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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry, through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law.

Consequently **JIS K 4810:2003** is replaced with this Standard.

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Testing methods of explosives

1 Scope

This Standard specifies the testing methods of explosives.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 1506 *Rolling bearings—Rollers*

JIS B 7414 *Glass thermometers*

JIS B 7507 *Vernier, dial and digital callipers*

JIS G 3452 *Carbon steel pipes for ordinary piping*

JIS K 0804 *Gas detector tube measurement system (Length-of-stain type)*

JIS K 4800 *Technical terms for explosives*

JIS K 4806 *Blasting caps and electric blasting caps*

JIS K 4813 *Trinitrotoluene*

JIS K 4822 *Reagents for stability tests of explosives*

JIS K 8073 *Benzoic acid (Reagent)*

JIS R 1302 *Porcelain basins for chemical analysis*

JIS R 3505 *Volumetric glassware*

JIS T 3201 *Glass syringes*

JIS T 3210 *Sterile injection syringes*

JIS Z 2246 *Shore hardness test—Test method*

JIS Z 8401 *Guide to the rounding of numbers*

JIS Z 8801-1 *Test sieves—Part 1: Test sieves of metal wire cloth*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS K 4800**, and the following apply.

3.1

Abel test time

retention time of a sample heated at a constant temperature in the heat resistance test (Abel test) which is one of the stability tests

4 Types and items of tests

Types and items of tests shall be as given in Table 1.

Table 1 Types and items

Type	Test item
Stability	Abel test, free acid test, thermal stability test
Sensitivity	Drop hammer test, gap test on sand, friction sensitivity test, detonation sensitivity test C, electric current sensitivity test
Calorific value	Calorific value measurement test
Gas volume	Combustion generated gas measurement test
Detonation velocity	Ion gap method, optical fiber method, Dautriche method
Power of explosion	Ballistic mortar test, ballistic pendulum test
Bulk density	Bulk density method A, bulk density method B, bulk density method C

5 Test methods

5.1 Stability

5.1.1 Abel test

5.1.1.1 Abel test with potassium iodide-starch paper

Abel test performed by using potassium iodide-starch paper shall be as follows.

- a) **Summary** A sample put in a test tube is heated at a constant temperature to produce a colour reaction of oxidizing gases (mainly nitrogen monoxide), which is generated by the sample decomposition, with potassium iodide-starch paper. The time required until the colour changes to a given standard colour is measured and the stability is examined according to the length of the measured time.
- b) **Apparatus and instrument** The apparatus and instrument shall be as follows.
 - 1) **Abel test apparatus**, having a structure capable of securely fixing the Abel test tube at the specified position in a thermostat and of maintaining a constant temperature of $65\text{ }^{\circ}\text{C} \pm 0.5\text{ }^{\circ}\text{C}$ in the thermostat. An example is shown in Figure 1.

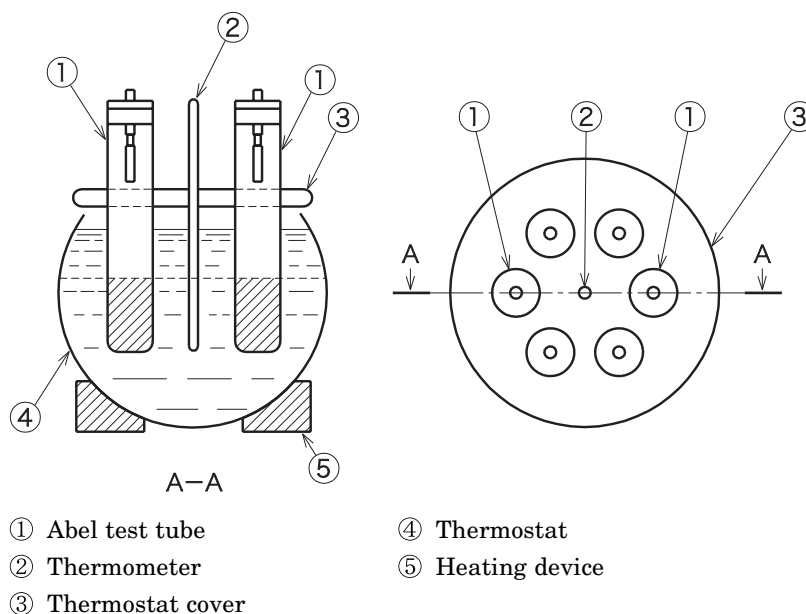


Figure 1 Abel test apparatus (example)

