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*Indian Standard*

**RECOMMENDATIONS FOR HANDLING AND  
DOSING DEVICES FOR CHEMICALS FOR  
WATER TREATMENT**

**PART 1 COAGULANTS**

*( First Revision )*

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**BUREAU OF INDIAN STANDARDS**  
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NEW DELHI 110002

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**Price Group 3**

## FOREWORD

This Indian Standard ( Part 1 ) ( First Revision ) was adopted by the Bureau of Indian Standards on 24 January 1990, after the draft finalized by the Public Health Engineering Equipment Sectional Committee had been approved by the Civil Engineering Division Council.

Dosing of chemicals forms an important part of water treatment. The actual dosing of chemical is arranged in several ways depending upon the type of chemical used, the capacity of the plant and quality of water.

Equipment for storage, handling, measuring or feeding chemicals should be arranged as compactly as possible taking into account its operation and maintenance. Generally chemical unloading point should be as near as possible to the place of storage which in turn should be sufficiently near the feed equipment.

Coagulant is a chemical agent added to the water to facilitate the settling down of colloidal or finely divided suspended matter.

In selecting the types and the doses of the coagulants for the treatment of water, the choice can be based upon the jar tests and/or study and analysis of water where available.

This standard was first published in 1979. In this revision, besides updating its provision, new materials such as calcium oxide and calcium hydroxide which are also used commonly in water treatment plants for pH correction, coagulation and softening have been included.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard***RECOMMENDATIONS FOR HANDLING AND  
DOSING DEVICES FOR CHEMICALS FOR  
WATER TREATMENT****PART 1 COAGULANTS***( First Revision )***1 SCOPE**

**1.1** This standard ( Part 1 ) covers recommendations for handling, storage, weighing, method of preparing solution and dosing devices of coagulants such as alum and iron salts used in water treatment plant.

**1.2** This standard does not cover recommendations for polyelectrolytes coagulant aids and automatic proportioning of chemical feed.

**2 REFERENCES**

**2.1** The Indian Standard listed in Annex A are necessary adjuncts to this standard.

**3 HANDLING**

**3.1** Ordinarily a plant labourer can handle 50 kg container when aided by small hand cart. Heavy containers should be handled with the aid of mechanical contrivance such as trucks, monorails, cranes and other special equipment.

**3.2** Rolling of cylinders, barrels, drums on the floor should be avoided.

**3.3** Iron salts generally require more careful handling as compared to alum salts ( see Table 1 ).

**3.4** While laying electrical wiring and fixtures adequate safety precautions should be observed during their installation for ensuring safe use of electricity ( see IS 732 ( Part 1 ), ( Part 2 ) and ( Part 3 ) and IS 5216 ( Part 1 ) and ( Part 2 ).

**3.5** Use of mechanical lifting devices should be preferred.

**4 STORAGE**

**4.1** The coagulant store should be suitably located to prevent entry of water. Where coagulants are purchased in bags, storage by piling on the floor of the store room shall be suitably located at a convenient level.

**4.1.1** In case when coagulants are purchased in blocks, the height of stack is generally limited up to 3 m for non-operational stacks and 1.5 m for operational stacks.

**4.2** Coagulants should be stored in a damp-proof storage room.

**4.3** Hygroscopic coagulant should be packed in moisture-proof container ( see Table 1 ).

**4.4** All plants, particularly small ones should keep on hand at all times the supply of coagulants sufficient to provide a safety factor. A storage of 3 months based on average consumption is advisable. Special consideration should be given to requirements of the monsoon season. But this again depends upon the type and form of coagulant, location of the plant, source of supply, transport facilities and the arrangement made with the suppliers.

**4.5** In case where the major storage is provided at a place away from the feeding device a week's storage space should be provided near the coagulants feeding device to facilitate handling. Special precautions against flooding should be taken.

