Analysis of influencing factors of data error in chemical analysis of iron and steel materials

Yanhong Bai*, Yun Wu

Inner Mongolia Vocational College of Chemical Engineering, Hohhot, China 010070
*buh2021@dlyteedu.cn

Abstract: This paper analyzes the influencing factors of data error in chemical analysis of iron and steel materials, including sample preparation factor, sample decomposition factor, analytical instrument factor, reagent factor, analysis method factor. The purpose is to reduce the error of data measurement results and improve the accuracy of data analysis results by studying the measures of eliminating instrument application error, doing a good job in reagent selection, appropriately increasing the number of experiments, strictly following the operation specifications and reasonably using the allowable deviation table.

1. Introduction
In recent years, with the rapid development of China's social economy, the iron and steel industry, as an important industry, plays a role that can not be ignored and replaced. Iron and steel industry is the basic industry in the process of industrialization in China, and it is also a resource, energy, capital and technology intensive industry. In the construction and development of China, there is a great demand for steel, and steel output is also increasing. Chemical analysis of iron and steel materials is an important work in the field of production and manufacturing. Therefore, it is of great significance and value to ensure the accuracy of steel material chemical analysis and reduce and avoid data error.

2. Influencing factors of data error in chemical analysis of iron and steel materials

2.1 Sample preparation factors

2.1.1 Sampling location
Sampling location is also an important factor in the chemical analysis of steel materials as required. If the selected content is not representative, the obtained experimental results will not be able to feed back the chemical analysis results, which reduces the rationality of the chemical analysis results. For example, when steel materials are used as welding specimens, the selected chip should not be in contact with the transition layer and the substrate. If contact occurs during sampling, the accuracy of chemical analysis results will be adversely affected. In addition, the welding thickness should be controlled according to the requirements in the event surfacing process. If the thickness is not up to standard in the sampling process, then the chemical composition will be piled into the welding layer, the carbon content in the steel will also be constantly reduced, and its content will be lower than the standard level in the specification, thus affecting the accuracy of the chemical analysis results. In addition, in the selection of sampling locations, if the number of sampling locations is small and there is no generality, it will also affect the reliability of the final analysis results.
2.1.2 Sampling method
In the process of steel material sampling, different sampling methods should be adopted according to the characteristics of steel, so it can be seen that the sampling method also has a crucial influence on the analysis results. For example, the lowest diameter of H10Mn2 submerged arc welding wire is 0.02mm. In view of the characteristics of the sample, it is necessary to cooperate with the workshop in the sampling process, obtain the welding screws first, and then scientifically sample according to the provisions. If the wrong sampling method is used, the amount of manganese and silicon in the analysis can be different from the actual amount. In the analysis attempt, it was found that if surfacing welding first and then sampling, the manganese content in the analysis result would be lower than the real content, which could not reach the required standard of 1.50%~1.90%, and the related silicon content would also be much higher than the actual content, which was much higher than the standard of \( \leq 0.070\% \). The factors that cause the error in the analysis of this result are the inadequate control of the welding conditions and the uneven chemical composition in the flux. The results of analysis under these conditions are often wrong. According to the current standard, in general industrial analysis, the relationship between the content of components to be measured and the tolerance range is shown in Table 1.

| Mass fraction of components to be measured | 90 | 80 | 40 | 20 | 10 | 5 | 1.0 | 0.1 | 0.01 | 0.001 |
|------------------------------------------|----|----|----|----|----|---|-----|-----|------|------|
| The tolerance                            | 0.3| 0.4| 0.6| 1.0| 1.2| 1.6| 5.0  | 20   | 5.0   | 100   |

2.2 Sample decomposition factors

2.2.1 Factors of fusion process
When the sample is decomposed, its role is to do a good job of pretreatment in advance, to lay a foundation for the follow-up analysis of the tested components. In this process, the rationality of fusion process will also affect the accuracy of analysis results. Based on previous working experience, temperature parameters, melting time and melting acidity should be controlled as required in the melting process. If there is a problem in one of the parameters, the accuracy of analysis results will also be affected. For example, when the content of manganese and chromium in steel is determined, the content analysis result obtained will be on the high side because the carbides in the sample are not easily destroyed. Moreover, the turbidity liquid obtained after dissolution generally needs to prolong the melting sample time to improve the accuracy of the analysis results. If the fusion sample time is not well controlled, the analysis results will also be larger than the actual standard, resulting in data deviation.