- 2) **Abel test tube**, of about 20 mm in outside diameter, about 165 mm in length and 38 ml to 40 ml in volume, which has etched lines at specified four positions on the surface and has a structure capable of sealing hermetically the top part of the tube with a rubber stopper. An example is shown in Figure 2.

Unit: mm

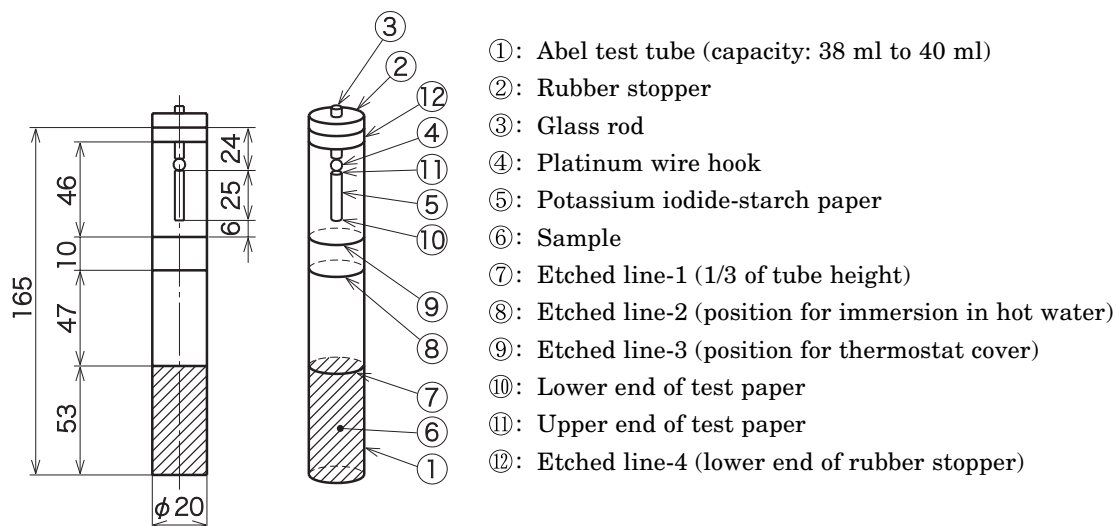


Figure 2 Abel test tube (example)

- 3) **Thermometer**, capable of measuring a specified temperature of $65\text{ }^{\circ}\text{C} \pm 0.5\text{ }^{\circ}\text{C}$.
- c) **Materials** Materials shall be as follows.
- 1) **Potassium iodide-starch paper**, as specified in **JIS K 4822** with dimensions of 25 mm long and 10 mm wide. Potassium iodide-starch paper shall have a manufacture date within two years when used for Abel test.

- 2) **Standard colour paper and purified talc powder**, as specified in **JIS K 4822** to be supplied for Abel test. The standard colour paper shall have dimensions of 25 mm long and 10 mm wide.

d) **Preparation of sample** The sample shall be prepared as follows.

