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Extract of a lecture given on the 11th of August, 1975.

Alkali Reduction in Cement Kilns.

1. Introduction.

Alkalies in Portland Cement have only being drawing attention within the last two decades. This is due to a combination of factors:

1. Changes in cement plant technology
2. Increase in fuel prices
3. Enviromental compatability
4. Concrete technology alkali-silica reaction.

The development in cement plant technology has been a change from the wet process to the dry process due to lower fuel consumption. The increase in fuel price over the last couple of years has accentuated this trend.

Calls for pollution control by the modern society are being met by the installation of dust filters with collection efficiency above 99.5%.

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As a consequence the alkalies no longer have any chance of escape. Due to their volatility they tend to circulate within the cement making process, where they cause various operational difficulties.

In the same period it has been established that reactions occur between the alkalies from the cement and certain types of aggregates. Fortunately these types of aggregate, though widespread, are not found everywhere.

Alkalies in cement do, however, offer some advantages:

1) Lower burning temperatures in the rotary kiln.

2) Higher earlier strength of the cement.

Both of importance for the cement manufacturer.

2. Manufacturing Processes.

Although most new plants to-day are of the dry type, many wet plants are still in operation and will continue to be so for many years.

./. Typical flow sheets are presented on figure 1 and 2.

When a reduction in the alkali content of the cement is required, this can be carried out by making modifications to the burning section of the plant. That is apart from the very few cases where it is possible to change the supply of raw materials.

3. Kiln Systems.

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A new type of kiln, the calciner kiln, has since then turned up. This type of kiln offers a special advantage with respect to reduction of the alkalies.

However, the consumer must pay attention to the existing plant as they supply the cement that he is using. In the USA 60% of all kilns are of the wet type and some 30% are more than 40 years old. The dry plants in the USA are dominated by long kilns (85%), and 20% are 40 years or older. In the future the picture will change as 90% of the planned dry process installa will be of the cyclone preheater type.

4. Alkali Circulation.

In the hot zone of the kiln alkalies are evaporated. Part of the alkalies are caught in the colder parts of the kiln system or in the raw mill, if kiln gas is used for drying the raw materials.

The kilns alone vary in their ability to trap alkalies. In short, when conserving heat alkalies are conserved as well.

Kilns are followed by filters (electrostatic precipitators) mainly, and sometimes by mills. Therefore, in some of the more open types of kilns, the alkalies in the clinker may be reduced by discarding filter dust.

This method is, however, effective only in the wet process due to the composition of the dust. Even for the wet process it is only kilns operating as so called "nodule" kilns which can use this principle. Large wet kilns often operate as "dust" kilns yielding a dust with only a moderate content of K_2O.

In short, in only some wet kiln plants the alkali content can be reduced by discarding filter dust. And it is as well to point out that filter dust disposal to-day is no easy matter due to restrictions from local anti-pollution authorities.

One way to overcome this is to leach the dust with water thereby dissolving the alkalies in the dust.

In the 4-stage preheater kilns a certain reduction in the alkali-content can be made by means of a so called by-pass. It is unfortunately a capital demanding installation, and it increases the fuel expenditure. Actually a by-pass is mainly installed for a reduction of chloride.

This is because of the limited effect it has on the alkali-content in the clinker where mainly K_2O is reduced.

The extra fuel costs incurred due to the by-pass are heavy and companies are therefore unwilling to pay for such equipment unless required for production reasons. The disposal of the dust is a major difficulty with the by-pass.

