## Contents


1 Subject of specification ..... 2
2 Scope of validity ..... 2
2.1 Order of precedence ..... 2
2.2 Local regulations ..... 2
2.3 Standards/norms ..... 2
2.4 Deviations ..... 2
3 Definitions ..... 3
4 Design and constructional requirements ..... 3
4.1 Design requirements ..... 3
4.2 Materials ..... 4
4.3 Mechanical design requirements ..... 4
5 Painting ..... 5
5.1 Nameplate ..... 5
5.2 Inspection and tests ..... 5
6 Technical documentation ..... 5
7 Relevant documents ..... 6
7.1 Grupa LOTOS S.A. specifications ..... 6
8 Record of changes ..... 7


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## 1 Subject of specification

This specification used in conjunction with other technical specifications of Grupa LOTOS S.A. establishes the minimum requirements for the design and fabrication of agitators.

## 2 Scope of validity

This specification applies to the preparation of tender documents, inquiries and contracts concerning new investments and modernization projects planned by Grupa LOTOS S.A.

It shall also be a basis for preparing both detailed specifications and inquiries for individual or package unit supplies.

This specification should be considered together with specification no. 2400 – "General requirements for Machines and drives".

References to other industrial standards for compliance shall be interpreted as an integral part of this specification.

### 2.1 Order of precedence

In case of conflicts existing between this specification and other documents, the following order of precedence shall govern:

- The current Polish legislation
- Terms of purchase order / contract and other requirements agreed in writing Grupa LOTOS S.A.
- Data Sheets approved by Grupa LOTOS S.A.
- This specification
- Other Specifications
- Drawings and other documents
- Standards

### 2.2 Local regulations

The agitator units shall be designed, manufactured and installed in compliance with all applicable national and local laws and regulations, Grupa LOTOS S.A. specifications and current technical standards referred to in purchase order documents.

### 2.3 Standards/norms

Agitators shall be designed in accordance with manufacturer's standard including requirements stated herein. Typical components shall be in accordance with industry recognized standards applied to refinery industry. Applicable standards shall be stated in agitator data sheets.

### 2.4 Deviations

Any deviation from this specification and the relevant specifications, standards and related documents including proposals, which the bidder claims to be economically and/or technically superior solutions,

must be submitted in writing for review and approval by Grupa LOTOS SA. Non-approved exceptions are not acceptable by Grupa Lotos S.A.

The Supplier must report in writing any ambiguity in this or any other specifications of Grupa LOTOS S.A. or non-compliance with the referred documents / standards and obtain a written explanation from Grupa LOTOS S.A.

## 3 Definitions

Definitions for the elements of an agitator package.

The main parts of an agitator unit are as follows:

- the agitator – a device used for preparing solutions and suspensions especially for liquid-gas, liquid-liquid systems where large differences in the densities of the components occur, for heat exchange in mass or for accelerating the course of a reaction, and for mixing different substances (solid, liquid and gaseous) in a forced way regardless of the occurring physical and chemical processes;
- gear – a device used for transmitting the driving torque and, at the same time, changing the rotational speed and/or the plane of the axis of rotation;
- seal – a device used for eliminating the emission of vapours/gaseous phase of the working medium or its leakages to the environment, made usually in the form of soft packing or a mechanical seal (single or double);
- coupling – a device used for transmitting the driving torque, vibration damping and compensation for misalignment of machine shafts;
- electric motor – the device that drives an agitator.

## 4 Design and constructional requirements

The manufacturer of the agitator unit shall perform an analysis to define hazards that may occur during the operation of the device due to the pressure, temperature or type of medium.

The device shall be designed and manufactured in compliance with the results of the analysis and be fitted with the necessary accessories and installed in such way to be safe in operation over the whole period of operation.

### 4.1 Design requirements

**General**

When designing agitators the process parameters and loads that may occur during their operation shall be allowed for. In particular factors such as the following shall be foreseen and taken into consideration:

- internal and external pressure;
- ambient and operating temperatures;
- the mass of the substance in operating conditions and during tests;
- dynamic loads;
- reaction forces and moments from the structure, supports;
- corrosion, erosion, material fatigue and other;

- decomposition of unstable liquids.

The Supplier shall inform Grupa LOTOS S.A. of any non-standard technical solutions.

### 4.2 Materials

Materials used for making agitator elements shall have properties adequate for the operating conditions specified in the data sheets and be sufficiently resistant to physical and chemical impact of the mixed media to be safe over the whole period of operation.

In case unfavourable conditions resulting in corrosion, erosion or abrasion of material may occur adequate measures shall be taken to restrict or eliminate those phenomena e.g. by adopting adequate material allowances, the application of suitable protective lining, or assuring easy replacement of the most exposed elements.

### 4.3 Mechanical design requirements

Agitator, motor and auxiliary equipment must be suitable for outdoor installation.