- 1) **Gelatine dynamite** Weigh out 3.5 g of gelatine dynamite cut into the size of a grain of rice to a mortar and add 7 g of purified talc powder. Grind gently into powder with a pestle.
- 2) **Dynamite other than that in 1)** Use 3.5 g of dry dynamite as it is. In the case of dynamite having absorbed moisture, dry at 45 °C for about 5 h and take 3.5 g to use.
- 3) **High explosives containing nitric ester other than those in 1) and 2)** Use 3.5 g of dry dynamite as it is. In the case of high explosives having absorbed moisture, dry thoroughly at ordinary temperature using e.g. a vacuum dryer or dry at 45 °C for about 5 h, and take 3.5 g to use.
- 4) **Nitrocellulose** Use dry nitrocellulose as it is in the amount equivalent to one third of the test tube height. In the case of nitrocellulose having absorbed moisture, dry thoroughly at ordinary temperature using e.g. a vacuum dryer or dry at 40 °C to 45 °C for 4 h to 5 h, and take the amount described above to use.
- 5) **Low explosives containing nitric ester** Use granular low explosives as it is in the amount equivalent to one third of the test tube height. For other low explosives than granular low explosives, break into strip-shaped pieces and take the amount described above to use.

e) **Procedures** Procedures shall be as follows.

- 1) In order to facilitate the judgement of colouring of potassium iodide-starch paper, bright lighting should reach every corner of the room where the test is performed or the test tube (at the position of potassium iodide-starch paper) should be lighted up by using a neutral white fluorescent lamp.
- 2) The colour of colour paper or plate installed at the backside of the test tube should be white.
- 3) The room temperature should be 23 °C ± 3 °C for preparation of sample and testing.
- 4) Put the specified amount of sample into the test tube.
- 5) Suspend the potassium iodide-starch paper using the platinum wire hook attached to the rubber stopper of test tube. Moisten the top part of the paper with 50 % volume fraction glycerine aqueous solution using a micropipet or glass rod to create wet-and-dry boundary.
- 6) Cover loosely the mouth of test tube containing sample with the rubber stopper from which potassium iodide-starch paper is suspended (see Figure 2).
- 7) Immerse the test tube into the hot water in the thermostat maintained at 65 °C ± 0.5 °C to the level of an etched line (etched line ⑧). Leave to stand for about 10 s and then seal hermetically the mouth of test tube with the rubber stopper (see Figure 1).

- f) **Evaluation** Time from insertion of the test tube into a thermostat to the instant when wet-and-dry boundary of potassium iodide-starch paper changes to the same colour concentration as that on the standard colour paper is taken as Abel test time (colouring).

5.1.1.2 Abel test with gas detector tube measurement system

- a) **Summary** A sample put in a test tube is heated at a constant temperature and the oxidizing gases (mainly nitrogen monoxide) generated by the sample decomposition are agitated and then collected. The concentration of the gases collected is quantitatively measured by using the detector tube measurement system for nitrogen oxides and the stability is examined according to the degree of the concentration.
- b) **Apparatus and instrument** The apparatus and instrument shall be as follows.
 - 1) **Abel test apparatus**, as specified in 5.1.1.1 b) 1).
 - 2) **Abel test tube**, of about 20 mm in outside diameter, about 165 mm in length and 38 ml to 40 ml in volume, which has etched lines at specified four positions on the surface and comes with gas introduction tubes. An example is shown in Figure 3.

