CONTROL OF EMISSIONS FROM PHOSPHATE DRYERS AND CALCINERS WITH HIGH PERFORMANCE WET SCRUBBERS

By

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presented at the

AMERICAN INSTITUTE OF CHEMICAL

ENGINEERS MEETING

May 25-27, 1979
Clearwater, Florida

ABSTRACT

High performance wet scrubbers, notably the CentriField (American Centrifugal Industries, Inc.), are being used successfully for the control of phosphate dryer and calciner emissions. Such scrubbers combine relatively low energy costs and low maintenance.

Variations in ore sources and process variables affect the selection of the scrubber. Until more is known about these variables, the authors recommend the use of adjustable pressure drop, high performance wet scrubbers.

CONTROL OF EMISSIONS FROM PHOSPHATE DRYERS AND CALCINERS WITH HIGH PERFORMANCE WET SCRUBBERS

High performance wet scrubbers are being used successfully for the control of phosphate dryer and calciner emissions. High performance wet scrubbers combine lower energy requirements with low maintenance to produce acceptable emission levels. The new CentriField scrubber* is particularly noteworthy. It has now been used successfully on several phosphate dryers and calciners.

This paper presents an overview of various emission control devices on phosphate dryers and calciners and examines the effects of ore source variables and process variables on the control problem. As expected, ore variations from region to region do affect the difficulty of the control problem. It is not expected that a given dryer or calciner would give widely different emissions from one day to the next. But that, in fact, is the case. The process variables that cause this are not well understood, but they can be great enough to play an even larger role than the ore source variables in determining the design of the final emission control device.

There are principally three types of source. Western type rock is one which contains sufficient organic matter to make high temperature calcining desirable. Eliminating the organics, and at the same time the carbonates, removes problems further along in the process. Other ores, principally Eastern, are dried directly or first separated by flotation (beneficiation). The floats become the commonly known "concentrate" where the clay is usually rich enough to dry directly. Land pebble may be combined with concentrate before drying. Sometimes, Western rock undergoes flotation and/or drying before calcining. Thus, a whole range of possibilities exists with respect to resulting emission characteristics. The distinctions inherent in the source may therefore be lost. The control techniques applied to one operation may not be directly applicable to another.

In addition, process variables, even within a given operation, create large differences in emissions characteristics. These can cause wide swings, even over short periods of time. They are recognized but not well understood. This is not a unique situation by any means. This kind of erratic behavior is also seen in other industries. Sludge incinerator emissions characteristically change with percent of operating capacity, actually creating a heavier burden for the control device as the load decreases. There are other processes where erratic behavior is the rule. Dryers and calciners in general tend to fall into this group.

*Manufactured by ACI, Inc.

Figure 1 shows a number of processes which were piloted with the CentriField wet scrubber. Many processes give reproducible results which dependably plot as simple log functions. Wire coating NH_4Cl fumes; brass smelting ZnO fumes; a lab test dust, Nytal 400, are good examples. In the other cases the curve shown is only a generalization of scattered data points.

Of interest in Figure 1 is the variation in slopes for different emissions. The slope for calcined phosphate ore is one of the steepest. This means that a relatively large change in the emissions will be realized by a relatively small change in the scrubber pressure drop.

Figure 2 shows actual data for the catalyst dryer shown in Figure 1. This dryer processes several differenct catalyst products. Catalyst A process gave stable results when it was tested. Catalyst B process shows slightly anomalous behavior on Day 1 tests. It was tested again another day while building up the slurry concentration, as a variable. The data shown where taken before the slurry concentration built up appreciably. It behaved on Day 2 like an entirely different product.

The curve shown in Figure 1 earlier for calcined Western phosphate rock is generalized from the data shown in Figure 3. Figure 3 also shows the guaranteed performance point which was offered on the basis of particle size data shown later in Figure 4. A pilot program was insisted on to substantiate the CentriField lower pressure drop guarantee. To get the guaranteed efficiency of 99%, the pilot data shows 12.5" w.c. is actually required, instead of the 18" guaranteed. The first full-scale scrubber test point is also shown, not as good as the pilot, but still within guarantee. At the time the guarantee was made, 99% removal was needed to meet code. For most of the time since, the scrubber has been operating at 8-10" w.c., with emissions averaging only 37% of code requirements (see Figure 6).

There is no doubt that process variables can affect emissions. Figure 4 shows the effect on a phosphate rock dryer emission as the percent moisture of the product is varied. Obviously, there are other operant factors, but the trend is clear. In this case the product is for stockpiling and is dried to prevent freezing. Some washing (beneficiation) was done beforehand. This material will be calcined later. The effects that might carry through the calcining step can only be conjectured about.

