IS 7090 (1985): Guidelines for rapid mixing devices [CED 24: Public Health Engineering.]

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IS : 7090 - 1985
(Reaffirmed 2001)

Indian Standard

GUIDELINES FOR RAPID MIXING DEVICES

(First Revision)

First Reprint OCTOBER 1996

UDC 628.16.06 : 628.162.5

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

Gr 3

February 1986

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Indian Standard

GUIDELINES FOR RAPID MIXING DEVICES

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 30 August 1985, after the draft finalized by the Public Health Engineering Equipment Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 In water treatment plants rapid mixing is an operation by which the coagulant is rapidly and uniformly dispersed throughout the mass of water, to create a homogeneous system. This helps in the formation of microflocs and results in proper utilization of chemical coagulant preventing localization of concentration and premature of hydroxides which lead to less effective utilization of the coagulant.

0.3 This standard was first published in 1973. The present revision incorporates the following major changes:

a) Design guidelines for mechanical mixing devices have been given in detail;

b) Velocity gradient for mechanical mixing devices has been given;

c) To prevent vibration and wobbling in vane type mixer, the maximum unsupported length of the shaft is given as 3 m;

d) The maximum ratio of tank diameter to impeller diameter has been changed to 5:1 for propeller type mixer;

e) More details of hydraulic jump have been given; and

f) More details of motor and starter have been included.

0.3 The common coagulant used is 'aluminium sulphate' (*see* IS : 260-1969*); other compounds of aluminium and iron are also used.

*Specification for aluminium sulphate, non-ferric (*first revision*).

0.4 The sources of power for rapid mixing to create the desired intense turbulence are gravitational, mechanical and pneumatic. Accordingly, the various devices used for rapid mixing can be broadly classified as:

a) Mechanical mixers,

b) Hydraulic mixers, and

c) Pneumatic mixers.

0.4.1 Mechanical mixers are the most commonly used devices. They are quite effective, produce little headloss and are unaffected by small fluctuations in flow. They are also amenable to variation in operation by changing the rotation speed. However, they require electrical energy and regular maintenance and supervision.

0.4.2 Hydraulic devices are simple and their main advantage is the absence of any mechanical equipment and hence may be preferred where replacement parts are difficult to obtain. They also require very little maintenance. However, they are less flexible and involve greater loss of head.

0.4.3 Hydraulic devices may be used up to design flows of 300 m^3/h. They are also used where power is not available. Mechanical devices may be provided in multiple units for flows exceeding 2 000 m^3/h.

0.4.4 Pneumatic devices and in-line blenders are not covered in this standard as they are not generally used in India.

0.5 The Sectional Committee has felt the desirability of laying down performance tests but has not found it feasible at the present stage due to lack of established data and comparative studies in this country on such units.

0.6 In the formulation of this standard due weightage has been given to international coordination among the standards and practices prevailing in different countries including India.

0.7 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 or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard lays down design considerations, guidelines for materials and methods of construction of the following types of rapid mixing devices:

a) Mechanical

i) Vane type mixer

ii) Propeller type mixer

iii) Jet type mixer

b) Hydraulic

i) Hydraulic jump

ii) Baffled channel

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Propeller Mixer — A mechanical device where propeller type blades are used for mixing.

2.2 Vane Mixer — It is a mixer where flat blades are used for mixing.

2.3 Jet Mixers — It is a mixer where hydraulic jet action is used to achieve mixing by suitable pumps.

2.4 Hydraulic Jump — It is a phenomenon that occurs in open channel flow when the bottom slope of the channel changes suddenly from greater than critical slope to less than critical slope. It may be defined as the sudden transition of the stream from low stage at less than critical depth to high stage above critical depth.

2.5 Baffled Channel — It is a channel in which baffles in the form of fins, blades or plates are provided at certain distance on opposite walls of the channel in alternate positions to enable flow around the end and proper mixing.

2.6 Detention Time — It is the time for which the water is theoretically retained in the (rapid mix) unit. It can be calculated by dividing the volume of water in the unit by the flow rate.

2.7 Velocity Gradient — For laminar flow, it is the rate of change of velocity with respect to the distance in the direction perpendicular to the flow velocity and is generally expressed as mps/m or sec^{-1}.

Velocity gradient for mixing devices can be calculated from the following equation:

$$G = \sqrt{\frac{P}{U}}$$

where

G = velocity gradient (sec^{-1}),

P = power input per unit volume of water in the mixer, and

U = absolute viscosity.

