

JIS

JAPANESE INDUSTRIAL STANDARD

**Method for Sampling of
Bauxite Ores**

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C O N T E N T S

	Page
1. <u>Scope</u>	1
2. <u>General</u>	1
2.1 Definitions	1
2.2 Notation	4
2.3 Summary of Sampling and Sample Preparation.....	5
2.4 Handling of Sample	5
2.5 Determination of Average Qualities	7
2.6 Rules for Rounding off of Numerical Values	7
2.7 Other Requirements	7
3. <u>Methods of Sampling</u>	7
3.1 Size of Consignment	7
3.2 Quality Characteristics to Specify Precision	7
3.3 Classification of Quality Variation	8
3.4 Time and Place to Carry out Sampling	9
3.5 Types of Sampling	9
3.6 Increment	10
3.7 Methods of Combining Increments	12
3.8 Split-use and Multiple-use of a Sample	14
3.9 Belt Sampling	14
3.10 Hatch Sampling	16
3.11 Waggon Sampling	16
3.12 Sampling for Size Sample	17
3.13 Sampling for Moisture Sample	17
4. <u>Methods of Preparation of Samples</u>	18
4.1 Summary of Method of Sample Preparation	18
4.2 Levels for Precision of Sample Division	18
4.3 Pre-drying of Sample	19
4.4 Methods of Comminution of Sample	19
4.5 Methods of Division of Sample	20
4.6 Preparation of Final Sample for Chemical Analysis	24
4.7 Preparation of Final Moisture Sample	25
4.8 Preparation of Final Size Sample.....	26

	Page
5. <u>Method of Moisture Determination</u>	26
5.1 Summary	26
5.2 Sample	26
5.3 Apparatus	26
5.4 Procedure	27
5.5 Calculation	27
5.6 Permissible Tolerance	27
5.7 Determined Value	28
6. <u>Method of Dry Mass Determination</u>	28
7. <u>Method of Size Determination</u>	28
7.1 Summary	28
7.2 Sample	28
7.3 Test Sieves	29
7.4 Procedure	29
7.5 Calculation	30
7.6 Determined Value	30
8. <u>Method of Ultra-fine Size Determination</u>	30
8.1 Summary	30
8.2 Sample	30
8.3 Test Sieve	30
8.4 Apparatus	31
8.5 Sieving Procedure with Water	31
8.6 Calculation	32
8.7 Determined Value	32
Appendix Figures	33

JAPANESE INDUSTRIAL STANDARD

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Method for Sampling of Bauxite Ores

M 8110-1975

1. Scope

This Japanese Industrial Standard specifies the methods given below with respect to a consignment of bauxite ore, hereinafter referred to as "ore", for the purposes of the determination of average values of quality characteristics, hereinafter referred to as "average qualities", such as chemical composition, moisture content, size fraction contents and others, of the consignment.

- (1) Methods of taking sample;
- (2) Methods of preparation of final samples;
- (3) Methods of determination of moisture content, dry mass of the consignment and size fraction contents.

Remarks 1. This standard has been prepared, as a rule, on the basis of JIS M 8100.

2. This standard is applicable to calcinated bauxite ore.

2. General

2.1 Definitions The technical terms used in this standard are defined as given below.

- (1) Consignment A quantity of an ore as decided between the parties concerned for the purposes of the determination of average qualities. The quantity of an ore constituting a consignment is called size of the consignment.
- (2) Sub-Consignment A quantity of an ore of part of the consignment as divided into appropriate quantities, where such is required. The quantity of an ore constituting a sub-consignment is called size of the sub-consignment.
- (3) Increment The ore taken for a sample with the sampling device, as a rule, by a single motion from the consignment or sub-consignment. The quantity of an increment is called size of the increment.
- (4) Sub-sample A composite of several increments; also a composite of several increments which have been prepared individually, where such is required.
- (5) Gross Sample A composite of all of the increments or all of the sub-samples taken from a consignment; also a composite of all of the increments or all of the sub-samples which have been prepared individually, where such is required.

Applicable Standards:

JIS M 8100-General Rules for Methods of Sampling Bulk Materials;

JIS M 8361-Methods for Chemical Analysis of Bauxite Ores;

JIS Z 8401-Rules for Rounding off of Numerical Values;

JIS Z 8801-Sieves for Testing Purposes.

- (6) Sample for Chemical Analysis General term to indicate any sample taken from a consignment or subconsignment for the determination of average qualities of the chemical composition.
- (7) Final Sample for Chemical Analysis The sample for chemical analysis which has been prepared by comminuting and dividing according to the prescribed methods, placed in a container, hermetically sealed, packed and identified by necessary items.

A quantity taken from the final sample for chemical analysis and ready to start the chemical analysis is called test portion.

