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Design And Development Of Industrial Drying System For De-Moisturising Minerals (Chrome Ore) For Nava Bharat Ventures Ltd.

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Abstract

The modest approach under the above heading is exclusively for the betterment of drying system in accordance with energy, environment and safety measures. The precious work is concerned to the design and development aspect of a drying unit in a small domain and which can be further extended in a large scale to step in to the direct operation environment. In particular, the enthusiastic approach is specifically meant for replacing the drying unit in a noble enterprise namely Nava-Bharat Ventures Private limited. The developed drying unit diverges out as a double shell, indirect heat, counter flow, bio-mass propelled rotary dryer. The specific objective fulfilled by the unit is to de-moisturize the chrome ore and consequently which fed for the ultimate operation. Apart from the macroscopic target of design and development, the study also goes around the drying mechanism, heat flow interaction, and discrete heat flow models in particular, where the microscopic revelation against the heat transfer mechanism in a global spectrum has been garnished. Under the design and development stage, along with the current existing drying unit of the above mentioned esteemed organization, our endeavor has also been documented. In a nut shell, the work revolves around the heat exchanger (specifically counter flow), dryer or drying system, bio-mass, chrome ore and the last but not the least the Nava-Bharat Ventures Private Limited units vividly.

Keywords:- Dryer, biomass, counter current heat exchanger, chrome ore.

1. Introduction

The term drying refers generally to the removal of moisture from a substance. It is one of the oldest, most commonly used and most energy consuming unit operation in the process industries. Drying is often necessary in various industrial operations particularly in chemical process industries to remove moisture from a wet solid, a solution or a gas to make it dry and choice of drying medium is depends on the chemical nature of the materials.

Modern society requires better product quality, improved safety practices and more environmentally benign operations, as well as higher productivity, better energy efficiency and reduced material wastage with the advent of feed-back controlled optimized dryer [22]. Drying,without doubt one of the oldest and most common unit operations in the process industries. It is a very complex and poorly understood process despite the research that has been carried out over many decades. The field is vast, as more than two hundred variants of industrial dryers can be found depending on the materials to be dried and the drying conditions. This means that extensive experimental observations and operating experience exist.Drying is an operation of great commercial importance in all industrial applications ranging through the food, agricultural, mining and manufacturing sectors.

1.1 Dryer

Drying, especially rotary drying is without doubt one of the oldest and most common unit operations in the process industries. Rotary dryers are workhorses which are easy and reliable to operate, but neither energy-efficient nor environmentally friendly. In order to conform better to the requirements of modern society concerning working conditions, safety practices and environmental aspects, the development of control systems can provide opportunities for improving dryer operation and efficiency. Our in depth understanding of rotary drying is poor, because it is a very complex process that includes the movement of solids in addition to thermal drying. Thus even today rotary dryers are controlled partly manually, based on the operator’s ”eye” and experience, and partly relying on conventional control methods. The control of a rotary dryer is difficult due to the long time delay, which means that accidental variations in the input variables can disturb the process for long periods of time before they are reflected in the output variables

1.2 Bio-Mass

Using dry biomass to produce energy for dryers has significant advantages as the handling, transportation and pyrolysis process reduces the cost. Three main choices for drying biomass are rotary dryers, flash dryers and fluidized bed dryers.

The pros and cons of various types of biomass dryers have been documented in this paper. Using dry biomass significantly reduces the cost of handling, transportation and pyrolysis. Environmental impacts of any dryer type should be considered for selection in addition to its traditional techno-economic performance.

2. Literature Review

The aim of the research proposed by Yliniemi Leena(39) et al. was to improve dryer control by developing new hybrid control systems, one consisting of a fuzzy logic controller (FLC) and PI controller and the other of a three-layer neural network (NN) and PI controller. The FLC and NN act as supervisory controllers giving set points for the PI controllers. The performance of each was examined both with simulations and in pilot plant experiments. The pilot plant dryer at the University of Oulu closely resembles a real industrial situation, so that the results are relevant. Evaluation of these results showed that the intelligent hybrid controllers are well suited for the control of a rotary dryer, giving a performance in which disturbances can be eliminated rapidly and operation of the dryer can thereby be improved, with the aim of enhancing its efficiency and environmental friendliness.The approach(1) by Tiwari expresses, numerical investigation of heat transfer and fluid flow in a single pass counter flow chevron corrugated-plates plate heat exchanger considering nano-fluids (CeO2 and Al2O3) as homogeneous mixtures has been done using the Commercial CFD software, ANSYS FLUENT. The required thermo-physical properties of the nano-fluid were measured and used in the CFD model through UDF (User Defined Function) commercial CFD software ANSYS/FLUENT. Individual optimum concentration of CeO2/water and Al2O3/water nano-fluids yield maximum heat transfer improvement has experimentally determined and then CFD simulation has been done with those concentrations to obtain the temperature, pressure, and velocity fields. The results of numerical simulation were compared with experimental data in order to verify the accuracy of the homogeneous model. Validation of the CFD model suggests that considering nano-fluid a homogeneous mixture, simulation can be performed to predict the plate heat exchanger performance with reasonable accuracy. CFD simulation shows that corrugation pattern of the plate develops turbulence and vortices of fluid which results in high heat transfer rates.

