October 1984

CRI TECHNOLOGY DIGEST

CEMENT RESEARCH INSTITUTE OF INDIA

CRI HIGH STRENGTH INSULATING BRICKS (HSIB) FOR CEMENT AND OTHER INDUSTRIES

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INTRODUCTION

The cement rotary kiln is not a good heat exchanging equipment, and as such accounts for much heat loss. As much as 6-15% of total heat input for clinker manufacture is lost through refractory lining and about one third of this heat loss is through preheating and calcining zones. Therefore, there is considerable scope for saving heat in these zones by using improved insulating techniques. The earlier experience of using moler (diatomaceous) bricks behind the conventional fireclay brick lining proved to be unsatisfactory as the rotation of the kiln caused relative movements between the working lining and the insulation, with the result that the mechanically weaker insulating bricks got pulverised by the heavier fireclay bricks.

The use of high strength insulating bricks has emerged as a solution to this problem. It has been found that the saving in heat required for clinker burning in short dry process kiln ranges from 2·0 to 3·6 k cal/kg of clinker (depending on the size of the kiln) for linings constructed with dense fireclay bricks with a backing of diatomaceous bricks and from 4·8 to 8·5 k cal/kg of clinker when a high strength insulating brick lining is installed instead of a fireclay brick lining. For long wet process kilns saving of the order of 15 to 30 k cal/kg of clinker can be expected by employing high strength insulating brick lining.

Figure 1 shows the kiln shell temperatures and respective heat losses for a lining consisting of high duty fireclay bricks, compound bricks, two layer lining of fireclay-moler bricks and insulating firebricks. It can be seen here that for a hot face temperature of 1150°C, the shell temperature is around 285°C and heat losses, from shell to the atmosphere, amount to 4754 k cal/m^2h for high duty fireclay brick lining. For compound brick lining, two layer lining of fireclay—moler brick and insulating firebrick lining, the shell temperatures are around 225°C, 205°C and 185°C respectively and heat losses of the order of 3184, 2728 and 2290 k cal/m^2h respectively. This gives a fair indication of the extent of energy conservation which can be brought about by switching over to the use of insulating firebricks in the relevant zone of cement rotary kilns.

