DESIGN OF INNER HOOD OF BELL ANNEALING FURNACE FOR BETTER HEATING EFFICIENCY

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ABSTRACT

Bell annealing furnace in salem steel plant is used to reduce the internal strain of hot rolling coil. The major problem faced in Salem steel plant while reducing the internal strain of hot rolling coil the inner hood was bulged due to continuous reheating of hot rolling coils. After 1400 hrs the life time of the inner hood was affected. Reduce the bulging action of inner hood by changing the design specification of inner hood present inside the furnace. Due to the bulging of inner hood resulted may be reduce the life time of inner hood. Present Study was based on changing the thickness of the inner hood and reducing the Bulging action. It is concluded that if change in thickness of inner hood in Salem steel plant might change the working efficiency of Bell annealing furnace.

Keywords: Bell Annealing Furnace, Inner Hood, Salem Steel Plant, Hot Rolling Coil.

1. INTRODUCTION

Bell annealing furnace in salem steel plant is used to reduce the internal strain of hot rolling coil. The efficiency of bell annealing furnace applied at salem steel plant the purpose to reduce the internal strain of hot rolling coil was achieved by changing the design of inner hood present within the bell annealing furnace. The major problem faced at steel company while reducing the internal strain of hot rolling coil for inner hood was bulged due to continuous reheating of hot rolling coils. Due to which bulging of inner hood occurred this resulted in less working efficiency of bell annealing furnace. Present Study was based on Changing the Thickness of the inner hood and reducing the Bulging of the inner hoods that resulted in increase of efficiency in salem steel plant.

To analysis the efficiency of bell annealing furnace by design the inner hood. To increase the efficiency of the bell annealing furnace by reducing the bulging of the inner hood. To increase the life time of inner hood. To study the efficiency of bell annealing furnace by design the inner hood using software.

2. BELL ANNEALING FURNACE

Annealing of stainless steel materials in grades of ferritic, martensitic as well as plain carbon steel sheet coils at cold rolling mill complex is accomplished in lift-off 'bell type high-convection electric furnaces engineered, built and commissioned by wesman.

The installation comprises of three production base units including one each of heating and cooling hoods and three inner covers. One repair stand provided to facilitate maintenance during down periods. The three bases are identical in design, construction and operation making them versatile units adaptable to heating, cooling and holding operation. The layout in shop provides floor space allocation to accommodate similar production line units to meet future expansion requirements. User must consider enough of holding areas in the shop for storage of coils before and after annealing treatments.

The furnace incorporates high convector system giving fast heating and cooling rates. In this system the heat is transmitted to the material being annealed mainly through its edges. Specially designed turbo-type convector plates are placed on top each coil, the heat being transmitted up through stack by high velocity gases induced trough theses convector plates under conditions of rigorous temperature
Control.

There is one high-power, high-velocity turbo-fan located centrally in the base with a diffuser unit in aid of above process.

Electro-heating is employed using long-life super alloy metallic resistor strips which procduces radiant heat by internal generation due to passage of electric current under the influence of normal voltage and frequency available in the shop grid.sss
Coils are handled by overhead crane facility. Individual covers are placed over coil stacks and are maintained gas-tight. Appropriate lifting tools are necessary (provided by user) to tackle various sizes of coils, convector plates, inner covers and hoods.

3. INNER HOOD

The inner cover as the name states is a completely welded construction specially meant for containing protective gas atmosphere. It is fabricated with heat resistant stainless steel; grade AISI-306SS (stainless steel), which has been imported from USA. The bottom ring is a cast steel suitably machine finished to serve desired purposes of dual gas sealing. It is provided with dipper plate at its underside which dips into the water maintained in the base trough. It has also dead blocks of steel welded to the bottom of ring, thus protects from surface damages. The top is a cone formed and is provided with a circular neck. This is to allow grabbing it which the help of a suitable tackle which in turn can be attached to overhead crane. . This tackle should be arranged by user in advance so that there is no time loss during production trials by WESMAN/ SALEM at commissioning stage. The tackle should have some manual locking/unlocking features to make it a suitable match to the design provided in the cover.