Remarks 1. For example, a 100 g which has been prepared by repeated comminution and division of the gross sample is the final sample for chemical analysis, and a one-gram weighed out from the 100 g for the determination of an chemical element is the test portion.

2. This standard specifies, with respect to the sample for chemical analysis, the requirements from the procedure of preparation of the final sample for chemical analysis through the procedure of sample handling.

- (8) Moisture Sample General term to indicate any sample taken from a consignment or sub-consignment for the determination of average quality with respect to moisture content.

A quantity taken from the moisture sample which has been prepared by crushing and dividing according to the prescribed methods, and ready to start the testing of moisture determination is called the final moisture sample.

- (9) Size Sample General term to indicate any sample taken from a consignment or sub-consignment for the determination of average qualities with respect to size fraction contents.

A quantity of the size sample subject to size testing is called final size sample.

- (10) Random Sampling The method of sampling to carry out so that the all sampling units constituting a consignment or part of the consignment have an equal probability to be taken as the increments of a sample.

- (11) Stratified Sampling The method of sampling to carry out the random sampling to each of the strata, after dividing a consignment into several strata. Normally, the sampling is carried out relative to the sizes of the strata. This method is called proportionate stratified sampling.

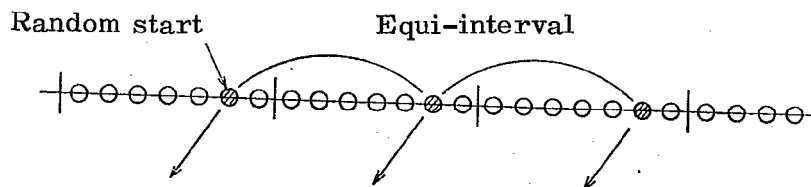
Remark: If the stratification is so designed that the variations within strata are small and the differences of levels between strata are large, the feature of this sampling method is effective to decrease the number of increments of a sample.

- (12) Two-stage Sampling The method of sampling to carry out, in the first stage to divide a consignment into several parts (called primary sampling units) and a number of primary sampling units is selected by the method of random sampling, and in the second stage a number of increments (called secondary sampling units) is taken at random from each of the selected primary sampling units.

The method of sampling to carry out by dividing a consignment into more than two stages is called multi-stage sampling.

- (13) Periodic Systematic Sampling The method of taking the increments from a consignment at an equi-interval, in terms of mass, between taking increments. In this instance, the first increment is taken within the first interval from a point selected at random. Of the periodic systematic sampling, aforementioned method of taking the first increment is called random start (see Fig. 1).

Fig. 1. Periodic Systematic Sampling



- (14) Belt Sampling When ore of a consignment is conveyed by means of a belt conveyor system, that method of taking the increments from the ore on the belt conveyor or at its falling ore stream.
- (15) Hatch Sampling When ore of a consignment is delivered by means of an ocean vessel, that method of taking the increments from the ore in vessel holds during periods of the ore handling.
- (16) Wagon Sampling When ore of a consignment is delivered by means of a train of wagons or a number of trucks, that method of taking the increments from the ore on the wagons or trucks.
- (17) Division Procedure to reduce the quantity of a sample.
- (18) Error Difference between the determined value and the true value. For example, error due to sampling, error due to sample preparation and error due to measurement are called sampling error, division error, and measurement error, respectively. Normally, the error is divided into precision and bias.
- (19) Precision Spread of error distribution (variation).
- (20) Bias Difference between the arithmetic mean of error distribution and the true value.
- (21) Maximum Particle Size The particle size of a sample of ore expressed by relative aperture size of a sieve on which approximately 5% in mass of the sample is retained. The test sieves to be used in this standard are, as a rule, those given in JIS Z 8801.

- (22) Split-use and Multiple-use of a Sample The split-use of a sample designates that the sample is divided into several parts and used each of the parts of the sample for determining two or more quality characteristics. The multiple-use of a sample designates that the sample in its entirety or part is used for determining another quality characteristics.

Examples 1. If the moisture sample is taken from an increment or sub-sample by the increment division method or other division method, and the sample for chemical analysis is taken from the balance, this is the split-use of a sample.

2. If the sample for chemical analysis is prepared from the increments which have been subjected to size testing, this is the multiple-use of a sample.

- (23) Ultra-fine Size Particle size of an ore under $250\mu\text{m}$ is specifically called ultra-fine size (commonly called mud).

