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## 18 MIXERS AND STIRRERS

### 18.1 GENERAL

#### 18.1.1 Scope

1 This part specifies the requirement for the design, manufacture, testing and commissioning of mixers and stirrers.

2 Related Sections and Parts are as follows:

Section 1 General

Section 8 Drainage Works

Section 10 Instrumentation, Control and Automation

Section 13 Building Electrical Works

Section 21 Electrical Works

List of 'Approved Suppliers' prepared by Public Works Authority

#### 18.1.2 References

BS 970 (ISO 683) Specification for wrought steels for mechanical and allied engineering purposes; (ISO 683-1 Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Non-alloy steels for quenching and tempering; ISO 683-2 Heat-treatable steels, alloy steels and free-cutting steels — Part 2: Alloy steels for quenching and tempering; ISO 683-3 Heat-treatable steels, alloy steels and free-cutting steels — Part 3: Case-hardening steels; ISO 683-4 Heat-treatable steels, alloy steels and free-cutting steels — Part 4: Free-cutting steels; ISO 683-5 Heat treatable steels, alloy steels and free-cutting steels — Part 5: Nitriding steels; EN 10250-4: Open die steel forgings for general engineering purposes - Stainless steels; EN 10095 Heat resisting steels and nickel alloys; BS PD 970 Wrought steels for mechanical and allied engineering purposes. Requirements for carbon, carbon manganese and alloy hot worked or cold finished steels; EN 10089 Hot rolled steels for quenched and tempered springs. Technical delivery conditions; EN 10277 Bright steel products. Technical delivery conditions; EN 10278 Dimensions and tolerances of bright steel products; EN 10088-1 Stainless steels - List of stainless steels; EN 10088-3 Stainless steels - Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes;)

BS 970-1..Specification for wrought steels for mechanical and allied engineering purposes - General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels; (ISO 683-1 Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Non-alloy steels for quenching and tempering; ISO 683-2 Heat-treatable steels, alloy steels and free-cutting steels — Part 2: Alloy steels for quenching and tempering; ISO 683-3 Heat-treatable steels, alloy steels and free-cutting steels — Part 3: Case-hardening steels; ISO 683-4 Heat-treatable steels, alloy steels and free-cutting steels — Part 4: Free-cutting steels; ISO 683-5 Heat treatable steels, alloy steels and free-cutting steels — Part 5: Nitriding steels; EN 10250-4: Open die steel forgings for general engineering purposes - Stainless steels; EN 10095 Heat resisting steels and nickel alloys; BSI PD 970 Wrought steels for mechanical and allied engineering purposes. Requirements for carbon, carbon manganese and alloy hot worked or cold finished steels)

EN 10084 . Case hardening steels - Technical delivery conditions; (ISO 683-3 Heat-treatable steels, alloy steels and free-cutting steels — Part 3: Case-hardening steels)

#### **18.1.3 Submittals**

- 1 In addition to the requirements of Part 1 of this Section, the Contractor shall reconfirm the information provided in the Technical Submission Schedules submitted with his Tender.

### **18.2 COMPONENTS**

#### **18.2.1 General**

- 1 Mixers and stirrers generally fall into the following categories:-
  - (a) Static In-line Mixers
  - (b) Submersible Shrouded Mixers
  - (c) Submersible Banana Blade Mixers
  - (d) Tank Mixers
  - (e) Stirrers/Flocculator Paddles
- 2 The mixer performance (excluding static mixers), related to its required duty and installed media, shall be stable and the unit shall be non-overloading.
- 3 Contractors shall select the most economic units given the constraints of the operating parameters and particular requirements of the specification.
- 4 For static mixers the pressure rating of the associated pipework shall be rated to a minimum of 16 Bar unless otherwise stated.
- 5 Mixer propellers, casings and all other external parts shall be of stainless steel construction minimum Grade 316 S31 to B S970-1.

#### **18.2.2 Bearings (Non Static Mixers)**

- 1 The axial thrust generated shall be taken by a thrust bearing arrangement or angular contact bearings. Thrust bearing arrangements incorporated into the motor housing are not permitted. The Contractor shall demonstrate that the bearings are suitably rated in his submittals for approval. Setting of thrust bearings shall account for dynamic loading, albeit setting is carried out with the machinery stationary.
- 2 Rolling element ball or roller bearings shall be sealed for life and shall be rated to give a minimum life of 75,000 hours at maximum load without replacement. Bearings shall be protected by water throwers and lip seals where appropriate. The bearing housing shall be of the cartridge type to allow removal of the bearing without disturbing the units.
- 3 Plain/Bush Bearings where utilised, shall be in bronze or equal, split for easy maintenance and positively locked to prevent rotation.
- 4 Bearing housings shall be of the cartridge type to allow removal of the bearing without disturbing the units.