3. DESIGN CONSIDERATION AND CONSTRUCTION

3.1 Mechanical Mixing Devices

3.1.1 Mechanical rapid mixing units shall be normally designed for a detention time of 20 to 60 seconds at design flow and to give a velocity gradient in the range of 300 to 900 sec^{-1}. For general guidance, the recommended detention time, the corresponding velocity gradient and net power input per unit volume of flash mixer are given in Table 1.

TABLE 1 RECOMMENDED DETENTION TIME AND VELOCITY GRADIENT AND CORRESPONDING NET POWER

(*Clauses* 3.1.1, 3.1.2, 3.1.3 *and* 3.1.4)

Sl No.	Detention Time	Velocity Gradient	Net Power Input	
			Per unit Volume of Flash Mixer	Per m^3/h Water Treated
	Sec	Sec^{-1}	Watts/m^3 of Tank Volume	Watts/m^3/h Flow of Water
(1)	(2)	(3)	(4)	(5)
i)	60	300	72	1·2
ii)	50	360	104	1·4
iii)	40	450	162	1·8
iv)	30	600	288	2·4
v)	25	720	414	2·9
vi)	20	900	648	3·6

NOTE — Power calculations are based on water temperature 30°C.

3.1.2 *Selection of Motors* — The power requirement recommended in Table 1 is the net power input. The capacity of the motor should be calculated taking in account the electrical and mechanical losses in the system. A maximum overall efficiency not exceeded 75 percent should be assumed.

3.1.3 *Vane Type Mixer* — This consists of mechanical device fitted with vanes and installed centrally in a chamber. A typical illustration is shown in Fig. 1. The inlet to the chamber may be from top or at the bottom. When the inlet is at the top, levels should be so adjusted as to prevent heading up of water in the inlet channel. For proper functioning of the unit, the mixer should be designed in accordance with the guidelines given in Table 1. To prevent vibration and wobbling, the maximum unsupported length of the mixer shaft shall not exceed 3 m. The rpm of the shaft is generally in the range of 60 to 100.

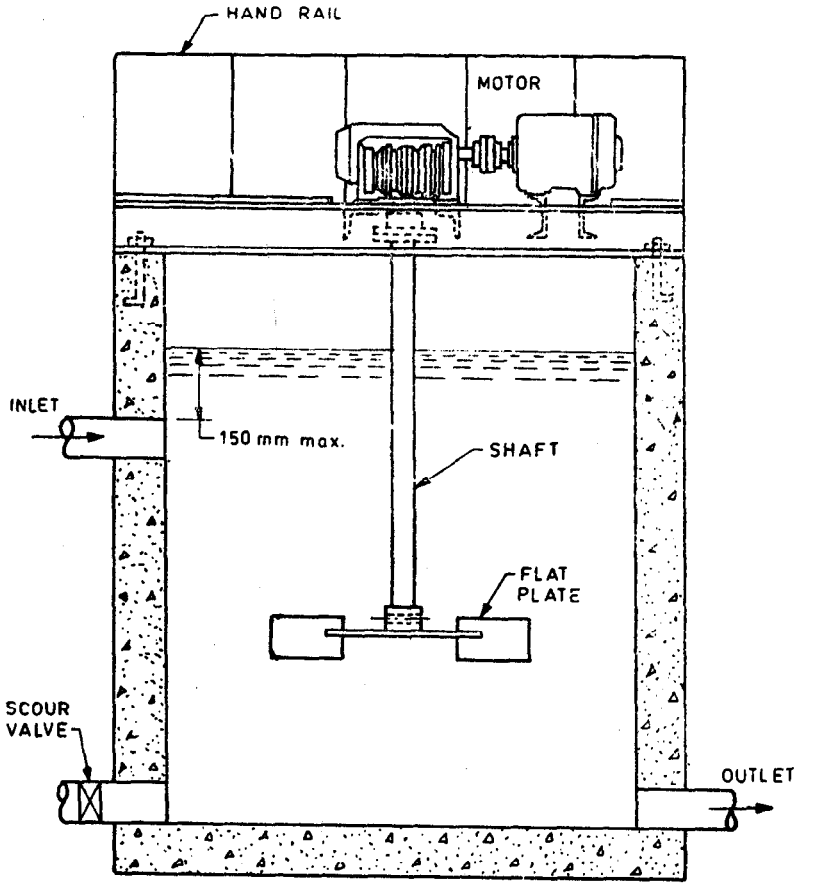

FIG. 1 TYPICAL ILLUSTRATION OF VANE TYPE MIXER

3.1.4 *Propeller Mixer* — This type of mixing devices consists of relatively small high speed impellers like that of ship's screws. Blades are mounted on a vertical or inclined shaft. They generate strong currents in axial direction and have high rate of flow displacement. The speed of rotation generally ranges from 400 rpm for large diameter propellers to 1 400 rpm relatively smaller diameter propellers. The usual ratio of tank diameter to impeller diameter (or side of a square tank) is 5:1 to 3:1. A ratio of tank height to diameter of 1:1 to 3:1 is recommended. The other design parameters shall be in accordance with Table 1.