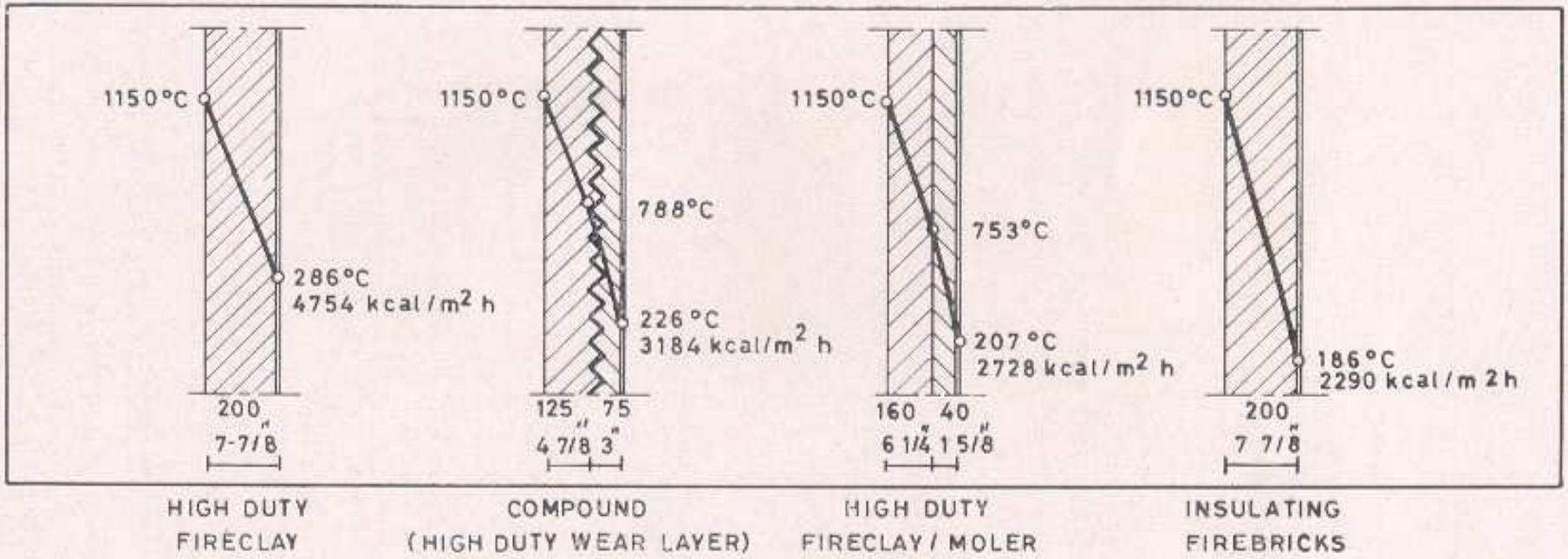

Fig 1 Heat transfer in insulating linings of rotary kilns

Table 1 shows fuel savings in tonnes/year for a typical long wet Indian kiln of 600 tpd capacity when high strength insulating refractory bricks are used. It works out to 1365 tonnes of coal per year which at a cost of Rs 400/t of coal comes out to Rs 5·46 lakh per year.

Keeping in view the present and future needs, CRI has developed high strength insulating bricks (HSIB) for use as exposed lining in preheating zone of cement rotary kilns. The evaluation of the bricks produced in a refractory plant and the test results obtained have shown these to be comparable to the imported ones. It is expected that these bricks would perform well in the recommended area (preheating zone) of cement rotary kilns. This technology digest highlights the salient features of the high strength insulating bricks developed by CRI.

PRODUCT DEVELOPMENT

Common refractory raw materials, viz, plastic fireclay and high heat duty fireclay grog were used for making high strength insulating bricks. Commonly used porosity inducing agents were employed. Conventional manufacturing techniques were used for making trial batches of these bricks at a refractory plant.

TABLE 1

SAVINGS IN FUEL COST BY THE USE OF HIGH STRENGTH INSULATING BRICKS

Assumptions

Calorific value of coal : 5000 k cal/kg of coal
Cost of coal : Rs 400/t
% length of lining with HSIB : 30%
Kiln capacity : 600 TPD (long wet)

Sl No	Coal Saved		Savings
	TPD	*TPY*	*Rs (lakh)/year*
1	4·135	1365	5·46

PRODUCT EVALUATION

The bricks were evaluated for physical, chemical, thermal and mineralogical properties. The important properties have been given in Table 2.

TABLE 2

IMPORTANT PROPERTIES OF CRI-HIGH STRENGTH INSULATING BRICKS

	PROPERTY	VALUE
1	Service temperature	
	Normal	1150°C
	Max	1200°C
2	PCE	1600-1650°C
3	Bulk density	1·35-1·45 gm/cm^3
4	CCS	100-120 kg/cm^2
5	MOR	50-60 kg/cm^2
6	PLC at 1200°C	0·10-0·12% (+)
7	RUL	T_a 1360-1400°C
		T_e 1500-1580°C
8	Thermal conductivity	0·43-0·52 k cal/m.h°C
9	Chemical Analysis	Al_2O_3: 37-39%
		SiO_2 : 51-54%

Besides Optical Microscopy, X-ray Diffractometry and Scanning Electron Microscopy, Ultrasonic Pulse Velocity Measurement and High Temperature Microscopy Techniques were also employed for the evaluation. SEM results indicate that the pores in the bricks are more or less uniformly distributed and of fairly even size. The grain growth and bond development is of higher order. The pulse velocity measurements confirm the bricks to be almost free from internal flaws/cracks.

For the developed HSIB the refractory-raw mix interaction was studied with the help of Leitz heating microscope. Fig 2 shows the fusion temperatures of homogeneous mixtures of a typical portland cement raw mix and HSIB in different proportions. It is observed that the lowest fusion temperature with CRI high strength insulating bricks is 1260°C as against 1200°C of an imported product of similar category. This indicates that the safe temperature limit of use of CRI product as an exposed lining material in the preheating zone of cement rotary kiln is higher than that of imported ones which are already in use abroad.

