Fuel Consumption of Spray Dryer Considering Humidity Parameter

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ABSTRACT

Enhancing energy efficiency is an important issue for oil and gas companies, who can contribute by implementing changes in their operations, planning and investments. There are many positive drivers for industry because energy efficiency can improve productivity, lower operating costs and reduce environmental impacts. Energy efficiency and conservation can also extend the life of finite natural resources and help to keep energy affordable for consumers by lowering investment and operating costs for harnessing new energy resources to meet rising demand.

In present study, industrial data for the spray dryer is obtained and using that industrial data fuel consumption of the current industrial set up and for modified set up of the spray dryer. Moisture balance and enthalpy balance was calculated and on the basis of that heat duty was calculated then Fuel consumption is calculated using humidity measurement of atmospheric air and according to that supply of the fuel can be controlled. After calculating all this data compare the fuel consumption for both the cases and on the basis of that cost saving is calculated.

Key words: *Humidity measurement, fuel saving*

1. INTRODUCTION

Spray drying is the process of contacting an atomized stream to be dried with a gas stream that is at a higher temperature than the liquid stream. The higher temperature of the gas stream causes evaporation of the liquid from the droplets, forming particles. Spray drying has been used extensively in the food industry for example the manufacture of milk powder; the pharmaceutical industry to form powders for palletization; and the agricultural industry to produce different granular materials, to name a few examples. *[1][2]*

Industrial dryers are used to efficiently process large quantities of bulk materials that need reduced moisture levels. Depending on the amount and the makeup of material needing to be dried, industrial dryers come in many different models constructed specifically for the type and quantity of material to be processed. The most common types of industrial dryers are fluidized bed dryers, rotary dryers, rolling bed dryers, conduction dryers, convection dryers, pharmaceutical dryers, suspension/paste dryers, and dispersion dryers [3]. Various factors are considered in determining the correct type of dryer for any given application, including the material to be dried, drying process requirements, production requirements, final product quality requirements and available facility space. [4]

Spray-drying technology is used in a wide variety of processes ranging from manufacture of food products to pharmaceuticals. Most recently, spray-drying technology has been investigated to produce hollow micro-particles. This chapter presents an approach to design a spray-drying chamber using a rate-based description of the drying process combined with a droplet size distribution model. The primary spray-drying chamber design criterion is the moisture content of the final particle [7].

For the industrial case Meghmani Dyes and Intermediates, Vatva Unit were visited for the Spray Dryer data for the spray Drying Process. The product that was drying by the company is yellow 3RX dye. And the data that I have collected from the industry are as below and on the basis of that data the heat duty and fuel consumption were calculated. After completion of this industrial case study different humidity were taken according to the seasonal effect and based on that fuel consumption were found as below. According to the current set up of the industry, fuel is supplied using the temperature control parameter where the temperature of the heating air is kept constant and fuel is supplied according to the temperature [5].

After considering some modification in current set up of industrial spray dryer such as humidity measuring instrument in place of temperature control of fuel supply and fuel can be supplied according to the humidity of

the incoming air then what are the effect on heating temperature of the air and fuel consumption that will be examine. Calculation of the fuel consumption using humidity parameter are as below, where the mass flow rate of the air is kept constant. As per the calculation different humidity were taken and based on that different fuel consumption were calculated and compare that calculated data with the actual spray dryer that are now working into the industry. After calculating the fuel consumption for the current spray dryer set up and for the proposed concept and comparing both the data and based on that fuel saving and cost estimation [6].

The data was calculated using different proposed equations:

Kay equation:

Absolute Humidity = $\frac{P_w}{P-P_w} * \frac{18}{29}$

Moisture content in Feed, $X_1 = \frac{x_1}{1-x_1}$

Moisture content of product, $X_2 = \frac{x_2}{1-x_2}$

Mass flow rate of dry solid,

$\dot{m}_s$ =mass flow rate of dry solid * mass fraction

Moisture Balance,

$\dot{m}_s\ (X_1\text{-}X_2) = \dot{m}_a(H_2 - H_1)$

Enthalpy of Solid at inlet,

$i_{s1} = C_s(t_i - 0) + X_1 C_L(t_i - 0)$

Enthalpy of Solid at Outlet,

$i_{s2} = C_s(t_0 - 0) + X_2 C_L(t_0 - 0)$

Enthalpy of air entering the Dryer,

$i_{a1} = 1.006(T_{DP} - 273.15) + H_1 i_{ws1} + C_{H1}(T_{DB1} - T_{DP})$

Enthalpy of air leaving the Dryer,

$i_{a2} = 1.006(T_{DP} - 273.15) + H_2 i_{ws2} + C_{H2}(T_{DB2} - T_{DP})$

Enthalpy Balance of Dryer,

$\dot{m}_s i_{s1} + \dot{m}_a i_{a1} = \dot{m}_s i_{s2} + \dot{m}_a i_{a2} + \phi_L$

Enthalpy of atmospheric air,

$i_{aa} = 1.006(T_{DP} - T_0) + H_1 i_{ws1}$

Heat Duty of air heater,

$\phi = \dot{m}_a(i_{a1} - i_{aa})$

Fuel Oil Consumption = $\frac{\phi}{NCV\ of\ fuel\ Oil * thermal\ efficiency\ of\ heater}$

2.Working of Spray Dryer

For spray drying, it is usual to pump a concentrate of the liquid product to the atomizing device where it is broken into small droplets. These droplets meet a stream of hot air and they lose their moisture very rapidly while still suspended in the drying air. The dry powder is separated from the moist air in cyclones by centrifugal

action. The centrifugal action is caused by the great increase in air speed when the mixture of particles and air enters the cyclone system. The dense powder particles are forced toward the cyclone walls while the lighter, moist air is directed away through the exhaust pipes. The powder settles to the bottom of the cyclone where it is removed through a discharging device. Sometimes the air-conveying ducts for the dry powder are connected with cooling systems which admit cold air for transport of the product through conveying pipes.