3.1.5 *Jet Type Mixer* — The jet system of flash mixing produces agitation in the mixer tank hydraulically. A centrifugal pump is used to draw a small portion of the flow and to deliver the same through a nozzle which discharges against a baffle plate. The nozzle shall be located 200 mm above the baffle plate which shall be kept 1/3 to 1/2 inlet pipe diameter above the flash mixer floor. The coagulant solution is admitted at the point where the nozzle discharges. A typical illustration of jet type mixer is shown in Fig. 2. The power requirement of the centrifugal pump should be worked out in accordance with Table 1.

3.2 Materials

3.2.1 *Shaft* — It shall be of mild steel and of solid construction of suitable dimensions but not less than 40 mm diameter.

3.2.2 *Shaft Bearings* — The bearings should be suitable for work under water and under suspension conditions.

3.2.3 *Shaft Couplings* — It shall be of cast iron not less than Grade 20 of IS : 210-1978*.

3.2.4 *Reduction Gears* — It should be made of steel conforming to IS : 1570-1961† and IS : 1870-1965‡ or any other suitable material.

3.2.5 *Vane or Propeller* — Vane shall be of mild steel conforming to IS : 1730 (Part 1)-1974§ and propeller shall be of cast steel conforming to IS : 2644-1979‖.

3.2.6 *Motor* — For vane or propeller type mixers, the motor shall be totally enclosed fan-cooled type conforming to IS : 325-1978¶ having method of cooling IC 41 (*see* IS : 6362-1971**) and having enclosures providing protection IP 54 or superior (*see* IS : 4691-1985††).

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*Specification for grev iron castings (*third revision*).

†Specification for schedules for wrought steels for general engineering purposes.

‡Specification for comparison of Indian and overseas standards for wrought steels for general engineering purposes.

§Dimensions for steel plate, sheet and strip for structural and general engineering purposes: Part 1 Plates.

‖Specification for high tensile steel castings (*second revision*).

¶Specification for three-phase induction motors (*fourth revision*).

**Specification for designation of methods of cooling for rotating electrical machines.

††Specification for degrees of protection provided by enclosures for rotating electrical machinery (*first revision*).

