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भाग 50 जार टैस्ट (स्कन्दन टैस्ट)
(पहला पुनरीक्षण)

Indian Standard
METHODS OF SAMPLING AND TESTS
(PHYSICAL AND CHEMICAL) FOR WATER
AND WASTE WATER
PART 50 JAR TEST (COAGULATION TEST)
(*First Revision*)

ICS 13.060.50; 13.060.60

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FOREWORD

This Indian Standard (Part 50) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Water Environment Protection Sectional Committee had been approved by the Chemical Division Council.

The empirical procedure is used to determine the optimum dosage of coagulants and/or coagulant aids and *pH* of coagulation for a given water or wastewater for removal of turbidity, colour, dissolved minerals, phosphorus, etc.

These data can not be quantitatively obtained from a theoretical understanding of the problem and analysis of water or wastewater. During operation of a treatment unit, it is essential to perform jar test as often as necessitated by changes in composition of wastewater.

The technical committee responsible for formulation of IS 3025 : 1964 'Methods of sampling and test (physical and chemical) for water used in industry' had decided to revise the standard and publish it in separate parts. This test method is one among the different parts being published under IS 3025 series of standards.

The composition of the committee responsible for preparation of this standard is given in Annex C.

In reporting the result of a test or analysis made in accordance with this standard if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

METHODS OF SAMPLING AND TESTS (PHYSICAL AND CHEMICAL) FOR WATER AND WASTE WATER

PART 50 JAR TEST (COAGULATION TEST)

(*First Revision*)

1 SCOPE

This standard prescribes the method of determining optimum dosage of coagulants (single/mixed) coagulant aids and the optimum pH of coagulation for removal of turbidity and colour caused by colloidal and non-settleable particles followed by sedimentation under quiescent condition.

2 REFERENCES

The Indian Standards listed in Annex A contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards.

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 7022 (Part 1) and 7022 (Part 2) shall apply.

4 OPERATING VARIABLES

4.1 The following primary variables are required to be investigated.

4.1.1 *Chemical Additives*

4.1.2 *Temperature*

4.1.3 *pH*

4.1.4 *Order of Addition and Mixing Conditions*

5 INTERFERENCES

5.1 The possible interference of optimum jar test conditions are as given below.

5.1.1 *Temperature Change*

Temperature control is very important since thermal and convection currents may occur during the test which interferes with the setting of coagulated particles.

5.1.2 *Release of Gases*

Due to chemical reaction, mechanical agitator or

temperature increase, there may be some gas release due to which coagulated flocs may float.

5.1.3 *Testing Period*

Biological activity or other factors may alter the coagulation characteristics of water on prolonged standing. To control this the sampling and testing period should be kept as minimum as possible and time shall be recorded.

6 APPARATUS

6.1 *Multiple Stirrer*

6.1.1 A multiple stirrer with continuous speed variation from 20 to 150 rpm shall be used (*see* Fig 1).

6.1.2 The stirring paddles shall be light, non-corrosive and having same configuration. An illuminated base is advisable to see the floc formation clearly. At the same time, it is to be noted that the illumination will not contribute any heat to the system, since heat can counteract on normal settling tendencies.

NOTE — The maintenance of constant and reproducible stirring condition is of prime importance in coagulation test. The basic requirement is for maintaining two speeds of stirring, a fast speed for initial addition and mixing (flash mix 30 seconds) of coagulant and a slow speed capable of promoting efficient flocculation (20 minutes). A stirring speed of about 200 rpm is found to give adequate mixing and a speed of 20 rpm for satisfactory flocculation for a wide range of wastewaters.

6.2 *Other Equipments*

6.2.1 *Beakers or Jars* — 1 000 ml capacity.