4.ANNEALING

Annealing is a softening process for metal that reduces internal strain caused by work hardening and facilitates recrystallization and grain growth. When metals are formed or processed, strain hardening occurs, decreasing ductility and increasing hardness. This hardening leaves metals brittle, often causing cracking or breaking during successive operations. For many applications, these residual stresses within the structural makeup of the molecules must be alleviated. Annealing returns the ductility to the metal allowing for future operations and processing. Both ferrous (iron-based alloys such as steel and stainless steel) and non-ferrous metals (such as bronze, copper and aluminum) use this process. This raw material is cleaned to eliminate rust, scaling, dirt, and other impurities. Cleaning can be performed using acid pickling or mechanical methods, depending on the application. The metal is then placed in a furnace where it is heated to meet metallurgical requirements. Variations exist within the process depending on the type of metal being annealed and the desired outcome. It is frequently advantageous to heat the metal within a controlled atmosphere, such as nitrogen or hydrogen, to prevent chemical reactions from occurring between the metal and elements in the air. The furnace heats the metal, usually through convection and radiation, to a desired level where it is either held constant or cycled. After the heating, a controlled cooling brings the metal back to room temperature.

5. BELL ANNEALING FURNACE PROCESS

Bell Annealing is a type of annealing that derives its name from the shape of the furnace used during the process. Bell Annealing heats batches of metal which are placed on a base assembly, enclosed by an inner cover, and covered by the furnace. An overhead crane is used to load the base and move the equipment-when the furnace is suspended from the crane; it looks like a -bell. The base assembly is the source of convection and the main method of heat transfer to the charge. The inner cover seals in the desired atmosphere and protects the charge from the burners' direct heat. Keeping contaminants out of the annealing atmosphere prevents chemical changes as well as eliminating the formation of oxides and soot on the metal. The furnace brings the charge to the desired temperature to allow for the metallurgical changes to occur. Direct fired, tangentially fired, radiant tube, and electrical resistance are furnace types related to the method used to heat the charge. After heat treatment, cooling is performed by removing the furnace leaving the inner cover in place to maintain the protective atmosphere. If a bright finish is desired, the metal must be cooled to near ambient temperature before exposing the metal to air. In this case, another piece of equipments utilized: a forced-cooler. The forced-cooler replaces the furnace at the end of the heating cycle and uses air and sometimes spray water to accelerate the cooling of the outside of the inner cover.

The main advantages of a Bell-Type annealing furnace are:

1. Excellent temperature uniformity

2. Consistent product quality

3. Good production rates

4. Low operating costs

5. Efficient use of furnace asset by cooling with inner cover

Savings in shop floor space requiring less capital investment and reducing material handling

Bell furnaces are used to anneal both strip and wire coils. Furnaces designed for strip are generally of a -single-stack configuration. The base diameter accommodates on coil centered over the base fan. The strip coils are stacked on top of one another, separated by convector plates. The circulated atmosphere flows up the sides and back down to the fan through the center of the coil.

To anneal wire, the coils must first be placed on a carrier, which is then loaded onto the annealing base. Furnaces designed for wire are generally of a multi-stack configuration. This requires a larger base, making the wire annealing furnaces short and wide compared to the strip counterparts. Like a strip furnace, the convection flow goes up on the sides and down the centre. For multi-stack wire systems, a plenum is used above the diffuser to direct all the flow to the inner cover wall and provide a return path for flow to the large convection fan.

