FluoSolids® Reactor Calcining of Lime Mud for the Sugar Beet Industry

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Lime mud waste in sugar beet refineries is a growing problem which can be eliminated using a fluid bed recovery process. Sugar beet processing plants are under increasing environmental pressure to cease the accumulation of this lime mud waste pile and to desist from the dust cloud that the pile can emit. Generally speaking the traditional sugar industry shaft kilns are unsatisfactory for lime mud recovery necessitating other technology. The purpose of this paper is to present schemes for reclaiming this pile as a salable byproduct or as a recyclable product.

The essence of the scheme is the fluid bed calciner where the lime mud can be regenerated to lime and carbon dioxide gas. The calciner is a two-compartment vessel as shown in Figure 1. The upper compartment contains a fluidized bed of lime pellets. The dry lime mud is blown into this fluidized bed where the mud with auxiliary fuel is calcined to lime. The feed has trace amounts of sodium that melts and causes the lime to form a pellet which accumulates in size to become part of the fluidized bed. As the fluidized bed grows from the pelletization process a portion is transferred to the lower compartment where the pellets are cooled by the upflowing air to be used in the calcining compartment. This preheated air then represents a fuel economy.

Dorr-Oliver has installations performing this process in the paper industry where a lime mud from the Kraft paper process is regenerated to lime pellets for return to slaking. The lime mud of the sugar beet industry is remarkably similar to the lime mud of the paper industry.

Table 1 shows some analytical data on sugar beet lime mud which we will share here. Also, Dorr-Oliver has conducted pilot tests on sugar beet lime mud which

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demonstrated the pelletization process and confirmed good product slaking characteristics.

Slaking tests of the pelletized lime product were conducted by measuring out 200 ml of water at 20°C into which 50 grams of lime pellets were stirred until there was no further temperature rise. As a guide our understanding is that a good and medium quality lime will have the slaking characteristics stated in Table 1.

Table 1

Size Analyses of dry sugar beet lime mud as feed to a calciner

10% greater than 10 micron
25% greater than 7 micron
50% greater than 4.5 micron
75% greater than 3.1 micron
90% greater than 2.5 micron

Typical chemical analysis of sugar beet lime mud as a calciner feed

83% $CaCO_3$
1% $MgCO_3$
2.5% $Ca(OH)_2$
6.2% hydrated H_2O
0.1% Na and K
4.1% Acid insoluble inerts which includes SiO_2
1.3% as SO_4
1.8% Soluble in acid as Fe, Al and Misc.

Anticipated product analyses from the calciner

88.2% Ca O
3.4% $CaSO_4$
8.4% inerts
0.01% MgO

SLAKING CHARACTERISTICS

TEMPERATURE RISE FROM 20°C

Time	Medium Quality Lime	Good Quality Lime	Pelletized Lime from a Fluidized Bed
0	0	0	0
30 sec			34°C
1 min			39°C
100 sec			41°C
2 min			44°C
160 sec			48°C
3 min			50°C
4 min	34°C	42°C	54°C
7 min	42°C	65°C	58°C
9 min		72°C	58°C
15 min	50°C		

We were disappointed that this typical chemical analyses which was developed from a grab sample from an existing pile did not show a carbon content or calorific value. Our understanding is that 400 to 800 BTU/lb. of heat value may be available in the lime mud from residual organics. This heat value would be released in the calciner as a fuel economy.

The lime pellets with their spherical shape are excellent for pneumatic conveying, bin storage and other material handling. The anticipated product analyses is somewhat high in inerts such that the product would not qualify as a high calcium commercial grade quick lime but the product would be salable to certain markets. The pellets are certainly very reactive in slaking.

Dorr-Oliver has pilot facilities in Golden, Colorado, where your sample of lime mud can be calcined. We would consider pilot testing mandatory to ascertain the product quality.

One recovery process for the lime mud is to use the calcining scheme of the paper industry. The intent would be that lime mud generated during a campaign would be stockpiled and calcined independent of the sugar beet process producing a salable byproduct. Perhaps other sites can transport their mud to the calciner. Here the calciner is coupled with a flash drying system to drive off surface moisture. The dry feed is then blown into the calciner as shown in the Figure 2 flowsheet. This is a flowsheet for a 100 TPD product which is one of our operating systems. Either natural gas or oil may be used for the auxiliary fuel. A conservative estimate of fuel usage is 7.5 million BTU/Ton product. This number presumes no heat value is available from the feed. Power usage is anticipated to be 115 KW/Ton. An order-of-magnitude installed capital cost for this facility is $3,800,000.

