Study on Sampling Deviation and System Water Loss of Removable Mechanical Sampling Based on Iron Ore Inspection

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Abstract. Manual sampling can easily lead to lack of representativeness and cause quality disputes. Combining with the actual situation of Rizhao Port, the paper discussed the necessity and advantages of removable mechanical sampling equipment for iron ore sampling. The deviation and water loss of the system are compared experimentally and the sampling equipment meets the standard requirements.

1. Introduction

Rizhao port is one of the largest unloading capacity and berth capacity of domestic ore system. The quantity of iron ore imported in Rizhao Port ranks first in Chinese coastal ports. With the gradual improvement of port facilities and the increasing demand of hinterland transportation, the iron ore import of the port will continue to show a growth trend in the coming years. Some of the bulk cargo terminals do not have the installation conditions of fixed sampling facilities, so that it makes sampling more difficult. They can only take manual sampling in yard or vehicle, resulting in the lack of representative samples, easy to cause quality disputes and causes the security risks of workers. In order to adapt to the development of trade situation, improve the supporting of port technical infrastructure, meet the customer needs, satisfy the inspection and quarantine law enforcement requirements, improve work efficiency and customs clearance speed, ensure that the inspection results are objective, fair, accurate and reliable. It is imminent to use mechanized sampling facilities to sample iron ore and other bulk commodities. However, the large-scale mechanized on-line sampling equipment has high investment in the early equipment and high daily maintenance costs. The construction of on-line sampling equipment and berth needs early planning, and it is difficult to upgrade the existing berth.

The company invented the removable sampling equipment creatively and carried out the experiment. The removable sampling process in Rizhao port has the following advantages: firstly, it is suitable for bulk cargo sites without fixed sampling facilities which makes sampling efficient, and reduces the quality disputes caused by the lack of representative samples; secondly, the parts of equipment are centralized and easy to overhaul, which can free workers from potential safety hazards or poor working environment. In addition, in the equipment PLC dialog interface, you can input cargo types, weather, sampling methods, sampling time and other information, and then the equipment automatically makes sampling, if necessary to adjust the relevant parameters, it can be corrected manually. The completion of vehicle-mounted removable sampling equipment for mineral products can help the port to further
complete the technical infrastructure construction, improve the technical level of the port, greatly enhance the efficiency of port operations, improve the utilization rate of berths, expand the influence of the port, and lay a foundation for the rapid development of the port. The advantages of removable mechanical sampling equipment can reduce the human errors of manual sampling, improve the quality of work, ensure the accuracy of inspection results, avoid trade disputes as far as possible, and improve the technical ability of inspection.

2. Literature Review
Inspection activity originates from information asymmetry, it is the activity of providing information positively for smooth progress of the trading activity, and it is essentially the remedy for market failures and the supplement and perfection for the market system under social and government supervision. Inspection industry is the important component of national quality infrastructure and national innovation system and the important component of modern service industry, and it has an important role in the aspects of strengthening quality safety, promoting industrial development, maintaining consumer rights and interests, and protecting environmental and social public safety, etc. There are a large number of literature having given researches on inspection. Peyrache and Quesada, (2011) discussed conspiracy of the third-party intermediary and enterprise Zhang et al(2017) analyses the national supervision on inspection body, this paper shall further analyze the game relation between national supervision department and inspection body from dynamic game of the two parties in bounded rationality and provide the inspection body supervision with new thoughts. Everett J E et al (2013) discussed according to ISO3085, gross duplicate samples are prepared at each of the three stages, yielding eight measurement assays. Appropriate calculations of the differences between assay pairs are then made to estimate precision of each stage of sampling. The international standard for checking precision in iron ore sampling, prescribes a method for identifying outliers that is ambiguous and possibly inappropriate.

3. The Deviation and System Water Loss Experiment
After precision experiment we found in line with ISO standard, then we carry out the deviation and water loss experiment

3.1. Deviation experiment
The experiment will compare the results of the checked method (called method B) with those of the standard method (called method A), which from a technical and empirical point of view is considered to be non-biased. If there is no statistically significant difference between the results obtained by method B and method A, method B can be used as a routine method. Within the 90% confidence interval, the difference is estimated by comparing the real mean deviation and the correlation deviation $\delta$. We choose 10 delivery lots.

Method A: the standard method for checking the sampling deviation is ISO3082. Because it is not practical to pause the discharging frequently for sampling, it is suggested that the sampling position should be located at the sample reduction point. After the material flow of the system sample belt is reduced, each sample should be intercepted at the discarded part. The length of the intercept sample is three times more than that of the nominal maximum grain size or at least 30mm, and the larger one is selected. The sampling interval is 130 tons, and the sample number is 25. The method B checked according to ISO3082 should be compared with method A using the same kind of ore. The increments are numbered in sequence, such as 1 - A, ...