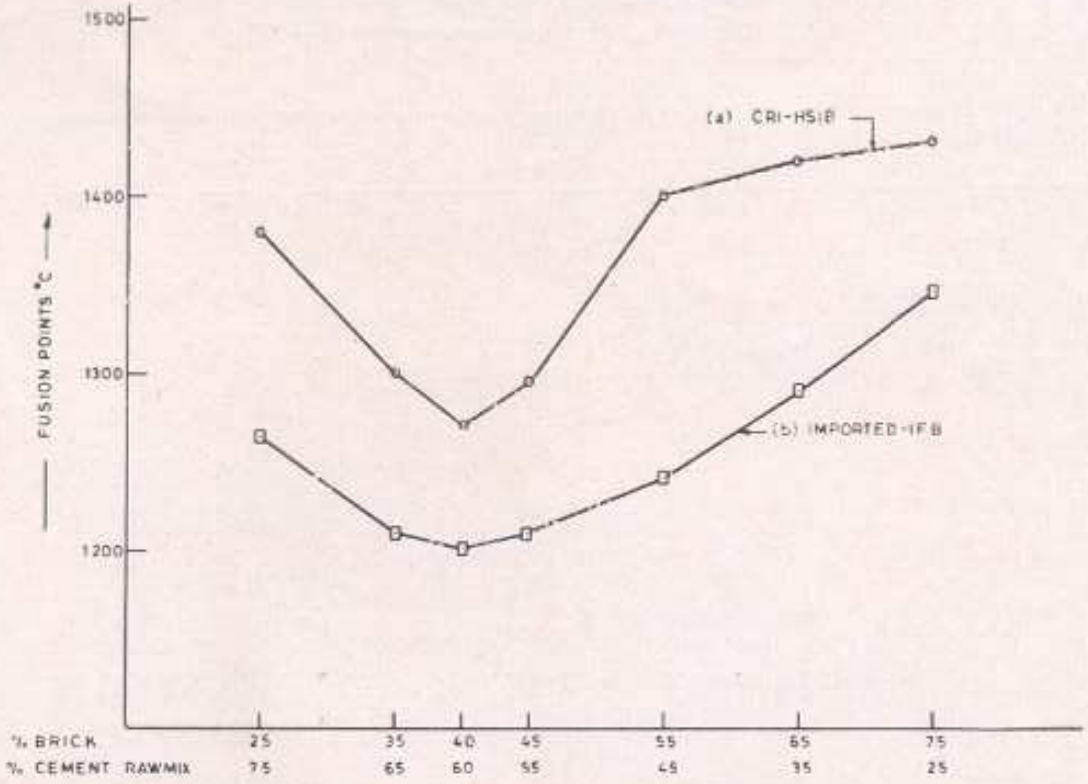

Fig 2 Relationship between fusion points of mixures of (a) Cement raw mix + CRI-HSIB and (b) Cement raw mix + imported IFB studied under Leitz heating microscope

EXTENT OF APPLICATION

Depending on the kiln size and operating conditions, 22 to 30 percent of the overall kiln length can be lined with HSIB in Lepol kilns, 24 to 42 percent in preheater kilns and 34 to 50 percent in long wet process kilns. In a precalcinator kiln, the lining portion can be 8 to 10 percent of the kiln length. These bricks can be used safely in the temperature range 400°C to 1150°C in cement rotary kilns.

DURABILITY

The economy offered by HSIB lining depends not only on the heat savings but on its durability also. The lining durability in preheating zone is to a great extent governed by aggressive action of alkali compounds present in the kiln atmosphere. The durability of HSIB lining in comparison to the brick lining currently being used in the preheating zone of cement rotary kilns, can be expected to be of the order as shown in Fig 3. for various kiln systems.