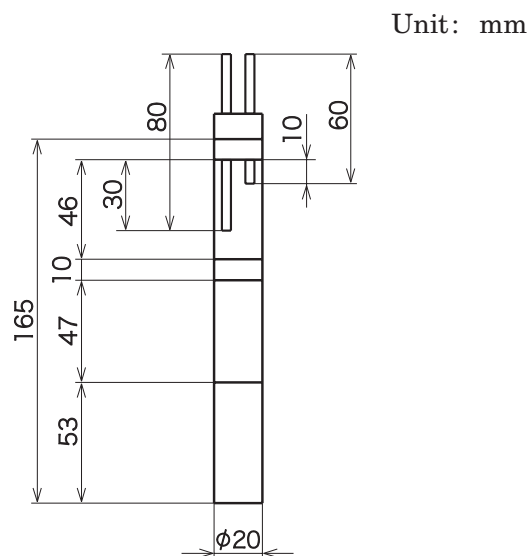
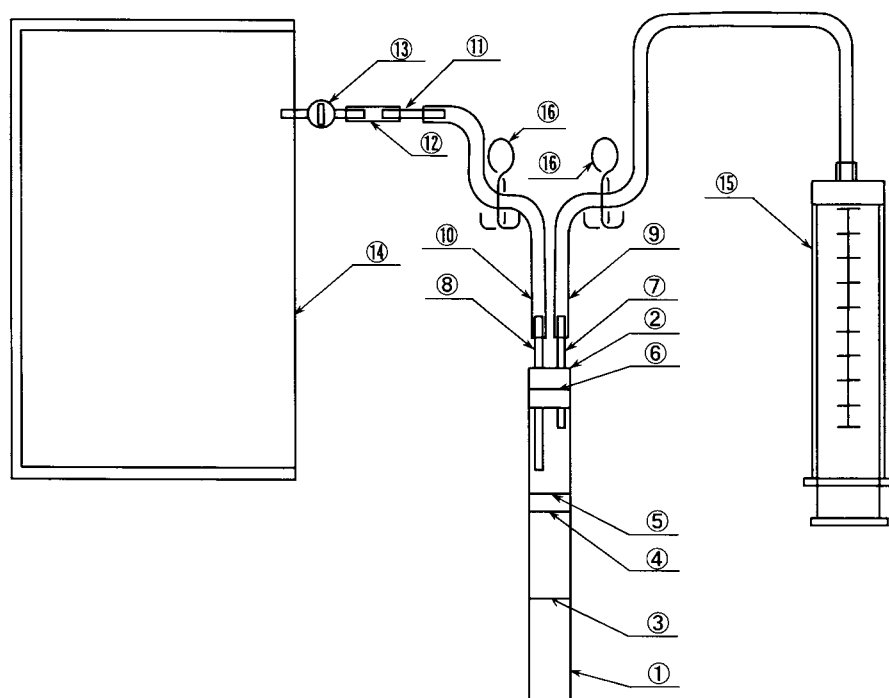


Figure 3 Dimensions of Abel test tube with gas introduction tube (example)

- 3) **Thermometer**, as specified in **5.1.1.1 b) 3)**.
- 4) **Syringe**, as specified in **JIS T 3201** or **JIS T 3210**, which has a capacity of 100 ml.
- 5) **Sampling bag**, for collecting exhaust gases from automobiles (made of e.g. polyvinyl alcohol or polyvinylidene fluoride), which has a capacity of 1 000 ml and comes with one-way stopcock as shown in Figure 4.

- 6) **Tubes**, of 6 mm in outside diameter and 4 mm in inside diameter, which are suitable for agitation of gas with excellent flexibility, such as a silicone tube, as shown in Figure 4. The tubes used for gas introduction shall have an adequate strength with dimensions of 5 mm in outside diameter and 3 mm in inside diameter and shall be made of polytetrafluoroethylene (hereafter referred to as PTFE tube) which are less prone to deterioration.
- 7) **Gas detector tube measurement system**, conforming to **JIS K 0804** or an equivalent system, which is capable of measuring the concentration of nitrogen monoxide (nitrogen oxide) using gas in amount of 100 ml or under.

Unit: mm



- | | |
|--|-----------------------------------|
| ①: Abel test tube (capacity: 38 ml to 40 ml) | ⑨: Silicone tube (length 370) |
| ②: Rubber stopper | ⑩: Silicone tube (length 130) |
| ③: Etched line-1 (1/3 of tube height) | ⑪: PTFE tube (length 35) |
| ④: Etched line-2 (position for immersion in hot water) | ⑫: Silicone tube (length 30) |
| ⑤: Etched line-3 (position for thermostat cover) | ⑬: Sampling bag stopcock |
| ⑥: Etched line-4 (lower end of rubber stopper) | ⑭: Sampling bag (1 000 ml) |
| ⑦: PTFE tube (length 60) | ⑮: Syringe (100 ml) |
| ⑧: PTFE tube (length 80) | ⑯: Pinch cock (50 from PTFE tube) |

