mianyang, Sichuan, China (lily20032302@163.com) (2010), focused on the combustion characteristics of turmeric industry waste by using thermogravimetric analyzer. The thermogravimetric analysis was used to study combustion characteristics of the solid of waste water and solid waste residue of turmeric industry. There were both two distinct phases in the combustion process of them. The ignition temperature of solid waste water was 364°C and solid waste residue was 311°C, while the ignition characteristics index Fz of them were 13.092 and 10.941 respectively. The authors concluded that the solid of waste water and solid waste residue of turmeric industry were easy to combustion. The ignition temperature of solid of waste water was 364°C and solid waste residue was 311°C.

D. Suresh, H. Manjunatha, Krishnapura Srinivasan [Central food technological research institute, Mysore, (2007)], focused on the effect of heat processing of spices on the concentrations of their bioactive principles. Turmeric (Curcuma Longa), red pepper (Capsicum annum) and black pepper (Piper nigrum) were selected for study. The studies were made to examine the loss of curcumin, capsaicin and piperine, the active principles of turmeric [Curcuma Longa], red pepper and black pepper respectively, as a result of subjecting the spices to domestic boiling processes. The heat treatment involved of each of these spices by boiling for 10 minutes, boiling for 20 minutes and steam boiling for 10 minutes, significant loss of spice active principles were observed when the spices were subjected to heat processing. The results of this investigation indicated diminished availability of spice active principles from boiled foods, when the food intergradient have subjected to either boiling or pressure cooking for few minutes.

K.J. Kamble and S.B. Soni of College of Agricultural Engineering and Technology MAU, Parbhani. [Karnataka Journal of Agricultural Science (2009)], focused on the study to improve the traditional turmeric boiling pot and reduce the losses in quality, time and fuel in turmeric processing. Turmeric boiled in improved boiling pot retained 3.30% essential oils and 2.30% curcumin as against 2.93%
and 2.57% respectively in traditional boiling pot. Also it was observed that turmeric Rhizomes boiled for 35 minutes in improved pot gave uniform colour than Rhizomes boiled for 25 to 45 minutes.

It is observed for Rhizomes of all turmeric verities boiled in the improved boiling pot retained 3.33% of oleoresin and curcumin 3.2%, whereas in traditional pot 2.93% and 2.57% respectively. About 50% loss of volatile matter takes place in boiling and drying. The loss of important essential oils and curcumin percentage is more in the traditional boiling pot, than improved boiling pot. It may be because of shallow pan, over boiling of bottom Rhizomes, under boiling of upper Rhizomes and more time required for boiling. In traditional method turmeric is boiled for about 50 to 60 minutes, which may lead to the loss of volatile matter. Also boiled turmeric Rhizomes are roughly handled, trampled under the feet of workers, which on exposure to sunlight causes more loss of curcumin and oleoresin. After analyzing the results obtained by boiling different varieties in traditional and improved boiling pots as per the treatments, it was observed that turmeric boiled in improved boiling pot for 3 minutes gives uniform yellow colour to the dried product. Turmeric boiled for 35 minutes in improved boiling pot reduces the loss in time, quality and fuel compared to traditional boiling and retains higher percentage of essential oil and curcumin than traditional boiling pot.

B.V. Hudge, S.A. Ghugal of Marathwada Agricultural University, Parbhani [International Journal of Agricultural Sciences, (June 2010)], focused on losses in yield and quality of turmeric due to leaf spot disease caused by Colletotrichum Capsici. The present study revealed that maximum losses were found in severely diseased plants i.e. 25.83 and 62.12 percent on fresh weight basis and 42.10 and 62.1 percent on dry weight basis of mother and finger Rhizomes respectively. The maximum losses in curcumin content (50.11%), were found in severely diseased plants. The percent curcumin content in Rhizomes from diseased plants and disease free plants ranged from 2.08 to 4.17.
2.3 CONCLUSION AND RESEARCH CHALLENGES:

Turmeric is the dried Rhizomes of the plant Curcuma domestica Val. Syn. C. Longa L. Turmeric is used in various food items in specified limits as listed in Table 1.1 (Peter, 1999). In addition, it is used as medicine, bio-pesticides, preservation of various items, etc. India is the major producer and exporter of the turmeric in the world. Primary processing of turmeric is still being done with traditional methods leading to many losses and difficulties. Many agricultural scientists, B. Sasikumar, B. Ravindram, P. N. Jonson, K. George, and Peter K. V. from Kerala have studied the turmeric species and turmeric processing methods but they have not focused on new methods of processing. Scientists Verghese J. from Indian Species, Joseph Philip, and Setumadhavan (1980). Li Ling, Luo-Xue Gang (2010) have studied various properties of turmeric.

