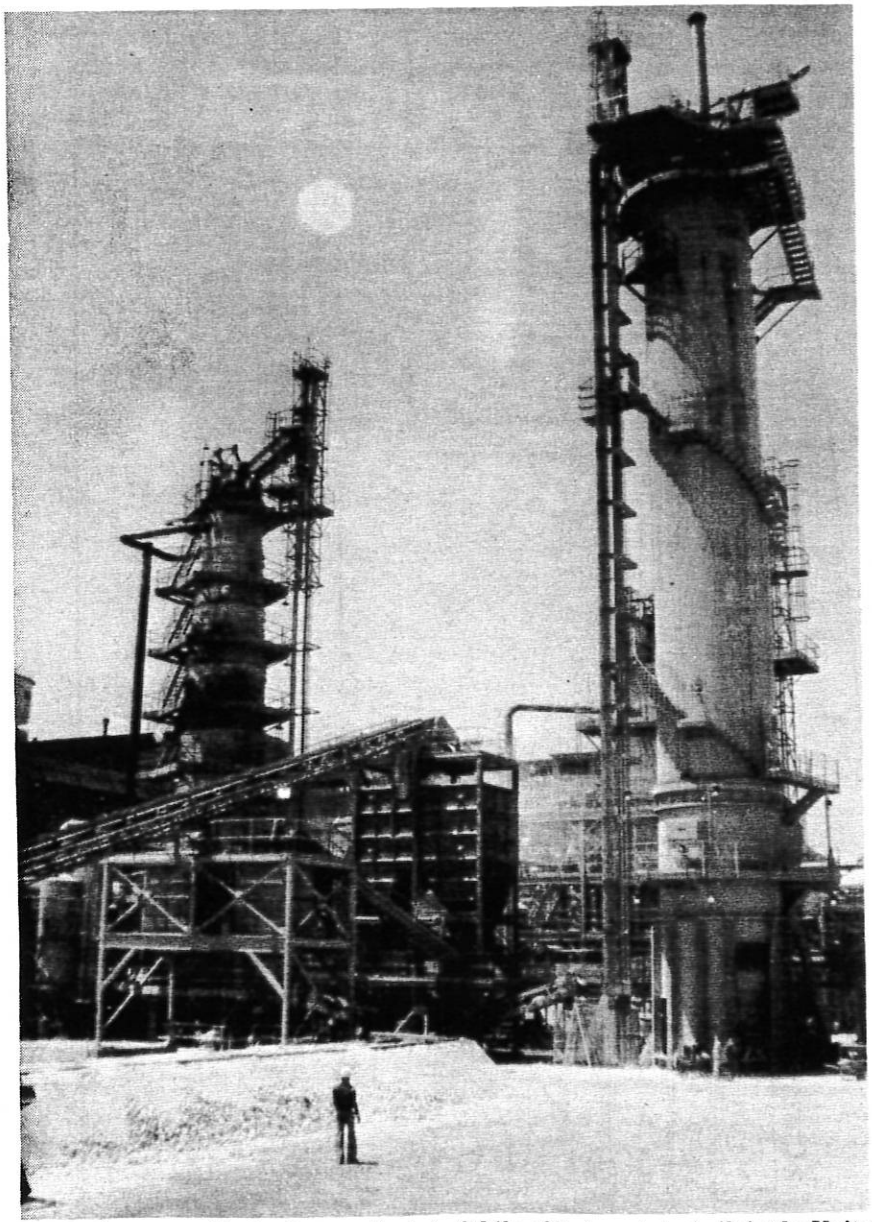
Holly Sugar sets new shaft kiln standards

By William D. Dorman



In right foreground is the first vertical shaft kiln of its type to be built in the United States. At left is a Belgian-type kiln; the stone and coke feed system, center, operates between the two kilns.

The first Fuller-Beckenbach mixed feed type shaft kiln to be built in the United States has been installed at Holly Sugar Corp. in Brawley, Calif. The mixed feed type kiln is one of several Beckenbach shaft kiln designs licensed by Fuller Company, Bethlehem, Pa., from Warmestelle Steine und Erden of Dusseldorf, West Germany. More than 200 mixed feed kilns of this type have been supplied by Beckenbach throughout the world.

