

# Recent Trends in Furnace Construction Work

Takayuki INUZUKA\*

## Abstract

*In recent years, there has been no increase in domestic steel production, and no large-scale furnace construction work associated with the construction of new facilities. However, blast furnaces and coke ovens have reached the end of their service life. For this reason, securing the labor for furnace construction is an important issue, and alarms have been sounded about the shortage of the labor for furnace construction. In this report, the situation of furnace construction work since 2008 is described.*

## 1. Introduction

Presently large blast furnaces or coke ovens are not constructed in Japan for capacity increase of ironmaking processes, but many of the blast furnaces, hot stoves, coke ovens, etc. in the country have been kept in operation through various life extension measures. Now they are nearing the end of their service life, and as a consequence, large reconstruction works such as the relining of blast furnaces and pad-up of coke ovens are under way, and their number is increasing. Since such works lead to a decrease in iron production in most cases, a short work period is strongly required. In this situation, securing the labor for furnace construction, especially that for brick laying work, is an important issue. Besides these large furnaces, on the other hand, at the plant floors of the steel industry, especially of steelmaking plants, refractories are constructed and repaired in comparatively shorter intervals of days or weeks for hot metal pretreatment facilities, converters, secondary refining furnaces, ladles, etc., and securing the labor for these works is another major issue.

There have been study reports on the measures against the shortage of furnace building workers,<sup>1,2)</sup> and measures have been proposed to improve the situation; such include the review of wages, improvement of the work environment, enhancement of the systems, facilities and supports for training, technical development, introduction of foreign workers, and work scheduling to avoid overlapping of works, but not all of them have actually been brought into action to solve the problems. This paper overviews the present situation of the labor market of furnace construction from these aspects.

## 2. Latest Changes in Labor Market of Furnace Construction

### 2.1 Age distribution of furnace construction workers

A paper in No. 388 of the Shinnittetsu Giho (No. 98 of the Eng-

lish version) pointed out aging as one of the most serious problems of the labor market of furnace construction in Japan. **Figure 1** shows the change in the age distribution of the workers over the last ten years, approximately, obtained through hearings with three main furnace constructors acting in Nippon Steel Corporation's works; the bars represent the percentages of different age groups to the total number of the refractory workers in 2008. Whereas the number of experienced and skilled workers in their 40s was smallest in 2008, thanks to the efforts of the companies to recruit young furnace workers, the poorly-balanced age distribution in the past seems to have been improved by 2019: the past age distribution biased toward higher ages has been adjusted by active recruitment of young people, and the companies now tend to keep experienced workers of higher ages to maintain the skill level. The total number of workers has increased by more than 20% during the period in response to the increased work volume.

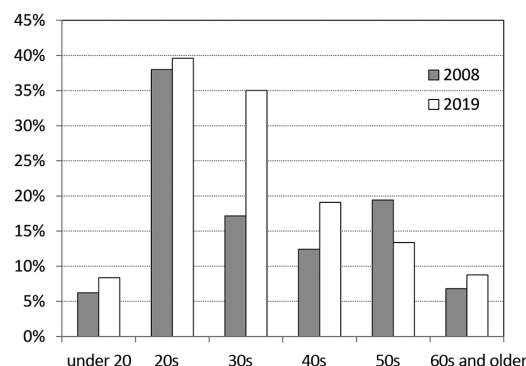


Fig. 1 Age distribution of furnace construction workers

\* General Manager, Head of Dept., Refractory Engineering Dept., Refractory Ceramics Div., Plant Engineering and Facility Management Center  
20-1 Shintomi, Futtsu City, Chiba Pref. 293-8511

## 2.2 Change in number of examinees for furnace technician test

I investigated the change in the number of the examinees for the Furnace Technician Test, a test for a governmental qualification, as an indicator of the upskilling of furnace construction workers. **Figure 2** shows the changes in the total number of examinees in the whole country and the pass rates. The qualification of furnace builders is divided into Levels 1 and 2. After the last relaxation of examinees' eligibility in 2004, those who have experience of real refractory work for 2 years (3 years before the relaxation) can apply for Level 2, those who have experience for 7 years (12 years before) for Level 1, and those who hold the Level 2 qualification for 2 years (5 years before) for Level 1. Presumably because of the relaxation, the number of the examinees increased rapidly by roughly 50 in 2004 from 160 to 170 in previous years. The number of the examinees continued to increase thereafter either for Level 1 or Level 2, and lately, the total number is around 400 every year.

