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DESIGN MODELING AND ANALYSIS OF TWO STAGE ROTARY KILN

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ABSTRACT
Submerged arc welding(SAW) is common arc welding process.The welding head moves from right to left.The flux powder is supplied by the hopper. Flux grains are made from dry chemical powder mixed with chemical binder. Moisture level of grains at initial stage is 70%.That need to be reduce below 4%. The scope of project is to design two stage rotary kiln. Unfired dryer which will take waste heat from fired dryer as input and utilize it for primary drying of flux grains. This system involve thermal calculation for heat required to remove moisture level and mechanical structure design analysis of kiln setup.

KEYWORDS:Rotary Kiln,Fired Dryer,Flux Grains,Moisture,Thermal Calculation.

INTRODUCTION
SUBMERGED ARC WELDING (SAW): is a common arc welding process. The molten weld and the arc zone are protected from atmospheric contamination by being "submerged" under a blanket of granular fusible flux.

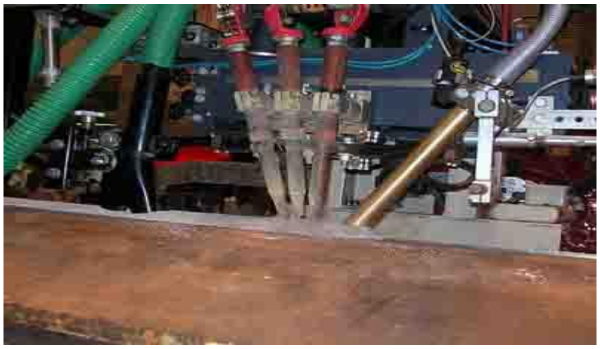

Fig 1. SAW or submerged arc welding equipment completing a weld. The weld starts on the right and moves left. The gray colored powder is flux.

The flux consisting of lime, silica, manganese oxide, calcium fluoride, and other compounds When molten, the flux becomes conductive, and provides a current path between the electrode and the work. This thick layer of flux completely covers the molten metal thus preventing spatter and sparks as well as suppressing the intense ultraviolet radiation and fumes that are a part of the shielded metal arc welding (SMAW) process.

Granulated Flux: The granulated flux shields and thus protects molten weld from atmospheric contamination. The flux cleans weld metal and can modify its chemical composition also. The flux is granulated to a definite size. It may be of fused, bonded or mechanically mixed type The flux may consist of fluorides of calcium and oxides of calcium, magnesium, silicon, aluminum and manganese. Alloying elements may be added as per requirements.The granular flux used in SAW serves several functions. In addition to providing a protective cover over the weld, the flux shields and cleans the molten puddle. The flux also affects the chemical composition of the weld metal, the weld bead shape, and the mechanical properties of the weld.Another function of granular flux is to act as a barrier that contains and concentrates the heat into the weld area thus enabling deeper weld penetration.

Fig 2. Pieces of slag from Submerged arc welding

OBJECTIVES

- An open fired kiln has excessive heat loss.to reduce existing heat loss.
- To reduce down the raised ambient temperatut to make it safe for humans to work around kiln.
- To reduce cost of fuel for heat generation.
- To increased drying capacity from 500kg/Hr to 2ton/Hr.

LITERATURE REVIEW

In Paper[1],**Rotary Kiln Design** by Prof.dr.ir. G.F. Versteeg etal.[1], explain,

Rotary kilns are amongst the most well-established unit operations in the process industry, yet are amongst the least understood. They can be used for 3 purposes: heating, reacting and drying of solid material, and in many cases, they are used to achieve a combination of these aims. In the design of kilns, there are four important aspects to consider from a process engineering point of view, and these are heat transfer, flow of material through the rotary kiln, gas-solid mass transfer and reaction.

In Paper[2] **A case study of high-temperature corrosion in rotary cement kilns** by J.H. Potgieter etal[2].

This paper describes two cases of corrosion that occurred in dryprocess, rotary, cement-clinker kilns. In the case of the kiln with five pre-heater stages, the attack occurred primarily from sulphates that probably originated in the raw feed and fuel being used in the plant and that penetrated the refractory lining. The corrosion was similar to ash-deposit corrosion often observed in steam boilers. In the second case the plant consisted of a long dry kiln with a single pre-heater fitted to the feed-end. In this case the corrosion could be ascribed to alkali chloride penetration through the refractory-brick lining and subsequent hot corrosion of the kiln shell.

In paper [3], **Fabian Herz,etal. Otto von Guericke University, Magdeburg, Germany “**Analysis of Local Heat Transfer in Direct Fired Rotary Kilns” 2010 14th International Heat Transfer Conference.

Heat transfer in the rotary kiln is a complex phenomenon due to the different modes of heat transfer. In the first part of this study, the local heat transfer coefficients are analysed theoretically, to describe the heat transfer mechanisms in the cross section of the rotary kiln. Furthermore, the axial solid motion along the length of the kiln is considered in the local surfaces which exchanges the heat.