The Holly Sugar kiln was commissioned in April 1984. The product quality and fuel efficiency of this kiln are believed to be the highest of any shaft kiln in North America. One of the limestones used by Holly Sugar averaged 91% available lime with 2.06% LOI (loss on ignition) at

a fuel consumption of 3.09 million Btu/short ton of lime. Another stone averaged 92.56% availability with 1.37% LOI and 3.37 million Btu/short ton. The performance data taken by Holly Sugar were averaged over one-week periods. The lime produced in this kiln is soft burned, highly reactive, and virtually free, in the center, of the unburned "core" that is typical of most shaft kiln lime.

Holly Sugar Corp. is one of the largest producers of beet sugar in the United States. When the requirements for lime production increased at their plant in Brawley, management looked to European technology as an improvement to the Belgian-type mixed feed kiln that was designed approximately 100 years ago and typically is used in the U.S. sugar industry. A Belgian kiln also is being operated by Holly Sugar at Brawley; this unit serves as an excellent means to compare directly performance using the same limestones and fuel. The objectives of the new kiln installation were to improve the fuel efficiency, product quality, and the carbon dioxide concentration in the exhaust gases from the kiln.

The sugar industry uses both the lime and carbon dioxide produced in shaft kilns to refine beet sugar. The mixed feed type kiln is best suited for this application because a mixture of limestone and coke is fed into the top of the kiln. Virtually all the fuel input is carbon that burns to produce carbon dioxide in the products of combustion.

By contrast, hydrocarbon fuels form water vapor that dilute the carbon dioxide dissociated from limestone to produce higher concentrations than found on other types of lime kilns. The carbon dioxide concentration from the Fuller-Beckenbach kiln is enhanced further because the kiln is a pressure type unit; any leakage of gases is outward to the atmosphere. Suction type kilns such as the Belgian design leak air inward, thus diluting the concentration in the exhaust gases.

The typical mixed feed kiln begins with a feed system including weigh hoppers for stone and coke. Pre-weighed quantities of limestone and coke are fed into a skip hoist bucket that carries the charge to the top of the kiln where it is introduced through an airlock. Air is introduced at the bottom of the kiln and flows upward countercurrent to the material. Incoming air cools the lime as it discharges from the bottom of the kiln. As air travels upward through the kiln, combustion of coke and calcination of lime take place in the middle section. The products of combustion and dissociated carbon dioxide then travel upward through the top portion of the kiln, preheating the limestone and coke feed. The critical factors in controlling the kiln are the ratio of coke to limestone in the feed and the ratio of combustion air to coke.

Several design features of the Fuller-Beckenbach mixed feed kiln contribute to the superior product quality, fuel efficiency, and carbon dioxide concentration as compared to the Belgian and other types of mixed feed kilns. First, great care is taken to evenly blend the coke with the stone as they are introduced into the skip bucket. This type of feed system also has been incorporated into the existing Belgian type kiln system that Holly Sugar operates at Brawley, with a noticeable improvement in performance. The skip hoist of the new kiln dumps the mixed feed charge into a surge hopper at the top of the kiln. The surge hopper is discharged, by means of a vibrating feeder, into a rotating charge hopper to assure that the stone and coke are well blended and reach a uniform level before being charged to the kiln. Once the rotating charge hopper is full, the hopper inlet is sealed and a cone valve lowers to drop the stone into the kiln.

A patented stone distribution mechanism attached to the cone valve deflects each successive charge into the kiln to obtain a fairly even level of stone in the top of the kiln, but with a slightly higher level