3. Results and Discussion:

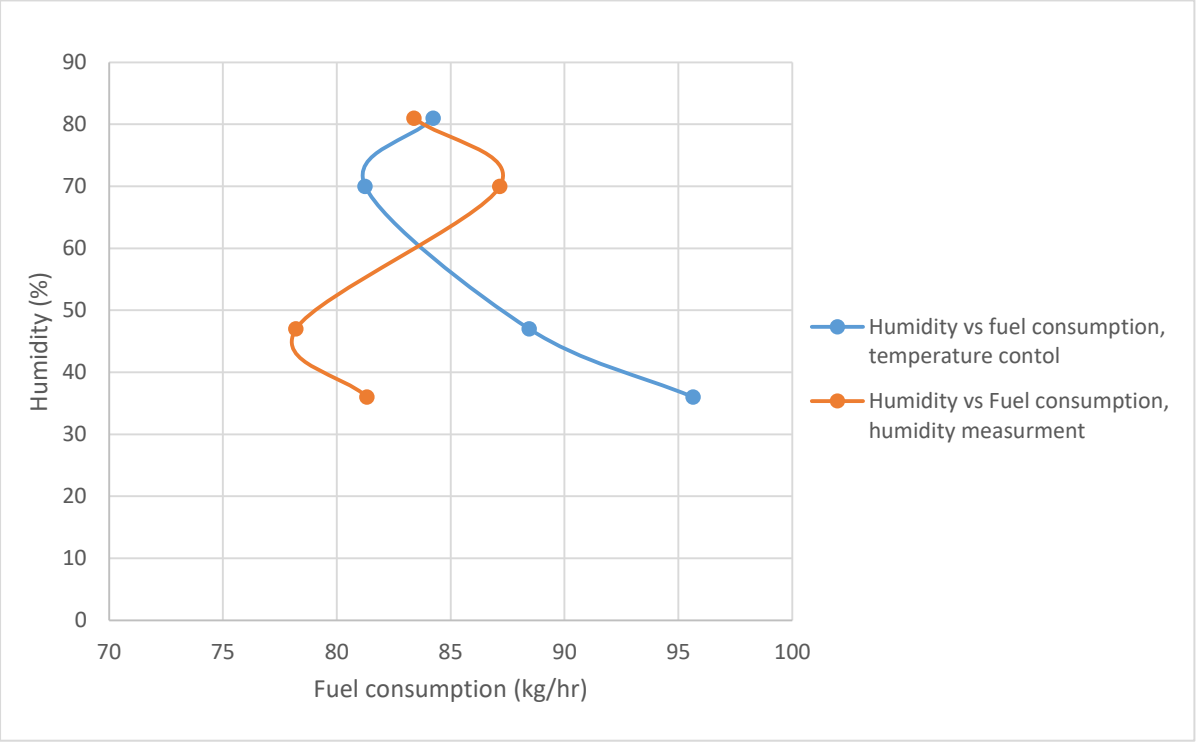
Table 1: Different Fuel Consumption with Seasonal effect

Temperature (^{0}C)	Humidity (%)	Fuel Consumption (kg/hr)
35	36	95.65
42	47	88.45
29	81	84.24
20	70	87.16

Table 2: Fuel Consumption Comparison

Temperature (^{0}C)	**Humidity (kg moisture/kg dry air)**	**Current Fuel Consumption, at fix temperature of 320^{0}C (kg/hr)**	**Proposed Plan Calculated data**	
			Fuel Consumption, using Humidity measurement (kg/hr)	Air Heating temperature(K)
35	36	95.65	81.33	312.18
42	47	88.45	78.21	313.83
29	81	84.24	83.40	318.52
20	70	76.38	87.16	319.20

Graph 1: Humidity vs fuel consumption



4.Cost Estimation

After calculating the fuel consumption for the current spray dryer set up and for the proposed concept and comparing both the data and based on that fuel saving and cost estimation for that are calculated as below.
Yearly Fuel Oil Consumption and Cost estimation

Average Current Fuel Oil Consumption, (For current set up of spray Dryer)

= 88.89 kg/hr.
= 682675.2 kg (for 320 days)
Currently Fuel price is 50 rs/kg
So, amount used yearly for fuel,
=34133760 rs/year

Average proposed Fuel Oil Consumption, (for proposed modification in Spray Dryer)

= 82.52 kg/hr.
= 633792 kg (for 320 days)
So, amount used yearly for fuel,
= 31689600 rs/ year
Cost saving,
= 34133760 - 31689600
= 2444160 rs/year

5. Conclusion

From the present study it was found that in all current working spray dryer temperature for heating the air is fixed at one temperature throughout the year and on the basis of that fuel is supplied, in place of that if humidity measurement instrument is used to control the fuel supply than fuel can be supplied and after calculating all other parameter and convert the fuel saving in terms of money than huge amount of money can be saved using this concept.

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7. References

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