Figure 4 Connection of syringe, sampling bag and tubes (example)

- c) **Preparation of sample** The sample shall be prepared as specified in 5.1.1.1 d).
- d) **Procedures** Procedures shall be as follows.
 - 1) Suck unnecessary gas out of the sampling bag used in the test with e.g. a vacuum pump beforehand, and examine the bag for any pinholes or other defects.
 - 2) The room temperature should be $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ for preparation of sample and testing.

- 3) Put the specified amount of sample into the test tube. Use the rubber stopper to which the gas introduction tube is attached as shown in Figure 3 and close ⑯ pinch cocks as shown in Figure 4.
 - 4) Immerse the test tube into the hot water in the thermostat maintained at $65\text{ }^{\circ}\text{C} \pm 0.5\text{ }^{\circ}\text{C}$ to the level of an etched line (④ etched line-2).
 - 5) Hold ① Abel test tube in the thermostat for the specified Abel test time. For example, when the Abel test tube is held in the thermostat for 8 min, state “Abel test time 8 min”. After holding the tube, take ① Abel test tube out of the thermostat and place in a test tube holder in the room temperature. Connect ⑮ syringe and ⑭ sampling bag to ① Abel test tube using ⑨ ⑩ tubes as shown in Figure 4. Hold for 1 min including time required for connection.
 - 6) As shown in Figure 4, take off pinch cocks, and as soon as ⑬ sampling bag stop-cock is opened, push and pull the plunger of ⑮ syringe a total of 10 times, 5 in and 5 out, to agitate gas generated from the low explosive. Agitate the gas thoroughly while paying attention to the low explosive whirled around inside the test tube and stop the agitation in 1 min to 1 min and 30 s (within 2 min and 30 s after the tube is taken out of the thermostat). After agitation, with the plunger all the way in the syringe, close the top part of Abel test tube with ⑯ pinch cocks, and remove ⑭ sampling bag and ⑮ syringe.
 - 7) Connect ⑭ sampling bag to the gas detector tube measurement system. In 3 min after the test tube is taken out of the thermostat, suck the gas into the detecting tube of the gas detector tube measurement system for the predetermined time. Read the concentration value after completion of the suction.
- e) **Evaluation** Since the concentration measured with the gas detector tube measurement system is diluted due to agitation, multiply the concentration read in d) 7) by dilution rate a which has been obtained beforehand and take the calculation result as the apparent nitrogen monoxide concentration (ppm) in the Abel test tube. The dilution rate a shall be calculated according to the following formula.

$$a = \frac{V_{\text{all}}}{V_{\text{gas}}}$$

where, a : dilution rate

V_{all} : all space volume (ml)

V_{gas} : gas volume (ml)

The apparent nitrogen monoxide concentration (ppm) in the Abel test tube when the Abel test tube is held in the thermostat for 8 min shall be stated as “nitrogen monoxide concentration (Abel test time 8 min)”.

5.1.2 Free acid test

The free acid test shall be performed as follows.

- a) **Summary** When a sample is put in the free acid test apparatus, the time required for the blue litmus test paper encapsulated in the free acid test apparatus to change its colour into red over the entire surface, which is caused by acid gas generated by decomposition of the sample, is measured, and the stability is examined by the length of this time.

- b) **Apparatus and instrument** The apparatus used shall be a free acid test apparatus which is a cylindrical glass container with dimensions of about 40 mm in outside diameter and about 165 mm in length, which has etched lines at specified two positions on the surface and which has a structure capable of sealing hermetically the top part with a rubber stopper. An example is shown in Figure 5.