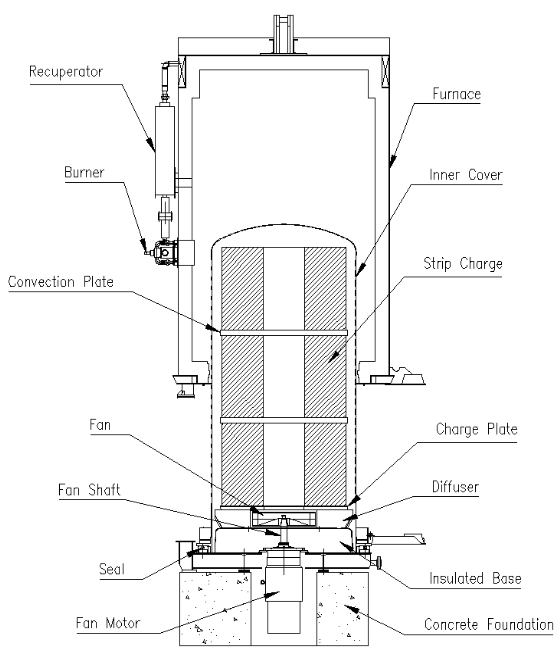
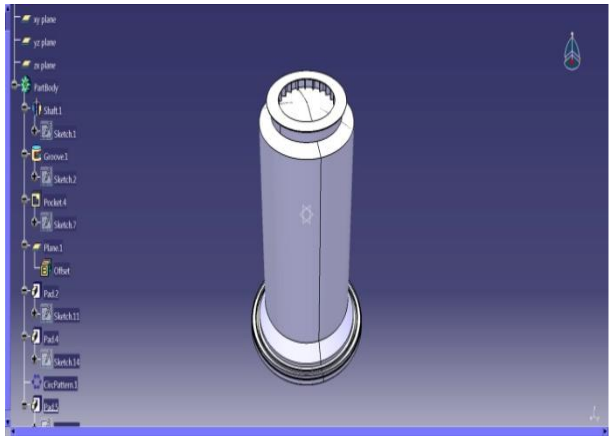
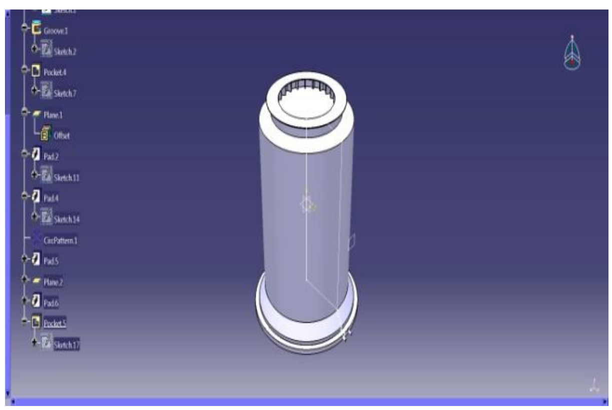


Fig: 5.1Bell annealing furnace process

6. INNER HOOD CATIA MODULING





SPECIFICATIONS

BASIC PARAMETER

coil size -610/710/760 mm Inner diameter

-1900 mm outer diameter (max)

Coil weight -15,000T(max)

Strip width -600 mm(min)

-1300 mm(max)

Hot rolled strip thickness -2.5 mm(min)

-7 mm(max)

Cold rolled strip thickness -0.3 mm(min)

-4.0 mm(max)

FURNACE DESIGN PARAMETERS

Batch load -30T(max)

(2 coils of 1300mm width (or) 3coils of 900mm width)

Stack height (max) -2820 mm (max) including top plat.

Maximum annealing temperature

of change -870°C

Maximum furnace temperature -1000°C

Furnace rating -405kW

Material -stainless steel

OLD INNER HOOD

The size of inner cover,

Thickness -8 mm

Inner diameter -2030 mm

Overall height -3718 mm

NEW INNER HOOD

The size if inner cover,

Thickness -12mm

Inner diameter -2030mm

Overall height -3845mm

HEATING ELEMENT

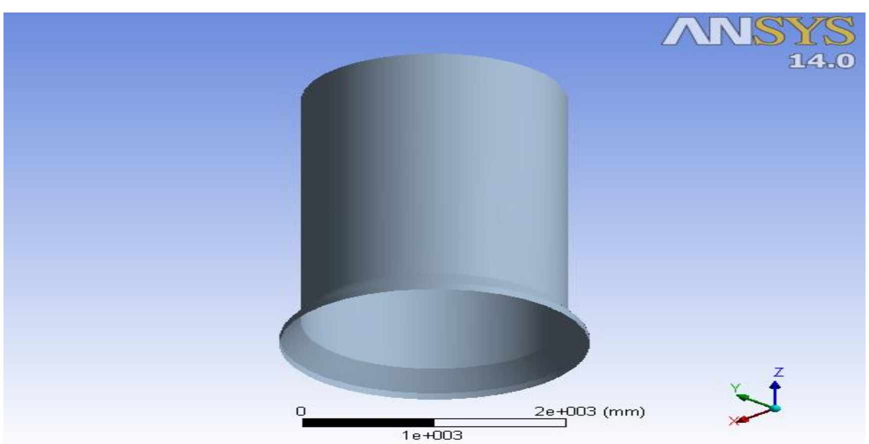
80/20 Ni.Cr strip element, size 25mm wide X2.5mm thickness carrying 3-zones (in each bell as-