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Fig 3.Single Stage Dryer

Problems identification in current Flux manufacturing process:

1] During flux granule manufacturing process, flux drying takes place in an open fired dryer.
[2] This leads to increase in ambient temperature of entire factory shed to level of 55 to 60 degree Celsius.
[3] The rate of flux production is 500 Kg/Hr. which also need to be enhanced to 2 ton/Hr.
[4] Being open dryer capacity enhancement is not possible due to impossible working condition.
[5] Apart from that open dryer results in excessive heat loss and the flux granules are sorted for acceptable size.
[6] In current setup, non-acceptable grains are also dried which consumes heat and ultimately results in heat loss.

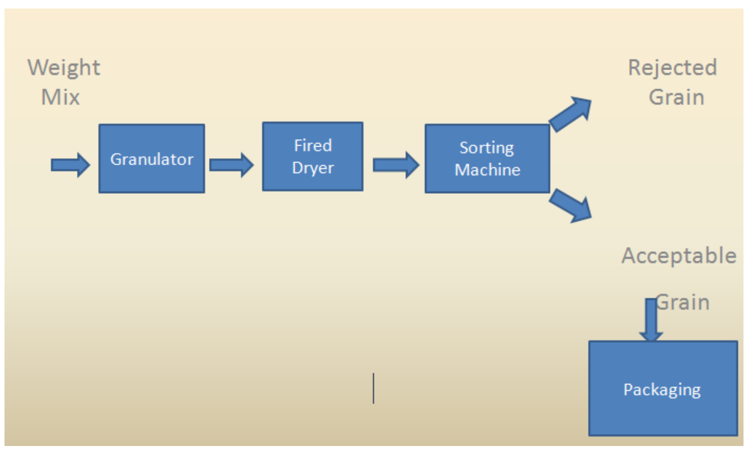

Fig 4. Existing process

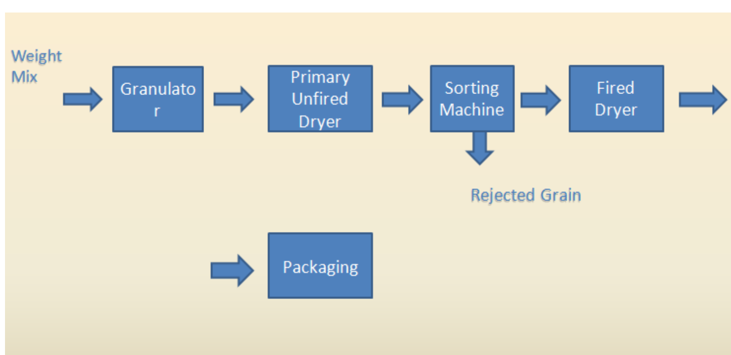

Fig 5. New Process

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MATERIALS AND METHODS

Calculations:

Theoretical Heat Required for Drying

- 1 Ltr. LPG can provide 22000 BTU of energy
- Evaporation of 1 Ltr water requires 2250 BTU of energy
- Water evaporated per hour- 150 Ltr
- Total Heat Required 150 X 2250 = 337500 BTU

Emissive Heat Loss

- Heat Loss / unit sq. meter= (emissivity X Tem. Difference)/wall thickness
- Emissivity for fire clay 1.4
- Temp. Diff. – 1100 Degrees Centigrade
- Fire Clay thickness- 0.1 meter
- Therefor total heat
- Loss = 1.4 X 1100 = 15400 BTU
- 0.1

Total Fuel required

- Total Heat required- 337500 + 15400 = 352900
- Heat per liter of LPG- 22000
- Total Fuel Required- 352900/22000 = 16 Ltr.

Air required for combustion

- 1ltr LPG = 0.27 meter cube
- Air Fuel ratio- 24
- Air required per ltr of LPG- 6.5 meter cube
- Total Air required -16× 6.5 =104 meter cube
- Burner need 20% excess air for complete combustion
- Therefore total hot Air generated is 104 X 1.2 = 125 cubic meter

Modified Process:

- Through conveyor granules are transferred to primary un-fired dryer.
- The stay time for granules in unfired dryer is 25 to 30 Min.
- After primary drying, granules are transferred to vibrating screen for size sorting. This is done through gravity feed for which dryer drums are installed inclined.
- Later only acceptable size lot is feed to fired dryer though a chute rest is sent for re crushing and further used as raw material again.
- In fired dryer the stay time for granules is 20 Min. and at any point of time fired dryer contains 650 to 675 Kgs of granules.
- After drying at 1100 degrees centigrade, granules are rapidly cooled down through baffled passages of cooler and later on sent for packaging.