This articleby Baker et al.(5) aims at modeling the rotary drying of carton packaging waste and analyzing the energy performance of the process. Drying data were obtained in a semi-pilot rotary dryer, 0.45 m diameter and 2.7 m rotating drum long, operating with an air velocity of 1 m/s and air inlet temperature of 90°C and 10 rpm. Under the operating conditions employed, the analysis of the data showed that the energy performance of the drying process increased from 5 to 75% as the inlet wet solid feed rate increased from 1.8 to 19 kg/h. In addition, at this latter wet-solid feed rate, the reduction of the air velocity in the dryer to 0.8 m/s also led to an increase in the performance of drying process from 80 to 94%. Furthermore, with a 95% confidence interval, the model used was adequate to predict the air and solid temperature as well as the air humidity and the solids moisture content.

3. Modelling And Fabrication

The model includes parameters for which values are calculated from correlations presented in the literature or determined experimentally. Of the physical parameters, heat capacity is evaluated for both solids and drying air at the arithmetic means of their input and output temperatures.

3.1 Modeling

Under the modeling process, **CATIA V-5** exclusive software package is implemented in order to bring out the maximum visual clarity through the 2-dimensional drafting graphics as well as 3-dimensional part diagrams. Underneath the step by step part diagrams has been produced. At first a basis frame which holds and supports the drying acthas been developed.

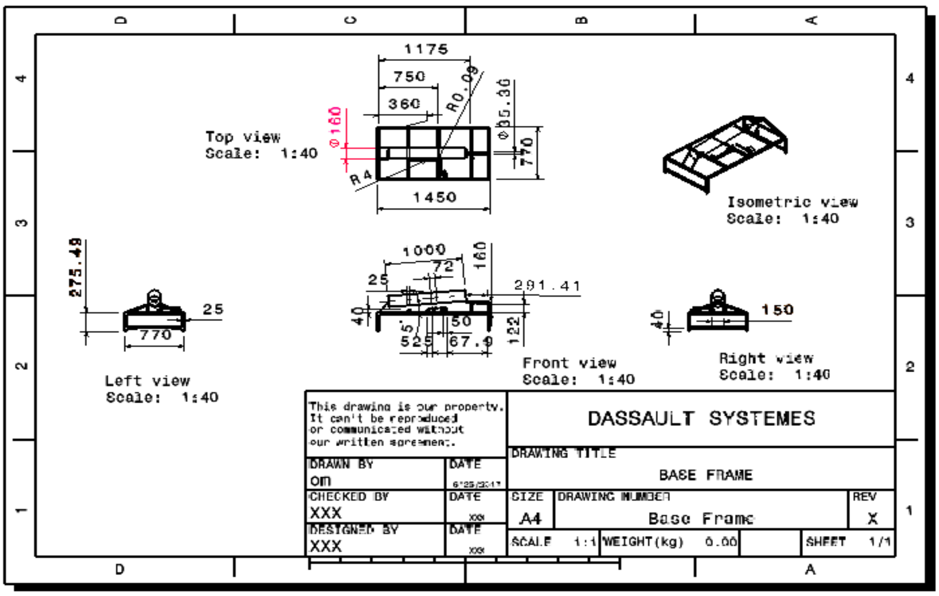
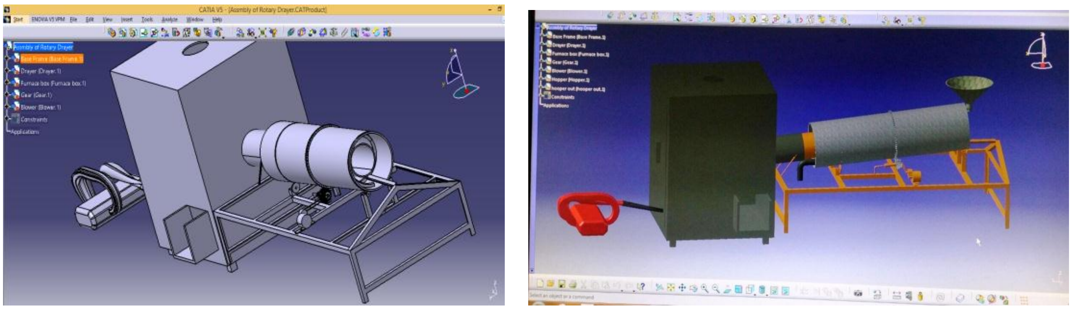