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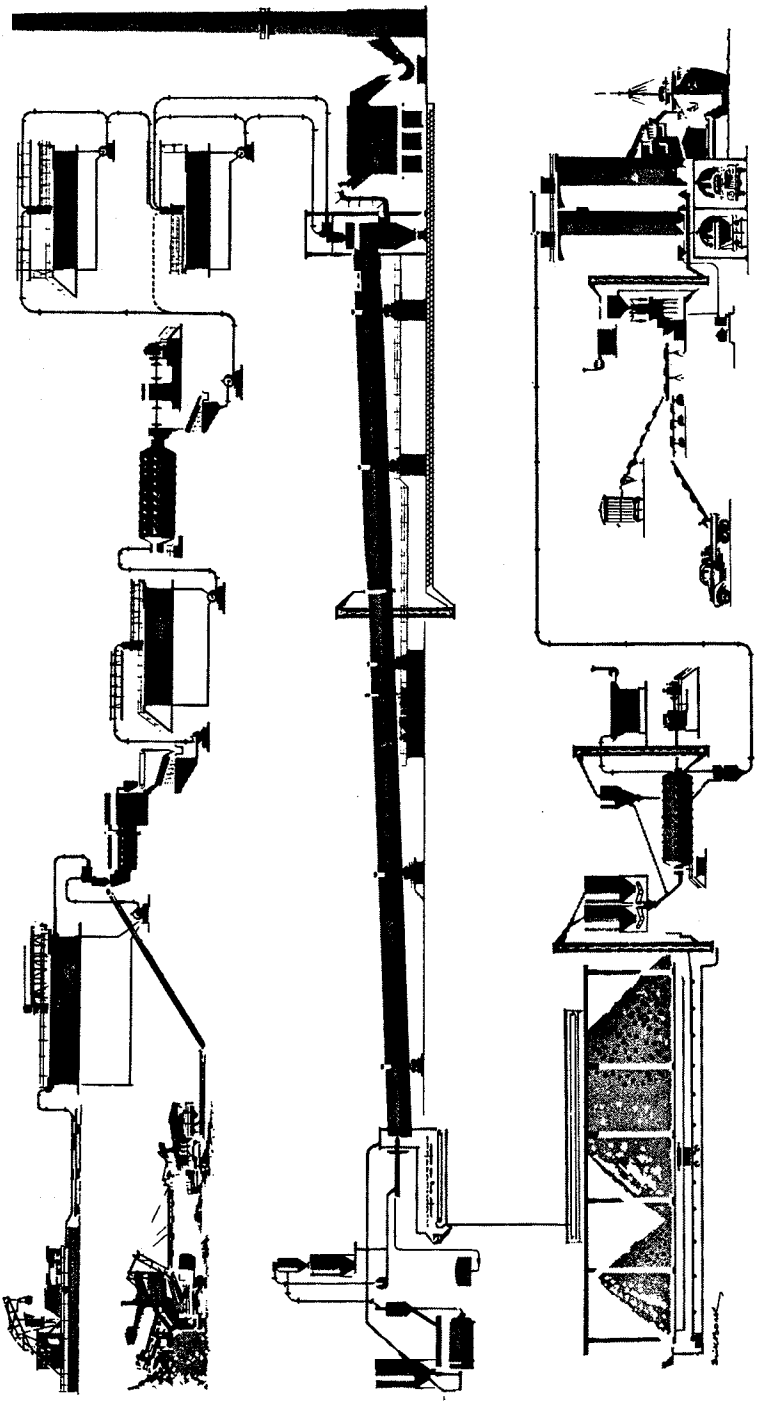
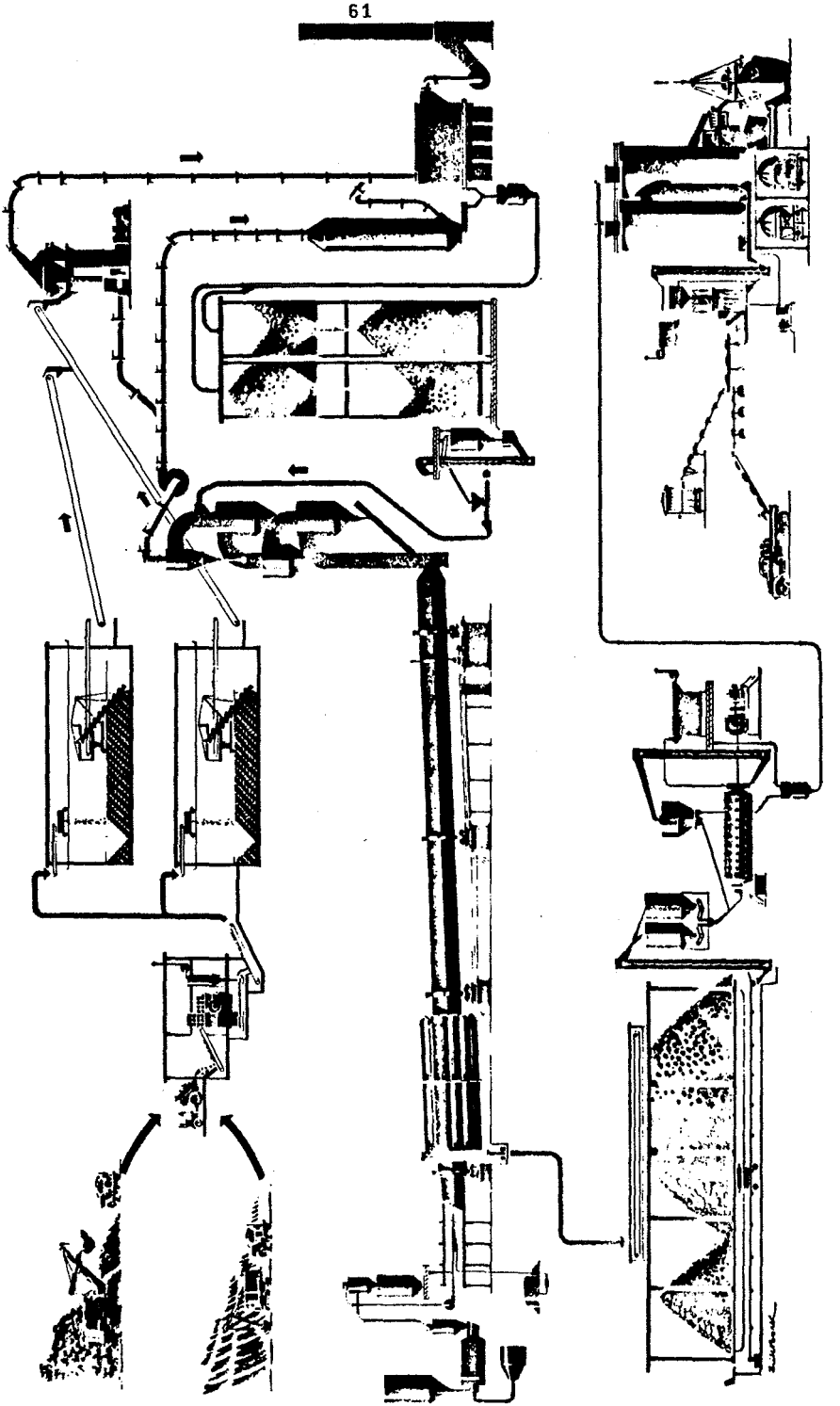
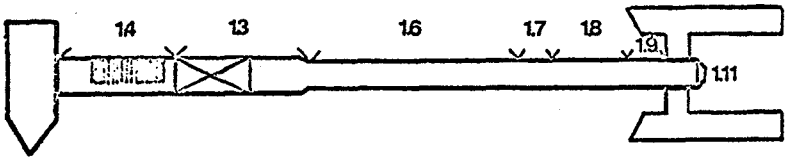
Only the calcinator kiln will provide an effective answer to the alkali control, and only a system where the rotary kiln gas is not combined with the air used for clinker cooling. In this case the volume of the kiln gas coming from the burning zone is 1/3 of the flow to a 4-stage preheater. This gas contains the volatilised alkalies and therefore an effective alkali valve is at hand.

