OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

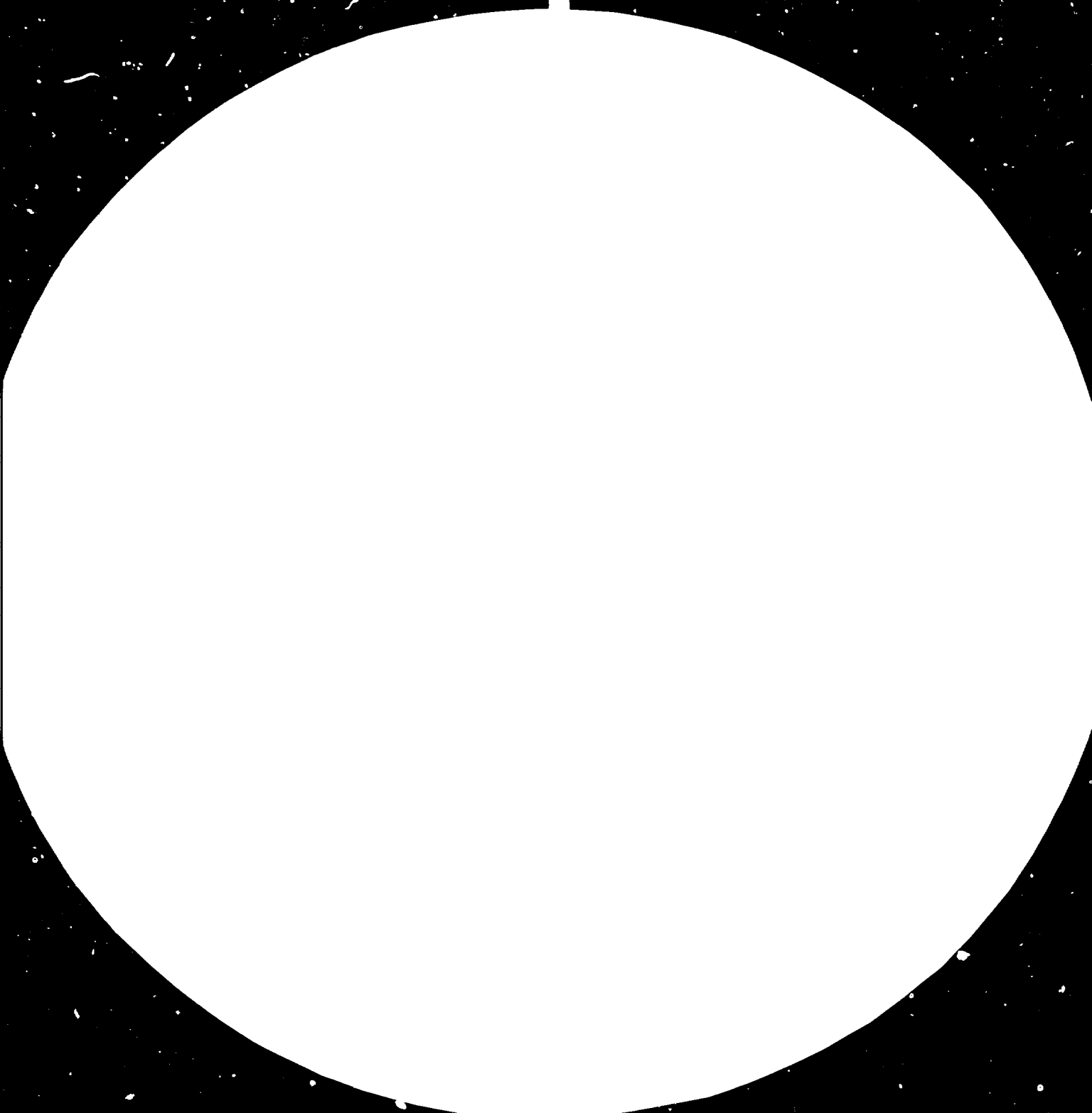
FAIR USE POLICY

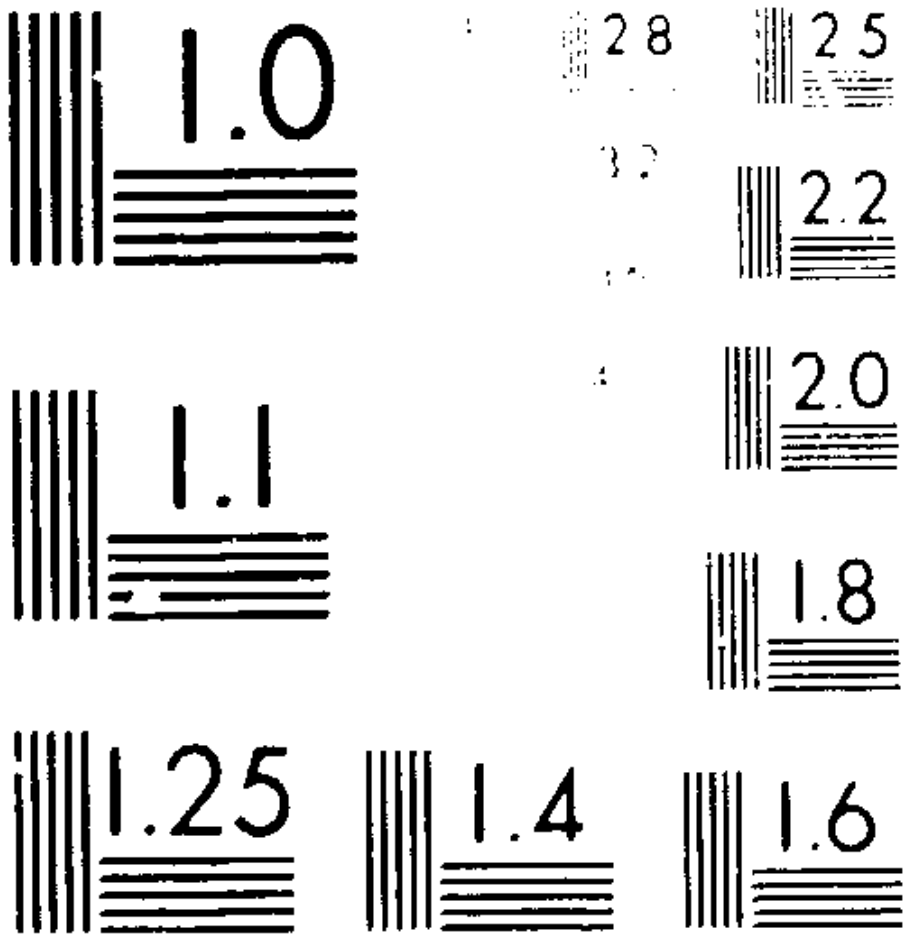
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org




1.0
2.8
2.5
2.2
1.1
2.0
1.8
1.25
1.4
1.6

10041

Distr.
LIMITED

ID/WG.326/5
25 August 1980

ENGLISH
ORIGINAL: CHINESE

United Nations Industrial Development Organization

Interregional Seminar on Cement Technology
Beijing, China, 9 - 24 October 1980

BACKGROUND INFORMATION FOR SEMINAR ON CEMENT TECHNOLOGY *

by

Fang Run **

/

* The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

** Engineer, The People's Republic of China

80-42866

BASIC CONDITIONS OF CHINA'S CEMENT INDUSTRY

China has quite a long history in developing its cement industry. As early as in 1889 its first vertical shaft kiln was built in Tangshan by Qixin Cement Plant. In 1906 Qixin Cement Co. was set up which installed the first rotary kiln with a capacity of 40,000 tpy. Just after the founding of the People's Republic of China in 1949, the annual cement output of the country was only 660,000 tonnes. The annual output went up to 6.18 million tonnes in 1956 (during the First Five Year Plan period). In 1979, 30 years after the founding of New China, cement industry was greatly developed as the total output reached 73.8 million tonnes among which 24.72 million tonnes were produced by big and medium-sized cement plants and 49.11 million tonnes by mini cement plants.

Since China is a developing country with a vast territory, a great amount of cement is badly needed in the vast rural areas, medium and small towns, local industry and especially in the construction of water conservancy works. In view of this situation, mini cement plants have been put up all over the country in line with local conditions so as to satisfy the above said demands.