Returning to the subject of the source ore, Figure 5 shows sizing data for uncontrolled emissions from a calciner and a dryer.

The calciner is processing a Western rock. The dryer is processing "land pebble." Both determinations were made with an inertial sampler; that is, an impact impinger. The authors consider this technique to be more relevant to what the control device sees than any other means. The dashed line is a sedimentation analysis of a collected sample from a similar calciner. It should show up finer if anything, and it does. It was on the basis of this sedimentation analysis that we guaranteed the 99% efficiency at 18" w.c., as explained earlier. As a side note, Venturi manufacturers quoted between 30 and 24" w.c. pressure drop. Inertial data are not available for phosphate concentrate. Presumable, it is coarser than "land pebble."

Figure 6 shows a number of calciner installations with various emission control devices and the respective emission levels. In Cases 1a and 3a a CentriField was added to existing calciner, cyclone installations (Cases 1 and 3). Early results indicate the emissions are reduced to 25% of the allowable level. In Case 5, an impingement scrubber was replaced with a CentriField scrubber[2] (Case 5a) that is operating in the 18-20" w.c. range. Emissions that previously averaged 155% of the allowable level are now reduced to an average of 10% of allowable. Similarly, the CentriField scrubber[2] in Case 6a replaced the moving bed scrubber in Case 6. The scrubber pressure drop in both cases is 8-10" w.c. By this substitution, the emissions were reduced from an average of 159% of allowable to an average of 37% of allowable emissions.

Figure 7 is a similar display for phosphate dryers. Cases 22 and 22a demonstrate a case where process variables obviously play a part in the final emissions. The same CentriField scrubber gave the two different results. Test 1 (22) was right on the heels of plant start-up and during debugging. After final adjusting and letting the process settle down at its full load rating, the results in Test 2 (22) were obtained. The pressure drop difference between the two cases is nowhere near enough to explain the shart drop in emissions. This may be tested by plotting on a slope like that in Figure 3. A twin installation is somewhere in between. The first certification test, while not at full load, shows it to be closer to 22a.

It is apparent that high performance wet scrubbers will meet emission standards. The CentriField with its low energy requirement is an excellent example for the economic justification of high performance wet scrubber.

REFERENCES

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2. "An Investigation of the Best Systems of Emission Reduction for the Phosphate Rock Processing Industry." EPA, unpublished draft.

3. "Control of Particulate from Phosphate Rock Dryers" by M. Lindsey and R. Segars, EPA, Region IV Study for the State of Florida.

4. "Selecting Dust Collectors" by J.L. Smith and H.A. Snell, Chemical Engineering Progress, Vol. 64, No. 1, 1968, p. 60-64.

5. "Scrubbers for Calciners" by J. Cochrane, J.R. Simplot Co., presented at Manufacturers Association Meeting in Washington, D.C., January 13, 1976.

6. "Scrubber Manual," The McIlvaine Co., Northbrook, IL; Chapter IX, Section 2571.