6.2.2 *Stop Watch*

6.2.3 *pH Meter*

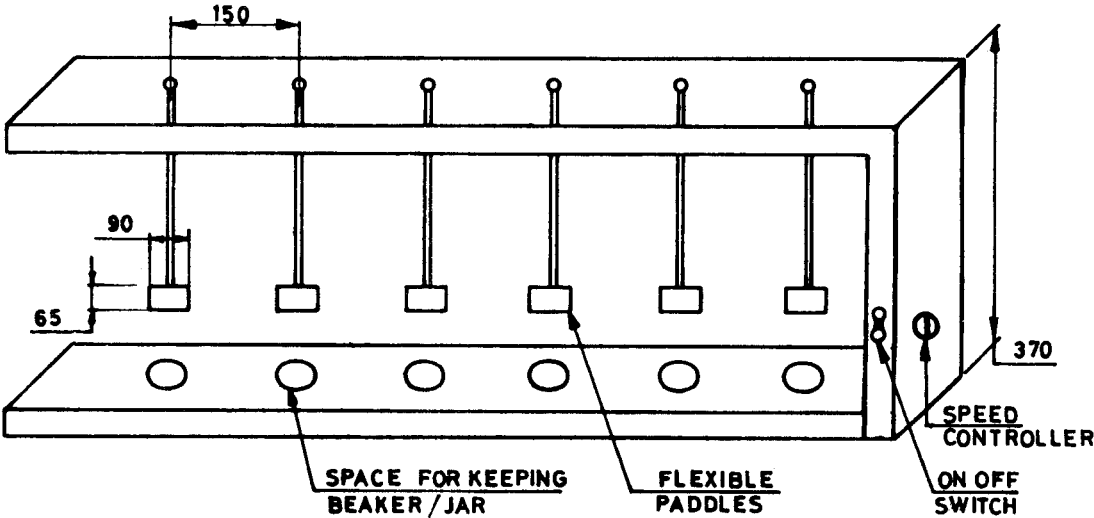
6.2.4 *Turbidity Meter*

7 REAGENTS

7.1 *Quality of Reagents*

Unless specified otherwise, pure chemicals and distilled water (*see* IS 1070) shall be employed in tests.

NOTE — 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the results of analysis.



All dimensions in millimetres.
FIG. 1 BEAKER/JAR TEST APPARATUS

7.2 Chemical Solutions

7.2.1 Stock solutions of coagulants, coagulant aids and other chemicals (see Annex B, for information) shall be prepared at concentrations such that quantities suitable for use in jar test can be measured accurately and with ease (see Table 1).

Table 1 Stock Solutions for Coagulation Test

Chemicals	Concentrations of Stock Solution of Suspension	Prepare Fresh Solution After	Remarks
(1)	(2)	(3)	(4)
Aluminium sulphate [Al ₂ (SO ₄) ₃ ·16H ₂ O]	1% (0.08%) Aluminium	1 month	—
Ferric sulphate [Fe ₂ (SO ₄) ₃ ·9H ₂ O]	1% (0.2%) Iron	1 week	Renew stock solution, if it becomes opalescent
Soluble starch	0.5 %	2 days	Dilute 10 times immediately before use
Polyacrylamide derivatives	0.5 %	1 week	Solution should be at least 1 day old. Dilute 10 times immediately, before use
Sulphuric acid (H ₂ SO ₄)	0.1 N	3 months	—
Sodium hydroxide (NaOH)	0.1 N	1 month	—
Fullers earth	0.5%	3 months	Shake well, before use

7.2.2 The volume of an 5% stock solution required to be added to a dose of d mg/l to a volume V ml of sample is: $10 \times V \times d$ ml. Coagulant aids are available in powder and liquid form. When powder aids are used for making reagents, care should be taken to add the powder to the distilled water and not in reversed order. The dissolution time may vary from several minutes to several hours. For this, the manufacturer's instructions should be strictly followed.

8 SAMPLING

Sampling shall be done in accordance with IS 3025 (Part 1).

9 PROCEDURE

9.1 Collect 10 litres of sample to be tested and store it (preferably) in a 10 litre polyethylene aspirator. Before taking sample for test, put the aspirator on its aids and roll it backward and forward vigorously to make it homogeneous.

9.2 Using 1 000 ml measuring cylinder, measure 800 ml sample into 1 000 ml tall form beakers and place them in position in multiple stirrer, taking care to keep a minimum of 5 mm gap between the stirrer blade and the inner surface of the beaker.

9.3 Take a further 250 ml of sample and determine its pH, turbidity and colour.

9.4 Transfer the required volumes of coagulant into the coagulant vessels using a graduated pipette of 10 ml.

9.5 Switch the stirrer on to fast, measure the temperature in one of the beaker and add coagulant after stirring vigorously for at least one minute. Start

the stop watch on adding the coagulant. Quickly rinse the coagulant vessels with distilled water and add the rinsings to the beakers.