The pass rate, on the other hand, fell temporarily after the eligibility relaxation, but it improved gradually, and the number of successful examinees has increased, but the pass rate has remained around 60% for Level 1, and around 70% for Level 2. It has to be noted, however, that all the examinees of the Furnace Technician Test are not refractory workers only for the steel industry, but those for the furnaces of the glass and the cement industries and incineration furnaces are also included.

## 2.3 Summary

It would not be altogether appropriate to say, based on the above change in the age distribution and that of the examinees of the Furnace Technician Test, that the training of the refractory workforce for the steel industry is progressing well. The furnace construction companies, however, have increased efforts to raise the skill level of their employees, not only through on-the-job training, but also by setting up training facilities for their employees in consideration of daily refractory maintenance work as well as the construction of large furnaces, and offering a wage increase when employees obtain relevant qualifications.

## 3. Development of Furnace Construction Technology

### 3.1 Patent applications

I investigated patent applications to clarify the latest trend of technical development in the field of furnace construction. **Figure 3** shows the number of patent applications in Japan of technologies related to different types of furnaces every year; they were searched using the key words of "furnace construction related to the steel industry." It is understood from the graph that the development of the use of unshaped refractories for the steel industry was actively promoted during the 1980s and 90s aiming mainly at labor saving and focusing mainly on the reaction vessels for steelmaking processes.<sup>3)</sup> The patent applications decreased in and after 2000, and no conspicuous trends were seen in the early 2000s, but those related to ironmaking furnaces, especially coke ovens, have been increasing over the last few years. This is presumably because, different from the steelmaking furnaces, for which unshaped refractories have come to be widely used, brick structure remained in large and long-working ironmaking furnaces such as coke ovens, hot blast stoves and blast furnaces, brick laying work accounts for most of their repair and construction works, the shortage of brick laying labor is expected to occur as a serious problem, and technical development for labor saving by mechanizing the brick laying work is being actively pursued. Targets of the technical development include the use of robots,<sup>4)</sup> and wider application of prefabricated refractory panels and blocks.<sup>5)</sup>

### 3.2 Current problems of furnace construction work

As stated in the above sub-section, to solve the problems of refractory work, wider use of unshaped refractories, with which it is easier to introduce machines for labor saving, was actively promoted for steelmaking facilities, and presently, unshaped refractories account for 60 to 70% of the refractory consumption in those processes, but the increase in their use has slowed down recently, mainly because brick lining is applied to furnace portions where durability is essential, and manual brick laying still remains.

Since brick laying work is a heavily muscular exercise, it is difficult to introduce female labor. As a solution, power assist robots, which are being introduced to the nursing and personal care establishments, have been used for trial purposes,<sup>6)</sup> but workability with