In traditional methods, Indian farmers use shallow open (mild steel) pans for the turmeric boiling. The pan is kept on the furnace, and turmeric Rhizomes are heaped in; water is added up to 3/4th of the heap weight in the pan and covered by gunny bags or plastered. It takes about 50 to 60 minutes to boil the water and next 40 to 45 minutes to boil the turmeric. The boiled Rhizomes are pulled out of the pan by wooden combs and allowed to leach the water thoroughly. The boiled Rhizomes are spread on a clean open ground for drying.

Because of shallow open pans, the heat losses are tremendous. The boiling time per batch is 80 to 90 minutes where as more time is consumed to boil water in the pan instead of boiling turmeric. In traditional methods, there is no any provision to handle the hot Rhizomes, loading and unloading, which is laborious and time-consuming. During traditional handling of boiled Rhizomes, causes trampling, mudmixing, and scorching, leading to quality and quantity loss.

Dr. K. J. Kamble, and S. B. Soni (2009) of the college of Agricultural Engineering and Technology, Parbhani have developed an improved boiling pot (pan) to modify the traditional method of turmeric processing. The boiling pot can improve
the loss of heat to some extent but the problems of handling hot Rhizomes, Loading and unloading, Labour cost and quality of Rhizomes is require to improve.

Another existing turmeric process plant with two boiling pots and a separate boiler unit is developed in Marathwada Agricultural Engineering and Technology, Parbhani (M.S.). The turmeric processing plant consists of two cylindrical boiling pots of 150 kg each. The pot is loaded with 150 kg of turmeric in each batch, from the bottom of the pot steam is supplied, it is supplied until white fumes come out from top. In this method there is uneven heating of the Rhizomes, by this method Rhizomes at centre get heated to higher extent compared with the Rhizomes at the circumference and top of the boiler unit. The uneven heating of Rhizomes leads to lower the quality of Rhizomes. It is difficult to load and unload the hot Rhizomes after boiling and to carry the Rhizomes for further sun drying.

A research is required for turmeric processing since the above methods are not economical, there is loss of heat in boiling method, there are difficulties in loading and unloading the hot Rhizomes, it is difficult to transfer the hot Rhizomes for sun drying. The quality of the Rhizomes is not maintained due to uneven heating, handling, trampling, mudmixing etc. More labour cost is required to load, unload and transfer the hot Rhizomes. The traditional method is time consuming, since more time is required to heat water around 45 to 60 minutes.

From the literature survey it is concluded that, it is required to design a new turmeric processing plant or boiling unit called blancher which requires following specifications.

It should be economical and rigid.

It should boil the Rhizomes uniformly to get good quality of Rhizomes by steam heating and supplying steam uniformly at every corner of the boiling unit.

The time consumption and labour cost of the processing plant is to be Reduced, which is possible by steam boiling and designing a new heating unit.
which can transfer the hot Rhizomes directly from the place of boiling to the place of sun drying, which can reduce the time consumption and labour cost.

The quality of the Rhizomes can also be improved by replacing a traditional mild steel boiling pan with high quality stainless steel pan.

A new design of the blancher should be easy and mobile to operate. Which can be easily installed at different places to boil less quantity of turmeric with small scale farmers in India.

Hence, it is decided to design the new blancher (boiling unit) which can fulfill the above requirements and which reduces the processing cost and it is mobile to operate.

In the literature review, there is thermostructural analysis of various components, design of various pressure vessels, design of heat and steam carrying devices is focused. It is found that the researchers have not focused on the design of turmeric processing unit. Prosenejit Santra, Vijay Bedakhale, Tata Ranganath (2009) have designed a SST-I vacuum vessel and cryostat assembly using ANSYS. Parul Agrawal, Daniel M.Empey, Thomas H.Squire (2009) have designed the heat shields subjected to severe thermal and mechanical loading. Many others have utilized the softwares like ANSYS, Uni-Graphics, SolidEdge, LS-dyna and other softwares for designing the various heat and steam carrying devices and pressure vessels. Today it is required to focus on the Agricultural devices and equipments used by farmers. The Agricultural equipments and the devices should be software designed and tested so that they can be manufactured in economical rate.

A research work is undertaken to design a turmeric processing unit called blancher in Uni-Graphics software. A high quality SS 304L steel is chosen for manufacturing. The methods for design, analysis and fabrication were studied from the literature review. The structural and thermal analysis of the blancher had been carried out using hypermesh and ANSYS software. The design is completed with double margin of safety. The test is carried out under temperature range 120°C to 210°C and pressure limits 2 to 9 bar.
After design and thermostructural analysis, it is decided to test the blancher by fabrication. For fabrication stainless steel (SS 304L) is used. The fabricated model is tested at the farmhouse of one of the farmer in Nanded district. The test is conducted for 15 minutes, 20 minutes and 25 minutes, during the test temperature is 120°C and pressure is 1.2 bar. The best period to boil the Rhizomes is between 15 to 20 minutes. The fabricated blancher was operating safely under given temperature and pressure conditions and the test results are found satisfactory. The proposed model is suggested to use for turmeric processing in future.