9.6 One minute after adding the coagulant switch the stirrer to slow and observe beakers carefully, noting the time taken for pin-point (just visible) floc to appear in each beaker.

9.7 After 15 minutes of slow stirring switch off the stirrer and carefully remove the beakers from the stirring apparatus. Allow them to stand for 15 minutes then carefully decant 150 to 200 ml of supernatant from each beaker in clean beaker or flask. A decanted sample is nearly always satisfactory but occasionally it may be found to have small amount of floc that tends to float. In such situation collect supernatant sample at a depth of 30-40 mm using glass syphon.

9.8 Mix samples prior to turbidity measurement [see IS 3025 (Part 10) : 1984]. Measure the colour [see IS 3025 (Part 4) : 1983] turbidity and pH [see IS 3025 (Part 11) : 1983] of the samples within 3 hours and tabulate results.

9.9 Repeat these steps with different concentration of chemicals, different flash mix speed and different settling time to arrive at the optimum conditions. Optional pH, if not already known, for the coagulants of interest, may be determined by conducting test at various pH.

10 REPRODUCIBILITY

To demonstrate reproducibility duplicate set of three

each jars 1 and 4, 2 and 5 and 3 and 6 are treated simultaneously and compared.

11 REPORTING

Record the data in the following manner and report the optimum values:

Sample.....pHDate.....

Location.....Colour.....Temperature.....

Sample Size.....

1 2 3 4 5 6

Chemical, mg/l

Flash mix time, minutes

Slow mix speed, rpm

Slow mix time, minutes

Temperature, °C

Time of first floc

formulation, minutes

Setting rate

Turbidity, NTU

Colour

pH

NOTES

1 Test for residual chemicals in the treated water may also be conducted apart from normal parameters.

2 The times given are illustrative only. The speed of the mix and time may be altered as per specific conditions.

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	Title	IS No.	Title
1070 : 1992	Reagent grade water—Specification (first revision)	(Part 11) : 1983	pH value (first revision)
3025	Methods of sampling and tests (physical and chemical) for water and wastewater	(Part 21) : 1983	Total hardness (first revision)
(Part 1) : 1986	Sampling (third revision)	7022	Glossary of terms relating to water, sewage and industrial effluents and wastewater, Part 1
(Part 4) : 1983	Colour (first revision)	(Part 1) : 1973	
(Part 10) : 1984	Turbidity (first revision)	7022	Glossary of terms relating to water, sewage and industrial effluents and waste water, Part 2
		(Part 2) : 1979	

ANNEX B

(Clause 7.2.1)

LIST OF COAGULANTS, COAGULANTS AIDS AND OTHER CHEMICALS

B-1 PRIME COAGULANTS

- Aluminium sulphate [$\text{Al}_2(\text{SO}_4)_3 \cdot 16 \text{H}_2\text{O}$]
- Ferric sulphate [$\text{Fe}_2(\text{SO}_4)_3 \cdot 9 \text{H}_2\text{O}$]
- Ferric chloride ($\text{FeCl}_3 \cdot 6 \text{H}_2\text{O}$)
- Ferric sulphate ($\text{FeSO}_4 \cdot 7 \text{H}_2\text{O}$)
- Magnesium carbonate ($\text{MgCO}_3 \cdot 3 \text{H}_2\text{O}$)
- Sodium aluminate (NaAlO_2)

B-2 COAGULANT AIDS

- Activated silica
- Anionic poly electrolytes
- Cationic poly electrolytes
- Nonionic polymer

B-3 OXIDISING AGENTS

- Chlorine (Cl_2)
- Chlorine dioxide (ClO_2)
- Potassium permanganate (KMnO_4)

d) Calcium hypochlorite ($\text{CaOCl}_2 \cdot 4 \text{H}_2\text{O}$)

e) Sodium hypochlorite (NaOCl)

B-4 ALKALIES

- Calcium carbonate (CaCO_3)
- Dolomitic lime (50 percent CaO , 40 percent MgO)
- Hydrated lime [$\text{Ca}(\text{OH})_2$]
- Magnesium oxide (MgO)
- Sodium carbonate (Na_2CO_3)
- Sodium hydroxide (NaOH)

B-5 WETTING AGENTS

- Bentonite
- Kaolin
- Other clays and minerals

B-6 OTHER CHEMICAL

Activated carbon (powdered)

ANNEX C

(Foreword)

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