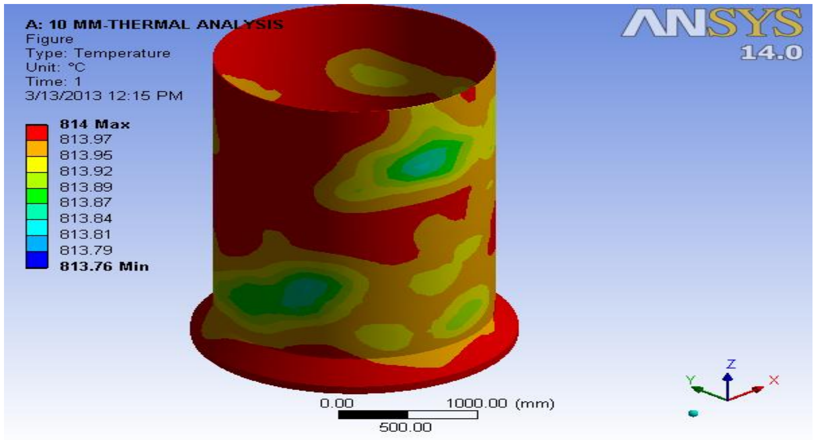
1. Bottom zone	-150kw
2. Middle zone	-135kw
3. Top zone	-120kw
Total	-405kw

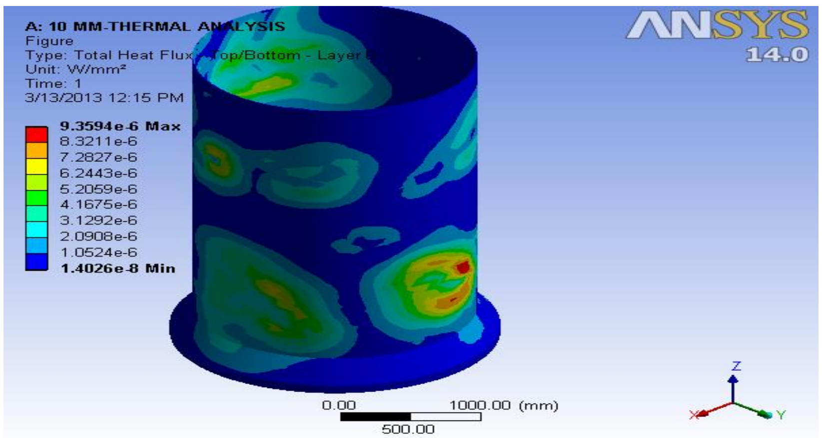
Table: 1. HEATING SEGMENT

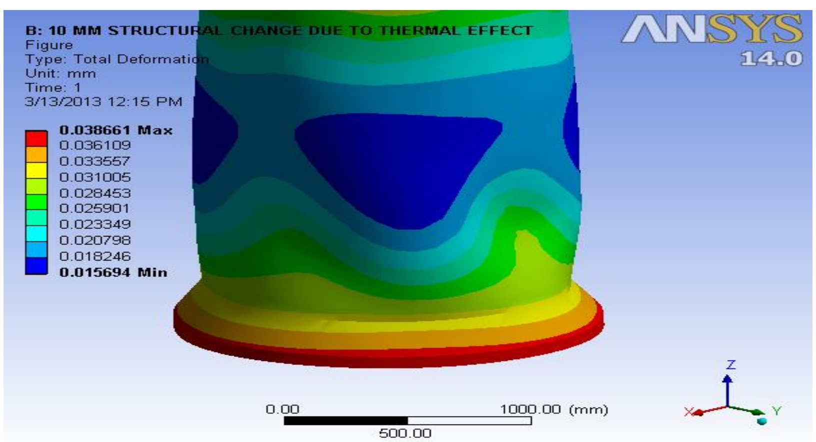
SEGMENT NO	TIME	TEMPERATURE
1.	0hr-10min	350°C
2.	0hr-30min	400°C
3.	1hr-15min	500°C
4.	1hr-15min	600°C
5.	1hr-0min	650°C
6.	1hr-0min	700°C
7.	1hr-30min	750°C
8.	2hr-0min	800°C
9.	1hr-15min	815°C
10.	5hr-0min	815°C
11.	12hr-0min	UPTO ROOM TEMPERATURE