2.2.2 Sample weighing factors
When the sample is weighed according to the requirements, it is also necessary to do a good job of sample selection according to the requirements, while reducing the influence of factors such as human operation error and environmental interference, so as to control the impurity content in the sample in a small range. Failure to do so will have a serious negative impact on the results of chemical analysis. For example, when photometric method (schematic diagram shown in FIG. 1) is used to detect manganese in alloy steel, if the sample size is small and the selected sample contains other impurities, the analysis results obtained at this time will also have obvious untruthfulness. In addition, in the test weighing also need to do a good job of careful selection, such as as far as possible to choose a thin chip as a sample. If the sample with large thickness is selected, although the complete data can be obtained by prolonging the dissolution time, the experimental value will also be less than the actual value due to the appearance of gases and sub-organisms during the dissolution, resulting in data analysis errors.
2.3 Analyser factors
When the sample is weighed as required, it is also necessary to do the selection of analytical instruments as required. Analysis instruments with high accuracy and sensitivity should be selected. At the same time, the debugging work of the instrument should be done well before application, and the application should be carried out after meeting the requirements, so as to reduce the negative impact brought by analysis instruments. The specific influence of this factor is also reflected in the following points: First, in the selection of analytical instruments, the analytical instruments with low sensitivity and poor accuracy are selected, and the experimental values obtained by this kind of analytical instruments themselves have large errors. After the completion of multiple experimental work, it is easy to appear error accumulation problem, which reduces the accuracy of chemical analysis results. Second, before the application of the analysis equipment, the state of the analyzer is not adjusted to the standard determination state as required, so there is a certain error between the initial state and the actual measured value, which will directly affect the accuracy of the chemical analysis results. Third, in steel chemical analysis, optical glass cuvettes will also be used, which are easy to be corroded by fluoride. If there is no proofreading before application, then with the extension of the test time, the corrosive effect of fluoride on the glass will increase, which also increases the quality of the solution and interferes with the accuracy of the chemical analysis results.

2.4 Reagent factor
In the process of chemical analysis of steel materials, some reagent will be used, so the quality of reagent used will also affect the accuracy of analysis results. The factors in the application of concrete embodiment in the following points: (1) Based on the analysis of the choice of reagent, the choice of the use of substandard reagent (such as below-standard metamorphism, parameters.), the experimental data obtained using this kind of analytical reagent itself there is a big error, easy to cause the result of the experiment is larger, which reduces the accuracy of chemical analysis results. (2) There are some differences in the shelf life of different types of reagents, and some reagents need to be prepared and used on the spot. Improper use of expired reagents, or failure to check the quality of reagents prior to the experiment, will also affect the accuracy of the experimental results. (3) The reactions of some reagents in different environments also have great differences. For example, at room temperature, some chromogenic agents can smoothly display normal colors. But in the case of high temperature in summer, there will be abnormal color. This will also bring some interference to the data collection of the experimenter, thus affecting the accuracy of the test results [1].
2.5 Analysis method factors

2.5.1 Operating Factors
When chemical analysis of steel materials is carried out as required, operational factors are also important interference items that affect the accuracy of test results. From the perspective of practical application, this factor can be subdivided into the following contents: First, the operating level of test personnel is not uniform, and the age structure of test personnel in many departments is unreasonable. The proportion of people over 35 years old is more than 40%, and the speed of updating of new equipment and new detection technology makes the personnel of these age groups unable to keep up with the operation requirements, which increases the fault tolerance rate of personal operation process, resulting in large error of experimental results. At the same time, affected by the uneven comprehensive level of personnel, it is easy to increase the fault tolerance rate of the operation process, affecting the accuracy of experimental results. Second, in the process of chemical analysis, if some attention is not found in time, it is easy to increase the error of experimental results. For example, the determination of chromium content in the steel materials, the use of silver halide sulfuric acid catalyzed - handled by ammonia oxidation method, some carbon steel material will exist in the chromium residue, at a time when processing solution drip into the chrome indicator, will not appear fuchsia, if direct judgment at this time there would be no chromium element in steel material, also will lead to the error increase. The correct way is to drop a drop of standard ferrous solution into it. If there is chromium, REDOX action will make the display agent develop color smoothly, and the specific content of residual chromium can be obtained after continuous dropping into the solution [2].

2.5.2 Environmental factors
In addition to the factors mentioned above, environmental factors will also affect the accuracy of experimental results in the chemical analysis of steel materials. This factor is embodied in the following aspects: First, temperature. In the process of chemical experiment, the temperature fluctuation of the surrounding environment should be controlled within $\pm 2^\circ C$, and the experimental environment should be carried out at normal temperature to ensure the uniformity of data collected at the same temperature. If the temperature fluctuation of data collection is large, it is easy to cause accidental error, so as to ensure the accuracy of experimental results. Second, due to the influence of steel characteristics, it is necessary to create a unified experimental environment when determining the content of carbon, sulfur and phosphorus in steel. If a problem occurs in an experimental link, it is easy to have the problem of false positive results, thus affecting the accuracy of experimental results. Third, humidity and magnetic force conditions. In order to improve the accuracy of test results, high-precision and high-sensitivity instruments will be used, which are sensitive to the external environment. If humidity and magnetic force conditions fluctuate greatly, the accuracy of environmental analysis results will also be affected [3].