**4.6** The floor of the storage room should be given anti-corrosive treatment. Similar treatment should also be given to side walls and intervening columns, up to a minimum height of 3 m above the floor level.

**4.7** A working space of minimum 30 percent of floor area should be provided so that all stacked coagulants are easily accessible.

**5 WEIGHING**

**5.1** It is necessary that predetermined quantity of coagulants is used for preparing the solutions. Arrangements of weighing of coagulants both when the consignments are received as well as before feeding it into the equipment should be provided.

**5.2** Depending upon the quality of the coagulant, appropriate weighing machine conforming to IS 1435 : 1960, IS 1439 : 1959 and IS 1854 : 1964 may be used.

**6 SOLUTION TANKS****6.1 Number of Tanks**

There shall be minimum of three tanks each capable of catering for 8 hours maximum dose

without any interruption. One of them would be for preparation, other for dosing and the third one as a stand by (for being got ready for receiving coagulants after cleaning). However, when the coagulant solution is to be used at the rate of 5 000 litres per 24 hours or less, the number of solution tanks can be restricted to 2, each tank to hold solution for 24 hours. When the quantity of coagulants used is large, more than one tank may be used to meet 8 hours dose.

**6.1.1** Where concentrated solutions with continuous arrangements are used, it is not essential to comply with the requirements of the provisions of 6.1.

**6.2** The solution tank should be provided with mixing devices for intimate mixing of chemicals. Generally square, rectangular or circular tanks are used.

### 6.3 Free Board

A minimum free board of 0.3 m should be provided.

**6.4** Solution tanks should be provided with inlet, outlet, overflow and clean out arrangements.

### 6.5 Trays for Dissolving

The tanks should be provided with perforated/slotted trays or boxes for dissolving the coagulant. Trays shall be made of same material as used for storage container indicated under col 11 in Table 1. These should be of sufficient size to accommodate total quantity of coagulants required for each tank.

**6.6** The solution tank may be constructed either of wood or reinforced cement concrete coated with bituminous paint. Lining with PVC or epoxy is preferred in case of reinforced cement concrete tanks. For mild steel tanks lining with rubber or PVC or epoxy to resist corrosion is essential.

### 6.7 Level Indicators

Level indicators shall be installed in the solution tanks to know the quantity of solution remaining in the tank at any given instant. The level indicator should be such that they are not affected by the agitation of the liquid in the tank.

**6.8** The coagulant solution tanks may be located in or as near the storage godowns as possible to facilitate handling of coagulants.

**6.9** Wherever the tanks are situated at an elevation, a lifting tackle for lifting the coagulants should be provided. Each tank should also be provided with a platform which should be 1.5 m wide to facilitate the workers in handling the coagulants and preparing the solution; wherever necessary the platforms should have railing up to a minimum height of 0.75 m. It

should be located at an elevation to have a clear headroom of 3.0 m. The floor of the platform should not be lower than 1 m measured from the top of the tank. Access ladder to the platform should be provided where required. These ladders should be of RCC, aluminium alloy or timber.

### 6.10 Material of Perforated Pipe

Adequate arrangements should be provided for dissolving the coagulants. Where perforated pipes are used for spraying jets of water on the coagulant placed on the perforated tray, the material of pipe should be high density polyethylene, unplasticized PVC or polypropylene.

## 7 PREPARATION OF COAGULANT SOLUTION

### 7.1 Mixing Devices

It is essential to ensure homogeneity of the prepared coagulants solution. Proper mixing may be done by the following methods:

#### a) Mechanical Agitation

The normal turnover capacity of the agitators for the alum solution tank should be 2 hours. Motor used shall be totally-enclosed fan-cooled type as given in 7.1 (c). Main components of the agitators shall conform to the following requirements:

##### 1) Shaft

Material for shaft shall be as specified in 7.1 (c);

##### 2) Paddles

Materials for paddles shall be stainless steel, wood polypropylene or fibre glass;

##### 3) Guide

Guide at the bottom of the shaft shall be made of stainless steel; and

##### 4) Gears

Gears should be mounted on concrete platform and should be provided with cast iron housing for protection.