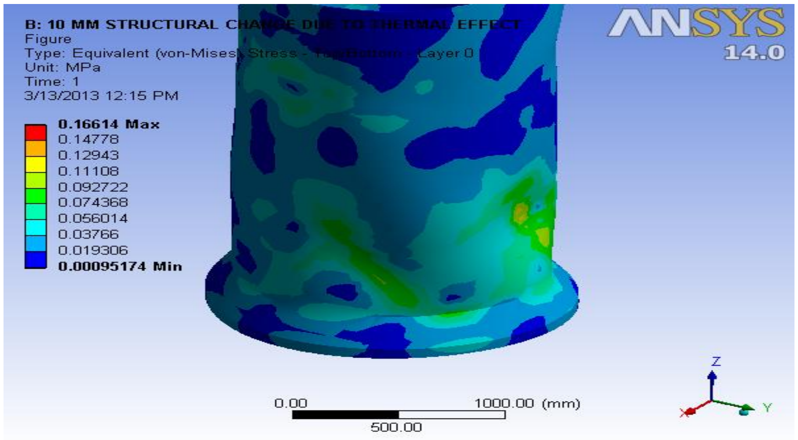
7. ANALYSIS FOR 10MM

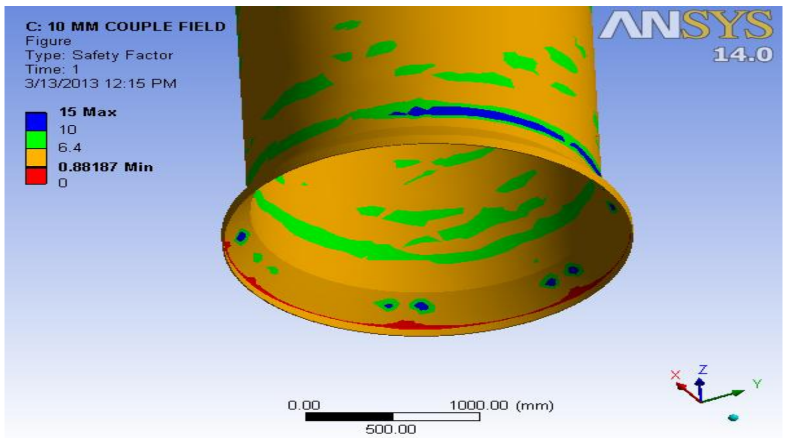



A: 10 MM-THERMAL ANALYSIS
Figure
Type: Temperature
Unit: °C
Time: 1
3/13/2013 12:15 PM
814 Max
813.97
813.95
813.92
813.89
813.87
813.84
813.81
813.79
813.76 Min
ANSYS
14.0
0.00
1000.00 (mm)
500.00

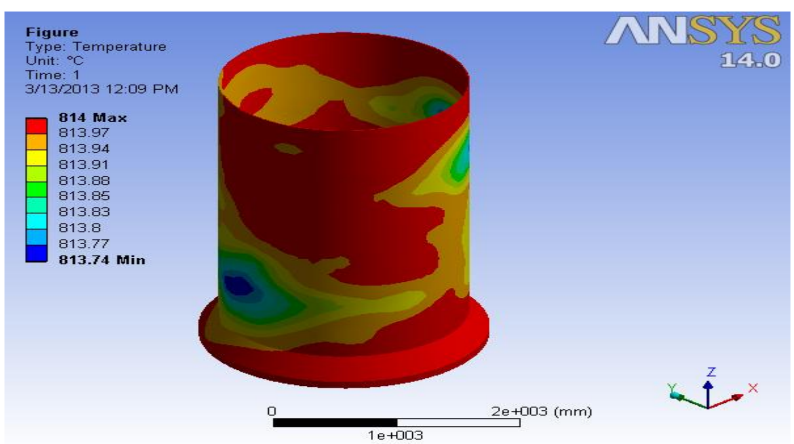

A: 10 MM-THERMAL ANALYSIS
Figure
Type: Total Heat Flux
Unit: W/mm²
Time: 1
3/13/2013 12:15 PM
9.3594e-6 Max
8.3211e-6
7.2827e-6
6.2443e-6
5.2059e-6
4.1675e-6
3.1292e-6
2.0908e-6
1.0524e-6
1.4026e-8 Min
ANSYS
14.0
0.00
1000.00 (mm)
500.00