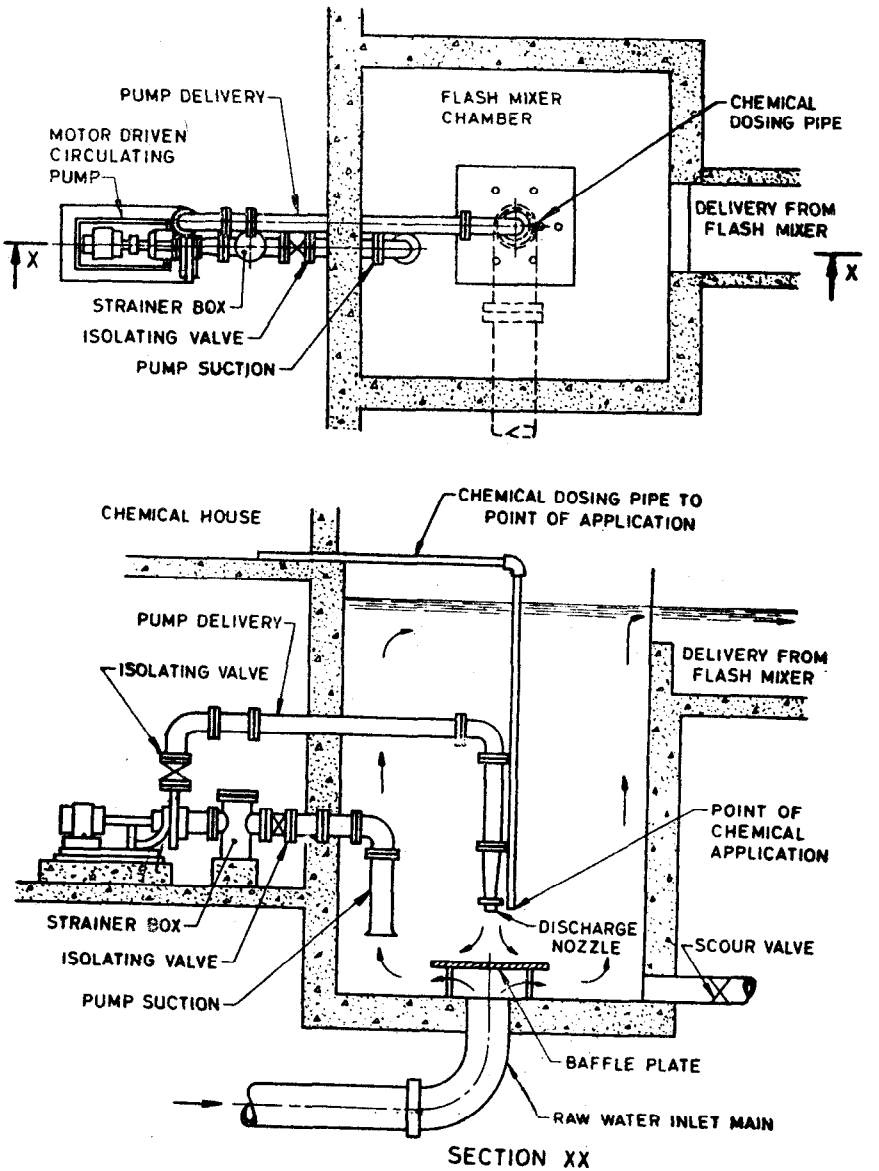

FIG. 2 TYPICAL LAYOUT OF JET TYPE FLASH MIXER

3.2.7 *Centrifugal Pumps* — They shall conform to IS : 1520-1980*.

3.2.8 *Nozzle* — It shall be made of gunmetal conforming to IS : 318-1981†.

3.2.9 *Baffle Plate* — It shall be of mild steel conforming to IS : 1730 (Part 1)-1974‡.

3.2 Chambers — The chambers shall be water-tight and built of concrete or brick masonry. It need not be provided with full cover but shall be provided with a dewatering outlet. A minimum free board of 300 mm shall be provided. In case of vane type and propeller type mixers, the motor assembly shall be provided with a suitable approach way of reinforced cement concrete or steel construction of a minimum width of 900 mm and provided with galvanized iron railings.

3.4 Controls — A push button control shall be provided at the unit. A remote control arrangements may also be provided where desired. Starters provided shall be star-delta type conforming to IS : 8544 (Part 2)-1977§ and shall be oil-immersed break type. The enclosures providing protection shall be of rating IP 54 conforming to IS : 2147-1962||,

4. PAINTING OF FABRICATED PARTS

4.1 Red Oxide (Zinc Chromate) — Red-oxide shall be used as primer for painting. One coat of primer and at least 3 coats of finishing paint after erection shall be applied.

5. HYDRAULIC MIXING

5.1 Hydraulic Jump — It is essentially a method of providing a rapid mix without the use of mechanical units. Coagulant is introduced to the water ahead of its entrance into an open; sloping and widening flume. In passing down the flume, the water acquires a high velocity, 3 to 3·5 m/s and on reaching the bottom, enters a pool of slowly moving water. Some of the kinetic energy acquired in passing down the flume is dissipated in the pool, resulting in considerable turbulence, which in turn, ensures a rapid initial mix. When hydraulic jump is used, the headloss shall not be less than 300 mm at design flow.

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*Specification for horizontal centrifugal pumps for clear cold, fresh water (*second revision*).

†Specification for leaded tin bronze ingots and castings (*second revision*).

‡Dimensions for steel plate, sheet and strip for structural and general engineering purposes: Part 1 Plates.

§Specification for motor starters for voltages not exceeding 1 000 V: Part 2 Star delta starters.

||Specification for degrees of protection provided by enclosures for low-voltage switchgear and controlgear.

5.2 Baffled Channels — Where baffled channels are used, the channel section (neglecting the baffle) shall be normally designed for a velocity of 0·6 m/s.

The angle subtended by the baffle in the channel shall be between 40° to 90° with the channel wall. This angle shall ensure a minimum velocity of 1·5 m/s whilst negotiating the baffle.

The main walls of the channel shall be constructed of brick masonry, stone masonry or reinforced cement concrete finished smooth to avoid growing of weed, etc. The baffle shall be made of concrete or brick finished in the same manner as the channel.

A minimum free board of 150 mm shall be provided.

(*Continued from page* 2)

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