Unit: mm

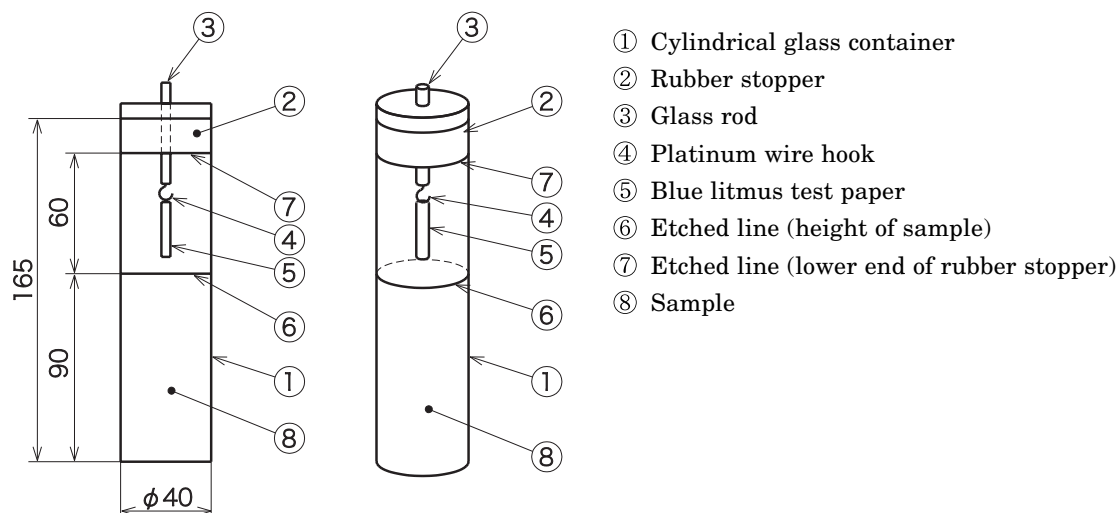


Figure 5 Free acid test apparatus (example)

- c) **Material** The material used shall be blue litmus test paper specified in **JIS K 4822** with dimensions of 40 mm long and 10 mm wide.
- d) **Procedures** Procedures shall be as follows.
- 1) Put the sample up to three-fifths (etched line ⑥) of the volume of the free acid test apparatus.
 - 2) Suspend the blue litmus test paper using the platinum wire hook attached to the rubber stopper of the free acid test apparatus.
 - 3) Insert the rubber stopper from which the blue litmus test paper is suspended until the lower end of rubber stopper reaches etched line ⑦ of the free acid test apparatus containing the sample to seal hermetically the mouth of free acid test apparatus.
 - 4) Measure the time from the sealing of the mouth of free acid test apparatus until the blue litmus test paper changes its colour into red over the entire surface.
- e) **Evaluation** The time from the sealing of the mouth of free acid test apparatus until the blue litmus test paper changes its colour into red over the entire surface is taken as free acid test time.

5.1.3 Thermal stability test

The thermal stability test shall be performed as follows.

- a) **Summary** A fixed amount of sample is weighed into a cylindrical weighing bottle and the cylindrical weighing bottle is put in the test apparatus maintained at a constant temperature. After the cylindrical weighing bottle is allowed to stand for a

definite period of time, the mass loss is measured. The depletion rate to the original sample mass is calculated and the stability is examined by the rate.

b) **Apparatus and instrument** The apparatus and instrument shall be as follows.

- 1) **Cylindrical weighing bottle**, made of glass with dimensions of 35 mm to 40 mm in outside diameter and 40 mm to 50 mm in height, which has a structure capable of sealing hermetically the top part with a ground joint glass lid. An example is shown in Figure 6.
- 2) **Test apparatus**, having a structure capable of maintaining uniform distribution of temperature at a constant level in the apparatus, such as a heater (apparatus which dries the sample by using warm water or warm current of air inside the double walls) and an electric heater.
- 3) **Balance**, having a measuring range of 0 g to 100 g with an accuracy of 1 mg.
- 4) **Desiccator**, which is a thick-walled glass container having a structure such that the container is separated into upper part and lower part by a perforated partition plate, a desiccating agent such as silica gel is put in the lower part, and inside of the container can be cut off from the outside air with a ground joint glass lid.