B: 10 MM STRUCTURAL CHANGE DUE TO THERMAL EFFECT
Figure
Type: Total Deformation
Unit: mm
Time: 1
3/13/2013 12:15 PM
0.038661 Max
0.036109
0.033557
0.031005
0.028453
0.025901
0.023349
0.020798
0.018246
0.015694 Min
ANSYS
14.0
0.00
1000.00 (mm)
500.00





8. ANALYSIS FOR 12MM



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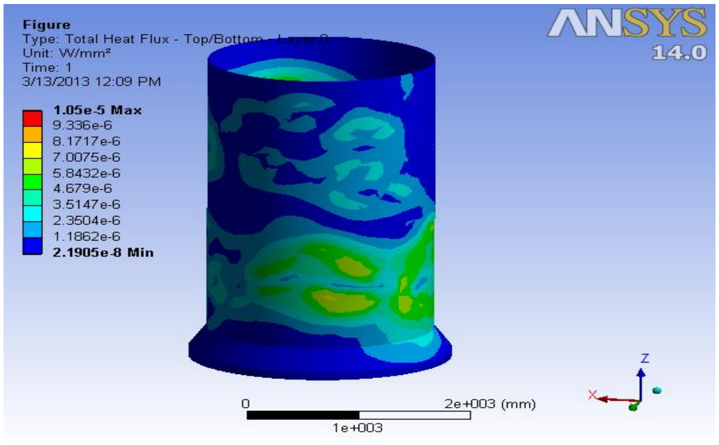
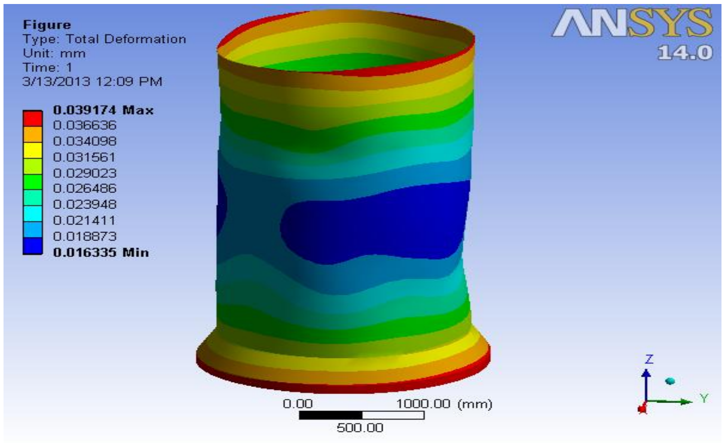
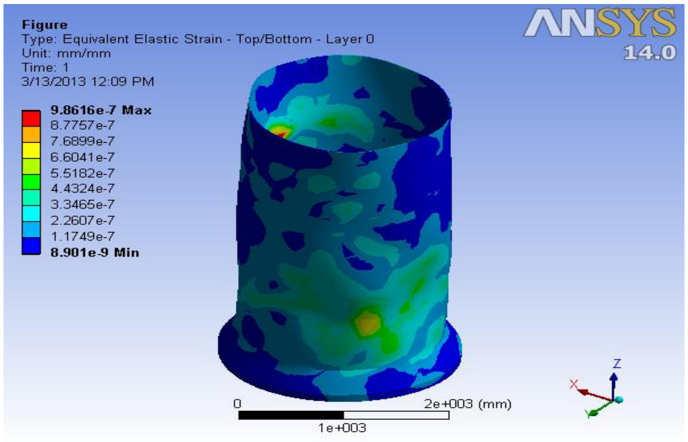
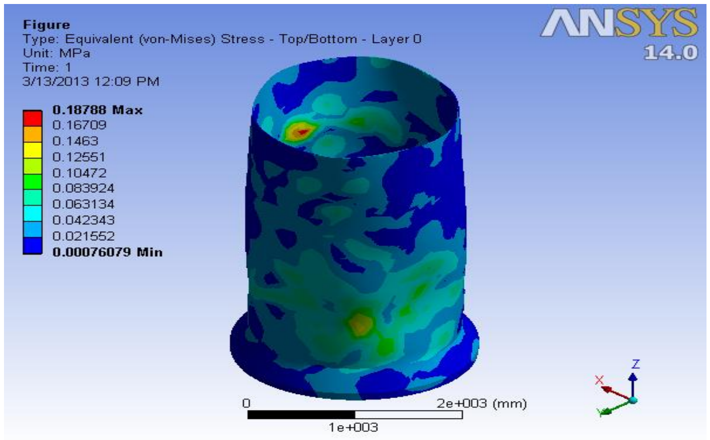
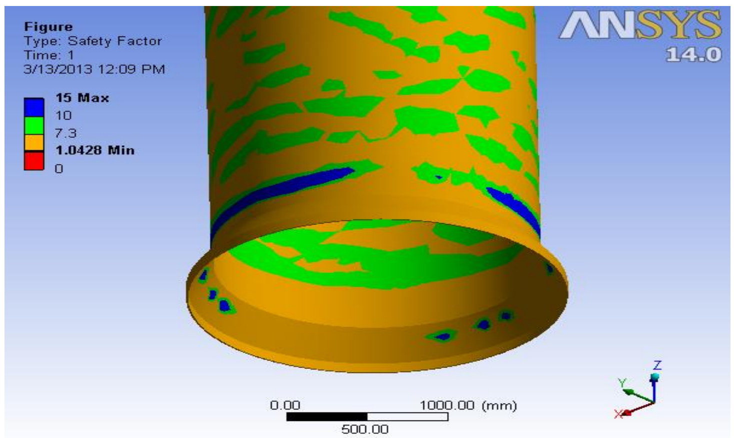