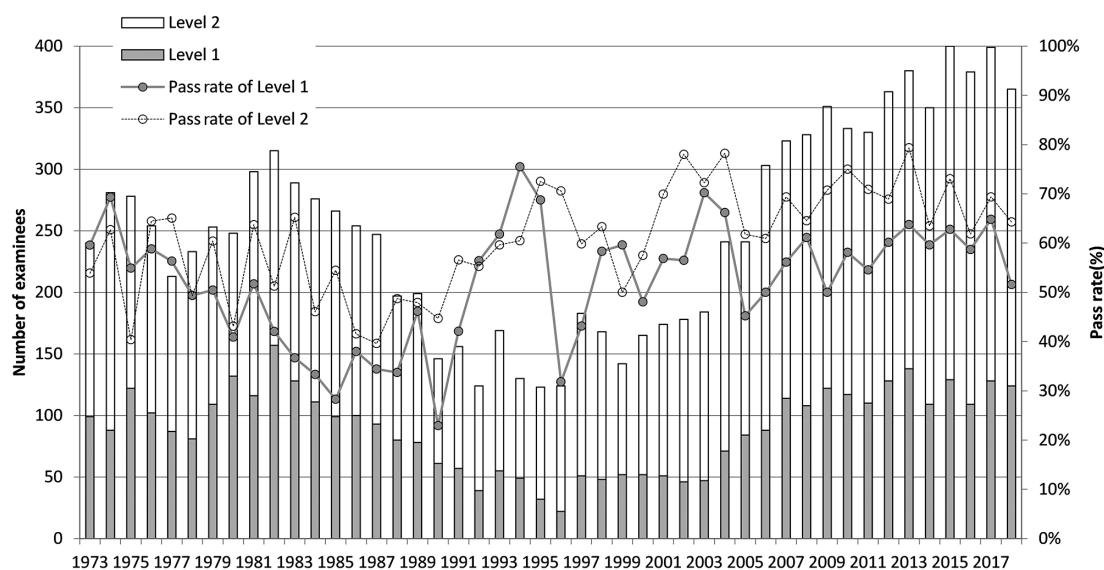


Fig. 2 Change in the number of furnace technician examinees

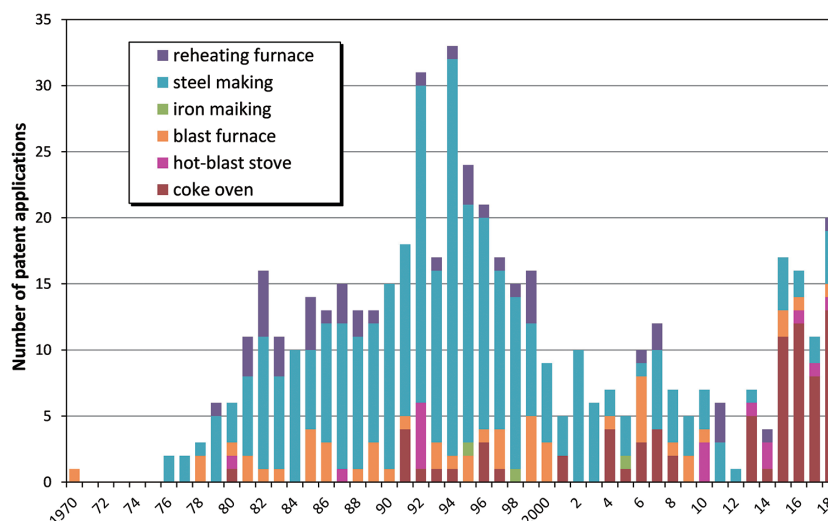


Fig. 3 Number of patent applications related to furnace construction

them was not as good as was expected, and the use of such robots as well as the introduction of female labor to brick laying work will still take a long time to realize.

The five-day week system has expanded under the Work System Reform, the change from past working conventions under government advocacy, and as a result, it has become difficult for the civil engineering and construction industry to secure a sufficient number of workers, and the same problem is being strongly felt in the field of furnace construction.

#### 4. Closing

The present paper has reviewed the trends and changes of furnace building work since the previous report of this technical report. As a result of common understanding of the problems between furnace builders and steelmakers and improvement of the work environment (dust suppression measures, elimination of hazardous materials restricted by regulations, etc.), some improvements have been achieved regarding the furnace builders' recruitment, training and retention of refractory technicians. However, the turnover ratio still remains high, and retention of refractory labor is expected to be-

come increasingly difficult as the Work System Reform further advances. In this situation it is desired that steelmakers, furnace builders, refractory manufacturers and engineering companies work in close cooperation to develop new technologies to mechanize the furnace building work of brick laying, or even to devise new refractory structures to allow departure from the conventional brick structure of furnaces, ovens and reaction vessels. All the people related to the steel industry are required to cooperate so that such technologies are brought into reality, and the furnace building in the steel industry becomes a more attractive work venue.

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Takayuki INUZUKA  
General Manager, Head of Dept.  
Refractory Engineering Dept.  
Refractory Ceramics Div.  
Plant Engineering and Facility Management Center  
20-1 Shintomi, Futtsu City, Chiba Pref. 293-8511