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FIGURE 1

PILOT SCRUBBER DATA

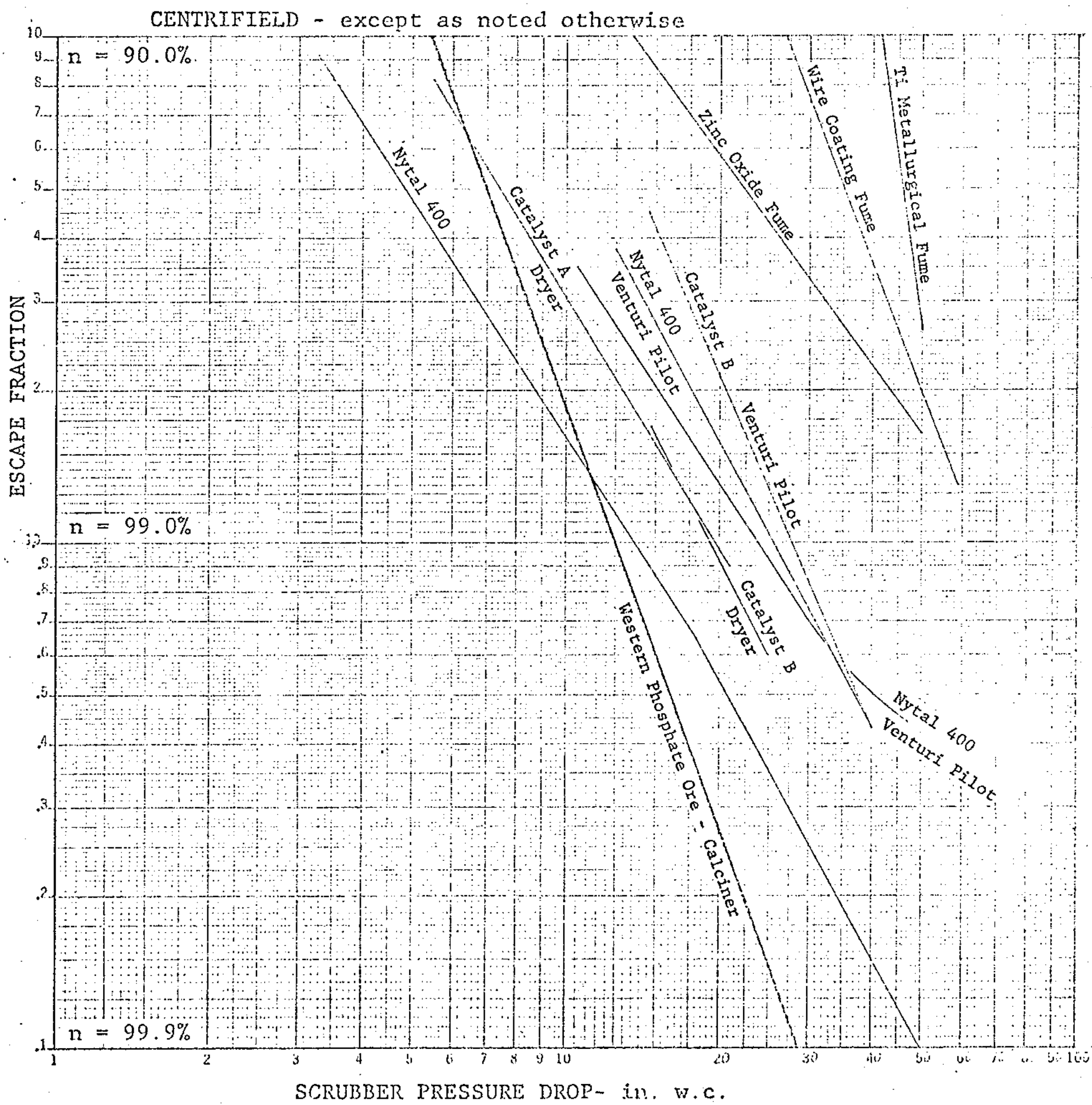
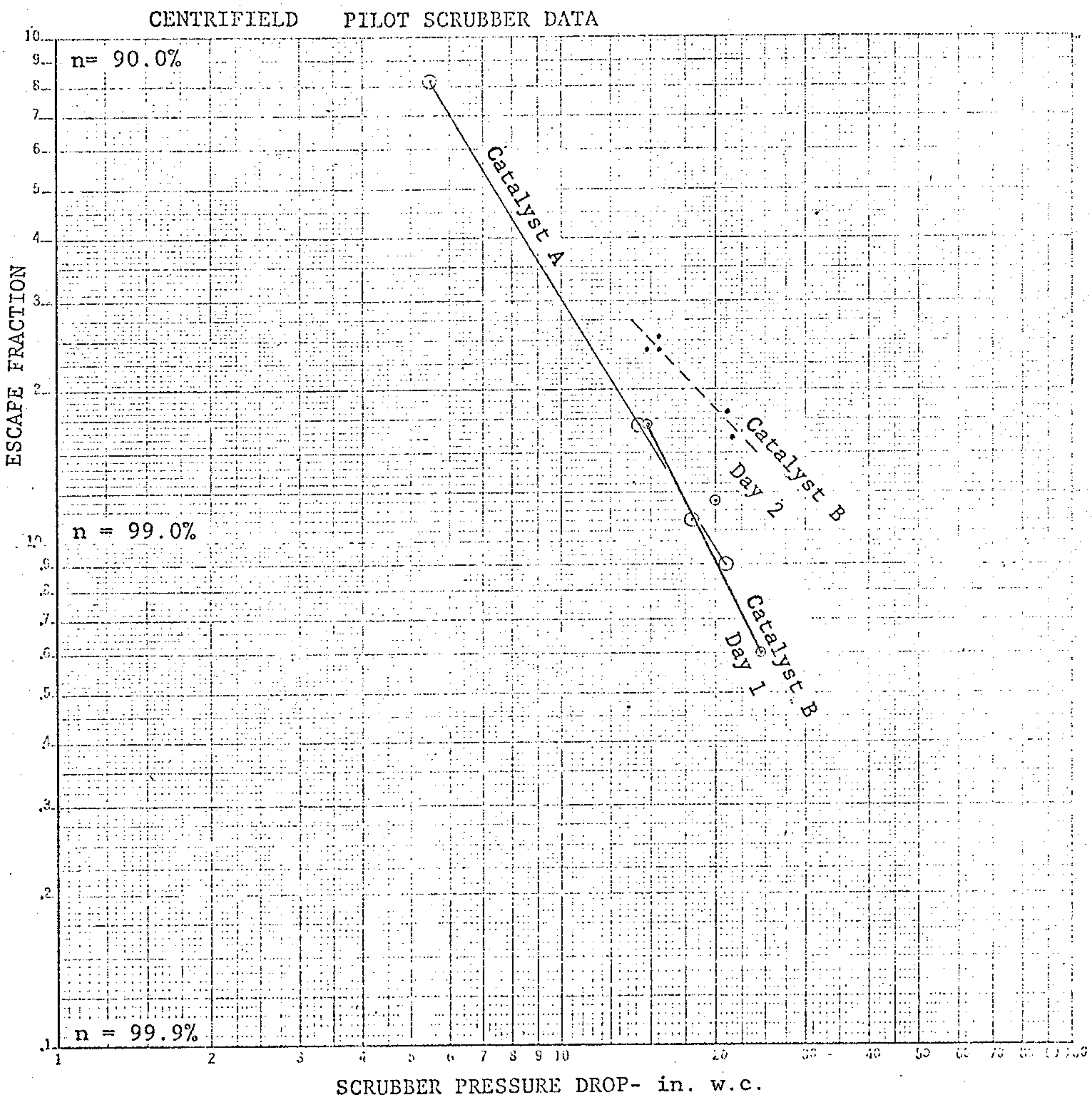
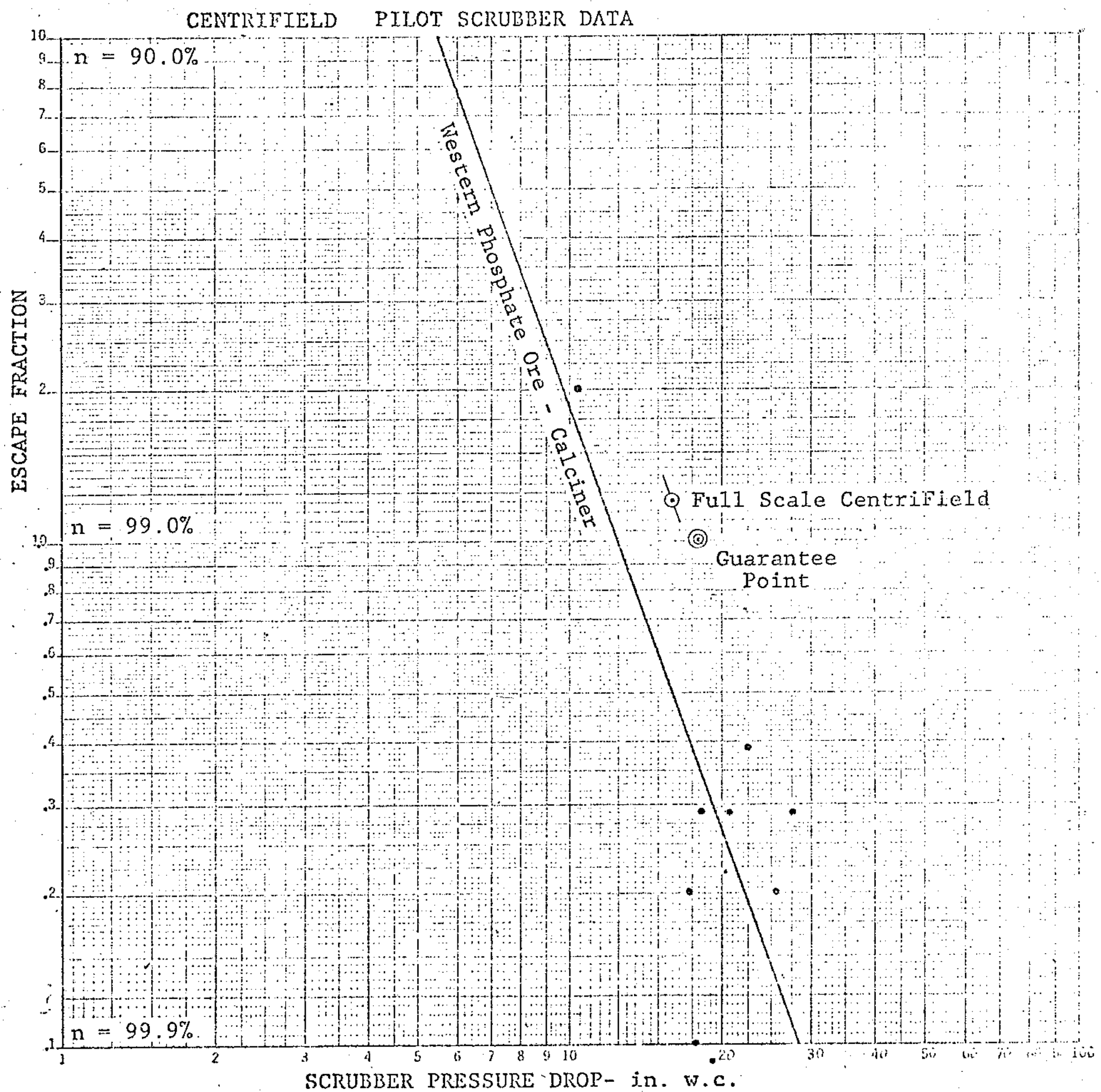