Method B: sampling with removable sampling equipment. The increments are also numbered in sequence, such as 1 - B, ...

From the same lot, two gross samples of A and B were made according to the increments obtained by method A and method B. Experiments were conducted according to the relevant standards, and a pair of measured values were obtained. According to the above steps, we carried out 10 or more than 10 lots of experiments. The above comparisons should be made with the same kind of ores, from a number of lots in pairs of sample values, but not by between increment and gross sample in several pairs, but should
be by between gross sample and gross sample or between increment and increment in a number of pairs of comparison.

This experiment takes the whole Fe as the characteristic index. XAi and XBi were used to represent the results of the determination according to the sampling method A and B, respectively, and k was used to represent the number of paired tests. The deviation test data are outlier test and Gruber test, and there is no outlier in data.

Calculate the \( d_i \) the difference between \( X_{Ai} \) and \( X_{Bi} \)

\[
d_i = X_{Bi} - X_{Ai}, \quad i = 1, 2, \ldots, k
\]

(1)

Calculate average difference

\[
\overline{d} = \frac{\sum d_i}{k}
\]

(2)

Calculate the square sum \( SS_d \) and the standard deviation \( S_d \) of the difference.

\[
SS_d = \frac{\sum d_i^2 - (\sum d_i)^2}{k}
\]

(3)

\[
S_d = \sqrt{\frac{SS_d}{k-1}}
\]

(4)

Determine the confidence interval, where LL means the lower limit of confidence interval, and UL means the upper limit of confidence interval.

\[
LL = \overline{d} - t \times S_d / \sqrt{k}
\]

(5)

\[
UL = \overline{d} + t \times S_d / \sqrt{k}
\]

(6)

**Table 1.** Statistical analysis of deviation experimental data

| k | XB   | XA   | \( d_i \) | \( d^2i \) |
|---|------|------|----------|----------|
| 1 | 62.30| 61.75| 0.550    | 0.3025   |
| 2 | 62.86| 62.80| 0.060    | 0.0036   |
| 3 | 62.05| 62.17| -0.120   | 0.0144   |
| 4 | 62.05| 61.80| 0.250    | 0.0625   |
| 5 | 62.05| 62.55| -0.500   | 0.25     |
| 6 | 62.17| 62.42| -0.250   | 0.0625   |
| 7 | 62.24| 62.18| 0.060    | 0.0036   |
| 8 | 62.55| 62.92| -0.370   | 0.1369   |
| 9 | 62.80| 62.55| 0.250    | 0.0625   |
|10 | 62.50| 62.55| -0.050   | 0.0025   |

\( \overline{d} \) -0.01

\( SSd \) 0.90

\( Sd \) 0.32

LL -0.20

UL 0.17

\( \delta \) 0.21
The t is the value of t distribution when the degree of freedom (k-1) is detected, and according to ISO3086, we get that $t=1.833$, $k=10$

Table 1 is based on the data of the whole Fe as the characteristic index. Fig. 1 is got according to Table 1. The lower and upper limits of the confidence interval are completely included in $\delta$. The results obtained by the two methods have no statistical significance. Method B can be used as a routine method.

![Fig.1 deviation experiment](image)

### 3.2. System water loss experiment

Based on ISO 3082, 15 increments of water were collected by moving sampling equipment (method B) and 15 increments by discarding sampling side (method A). The water values of the two groups compared was shown in Table 2.

#### Table 2. Mathematical statistics of system water loss experiment

| lot | Sample discard $X_i(\%)$ | Sample degrading $Y_i(\%)$ |
|-----|--------------------------|---------------------------|
| 1   | 7.52                     | 7.68                      |
| 2   | 7.51                     | 7.59                      |
| 3   | 7.82                     | 7.67                      |
| 4   | 7.91                     | 7.95                      |
| 5   | 7.87                     | 7.82                      |
| 6   | 7.66                     | 7.65                      |
| 7   | 7.92                     | 7.71                      |
| 8   | 7.50                     | 7.33                      |
| 9   | 7.89                     | 7.75                      |
| 10  | 7.80                     | 7.83                      |
| 11  | 7.55                     | 7.51                      |
| 12  | 7.70                     | 7.75                      |
| 13  | 7.65                     | 7.72                      |
| 14  | 7.90                     | 7.92                      |
| 15  | 7.91                     | 7.98                      |
| SUM | 116.110                 | 115.950                  |
| Average | 7.741                  | 7.730                    |
| Water loss | 0.01                  |

Water loss is $0.01\%$ and less than $0.5\%$ which meets the standard.

### 4. Conclusion

From above analysis, we can see that the experiments are in line with international standard requirements, so the method B can be used.

### References

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