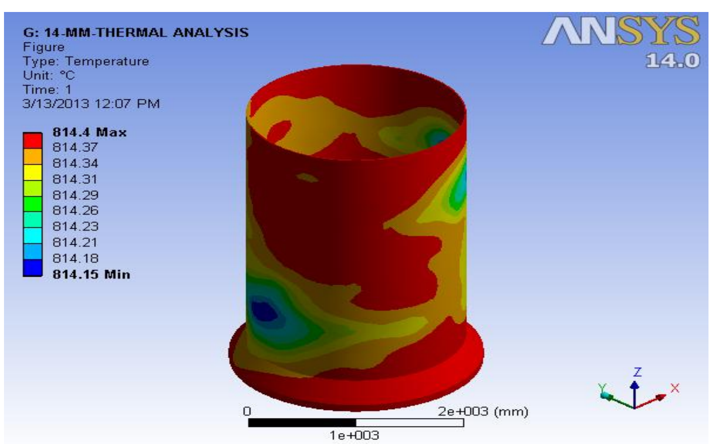








9. ANALYSIS FOR 14MM



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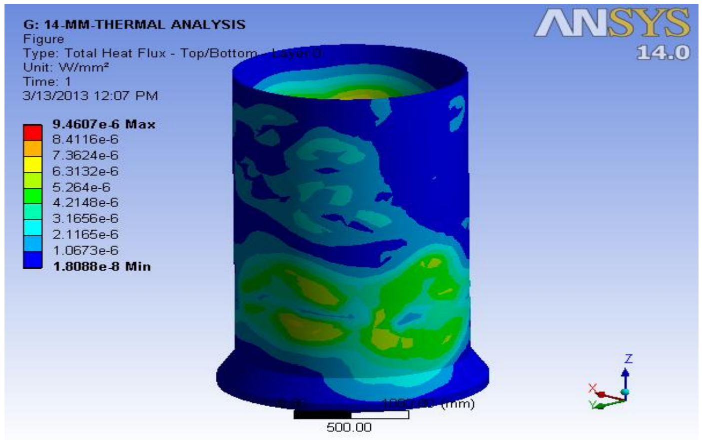