A second, and more interesting, scheme for recovering lime mud is using the fluosolids calciner to generate a lime product for slaking and to use the calciner off-gases with their CO_2 content in the carbonation step. Here the calcining system is sized for the plant production. The lime mud filter produces a 50% solids cake which is indirectly dried to a powder capable of being blown into the calciner. The FluoSolids calciner is usually designed for 20% excess air which produces a CO_2 content in the calciner exhaust gases of 22% (dry basis). However, this CO_2 content can be enhanced by oxygen enrichment of the air to the calciner to produce the 28% CO_2 which is normally seen in carbonation. There could be a control loop between CO_2 content and oxygen. The hot calciner exhaust gases go to a scrubber for final dust removal and for heating water to be used in slaking. This conceptual scheme is shown in Figure 4.

There is a certain inevitability that indefinite accumulation of sugar beet lime mud will stop. Perhaps the time is now for planning the alternates.

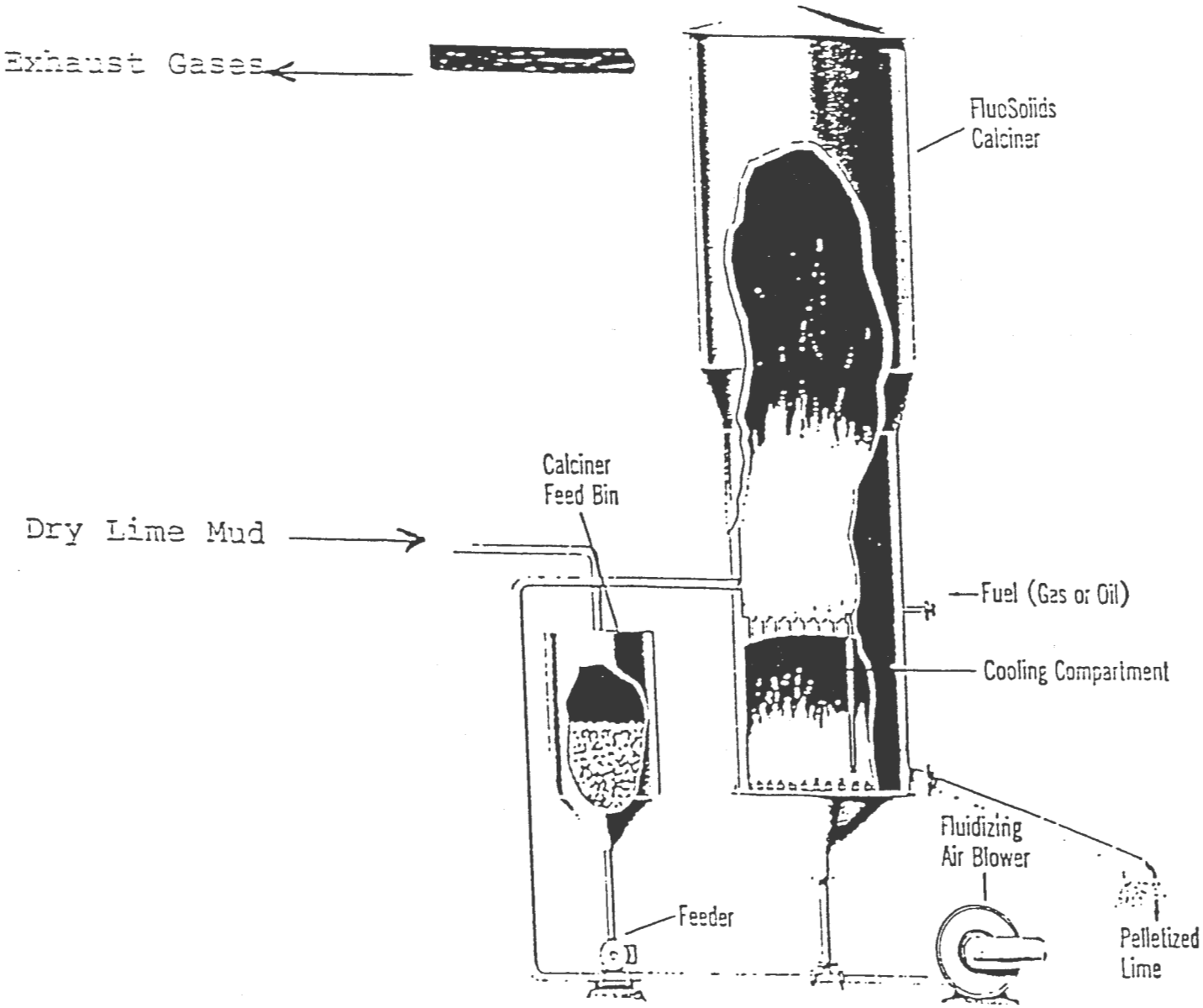

Figure 1

Two Compartment Lime Mud Calciner

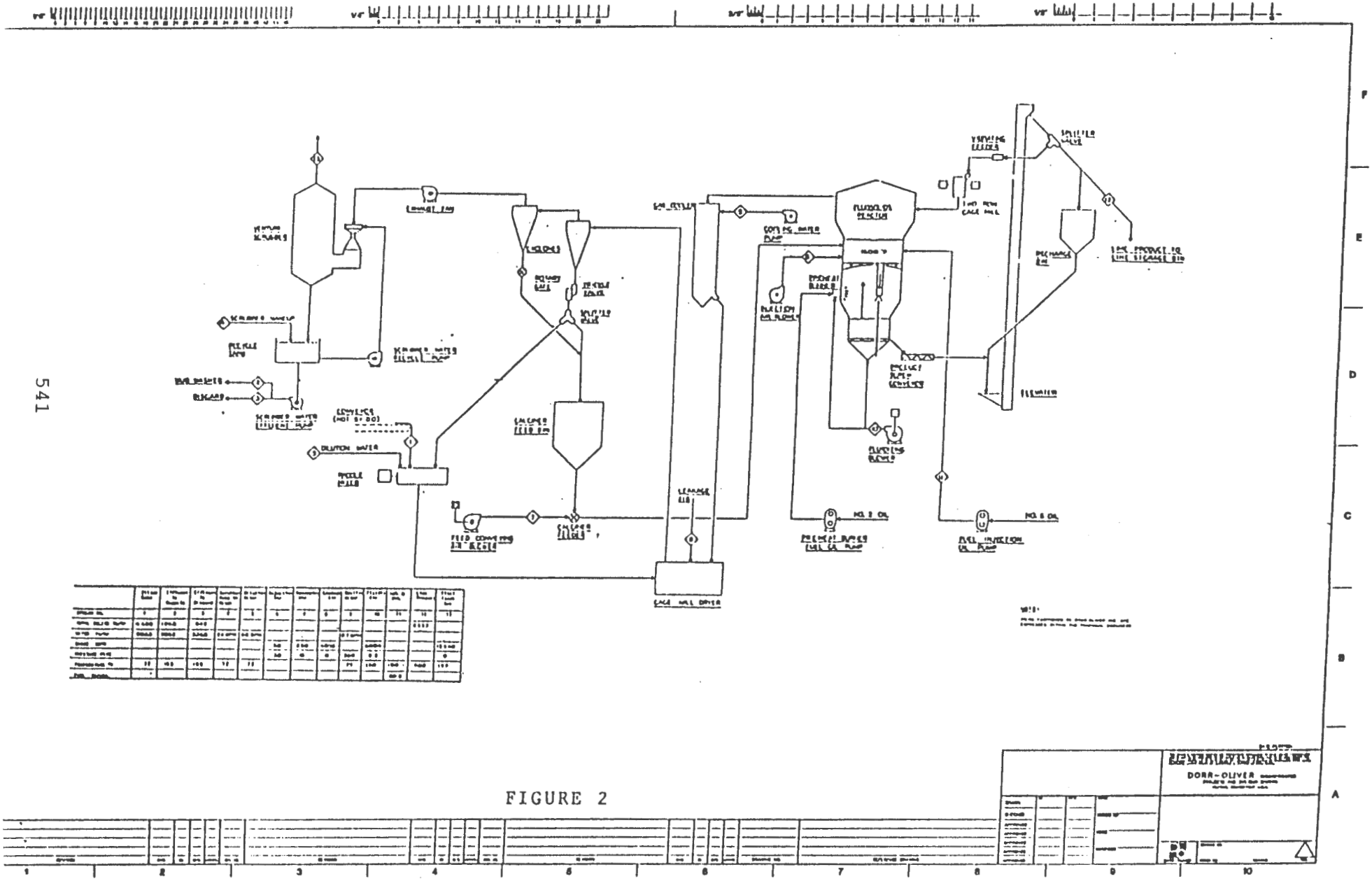

FIGURE 2

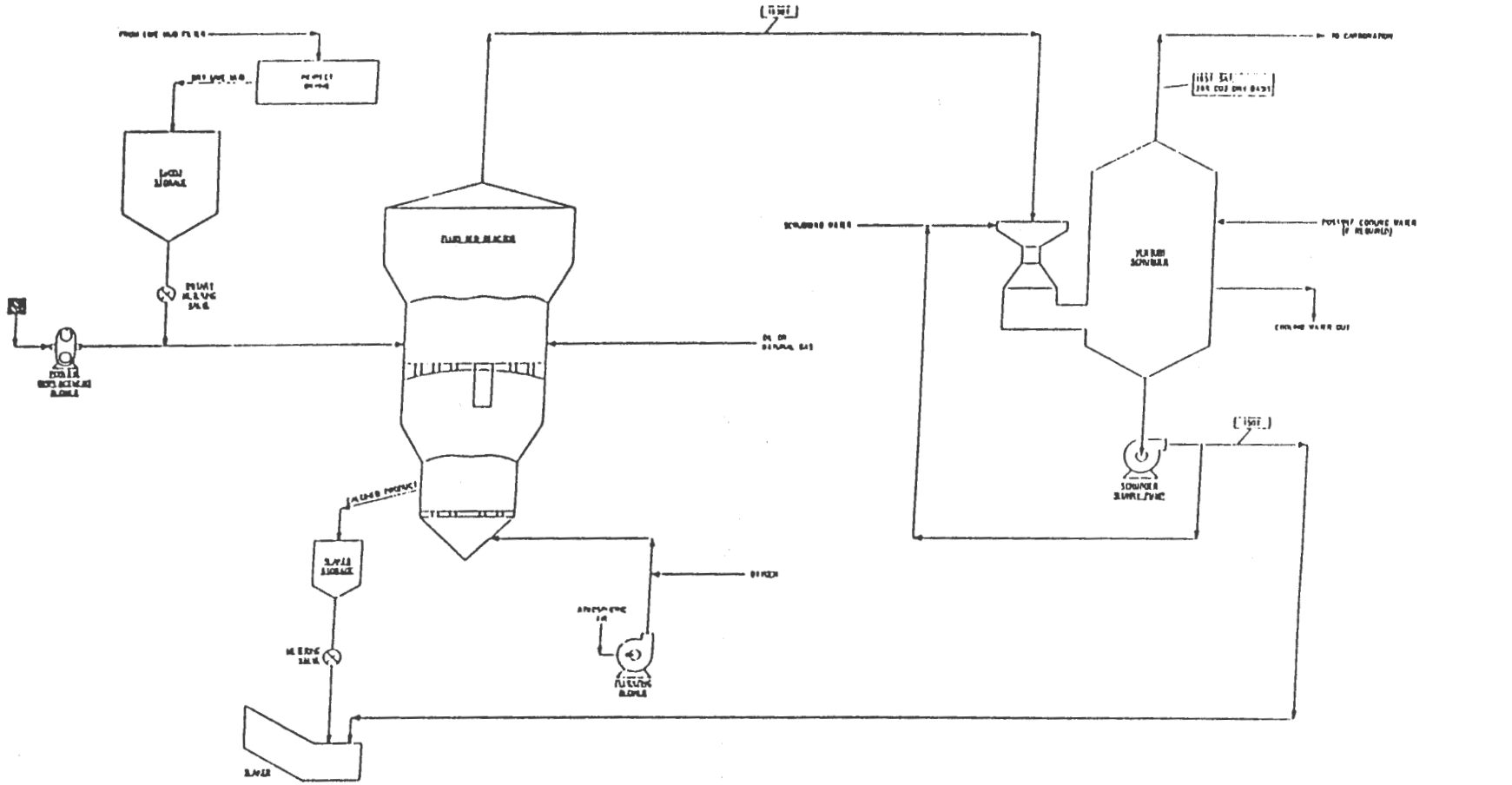
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FIGURE 3