Unit: mm

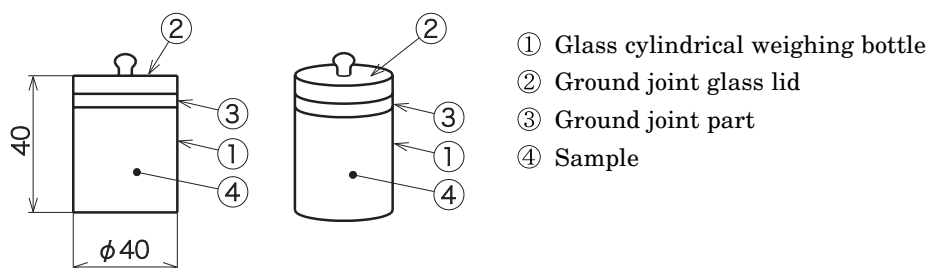


Figure 6 Cylindrical weighing bottle (example)

- c) **Preparation of sample** Use about 10 g of dry sample as it is. In the case of sample having absorbed moisture, dry thoroughly at ordinary temperature using e.g. a vacuum dryer and take about 10 g of the dry sample to use.
- d) **Procedures** Procedures shall be as follows.
- 1) Weigh the mass of the cylindrical weighing bottle covered with the ground joint glass lid.
 - 2) Weigh out about 10 g of the sample into the cylindrical weighing bottle, cover loosely the mouth of the bottle with the ground joint glass lid, and weigh all of these together. Calculate the accurate mass of the sample weighed out.
 - 3) Remove the lid of the cylindrical weighing bottle containing the sample and put the bottle in the test apparatus maintained at a constant temperature (75 °C).
 - 4) Put the cylindrical weighing bottle containing the sample in the test apparatus. While maintaining the temperature at 75 °C, leave to stand for 48 h.

- 5) Take the cylindrical weighing bottle containing the sample out of the test apparatus, separate the lid from the cylindrical weighing bottle, and put both of these in a desiccator. After cooling to ordinary temperature, weigh, and calculate the depleted mass of the sample.
- e) **Calculation** The depletion rate to the original sample mass weighed out shall be calculated according to the following formula.

$$D = \frac{W_0 - W}{S} \times 100$$

where, D : depletion rate (%)

W_0 : total mass of cylindrical weighing bottle and sample weighed out (g)

W : total mass of cylindrical weighing bottle and sample after being left to stand for 48 h (g)

S : mass of sample weighed out (g)

- f) **Evaluation** The stability shall be evaluated by the depletion rate.

5.2 Sensitivity

5.2.1 Drop hammer test

The drop hammer test shall be performed as follows.

- a) **Summary** A sample is inserted between two cylindrical rollers placed on the anvil of a testing machine, the drop hammer is let fall on it, and the sensitivity of explosives is examined from the relation between the height of drop hammer and the state of explosion.
- b) **Apparatus and instrument** The apparatus and instrument shall be as follows.
- 1) **Drop hammer testing machine** having a mechanism for preventing double hammering, with which the drop hammer vertically falls almost freely and there is no single hammering. An example is shown in Figure 7.
 - 2) **Drop hammer**, with a mass of 5 kg.
 - 3) **Cylindrical roller**, of nominal designation 12 × 12 as specified in **JIS B 1506**.
 - 4) **Cover** made of steel, which has a degassing hole as shown in Figure 8.
 - 5) **Anvil**, of about 30 mm or more in thickness and made of steel.
 - 6) **Tin foil pan** of 12 mm in diameter in the pan shape, which is prepared by recessing a cylindrical tin foil pan of about 20 mm in diameter (80 g/m² to 100 g/m²) with a die.