FIGURE 2



Logarithmic, 2 x 2 Cycles

FIGURE 3



CENTRIFIELD PILOT SCRUBBER DATA
n = 90.0%
n = 99.0%
n = 99.9%
ESCAPE FRACTION
Western Phosphate Ore - Calciner
Full Scale CentriField
Guarantee Point
SCRUBBER PRESSURE DROP- in. w.c.

FIGURE 4

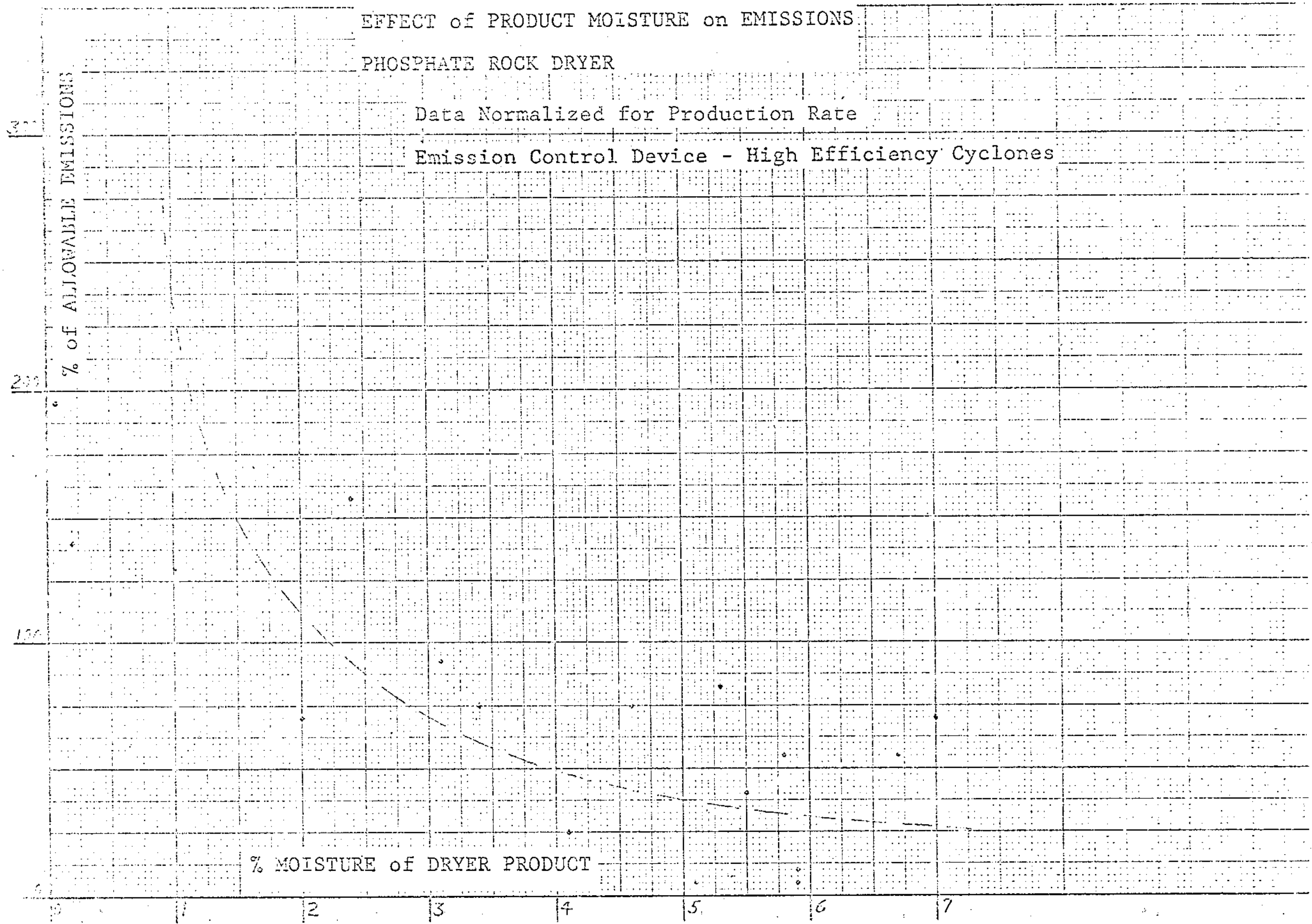

EFFECT of PRODUCT MOISTURE on EMISSIONS
PHOSPHATE ROCK DRYER
Data Normalized for Production Rate
Emission Control Device - High Efficiency Cyclones
% of ALLOWABLE EMISSIONS
% MOISTURE of DRYER PRODUCT
1
2
3
4
5
6
7