#### b) Compressed Air

Agitation by compressed air is particularly economical for large size tanks and also when number of tanks is more than four.

Air supply should be 0.1 to 0.15 m<sup>3</sup>/minute per m<sup>3</sup> of effective liquid capacity of solution tank. The pressure of air supply will depend upon depth of liquid and losses through distribution pipe and orifice holes. High density polyethylene, unplasticized PVC or polypropylene pipe should be used as distribution pipe inside

**Table 1 Commonly Used Coagulants in Water Treatment**  
( Clauses 3.3, 4.3, 6.5, 7.2, 8.2 and 9.2 )

Sl No.	Chemical				Properties				Storage		Method of Preparing Solution	Feeding			
	Name	Formula	Trade Name	Use	Available Forms and Appearances	Mass kg/m <sup>3</sup> and Commercial Strength	Solubility in Water g/h/100 cm <sup>3</sup>	Properties Requiring Special Attention	Space Required	Storage Container Material		Best Feeding Forms	Method	Strength of Solution or Suspensions and Properties	Suitable Handling Material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	Aluminium sulphate ( see IS 260 : 1969 )	Al <sub>2</sub> ( SO <sub>4</sub> ) <sub>3</sub> · 18H <sub>2</sub> O	Filter alum	Coagulation, sludge conditioning. Most effective as coagulant when pH of water is between 5.5 and 7.4	Light tan to grey-green slabs, broken lumps, granules, liquid	960 to 1 200 kg/m <sup>3</sup> , 17% Al <sub>2</sub> O <sub>3</sub> ( Min )	60.0 at 0°C	Dusty, sticky, hygroscopic, corrosive, acidic	0.93 m <sup>3</sup> /t in bags or bulk. 0.79 m <sup>3</sup> /t for liquid, broken lumps packed in hessian or paper bags	Concrete with integral metallic hardener. Steel suitably painted. Moisture proof wood. For liquid, use concrete lined with acid-proof bricks laid in acid-resistant cement	For slabs, lumps and granules—place the chemical on a surface screen and await complete dissolution before stirring. Tanks should necessarily be protected against corrosion. For solutions, tanks should be protected against corrosion. In the event of dilution stir well	Slabs, granules or liquid	Slabs, lumps and granules can be fed in solution form without any special difficulty. Granules can also be fed in dry powder form. Gravity feed of solution can be done	Up to 10% acidic. Corrosive	Lead, rubber, acid resisting tile, Polythene, PVC, stoneware, asphalt, cypress wood, cast iron, rubber-lined mild steel
2	Ferric chloride ( see IS 711 : 1970 )	FeCl <sub>3</sub> · 6H <sub>2</sub> O	Perchloride of iron	Coagulation, sludge conditioning, odour control. Most effective as coagulant when pH of water is between 5 to 11	Oily brown liquid, yellow or brown lumps. Greenish black crystals ( anhydrous )	Liquid solution 186 to 203 kg/m <sup>3</sup> , 37 to 47 percent. Crystals 960 to 1 024 kg/m <sup>3</sup> 60% anhydrous 1 040 to 1 120 kg/m <sup>3</sup> 60% FeCl <sub>3</sub>	Liquid solution completely soluble. Crystals 64.4 at 10°C and 91.1 at 20°C Anhydrous 74.4 at 0°C	Liquid solution acidic, corrosive, stains. Crystal melts at 37°C hygroscopic, corrosive, stains. Anhydrous deliquescent, corrosive, stains	Liquid solution