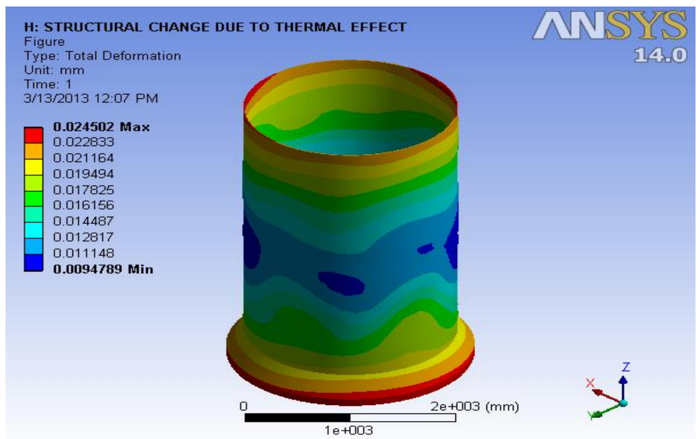

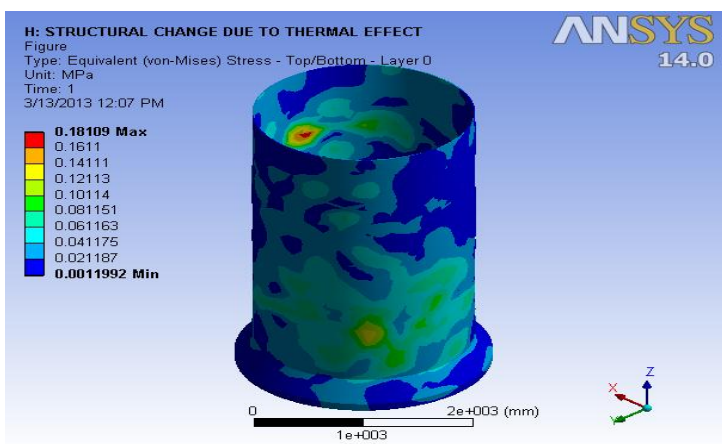

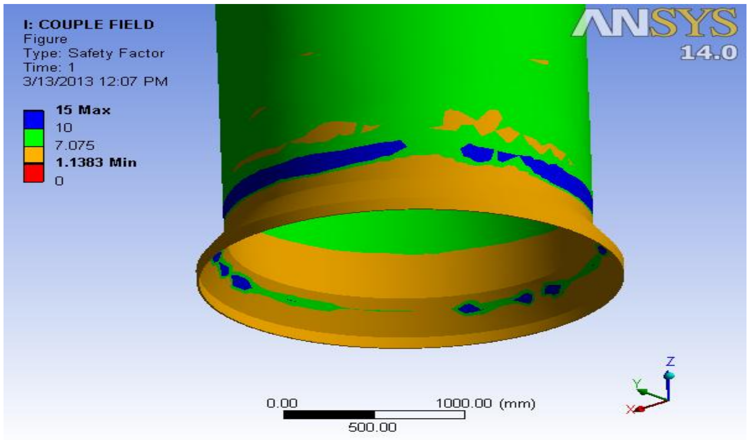

Inner hood(thickness in mm)	Total heat flux(w/ mm^2)	Thermal expansion (mm)	Thermal stress (Mpa)	Coupled filed (Mpa)	Safety factor
10mm	9.3594 e-6	0.038661	0.16614	623.68	0.88187
12mm	9.336 e-6	0.039174	0.18788	527.4	1.0428
14mm	9.4607 e-6	0.024502	0.18109	483.17	1.1383

10. NOTS FOR INNER HOOD COVER

1. All welds to be absolutely gas tight where indicated.

2. All welding to be done from the inside first, chipped from the outside and then welded on the outside.

3. All steel to be free from dust, oil, grease, rust, loose scale or any other foreign substances.

4. The flatness tolerance on the bottom surface mark thus must be within ±1mm.

5. Check cover for vertical alignment, with respect, to bottom seal ring.

6. Do not paint.

11. CONCLUSION

About the project of hot rolling coils was heated after which the inner hood bulged due to the heat action inside the bell annealing furnace and the working efficiency of the bell annealing furnace was analyzed and the bulging of the inner hood was observed. The major problem faced at salem steel plant industry while reducing the internal strain of hot rolling coil. Inner hood was heating upto 15 hrs time taken for two coils. Due to which bulging of inner hood occurred for to repeated heating this resulted in less working efficiency of bell annealing furnace. Present Study was based on Changing the Thickness of the inner hood and reducing the Bulging of the inner hood that resulted in increase of the efficiency in bell annealing furnace. It is concluded that if change in thickness of inner hood is adopted in salem steel plant industry it might change the working efficiency of bell annealing furnace.

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3. 'SIETEX' instruction manual "minor" controller.
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5. 'EMCO' transformer leaflet.
6. 'DIGICONT' electronic timer leaflet.
7. 'IEPL' installation, operation and maintenance of rotameter.