FIGURE 5

DRYER & CALCINER DUST SIZING

UNCONTROLLED EMISSIONS

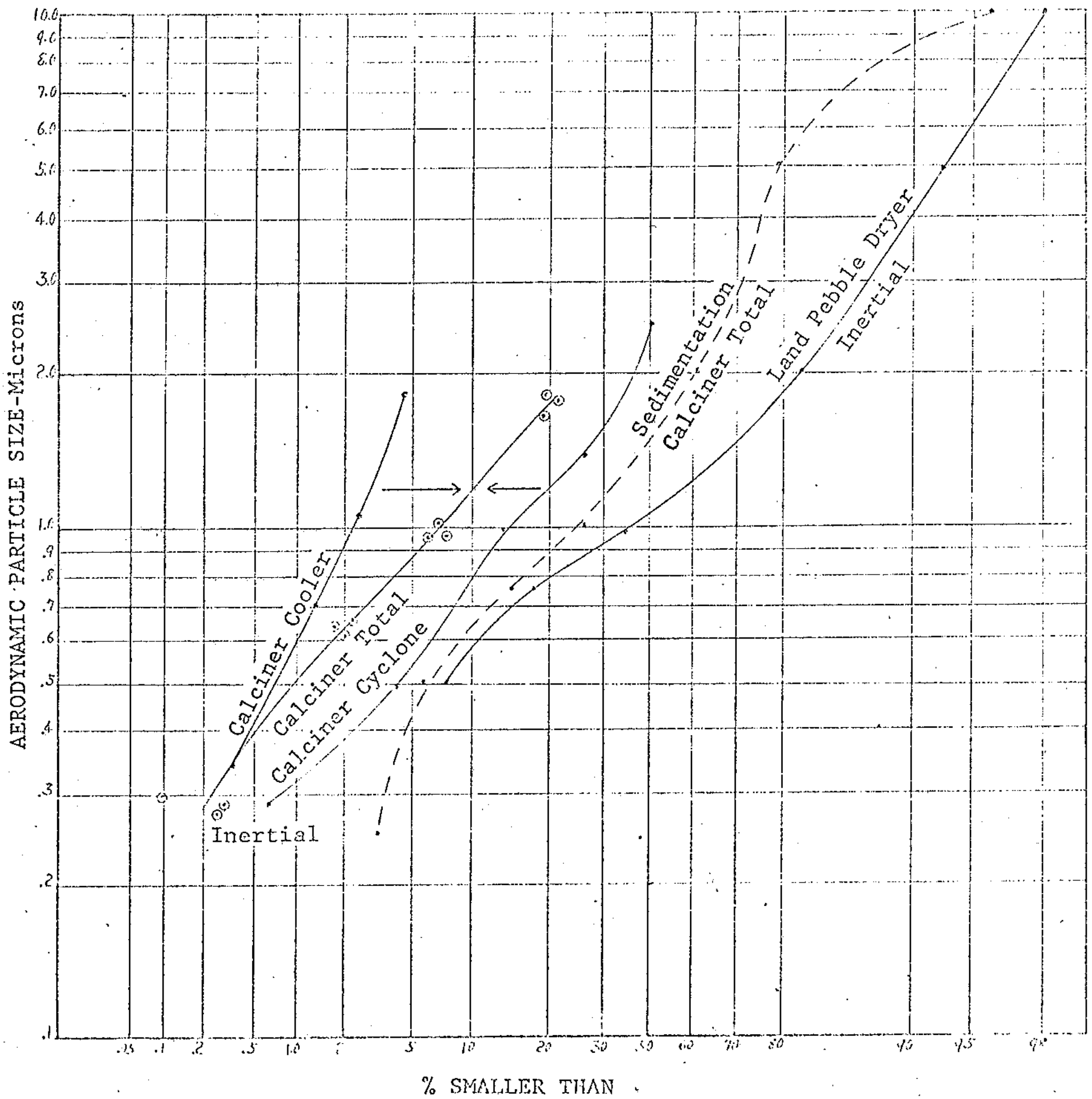


FIGURE 6