In 1958 there were only 5 mini cement plants with a total output of 270,000 tonnes. In 1965 the number of mini cement plants reached 234 with an output of 5.23 million tonnes altogether. In 1979 the figure increased to 3,400 and the production went up to 49.11 million tonnes of cement.

The construction of these mini cement plants has satisfied the local need of cement and played a great role in the construction of water conservancy works and in the development of local industry. The advantages of such construction are less investment and short construction period whereas the disadvantages are that some plants produce clinker with unstable quality due to problems in mineral resources and technology, and some plants involve quite high production cost. The mine location, production technology, management and administration must get improved in the future so that consolidation and development of mini cement plants can be achieved.

The big and medium-sized cement plants with rotary kilns are the backbone of China's cement industry. The main construction projects, the urban, transportation and port construction of the state chiefly depend on the cement produced by these big and medium-sized cement plants. That is why we wish to lay emphysis on discussing and solving problems in this respect.

In 1979 there were in China 49 big and medium-sized cement plants with 135 rotary kilns having a yearly output of 24.72 million tonnes.

The Annual Output by Big and Medium-sized Cement Plants

Year	1975	1976	1977	1978	1979
Output (in million tonnes)	19.06	17.58	19.09	22.71	24.72

In 1979 average strength grade of clinker was No. 600 and of cement NO. 500 (according to China National Standard for dry mortar).

Regarding cement varieties, the proportion of different cement manufactured is as follows:

Ordinary Portland cement	49.93%
Slag cement	41.40%
Pozzolanic cement	1.55%
Rapid-hardening cement	3.49%
Oil well cement	1.92%
Dam cement	0.83%
White cement	0.17%
Other cements	0.71%

As far as production process is concerned, the most popular process in China at present is wet process, next is semi-dry process and then dry process. Their proportion and unit heat consumption of clinker is cited below:

Production process	Proportion (%)	Heat Consumption of clinker (kCal/kg. clinker)
Wet process	62.56	1503.5
Semi-dry process	20.80	1205.8
Dry process	16.64	1506.7

At the moment all types of giant dry process rotary kilns with cyclone preheaters or precalciner burner have been developed on commercial scale in the world so as to save energy. The heat consumption can thus be reduced to 750 kCal/kg. clinker. Nevertheless such kilns have not yet been greatly developed and popularized in China. Only some dry process rotary kilns have been modified with cyclone preheaters in some existing plants and two kilns with shaft-type preheaters constructed. Though the heat consumption of clinker has been reduced to some extent (1,100-1,200 kCal/kg. clinker), it still falls far behind the world advanced level. In a word

such type of kiln is at a stage of developing and popularizing in China.

The fuel for China's cement industry is mainly coal. Only a few cement plants use oil or natural gas as fuel. The proportion of different types of fuel used in cement industry is shown below:

Type of fuel	Percentage (%)
Coal	88.28
Oil	11.09
Natural gas	0.63

As to the raw materials for cement production in China, limestone is the most important calcinaceous material. Only a few plants use marble or marl. Limestone in China is quite abundant and widely dispersed. At the moment there are more than 500 deposits with an estimated reserve of about 20 billion tonnes. The limestone for most cement plants now contains more than 50% CaO, and less than 50% for a few cement plants which comprise about 10% of the total. In recent years, because of the construction of many new cement plants, the high quality limestone deposits adjacent to big cities, industrial areas or communication lines have been exploited one after another. The abandoned limestone deposits can in no way be utilized either because of high content of MgO (3-4%) or flint nodule; or because of low content of CaO (Cao less than 48%) or high content of alkali ($Na_2O + K_2O$ more than 0.6%), or high content of chlorine (Cl^- more than 0.015%). Especially nowadays, the development of kilns with cyclone preheaters requires a strict control of K_2O, Na_2O, $SO_3^=$ and Cl^- content in cement raw materials. The explored limestone deposits in the vicinity of communication lines usually can not meet the requirements for setting up plants as far as the quality is concerned. So how to carry out utilization of low grade raw materials and the research of adaptability of cyclone preheaters to raw materials remains a problem to be solved at present.