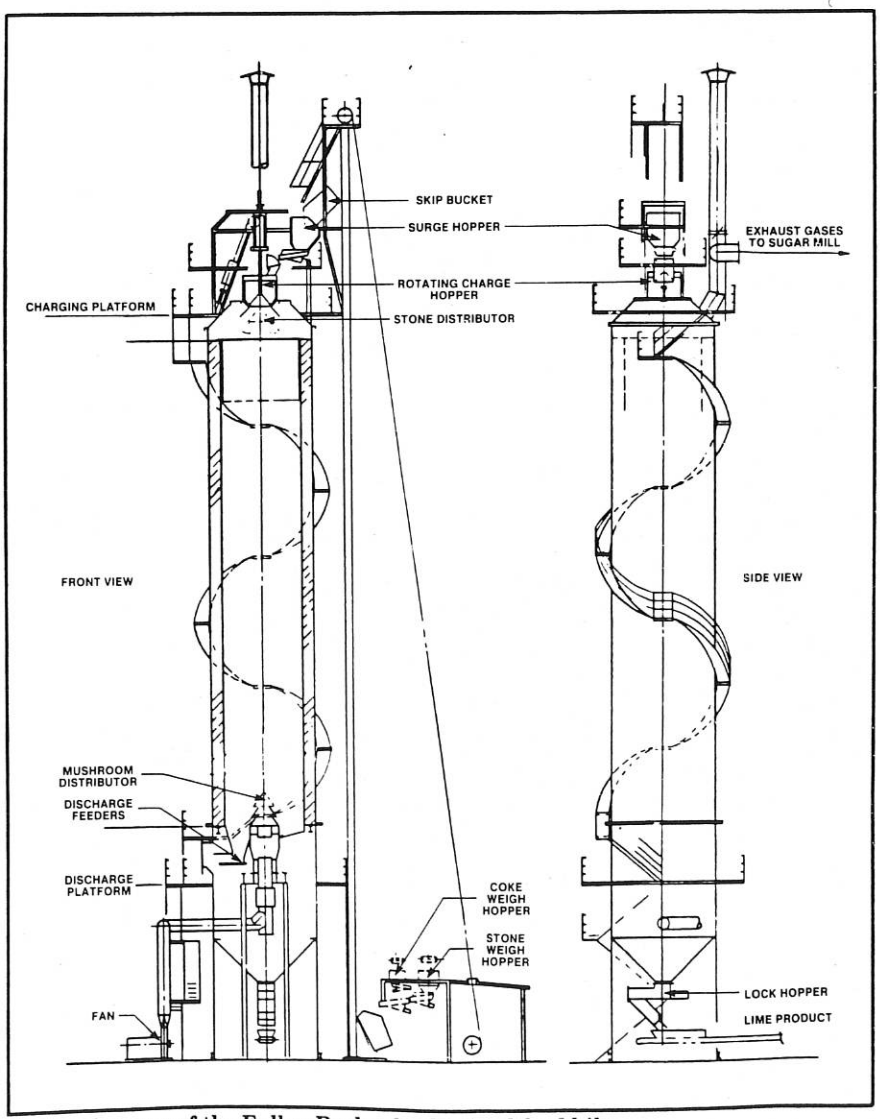


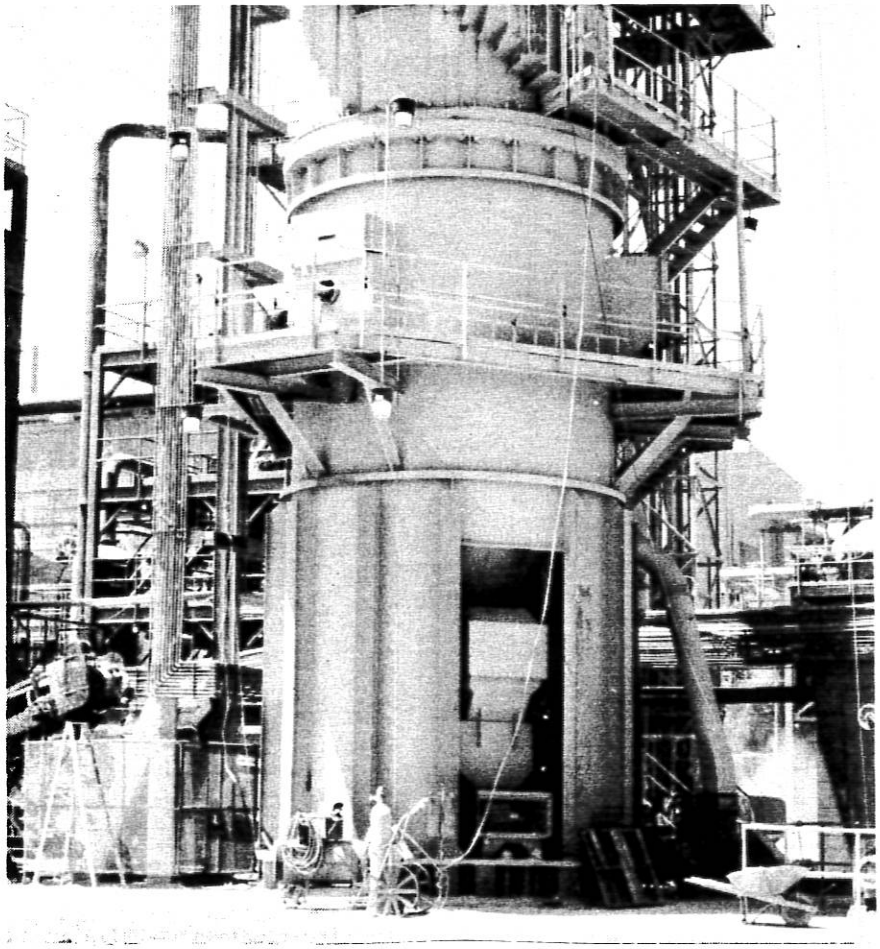
Fig. 1.Diagram of the Fuller-Beckenbach mixed feed kiln.