PHOSPHATE CALCINER EMISSIONS CONTROL

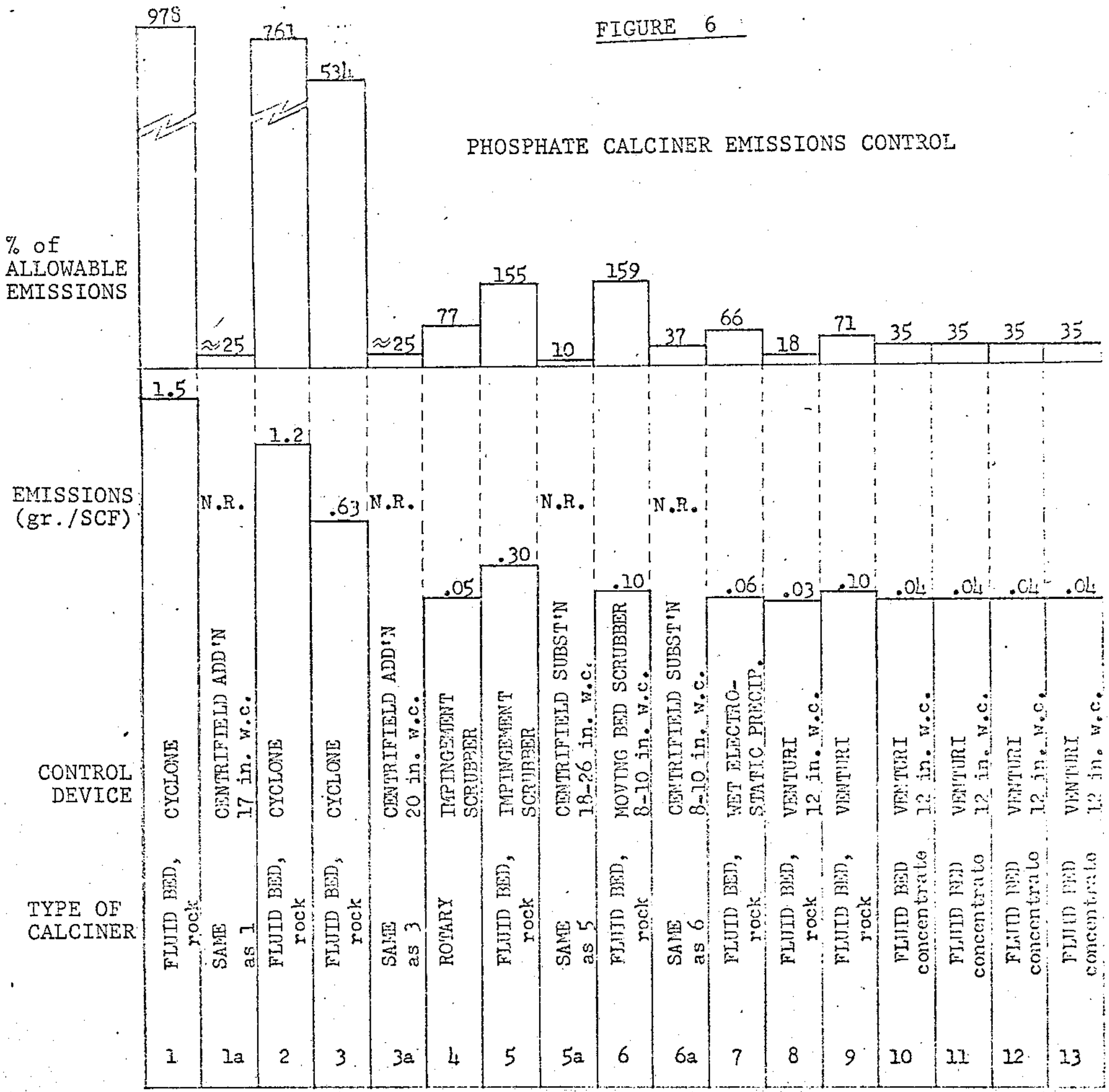
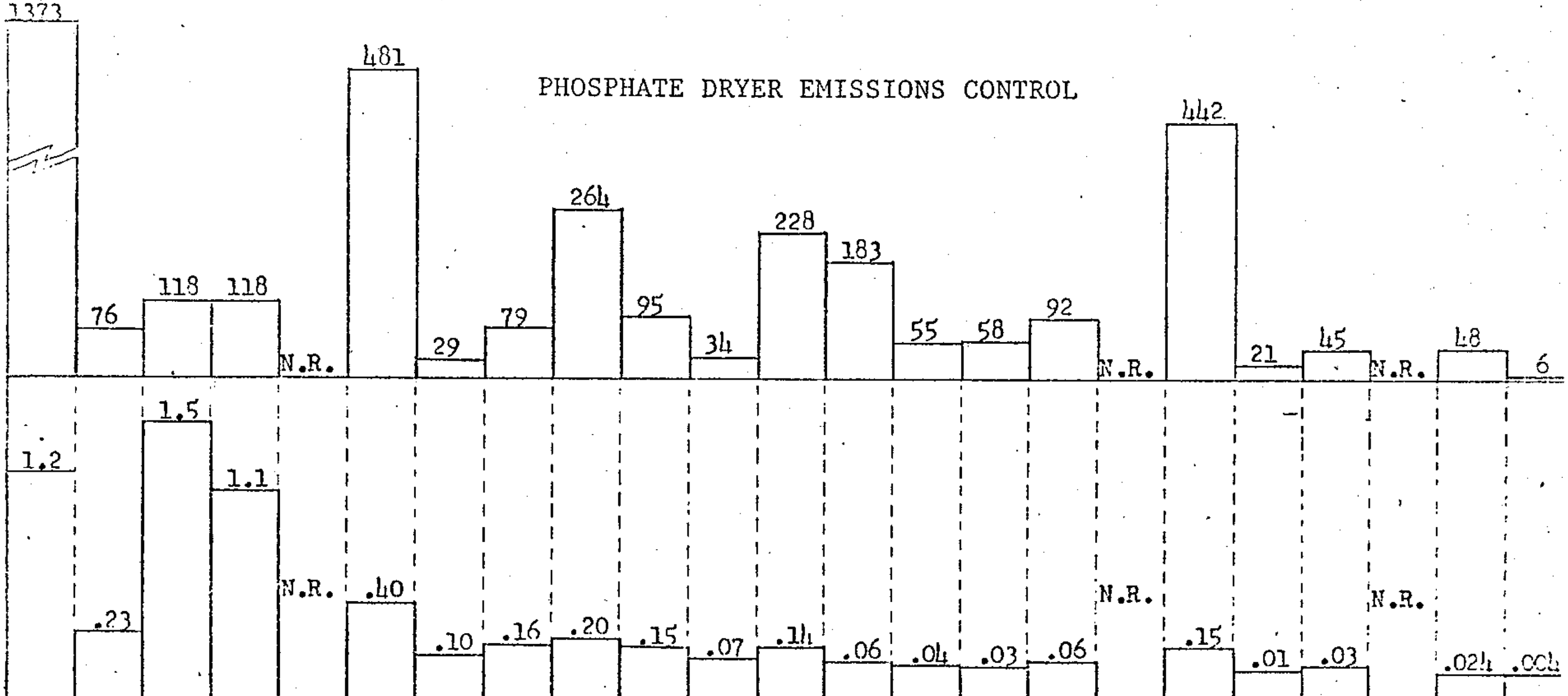