#### 18.2.3 Sealing (Non-submersible mixers)

- 1 For soft-packed gland arrangements, packing shall be graphite impregnated PTFE, of approved manufacture. Asbestos based packing will not be permitted.
- 2 The gland design shall incorporate the following:
  - (a) A tapered "lead in" at the mouth of the gland entry to facilitate packing replacement and obviate the risk of damage on assembly.
  - (b) The surface finish of the adjacent metal parts shall be  $0.4\mu\text{m}$  CLA on the shaft gland sleeve and  $1.6\mu\text{m}$  CLA on the stuffing box bore.
  - (c) Where running clearances are excessive, the packing shall be protected by an independent ring of robust material which reduces the clearance to a minimum.
  - (d) The packing must not be used as a bearing.
  - (e) All studs, dowels and adjustable nuts shall be manufactured from stainless steel.
  - (f) Lantern rings shall be of gun metal or bronze and shall be split for ease of removal.
- 3 The stuffing box shall be manufactured from cast iron of a heavy section independent of the mixer body and shall be provided with drain holes.
- 4 Mechanical seals shall be employed in submersible or closed tank applications with differential pressures greater than 17 Bar or where controlled leakage is not permitted.
- 5 The Contractor shall specify the type, size and material of the mechanical seal he intends to supply. It shall be the responsibility of the mixer manufacturer to ensure that the tolerances required by the seal manufacturer are not exceeded. Checks shall be carried out on the mixer casing and shafting for:
  - (a) Shaft straightness
  - (b) Rotational Balance
  - (c) Shaft run-out
  - (d) Bearing clearance - lateral and radial movement
  - (e) Shaft tolerance and ovality
  - (f) Concentricity
  - (g) Seat squareness
  - (h) Coupling alignment
- 6 The Contractor shall ensure that the seat, face and component materials of the mechanical seal are suitable for the media.

#### 18.2.4 Balance

- 1 The whole of the rotating assembly, including locking key(s) and mixing element, shall be dynamically balanced as an integral component. The mixing element shall also be dynamically balanced separately and then assembled to the shaft, to form without further adjustment, a dynamically balanced whole.

#### 18.2.5 Rating Plate

- 1 Rating plates shall be fitted to all mixers, be manufactured and fixed by corrosion resistant material (excluding brass), and include full details of the mixer including size, type and serial number.
- 2 The weight of the mixer including motor/mounting brackets etc. shall be marked on the data plate

#### 18.2.6 Couplings

- 1 For large mixers, couplings shall be provided to permit the removal of drive shafts, bearings, etc. without removing the mixer or motor. Couplings between the thrust bearing and motor shall be accommodated within motor/support stools.
- 2 Couplings shall be of the pin and buffer type unless otherwise specified.

#### 18.2.7 Guarding

- 1 All machine enclosures shall be safeguarded with guards fixed to the body or motor as practical for the application.
- 2 Shaft guards shall extend the whole length of the shaft.

#### 18.2.8 Installation and Lifting Equipment

- 1 Independent of application, the mixer shall be positively located and secured when operating. Methods of installation shall be one of the following methods:-
  - (a) Swivel Mounting (for tank mixers/stirrers) - ease of removal of the mixing element from the media shall be facilitated by means of a swivel mounting arrangement installed on the top of the tank. This shall incorporate an adjustment to enable off centre mixing.
  - (b) Guide Rail mounting (for submersible mixers) - the mixer shall be supported by the lifting chain from a hanging point and have a sliding guide bracket of stainless steel Grade 316 S31 to BS 970-1 (partially replaced by EN 10084) mounted on a vertical guide rail. It shall be possible to remove and replace the mixer safely without lowering the level in the sump, or leaning into or entering the sump. The guide rail and hanging arrangement shall permit full adjustment of the depth and direction of the mixer. The guide system shall be retained at the lower end and upper end by stainless steel mounting brackets. Rails shall be installed to within  $\pm 05\text{mm}/\text{m}$  length of the vertical with no more than +1mm -0mm tolerance between parallel rails.
  - (c) Direct flange mounting to a mixing tank shall preferably be from the top. Side entry mounting is acceptable for vessels greater than  $4\text{m}^3$ . The mounting shall be designed to enable removal through the flanged hole. Alternatively and especially for drum applications, the impeller can be of the folding type.