2.2 Notation The notation used in this standard are as given below.

- μ Arithmetic mean of population of a quality characteristic of the consignment
- $\bar{x}$ Arithmetic mean of measurements of a quality characteristic
- $\overline{\overline{x}}$ Arithmetic mean of a set of arithmetic means of measurements
- R Range (difference between the largest value and the smallest value of a set of measurements)
- $\bar{R}$ Arithmetic mean of a set of ranges
- N Size of the consignment
- M Number of primary sampling units constituting a consignment
- m In the two-stage sampling, number of primary sampling units be taken at the first stage
- n Number of increments to be taken from a consignment
- $\bar{n}$ In the two-stage sampling, average number of increments to be taken from each of the primary sampling units in the second stage, i.e., $\bar{n} = n/m$
- d_2 Multiplier to obtain standard deviation from the arithmetic mean of ranges, $\bar{R}$
- D_1 Multiplier of mean range, $\bar{R}$, to obtain the three-sigma upper control limit (for the two-sigma, it is denoted by $D_1(2)$)
- σ Precision expressed by standard deviation
- σ_b Variation between primary sampling units, between sub-consignments, or between strata, expressed by standard deviation
- σ_w Variation between increments relative to within primary sampling units, within sub-consignments, or within strata, expressed by standard deviation

σ_i Variation between increments within consignment, expressed by standard deviation

σ_s Precision of sampling expressed by standard deviation

σ_R Precision of sample division expressed by standard deviation

σ_M Generally, precision of chemical analysis or testing expressed by standard deviation

CV Coefficient of variation in percentage calculated by the following formula

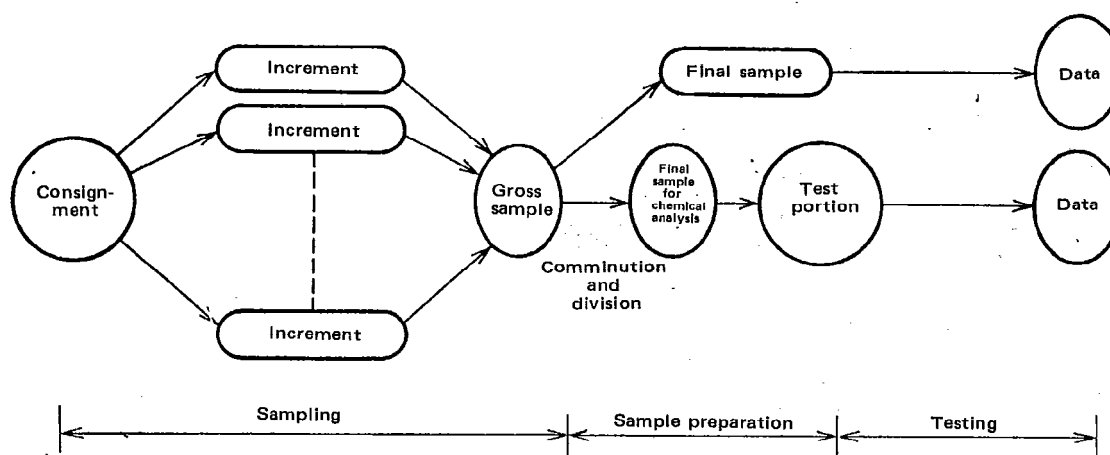
$$\frac{\text{Standard deviation}}{|\text{Arithmetic mean}|} \times 100 (\%)$$

β Precision at about 95% probability level ($\beta = 2\sigma$)

2.3 Summary of Sampling and Sample Preparation The methods of sampling and sample preparation in general shall be as given below (see Fig. 2).

- (1) Identify the consignment to be sampled;
- (2) Take increments of required size and number from the consignment;
- (3) Constitute sub-samples or a gross sample by combining the increments;
- (4) Prepare the final samples from each of the sub-sample or the gross sample, where such are required, after comminuting and dividing the sample.

Fig. 2. Summary of Sampling and Sample Preparation (Example)



2.4 Handling of Sample Throughout all the procedures of sampling, sample preparation and measurement, care shall be taken so as not to introduce foreign materials into the sample, not to loss the sample and not to alter the quality of sample, by thorough cleaning of the apparatus to be used and by adhering to other precautions.

2.4.1 Sample Containers The containers for sample shall be as given below.

- (1) The containers to be used for the purposes of transportation or storage of various types of sample, such as increment, sub-sample and gross sample, or the final samples prepared from these samples after comminution and division, shall be capable of holding the entire quantity of sample, be clean and robust, and be provided with a lid placed tightly and be capable of sealing.
- (2) The container for moisture sample shall be air-tight, be made of non-hygroscopic material, and the inside be free from rust.

Remark: Straw bag and gunny bag are not suitable for the container for moisture sample.