FIGURE 7

PHOSPHATE DRYER EMISSIONS CONTROL



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	22a
% of ALLOWABLE EMISSIONS	1373	76	118	118	N.R.	481	29	79	264	95	34	228	183	55	58	92	N.R.	442	21	45	N.R.	48	6
EMISSIONS (gr./SCF)	1.2	.23	1.5	1.1	N.R.	.40	.10	.16	.20	.15	.07	.14	.06	.04	.03	.06	N.R.	.15	.01	.03	N.R.	.024	.004
CONTROL DEVICE	CYCLONE	CYCLONE	CYCLONE	CYCLONE	CYCLONE	WET SCRUBBER	SPRAY TOWER	EDUCTOR VENTURI	IMPINGEMENT TRAY	IMPINGEMENT TRAY	CYCLONIC SCRUBBER	CYCLONIC SCRUBBER	CYCLONIC SCRUBBER	CYCLONIC SCRUBBER	CYCLONIC SCRUBBER	CYCLONIC SCRUBBER	CYCLONIC SCRUBBER	ELECTROSTATIC PRECIPITATOR	E.S.P. after IMPINGEMENT	2 VENTURI 18 in. w.c	VENTURI	CENTRIFIELD 18 in. w.c.	CENTRIFIELD [illegible]
TYPE OF DRYER	ROTARY	ROTARY, rock	ROTARY	ROTARY	FLUID BED	ROTARY	ROTARY	ROTARY	N.R.	N.R.	FLUID BED	N.R.	N.R. concentrate	FLUID BED, concentrate	FLUID BED	FLUID BED	ROTARY	N.R.	ROTARY & FLUID BED	2 ROTARY	ROTARY	FLUID BED, land pebble	Same after [illegible]

NOTES