3. measures to improve the accuracy of chemical analysis data of iron and steel materials

3.1 Eliminate instrument application error
By eliminating instrument application errors, it can lay a foundation for the smooth development of subsequent experimental activities and improve the accuracy of data analysis results. In specific practice, first, in the selection of analytical instruments, it is necessary to select analytical instruments with corresponding sensitivity and accuracy according to the actual situation, so as to reduce the error range of measured data and avoid error accumulation. Second, on the analysis of the equipment before application, testers need to debug according to the requirement, the analysis status of adjustment to the standard determination of state, the process will use to display data initial state checking compliance standards bodies, avoiding the instrument error of initial conditions, to ensure that subsequent chemical analysis activities smoothly. Thirdly, in steel chemical analysis, for vessels with coarse corrosion characteristics, in addition to calibration before the experiment, vessels should also be replaced in time
during the experiment to reduce the influence of vessel corrosion and improve the accuracy of chemical analysis results [4].

3.2 Make good selection of reagents
Reagent selection can give full play to reagent application value and improve the practicability of data analysis results. In practice, the following points should be paid attention to: (1) in the selection of analytical reagents, qualified reagents should be selected according to the requirements of the corresponding specifications. Using such analytical reagents can ensure the accuracy of the obtained experimental values and reduce the probability of the occurrence of the problem of experimental product yield. (2) Make clear the shelf life of different types of reagents to be used, do the corresponding marking work well, and check the quality of reagents before the experiment to avoid the mixing of deteriorated reagents and affect the accuracy of experimental results. (3) Sorting out the reagent use environment and controlling environmental factors to ensure the uniformity of chemical reaction process, thus improving the reliability of collected data analysis results [5].

3.3 Increase the number of experiments appropriately
By increasing the number of experiments, the error tolerance rate of experimental results can be effectively reduced and the accuracy of experimental results can be improved. In practice, it can be divided into the following links: First, in the material sampling link, the number of samples should be appropriately increased according to the requirements of experimental accuracy and material characteristics, for example, from 8-10 groups in the initial state to 10-15 groups, so as to optimize the experimental process. Second, in the process of sample processing, the measurement times of each sample should be more than two times. If the accuracy of test results is required to be high, the measurement times will be increased to 3-8 times, which can be adjusted according to the actual situation, so as to offset the influence caused by accidental errors and improve the accuracy of chemical analysis results [6].

3.4 Strictly follow the operation specifications
Strict compliance with the operation specifications can effectively constrain the individual operation behaviors of the experimental personnel to ensure the orderly advancement of chemical analysis activities [7]. From the point of view of practical application, information technology and big data technology can be used to help sort out the existing operation specifications, and make content adjustments based on the actual situation of the laboratory, so that it can meet the requirements of laboratory management. In addition, the comprehensive assessment system should be used to divide the levels of operators into three levels: simple, medium and professional. The cross-level operation should be prohibited according to the operation steps of different difficulties in chemical analysis, so as to ensure the smooth progress of experimental process and improve the accuracy of experimental results.

3.5 Reasonable use of allowable deviation table
Reasonable use of allowable deviation table can improve the standardization and rationality of analysis results to meet the requirements of chemical analysis standards. In specific practice, firstly, for the same type of iron and steel materials, the same allowable deviation table can be used to determine the allowable value to ensure the uniformity of evaluation results. Secondly, in the use of the operating deviation table, the correlation between the chemical analysis value and the upper limit of the allowable deviation range should also be taken into account, and the upper limit of the allowable deviation value should be reasonably determined according to the actual situation, so as to reduce the error accumulation problem and improve the accuracy and value of the chemical analysis results [8].

4. Conclusion
To sum up, eliminating instrument application errors can lay a foundation for the smooth development of subsequent experimental activities. Good selection of reagents can give full play to the application
value of reagents. Appropriately increasing the number of experiments can effectively reduce the error tolerance rate of experimental results. Strictly following the operation specification, can effectively restrain the experimental personnel’s personal operation behavior. Reasonable use of allowable deviation table can improve the standardization and rationality of analysis results. Based on the error factors of chemical analysis data of iron and steel materials, it is of positive significance to formulate appropriate treatment measures for speeding up chemical analysis speed and improving the accuracy of analysis results.

Reference
[1] Shuang Ruiqian. Influence factors of data error in chemical analysis of iron and steel materials [J]. Chemical Design Communication, 2014, 47(06): 135-136.
[2] Jia Baoli. Study on influencing factors of data error in chemical analysis of iron and steel materials [J]. Contemporary Chemical Industry Research, 2020(21): 15-16.
[3] Zhang Jinchang, Kou Dexiang, Kang Qiang, Li Wancun, Su Siyan. Chemical engineering design communication, 2020, 46(08): 128+143.
[4] Xu Shulan. Discussion on “Causes of analysis error in chemical analysis of iron and steel materials” [J]. China Metal Bulletin, 2020(08): 14-15.
[5] Yin Fang. Factors of data error in chemical analysis of iron and steel materials [J]. Shanxi metallurgy, 2019, 42(05): 142-143.
[6] Tang Yong. Discussion on factors of data error in chemical analysis of iron and steel materials [J]. Contemporary Chemical Research, 2018(05): 16-17.
[7] Qu Tao. Factors of data error in chemical analysis of iron and steel materials [J]. China petroleum and chemical standards and quality, 2017, 37(22): 132-133.
[8] Chen Yinseng. Factors of data error in chemical analysis of iron and steel materials [J]. Science and technology outlook, 2016, 26(04): 68.