Relating to the silicious materials, quite many of which can be utilized as cement raw materials such as loess, clay, shale, marl, silt stone and fluviatile mud etc.. Loess is abundant in northern part of China. The loess has a silica modulus of 3.5-4 in general, alumina modulus 2.3-2.8, CaO content is generally within the range of 5-10%, alkali content (Na_2O, K_2O) 3.5-4.5%. The clay in north-eastern and southern part of China has a silica modulus 1.4-3.3, alumina modulus 2.5, and low content of alkali. In recent years, when building a new cement plant, shale, silt stone etc. are considered in the first place to replace clay in order not to occupy cultivated lands and good results have been achieved. But sometimes shale has a low SM which needs silicious material for correction. Silt stone is widely used for this purpose, and some plants use fluviatile mud instead.

With regard to the utilization of industrial wastes, about 300 million tonnes of waste slags are discharged by the industrial sector every year, in which 27 million tonnes are fly ash, 70 million tonnes colliery waste, 18 million tonnes blast furnace slag, 6 million tonnes steel slag, 50 million tonnes slags from municipal industry and households, and about 100 million tonnes of other waste slags such as tailings, aluminium slag, calcium carbide sludge and so on.

At present the utilization ratio of these industrial waste slags is not high in our country. In 1977, the utilization ratio of fly ash was 9% which amounted to about 2.36 million tonnes, out of which about 1 million tonnes used for cement industry; the utilization ratio of colliery waste was 12% which amounted to about 8.5 million tonnes out of which 1 million tonnes or so for cement industry while the ratio of blast furnace slags was 70% mainly for cement industry.

After the success by experiment in 1959 in using the slags as raw materials which were discharged by Shandong Aluminium Works after making alumina by

sintering process, we built a cement plant with 500,000 tonnes capacity per year. The production of per tonne alumina will cause the discharge of about 1.5-1.8 tonnes of slags. If these slags are not properly utilized, it will occupy a great amount of land to pile them up, and as the discharged water contains NaOH and Na_2CO_3, it will contaminate the environment and the cultivated lands. But aluminium slag contains as much as 42-50% calcium oxide (CaO) of which the main mineral is BC_2S which is a very good raw material for cement manufacture, and the main problem of which is high content of alkali. Its chemical composition is cited bellow:

	Loss on ignition	SiO_2	Al_2O_3	CaO	Fe_2O_3	MgO	TiO	R_2O	K_2O
Shandong Alumina Slag	7.0-12.2	16.1-22.4	5.3-7.2	42.5-50.6	8.3-12.5	2.0-3.9	2.0-2.9	2.4-2.7	
Zhenzhou Alumina Slag	4.2-7.8	19.9-24	5.5-7.7	46.0-50.1	4.0-5.0	0.4-0.9	6.3-7.5	3.2-3.9	0.5-0.6

The aluminium slag has a water content of 45% after its concentration and of 39-43% after slurry preparation. In cement production, wet process is employed and rotary kiln with evaporator at the kiln inlet is selected which has a heat consumption of 1,290-1,370 kCal/kg. clinker.

Besides, we also succeeded in utilizing the calcium carbide sludge as cement raw material which was hydrated by a vinylon plant of Jiling Chemical Co. The main chemical composition of calcium carbide sludge is calcium hydroxide $Ca(OH)_2$ in which particles are fine and evenly distributed and which has a water content of 53% after concentration. The water content of the slurry after its preparation with such sludge reaches as high as 53%. Wet process is adopted in the manufacture of cement with a heat consumption of 1,900 kCal/kg. clinker. Thus it can be seen that the problem we face in manufacturing cement with aluminium slag and calcium carbide sludge as raw materials are high water content of slurry and high heat consumption of clinker. And

because of these problems, a large quantity of aluminium slag and calcium carbide sludge is not yet utilized. In short, a lot of problems still exist in the utilization of industrial waste slags as compared with the advanced world level. In cement industry, not only the utilized quantity of these industrial waste slags, but also many technical problems involved must be tackled and solved urgently.