Time Period		Feed	Product	Fuel Rate	Fuel Rate	% Avail.		
(7 Day Avg)	Stone	STPD	STPD	% Coke	MM BTU/ST	(Free) CaO	% LOI	% CO_2
4/24/84 - 4/30/84	A	239	138	7.08	3.37	92.56	1.37	39.67
5/14/84 - 5/20/84	B	244	141	6.49	3.09	91.00	2.06	40.71

Fig. 2.Operating data on Holly Sugar Corp.'s mixed feed kiln.

around the outer periphery. This arrangement eliminates the typical material "hump" or pile that forms at the center of most kilns. It also prevents the natural segregation of coarse and fine material (caused by different angles of repose) typical of many other types of shaft kilns. Lower stone levels at the periphery and the natural segregation make it easier for the gases to flow up the outside walls of the kiln, resulting in uneven heat distribution and calcination in the kiln.

To further eliminate uneven flow of stone and gases through the kiln, the Fuller-Beckenbach design uses discharge feeders at the bottom of steep hoppers. These units are placed around the outer periphery at the bottom of the kiln, thus resulting in a uniform mass flow through the kiln and preventing hot spots, clinkering, underburning, and overburning--all detrimental to product quality. The surge hopper is pressurized by a fan to inject combustion air evenly into the kiln through each of the discharge feeders and through a "mushroom" type air distributor at the center of the kiln bottom. The feeders at the bottom of the kiln discharge into a small surge hopper that then is discharged by a lock hopper at the bottom.



Discharge platform and discharge feeders at kiln base.

To maintain minimum radiation loss through the shell, the refractories in the shaft kiln are 16½ in. thick. The refractories are installed in three layers. Each successive layer (outward from the shell) has a lower K factor for better insulating value.

The design features of the Fuller-Beckenbach kiln improve thermal efficiency by assuring uniform distribution of coke throughout the stone charge and an even flow of gases and material through the kiln. The design also assures that all the lime is calcined evenly using the least amount of fuel.

Holly Sugar has burned two types of high quality limestone in their kilns. Stone "A" produces a slightly higher lime quality, but is harder burning and requires slightly more fuel than Stone "B." The average operating data for burning each of these stones for 7 consecutive days are illustrated in an accompanying figure. The percentage ratio of coke to limestone feed is a method of expressing fuel consumption commonly used for mixed feed kilns. Daily averages of the percentage of coke for the Fuller-Beckenbach kiln range as low as 6.1 or 2.9 million Btu/short ton of lime produced at 90% lime availability.

A direct comparison with the Belgian kiln indicates that the Fuller-Beckenbach unit averages 24% lower fuel requirement. Comparisons were made over the same time period on each kiln burning the same stone. The lime availability and carbon dioxide concentrations also were significantly higher than the Belgian kiln. Holly Sugar Corp. indeed has set new standards for shaft kiln lime quality and fuel efficiency in North America. ●

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