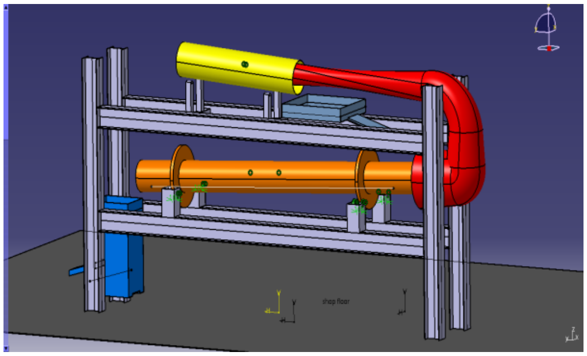

Fig.6. CAD Model

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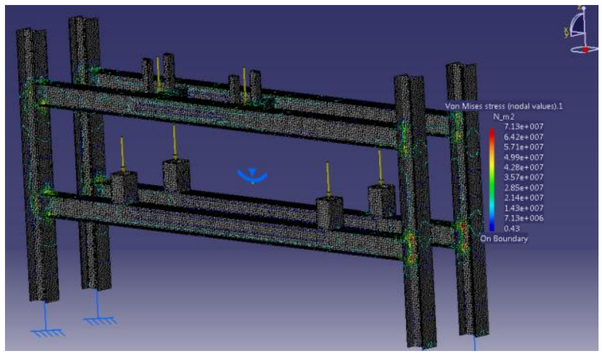
FEA Analysis using CATIA Software

CATIA V5 software is used. Model generation is conducted in this processor, which involves materialdefinition, creation of a solid model, and, finally, meshing. Important taskswithin this processor are:

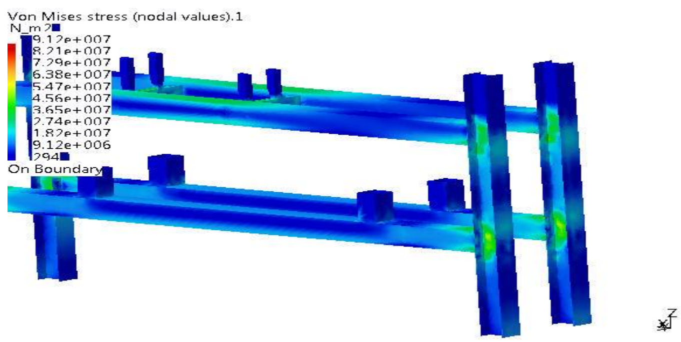
- Specify element type.
- Define real constants (if required by the element type).
- Define material properties,
- Create the model geometry.
- Generate the mesh.

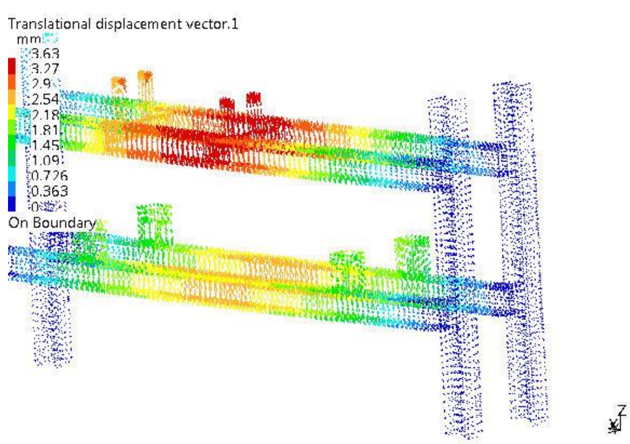
Meshing

Tetrahedral Meshing is generated after specifying element type and material properties.



Stress and Strain Analysis:





FEA Analysis Result

The Output Result File generated while analyzing the part is shown below.

Analysis

MESH

Entity	Size
Nodes	94420
Elements	271565

Element Type

Connectivity	Statistics
TE10	271565(100.00%)

Element Quality

Criterion	Good	Poor	Bad	Worst	Average
Stretch	265736 (97.85%)	5829 (2.15%)	0 (0.00%)	0.200	0.458
Aspect Ratio	42649 (15.70%)	225238 (82.94%)	3678 (1.35%)	8.450	3.307

RESULTS AND DISCUSSION

Result:

Finite Element analysis of the Two stage Kiln has been done using FEA tool CATIA Workbench. The Mathematical calculations and CATIA calculations are compared and tabulate below.

Parameter	Old	New
Production Capacity	0.5 Ton/Hr	2 Ton/Hr
Fuel	LPG	LPG
Total drying heat required	90000 BTU	349100 BTU
Fuel consumption	5 Ltr/Hr	16 Ltr/Hr
Fuel saving 4ltr/hr		

CONCLUSION

It has been seen that the Two Stage Kiln concept for Drying and Sorting is possible and can be use for large production due to high capacity. The special arrangement of Two Kiln (fired and unfired kiln) reduces heat and fuel loss and the human effort and helps to improves production and efficiency of the system.

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