carboys 1.86 m <sup>3</sup> /ton. Solid form bulk 1.63 m <sup>3</sup> /tonne barrels 6.5 m <sup>3</sup> /tonne drums 1.13 m <sup>3</sup> /tonne	Same as for alum. Liquid solution 54.5 litres PVC carboys, 18 184-36 368 litres rubber-lined car tanks. Crystals—197 kg paraffin lined barrels. Anhydrous—68 kg rubber-lined steel drums, 50.8 kg packings of fibre board sprayed with polythene	In case of liquid solution tanks should necessarily be protected against corrosion. In case of solid place the chemical on a surface screen and await complete dissolution before stirring. Tanks should necessarily be protected against corrosion	Solution	Liquid or solid form can be fed in solution without any difficulty. Gravity feed of solution can be done	3 to 4% acidic. Corrosive	Acid proof brick, stoneware, concrete faced with anti-corrosive paint, rubber, PVC, wood
3	Ferric sulphate	Fe <sub>2</sub> ( SO <sub>4</sub> ) <sub>3</sub> · 2.3 H <sub>2</sub> O	Partly hydrated ferric sulphate	Coagulation. Most effective as coagulant when pH of water is 5 to 11	Reddish tan-grey granules liquid	1 120 to 1 152 kg m <sup>3</sup> Fe <sub>2</sub> ( SO <sub>4</sub> ) <sub>3</sub> · 3H <sub>2</sub> O 68% Fe <sub>2</sub> ( SO <sub>4</sub> ) <sub>3</sub> · 18.5% Fe Fe <sub>2</sub> ( SO <sub>4</sub> ) <sub>3</sub> · 2 H <sub>2</sub> O 76% Fe <sub>2</sub> ( SO <sub>4</sub> ) <sub>3</sub> 18.5 to 21% Fe	Very soluble	Acidic and corrosive, stains	0.79 m <sup>3</sup> /t in bags or bulk	Same as for alum 45.4 litres returnable plastic carboys in plastic coated steel crates	Place the chemical on a surface screen and await complete dissolution before stirring. Tanks should necessarily be protected against corrosion	Solution	In solution form without any special difficulty. Gravity feed of solution	Up to 25%	Plastic or rubber lined mild steel, fibre glass, rubber, duriron, stainless steel, lead ceramics
4	Ferrous sulphate	FeSO <sub>4</sub> · 7 H <sub>2</sub> O	Copperas, sulphate, green vitriol	Coagulation. Most effective as coagulant when pH of water is 8.5 to 11	Green to brownish yellow granules, crystals, powder lumps	1 008 to 1 056 kg m <sup>3</sup> 55% Fe <sub>2</sub> ( SO <sub>4</sub> ) <sub>3</sub> 20% Fe	28.7 at 0°C 37.5 at 10°C 48.5 at 20°C 60.2 at 30°C	Acidic and corrosive stains. Cakes over 20°C in moist air. Ferrous sulphate mixed with lime may generate heat to start combustion of dust bags	88 m <sup>3</sup> /t in bags or bulk	Same as for alum in solid form. Storage space shall be cool and properly ventilated. Hessian or polyethylene lined hessian bags of 50.8 kg	In case of crystals place them on a surface screen and await complete dissolution before stirring. In case of powder ( anhydrous ) stir the water and slowly add the powder. Tank should be protected against corrosion	Solution or dry	Crystals and powder can be fed in solution form without any special difficulty. In case of later it can be fed in dry powder form too. Gravity feed of solution can be done	Up to 10% acidic. Corrosive	Rubber, dur iron, stainless steel, lead, plastic or rubber-lined mild steel



Table 1 ( concluded )