2.4.2 Packing and Marking of Sample The final samples for chemical analysis shall be the final sealed hermetically in containers, transported, and distributed or reserved. The following items, as a rule, shall be shown on the containers:

- (1) Type of ore and name of the consignment (e.g., name of ocean vessel);
- (2) Size of the consignment;
- (3) Place of sampling;
- (4) Dates of sampling and sample preparation (time, weather, etc.);
- (5) Any other items, if necessary.

2.4.3 Retention of Reserve Sample The requirements for the reserve sample shall be as follows:

- (1) The final sample for chemical analysis after having been prepared and sealed shall be retained, as a rule, three months for domestic transactions and six months for international transactions;
- (2) During periods of retention of the reserve sample, care shall be taken in selecting the place where temperature, direct sunlight and moisture do not alter the quality of sample.

2.4.4 Transportation of Sample The sample other than the final sample for chemical analysis, as a rule, should not be transported outside the premises of sample preparation. However, under a compelling situation, if this sample is required to transport to other place, the method shall be as agreed upon between the parties concerned.

2.5 Determination of Average Qualities The determined values of average qualities of a consignment shall be the mean values of each of the required number of measurements which satisfy the permissible tolerance of measurements set forth for each of the quality characteristics. Where such is required, the average qualities of a consignment shall be the weighted mean values with respect to masses of sub-consignments. The determined values of each of the chemical characteristics shall be as specified in JIS M 8361. The determined value of moisture content shall be as specified in 5, Method of Moisture Determination, and be expressed to the first decimal place by rounding off the second decimal place. The determined values of size fraction contents and ultra-fine size content shall be as specified in 7, Method of Size Determination, or 8, Method of Ultra-fine Size Determination, respectively. Each of the determined size fraction contents shall be expressed by whole numbers by rounding off the first decimal place; and the determined value of ultra-fine size content to the first decimal place by rounding off the second decimal place.

2.6 Rules for Rounding off of Numerical Values The requirements as given in JIS Z 8401 shall be applied.

2.7 Other Requirements

2.7.1 The check experiments for the methods of sampling shall be carried out as given in Appendixes I through IV of JIS M 8100.

2.7.2 If particular part of this standard is deemed difficult to be applied, an alternative method may be applied provided that this alternative method has been confirmed to be free of bias and satisfies the specified precision, by conducting check experiments.

3. Methods of Sampling

3.1 Size of Consignment The consignment shall be the quantity of a type of ore designated by the contract and to be delivered at one time.

3.2 Quality Characteristics to Specify Precision

3.2.1 Quality Characteristics The quality characteristics to specify precision shall be alumina content (% Al_2O_3), moisture content (%) and ultra-fine size content (%).

3.2.2 Levels of Precision For each of the quality characteristics selected for precision requirements in this standard, the levels of precision shall be expressed in terms of percentage coefficient of variation ($CV = \sigma/\mu \times 100\%$) and as given in Table 1. Where, σ is the overall precision for sampling (σ_s), sample division (σ_R) and measurement (σ_M), i.e., $\sigma = \sqrt{\sigma_s^2 + \sigma_R^2 + \sigma_M^2}$.

Table 1. Levels of Precision

Quality characteristic	Level of precision (% CV)
Alumina content (dry basis)	0.5
Moisture content	2.5
Ultra-fine size content (dry basis)	5

- Remarks
1. The levels given above are for the sizes of consignment under 5,000 tons, and better precision has been applied for the sizes of consignment 5,000 tons and over so that a greater number of increments is taken.
 2. With respect to ore having relatively coarser particle sizes and containing under 5% moisture content, the level of precision for moisture content has been selected to be 10 % CV.
 3. The level of precision for size fraction content with respect to over 250 μm in size shall be selected by agreement between the parties concerned.

3.2.3 Precision The overall precision with respect to the average quality of a consignment is defined by twice the standard deviation (2σ probability level). This precision is denoted by β , then the probability that the average quality is included in the limits, (determined value of consignment) $\pm \beta$, is about 95%. The values of 2σ precision are given in Table 2.

Table 2. Precision (% β absolute)

Quality characteristic	Size of consignment, (tons)	
	20,000 t and over	Under 5,000 t
Alumina content (dry basis)	0.50	0.55
Moisture content	0.3	0.4
Ultra-fine size content (dry basis)	0.9	1.0

Remark: The values of β for sizes of consignment between 5,000 tons and up to 20,000 tons are in-between the values given in two columns of Table 2.

3.3 Classification of Quality Variation

3.3.1 Types of Quality Variation The types of quality variation shall be either one of the followings in terms of standard deviation:

- (1) In the cases of proportionate stratified sampling and periodic systematic sampling, expressed by standard deviation within strata (σ_w);
- (2) In the case of two-stage sampling, expressed in double ways by standard deviation between increments relative to within primary sampling units (σ_w) and standard deviation between primary sampling units (σ_b).