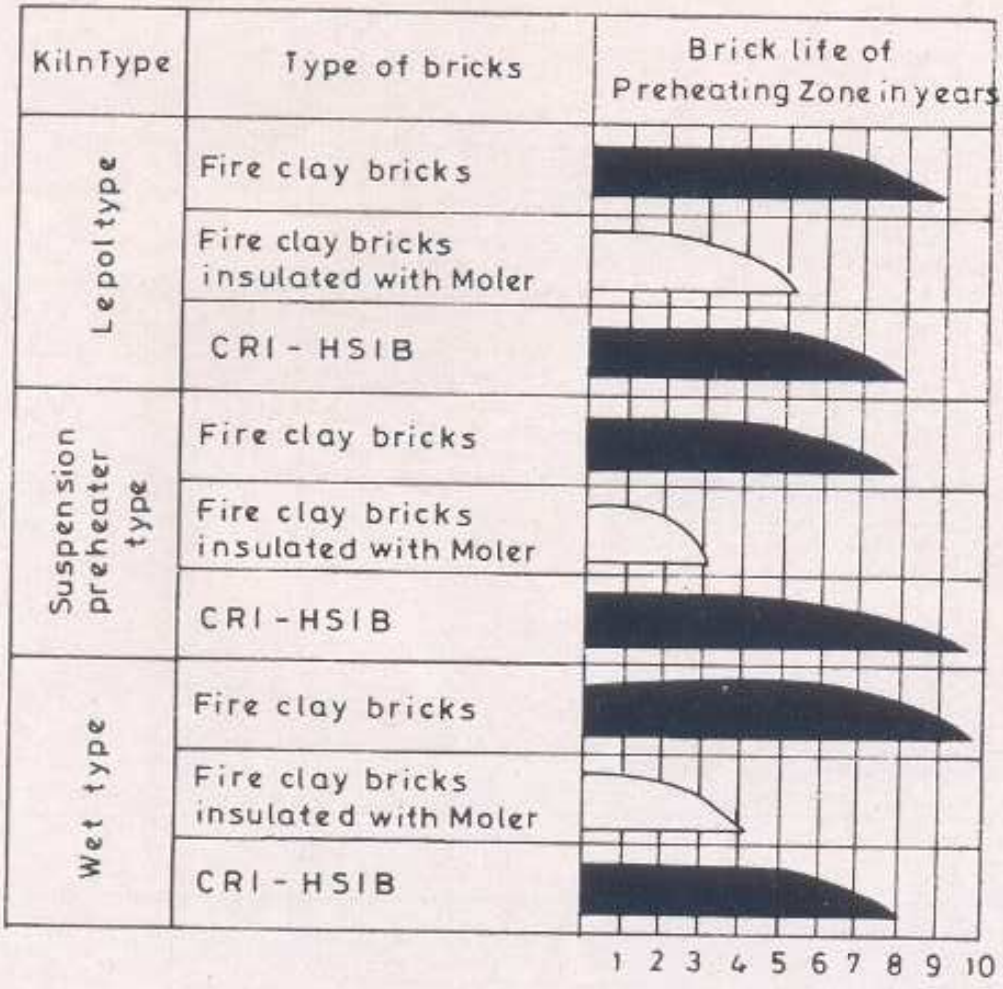

Fig 3 Expected life of CRI High Strength Insulating Bricks in comparison to other bricks

ADVANTAGES

The advantages of HSIB can be summarised as under:

a) Fuel economy of 2-3%,

b) Lowering of shell temperature by about 50°C,

c) Reduction in lining weight,

d) Corresponding increase in production,

e) Better kiln stability and

f) Lowering of kiln power consumption, etc.

CRI ASSISTANCE

CRI is ready to transfer the technology of making high strength insulating bricks (HSIB) to interested refractory manufacturers on mutually agreed terms and conditions.

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Published by Shri S K Khanna on behalf of Cement Research Institute of India, M 10 South Extension II, New Delhi 110 049 and Printed at Indraprastha Press (CBT), Nehru House, New Delhi 110 002
Regd No. R N 40434/82