- 2 Integral lifting brackets, shackles and lifting eyebolts shall be provided and shall be manufactured from stainless steel with a minimum U.T.S. of  $540 \text{ MN/m}^2$ , and certified by an approved testing authority. Both bolt and hole shall be permanently marked, preferably by punching, with the diameter and thread form used. All eyebolts shall be of the collar type

#### 18.2.9 Protection from Corrosion

- 1 The internal & external finishes shall be in accordance with Section 8 Part 8.

### 18.3 SUBMERSIBLE MIXERS

- 1 Submersible shrouded mixers installed in open or closed topped tanks or chambers, should be considered for the mixing of sewage, slurries, sludges and industrial process solutions where there is an absence of rags and other large debris.
- 2 The mixer shall be easily removable from the installed position and this shall be achieved by means of a guide rail system which also allows depth adjustment of the unit.
- 3 The assembly shall be directly driven from a submersible motor through an oil casing and, when the specified duty dictates, also via a reduction gearbox. The motor shaft shall extend to form the drive shaft of the propeller.
- 4 The oil casing shall provide lubrication and cooling for the seals and create a barrier between the motor and the media. Expansion of the oil within the sealed casing shall be contained by an air volume. Moisture sensor shall be provided for detecting any seal failures.
- 5 The propeller shall be designed to deter clogging and produce high efficiency, and the shroud shall be fitted over the propeller to improve efficiency and direct the flow from the mixer. The shroud shall be optional and the unit shall be capable of continuous operation without it.
- 6 Motor cooling shall be achieved by the surrounding media.
- 7 Submersible banana blade mixers shall be easily removable from the installed position and the blades shall be manufactured from lightweight glass reinforced plastic
- 8 Shafts shall either be sealed from the media in which they are working or shall be manufactured from grade 316 stainless steel. Coated shafts shall not be permitted.
- 9 Submersible mixer motors shall be certified for use in a Zone 1 explosive atmosphere and be capable of working at 20m liquid depth. All other requirements for motors and shaft seals shall be to the requirements of Section 9 Part 2 2.4 (submersible pump fabrication).

### 18.4 Tank Mixers

- 1 Tank mixers installed in open topped or closed tanks or chambers should be considered for the mixing of chemicals, slurries, sludges, industrial process solutions where there is an absence of rags and other debris.
- 2 Tank mixers and stirrers shall be easily removable from the installed position and shall be achieved by means of a flanged connection at the top or side of the tank or, in the case of portable mixers, by means of a positioning bracket which shall be universally adjustable as necessary for the application.
- 3 The assembly shall be driven from a totally enclosed fan cooled motor or air motor through a reduction gear box.
- 4 The gear box output shaft shall extend to the propeller shaft via a rigid coupling. Shaft sealing shall be provided between the mixer and a closed tank. The motor shaft shall extend to form the drive shaft of the gear box.
- 5 Propellers shall be designed to produce high efficiency.

## 18.5 STATIC MIXERS

- 1 Static Mixers installed in line within pipework for the blending of liquid to liquid and gas to liquid in waste water treatment applications shall be constructed from materials suitable for use with the chemicals they are associated with and shall be complete with end connections compatible with the mating pipework. Changes in diameter or shape relative to the adjacent pipework shall not be permitted.
- 2 Mixing shall be achieved by either flow splitting, rotating and recombining, or by vortex action. The mixer shall incorporate sufficient elements to ensure complete and homogenous mixing across the pipe section given the specified flow variations.
- 3 Assuming complete and homogenous mixing, the mixer shall maximise energy efficiency to reduce the pressure losses through the unit. A characteristic curve of pressure loss against flow shall be provided at the tender stage.
- 4 Where chemical injection points are integral with the mixer, they shall be designed and positioned to maximise the mixing efficiency. Injectors shall be manufactured from materials that tolerate the chemicals being dosed allowing for the design pressures.

## 18.6 INSTALLATION AND COMMISSIONING

- 1 Installation and commissioning shall be in accordance with Part 1 of this Section 9.

END OF PART