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WHITE PAPER ON THE FLUIDIZED BED DRYER OPTIMIZATION OF PERFORMANCE – AUTOMATED MODEL FOR CONVERGENCE OF INTERNAL AND EQUILIBRIUM HEAT COORDINATES

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A. Abstract

The automated model for monitoring the performance criteria of the FBD (fluidized bed dryer) is a functional convergence of the internal heat of the fermented dhool with the equilibrating heat of the applications within the dryer at the exchange coordinates across the wet through the dry zones.

Internal heat evaluation is a mathematical model that builds the algorithm for the real time evaluation of the withering states, the run through the mechanical friction field of the rotovane and the cut rollers in the CTC and finally the differential rate of moisture and gravimetric weight degradation of the dhool during the oxidation process. All of these define the internal heat of the dhool being introduced into the drying medium.

Drying mechanism in the FBD is essentially the equilibrium heat determinant and a mathematical function of a time series in the designated residence time, the particle velocity of the heating medium as well as the food substrate and the progressive shift in the conductivity or dielectric field of the food substrates.

The algorithm sought to be developed by the Marshall-Fowler team is designed to be quantitatively robust and durable in establishing real time triggers for the operating teams on the shop floor.

The approaches to formulating the algorithm is to wire in the key determinants of the internal heat through a chain of lead indicators in the form of proximity sensors or contact transmitters to generate real time process data right through the chain and provide mathematical treatment to establish the relationships for the derivatives of controls and the triggers therein within the process loop.

The primary objectives of the automation are two-fold:

1. Enable the factory personnel to control the process real time and reduce the bandwidth of variation of in-process quality data that can potentially disrupt the throughput data of the dryer.

2. Enable the technical teams on the factory floor to objectively compare performances between batches of process runs and institutionalize the corrections.

B. ANALYSIS OF THE ALGORITHM DERIVATIVES FOR DYNAMIC TROUBLE SHOOTING AT THE PLANT			
KEY DERIVATIVE	TRIGGERS	DECISION TREE	LIKELIHOOD FUNCTION FOR EFFECTIVE SOLUTIONS
Dryer heat - external applications of steam	1. Changes in internal heat of fermented dhool fed into the dryer	1.a) Change withering parameters and duration	0.995
		1.b) Increase activation energies to accelerate the withering impact **1. Temperature transmitter and moisture analyzer**	0.992
		1.c) Reduce the conductivity of the withered leaves at the rotovane through effective earth of the leaf substrates **2. Conductivity transmitter**	0.998
		1.d) Equalize the mass and moisture differential between the modules in fermentation **3. Bulk density evaluation and conductivity measurements - manual inputs into the network**	0.935
		1.e) Manage the moisture at the dryer feed at the terminal coordinates of the oxidation unit **4. Temperature transmitter and moisture analyzer**	0.944

	2. Drops in dynamic real time air changes and resultant saturation levels of the equilibrium air in the dryer at the wet zones within residence times in a time series	2.a) Occurrences of wet steam and significant changes in velocity and air momentum **5. Anemometer complex for real time velocity changes after the heat exchanger at the suction fan coordinates**	0.979
	3. Combustion drops in the boiler	3.a) Increased quantum of radiation and convection losses, higher condensate load and increased incidents of un-burnt fuel as well as higher flue gas incinerating temperatures **6. Temperature transmitter for simulated flame temperature values**	0.999
	4. Radiation and convection losses in the steam networks for reduced specific heat at transfer coordinates		0.999
	5. Conductivity differential at the fluidized bed	5.a) Reduced conductivity at the oxidized dhool **7. Dielectric field measurements - real time in the wet zone**	

C. KEY NOTES:

a) Internal Heat computation

$$(\boldsymbol{x}+\boldsymbol{a})^{\boldsymbol{n}} = \sum_{\boldsymbol{k=0}}^{\boldsymbol{n}} \binom{n}{k} \boldsymbol{x}^{\boldsymbol{k}} \boldsymbol{a}^{\boldsymbol{n-k}} \quad \text{------ (Eqn. 1)}$$

The internal heat of the tea substrate is a binomial process with discrete aggregation in the process. The stages in the batch process are mutually exclusive and independent of each other in the process chain thereby enabling super imposition of the states in the progressively terminal coordinates of the process. Dryer is essentially the terminal stage of the series of super impositions of various states and consequently the computation of the internal heat is a binomial distribution of the stochastic process of evaluating the probability density function.

x = **Specific internal heat after the binomial aggregation at the coordinates of equilibrium in the process**

a **= The instantaneous process definition around the terminal coordinates with vector moment at** x

n **= iterations commensurate with process throughput to termination of binomial aggregation**

k **= the process constant as an indicator of the relative quality of entropy within the structural heat of the dryer feed**

ENTROPY IN THE STRUCTURE OF INTERNAL HEAT AT THE DRYER FEED:

1. The parametric treatment for internal heat is crystallized into a cluster of influence variables that on being subjected to a stochastic process across the tea chain has had the entropy evaluation to chronicle the randomness in the process.

2. The computation of the entropy is on an exponential distribution to bring forth the amplification of the changes in the variables. Higher impact weights typically increase the entropy or degrees of randomness in the process.

3. The computation of the entropy is empirical founded on domain understanding whilst the algorithm shall update real time and enforce corrections as the iterations evolve.

b) Equilibrium heat computation

$$f(x) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos\frac{n\pi x}{L} + b_n \sin\frac{n\pi x}{L} \right)$$ --------- (Eqn. 2)

The equilibrating heat in the dryer is a Fourier series with periodicity that is tonic in configuration with elements of peaks and troughs portraying changes in the infinitesimal increments in the time series. The process variables have dynamic entropy values that are normalized in nature as a consequence of the Fourier series of the data scatter. **a_0 = Initial entropy of the equilibrating coordinates with nth iteration as the balancing coordinates and x being the phase difference between the two planes for a_n and b_n**

The amplitude of variances in a shorter time series is a projection of the damping on the internal heat that has been built into the dhool. Consequently, the angular displacements are tracked in the wave series of the data and hence define the cluster strength of influences in the process.

ENTROPY DETERMINANTS OF THE EQUILIBRATING HEAT

1) Boiler combustion quality is one of the major determinants in a cluster with the conductivity or changing dielectric field strength of the dhool.

2) The changes in air within the residence time in congruence with the changing conductivity of the fluidized particles of tea register dynamic changes that need to be recorded real time to compute the equilibrating heat and predict the corrections in the process with higher accuracy.

3) Since the process entropies are generically higher in a Fourier series of data scatter, the linkages in the matrix of influence are intrinsically strong thereby effectively precluding overlapping clusters of influence from clouding decisions.

The decision tree gets refined to higher levels of accuracies and promotes the reduction of the entropy as computed real time as an effective measure of the power of the course correction in the process.

The algorithm is designed with higher accuracies in the efficacy of the predictive analytics and the concomitant recommendations for the corrections in the process real time.

Machine learning of real time process data and evaluation of the process entropies do enable decisions to be refined for higher thresholds of practical effectiveness.