Sl No.	Chemical				Properties				Storage		Method of Preparing Solution	Feeding			
	Name	Formula	Trade Name	Use	Available Forms and Appearances	Mass kg/m <sup>3</sup> and Commercial Strength	Solubility in Water g/100 cm <sup>3</sup>	Properties Requiring Special Attention	Space Required	Storage Container Material		Best Feeding Forms	Method	Strength of Solution or Suspensions and Properties	Suitable Handling Material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
5	Chlorinated ferrous sulphate	Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·FeCl <sub>3</sub>	Chlorinated copperas	Coagulation. Sludge conditioning. Most effective when pH of water is 6 to 9	Yellow solution	—	—	Acidic and highly corrosive staining liquid	—	Same as Fe Cl <sub>3</sub> ·6H <sub>2</sub> O	Produced at site by reaction of chlorine and ferrous sulphate	Dry in solution form	—	1 part Cl <sub>2</sub> to 7.8 parts FeSO <sub>4</sub> by mass. Corrosive	Plastic or rubber-lined mild steel, rubber, ceramics, plastics
6	Sodium aluminate ( see IS 4200 : 1984 )	Na <sub>2</sub> Al <sub>2</sub> O <sub>3</sub>	Soda alum. Aluminate of soda, Alfloc	Coagulation. Treatment of boiler feed water. Coagulant acid	Powder granules briquettes liquor white or pale greenish yellow	1 360 to 1 400 kg/m <sup>3</sup> Dry powder 50-54% Al <sub>2</sub> O <sub>3</sub> 9-10% Na <sub>2</sub> O Liquor 13% Al <sub>2</sub> O <sub>3</sub> 1.65% Na <sub>2</sub> O	Soluble	Hydroscopic	Paper sacks, steel drums, road tankers, Powder—1.02/1.19 m <sup>3</sup> /t	Concrete or steel	In case of powder stir the water and slowly add the powder product. In the event of dilution stir well	Solution or dry	In solution form without any special difficulty. Gravity feed of solution	Up to 10% alkaline	Rubber, iron
7	Sodium silicate ( see IS 381 : 1972 )	Na <sub>2</sub> SiO <sub>3</sub>	Silicate of soda, water glass, or activated silica	Coagulant acid	Viscous opaque whitish aqueous solution	1 395 to 1 500 kg/m <sup>3</sup> SiO <sub>2</sub> 28.1 to 29.2% Na <sub>2</sub> O 8.9 to 14%	7.0 at 20°C	Alkaline and sticky	Steel drums of 45 l or 205 l, 4.65 m <sup>3</sup> /t in drums	Steel drums	In case of powder stir the water and slowly add the powder product	Solution	In solution form without any special difficulty. Feeder with continuous stirring arrangement is essential. Administration by chemical feed pump	Up to 5% alkaline and incrustant	Rubber, iron
8	Calcium Oxide [ see IS 1540 ( Part 1 ) : 1980 ]	CaO	Quick lime	For pH correction, coagulation and softening	White or light grey caustic	1 040 kg/m <sup>3</sup> 1.5%	Soluble	Dusty slakes or exposure to moist air	Drums	Concrete, PVC, wood or steel with protective lining	In case of powder, stir the water and slowly add the powder	Solution or dry	Dry or wet can be fed in suspension	Alkaline and incrustant	Rubber or PVC
9	Calcium hydroxide [ see IS 1540 ( Part 2 ) : 1978 ]	Ca ( OH ) <sub>2</sub>	Hydrated lime	Same as CaO	White powder caustic	800 kg/m <sup>3</sup> 1.5%	Soluble	Dusty	Drums	Concrete, PVC, wood or steel with protective lining	Same as CaO	Solution or dry	Dry feed generally discharge to shake before application	Same as CaO	Rubber or PVC

the tank at a level 300 to 350 mm above tank bottom.

Air agitation need not be continuous. Five minutes agitation followed by 20 to 30 minutes of rest is sufficient to keep the solution homogeneous.

### c) *Recirculating Solution*

When recirculation pumps are provided the capacity should be sufficient to turn over the tanks content in 2 hours. The pump impeller, shaft and sleeve should be of stainless steel or polypropylene. Material for pump body shall be of cast iron conforming to IS 210 : 1978. Motor used for this purpose shall be totally-enclosed fan-cooled type conforming to IS 325 : 1978 having method of cooling IC41 ( *see* IS 6362 : 1971 ) and having enclosures providing protection IP 54 or superior ( *see* IS 4691 : 1985 ).