./. Summarizing let us look at figure 4. Here is shown how the alkali-contents may be brought down at various types of cement plants, and at the same time giving the extra fuel costs on a relative scale, taking a 4-stage preheater kiln as 100%.

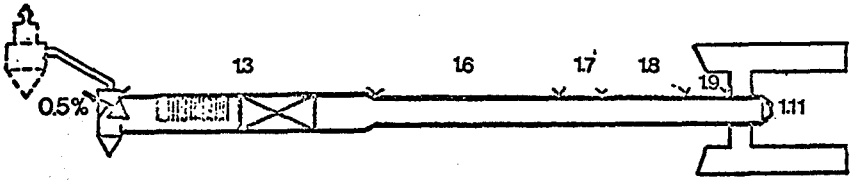




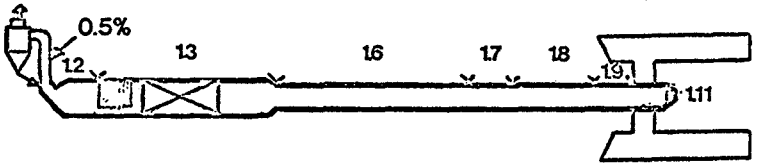
Wet Process Kiln



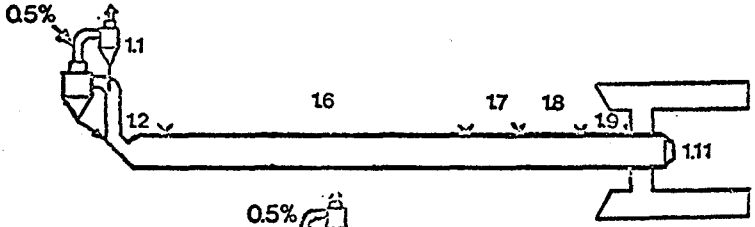
Dry Process Kilns



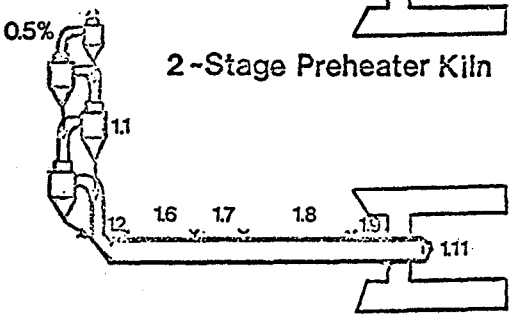
Long Dry Kiln
often with dedusting cyclone



1-Stage Preheater Kiln



2-Stage Preheater Kiln



4-Stage Preheater Kiln

KILN FEED WITH:
0.50% K_2O + 0.25% Na_2O