Fig.:-2-D model of Basic frame with drafting

Finally, the assembled drying system comprising exclusively of furnace box, basic frame, drying drum, blower and power propelled gear unit has displayed its isometric projections aided by the same software package underneath.



(a) (b)

Fig.:-Assembly Drawingsof the drying unit

3.2Fabrication

The physical drying unit has been processed considering different major manufacturing processes like welding, riveting, shearing etc. as per the design criteria. After the raw manufacturing processes carried out, some specific adjustment measures like finishing operation etc.have been implemented in order to satisfy the definite objective.

The above figure displays the firing activity without material flow.

(a) (b)

Fig.:-Complete Drying Unit

Whereas the figures displayed above realizes the side and front arrangement of the complete assembled unit of the drying system

4. Measurements And Facts

Ultimately the drying unit along with some of its important parameters has beenlisted below for the general concern.

Name of the Model: - Indirect counter-flow rotary dryer

Shell Material: - Mild steel, alloy steel, Confirming to IS: 2062

Material to be dried: - Chrome ore of bulk density 2300 kg/m^3;

Length of the Drum: - 1000mm.

Outside Drum diameter: - 280mm.

Inside Drum diameter:-160mm.

Outer Drum thickness: - 8mm.

Inner Drum thickness:- 6mm.

Shell Cubage: -6.15752×10^7 mm^3

Shell Inclination/Obliquity: - 3-5 degree

Rotary speed of the Drum: - 10 rpm

Exhaust Gas Quantity**: - 6**00 m^3/Hr**.;**

Drying capacity: - 0.5 TPH, Dry basis;

Moisture removal rate: - From12% to 3 %;

Heating Medium**: -** By Bio-mass Fuel Burner**;**

Total Weight**:** 0.45 Tones (Dryer & Burner)**;**

5.1 Conclusion

The unique counter-flow, indirect heat, double tube, bio-mass aided approach systematically depicting the design and development criteria. Above that the dryer- a brief divergence, heat flow mechanism, discrete heat flow model from global concern has enthusiastically embedded within the domain. The confluence of the study has also drifted sub topic like drying mechanism, rotary drying, residence time, etc inside significantly. It can be offer cost competitive designs for pilot scale units that process as little as one ton per hour to heavy duty units in excess of seventeen foot in diameter that process hundreds of tons per hour. Subject to constraints this unit isless sensitive to particle size, can accept the highest flue gasses of any type of dryer, low maintenance cost; thus economical.The critical difference between biomass fuels and fossil fuels is the type of carbon emitted: biomass fuel releases contemporary carbon, whereas fossil fuel releases fossilized carbon.Considering one of the major aspect of the biomass, our locally sourced bio-mass fuel enhances the security of the supply in terms of both its availability and its cost. Local sourcing secures clients against 'fuel shocks' caused by increasing global demand for fuel and political instability overseas. A localised nature of the supply chain minimises the financial and environmental costs of transporting fuel.Expressing the cons of the exclusively operating unit, it can only be said out that excessive entrainment loss in the exit gas stream is possible especially if the material contains extremely fine particles due to the large gas volumes and high gas velocities that are usually required.

5.2 Scope for Future Work

The present study was concentrated on a counter-flow, indirect heat, double tube, bio-mass assisted rotary dryer (prototype). The following works are suggested to be carried out infuture.

- Pilot plant study on large industrial scale may be carried out to realize the small domain parameters in a proportional scale.
- Similar type of study may be extended for any other bio-fuel, petroleum fuel oil etc.
- The feed-back system may be opted for normal as well as from critical operation concern.
- The optimization tool like fuzzy logic, neural network, genetic algorithm etc which is actively implemented in the current time may opt into this issue to provide better parametric control.
- The advanced heat recovery principle can be implemented for higher thermal efficiency as well as overall productivity.
- The drying unit can be opted with HHO assisted to bring out maximum overall gain.

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