## 7.2 Concentration of Solution

For solution strength reference may be made to Table 1.

## 7.3 Water for Preparing Coagulants

Wherever filters are installed filtered water should be used for making chemical solutions. In absence of filters or in an industrial water treatment plant, settled clear water may be used.

## 8 SOLUTION FEED AND DRAIN LINES

**8.1** The coagulants solution is conveyed from the solution tanks to the point of application by means of coagulant feed lines. These should be as short and straight as possible.

**8.2** Solution food and drain lines should be durable and of corrosion resisting material as stated in Table 1. These lines should be easily accessible. To avoid choking and for easy cleaning, a minimum diameter of 50 mm is

recommended for gravity feed solution lines. For pressure feed lines, a minimum diameter of 25 mm is recommended. Where sharp bends occur, a cleaning eye should be provided at the bend. Wherever freezing conditions are likely to occur, additional protection to these lines should be given to prevent freezing.

**8.3** Solution feed and drain lines be laid in such a way that air trapping is avoided. Rubber hoses, wherever used, may be supported in troughs with easy bends wherever change of direction occurs. The minimum size for drain lines should be 100 mm.

**8.4** Water connection for flushing the solution lines should be located conveniently and all coagulant feed lines should be cleaned as frequently as possible to prevent choking.

## 9 SOLUTION FEED DEVICES

**9.1** Solution feed devices are used to regulate the dose of coagulant feed into water [ *see* IS 10553 ( Part 5 ) : 1988 ]. The rate of flow of the coagulant solution of the known strength prepared in the solution tank is either measured by means of rota-meter, orifices or weirs which are suitably calibrated and have a scale plate. The solution feed equipment should be of non-corrodible construction wherever the solution warrants it. The solution feed devices shall be preceded by strainers ( which can be taken out for cleaning ) for removing suspended impurities which may otherwise clog the rotameter.

**9.1.1** The feeding of solution to these devices should be done by positive displacement pump or constant head device.

**9.2** Pumps may also be used for dosing coagulants. They are adaptable to feed in proportion to the rate of flow through the plant. The pump selected should be made of material specified in Table 1. Ejectors may also be used for feeding of coagulant solutions.

## ANNEX A

( Clause 2.1 )

## LIST OF REFERRED INDIAN STANDARDS

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
210 : 1978	Grey iron castings ( <i>third revision</i> )	1854 : 1964	Person weighing machines ( <i>revised</i> )
260 : 1969	Aluminium sulphate, non-ferric ( <i>first revision</i> )	4200 : 1984	Sodium aluminate ( <i>first revision</i> )
325 : 1978	Three-phase induction motors ( <i>fourth revision</i> )	4691 : 1985	Degrees of protection provided by enclosures for rotating electrical machinery ( <i>first revision</i> )
381 : 1972	Sodium silicate ( <i>first revision</i> )		
711 : 1970	Ferric chloride, technical ( <i>first revision</i> )	5216	Recommendations on safety procedures and practices in electrical work:
732	Code of practice for electrical wiring installations:	Part 1 : 1982	General ( <i>first revision</i> )
Part 1 : 1983	Definitions and general requirements ( <i>second revision</i> )	Part 2 : 1982	Life saving techniques ( <i>first revision</i> )
Part 2 : 1983	Design and construction ( <i>second revision</i> )	6362 : 1971	Designation of methods of cooling for rotating electrical machines
Part 3 : 1982	Inspection and testing of installations ( <i>second revision</i> )	10553	Requirements for chlorination equipment: Part 5 Bleaching powder solution feeder displacement type chlorinator
1435 : 1960	Platform weighing machines	Part 5 : 1988	
1439 : 1959	Steelyards		

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