Agitator construction shall be suitable for the properties of the mixed medium to ensure the required mixing efficiency and speed regardless of the ambient conditions in place of operation.

Agitators intended for mixing hazardous media of toxic, caustic, infectious, flammable or self-ignition properties shall be fitted with a double mechanical seal ensuring air-tight sealing of the mixing process.

For the vertical agitator located on the top cover of the tank and operating with the medium vapours, the mechanical seal shall be executed with soft and hard rings. Stationery ring shall be made of silicon carbide or tungsten carbide, whereas the rotating ring shall be made of carbon impregnated with resin or antimony. For side-entry mixers operating with polluted media, the mechanical seal shall be executed with both hard rings where the stationery and the rotating rings are made of silicon or carbide or tungsten carbide. All metal parts shall be made of alloy steel 316. If it is necessary to flush the seal, the Supplier shall specify the liquid quality, quantity and parameters (pressure, temperature).

The first critical speed shall be 25% higher than the maximum rotational speed. The Supplier shall submit the calculations to Grupa LOTOS S.A. for checking and approval.

The dimensions of the agitator components and the agitator itself must enable their assembly through the agitator nozzle stated in the purchase order.

The electric motor shall be supplied in accordance with the requirements of Grupa LOTOS S.A. specification no. 4200.

Motor rating shall be at minimum 110% of the agitator shaft power, including gear loss.

Depending on the coefficient increasing the motor power, where a gear is used, the following service factors must be taken into account:

- 1.25 for normal service
- 1.5 for medium variable service
- 2.0 for cycling service.

The gear shall be made according to AGMA standard, and the service factor shall be stated in the technical specification of the agitator.

The use of helical or helicoidal gears shall be preferred. Other types of gearing, if proposed, shall be clearly indicated in the offer.

Belt drive shall be applied in case the viscosity of the medium is strongly dependent upon temperature (e.g. bitumen).

Solid, of constant diameter, one piece shaft design shall be preferred.

Total run-out, eccentricity, and deflection of the shaft at the seal during agitator operation shall not exceed the limits stated by the seal manufacturer. Confirmation data shall be presented in the offer.

When mounted into tanks made of alloy steel agitator's mounting flanges shall be also made of alloy steel or of carbon steel with an alloy liner. The thickness of the liner shall be at minimum 3 mm (1/8 inch) plus adequate corrosion allowance. The liner shall be welded to carbon steel first by plug welding and then by seal welding both on the inside and outside of the nozzle.

The radial bearings and thrust bearings applied shall be rolling bearings of a life time of $L_{10}$=30 000h. Bearings lubricated by a non-pressure system shall be fitted with oil level indicator, and the recommended type of lubrication oil shall be clearly indicated on the gear.

Coupling between the gear unit and agitator shaft shall be of flexible forged steel type with a service factor of 1.5. Spacers shall be provided where required for removal of shaft seals and normal maintenance.

## 5 Painting

Painting shall be in accordance with specification no. 2400.

### 5.1 Nameplate

The agitator assembly shall be provided with a permanently attached stainless steel nameplate which shall show, at the minimum, the following:

- Supplier's name and serial number
- Date of fabrication
- Tag number and type of the device
- Direction of rotation
- Rated power (kW) and rated speed (rpm)
- Max. operating pressure (bar) and max. operating temperature ($^0$C)

### 5.2 Inspection and tests

For general requirements refer to Grupa LOTOS S.A. specification no. 2400 – "General requirements for machines and drivers."

Shaft seal shall be tested at the design differential pressure and at the design speed. Test method and procedures shall be submitted to Grupa LOTOS S.A. for approval.

## 6 Technical documentation

During design stage of the agitator the technical documentation shall be prepared and the agitator's Supplier shall submit this documentation in at least two copies for approval:

The technical documentation shall include the following:

- a specification of the applied regulations and standards;

- assembly drawings for assemblies and subassemblies as well as manufacturing drawings of the components which allow to verify the compliance of the agitator design with the requirements of relevant standards,
- list of materials/parts (with manufacturer's codes) of which the agitator is consisting of,
- the technical data for thermal insulation, if applicable,
- the electrical diagram, if applicable,
- instruction operation manual,
- a hazard analysis.

Instruction operating manual shall include at least the following:

- a general description of the device, its application and technical data (working parameters);
- a description of the structure, operation and adjustment of the drive mechanisms and their equipment (both mechanical and electric);
- a description of the structure, operation and control for the protecting equipment;
- a description of activities to be performed during operation of the equipment (a description for operation of the devices and indications of instrumentation) together with the arrangement (layout) drawings for this equipment as well as operator's responsibilities;
- the requirements concerning safe operation of the agitators depending on their application and operating conditions;
- information about the required qualifications for maintenance personnel;
- lubrication instructions with a specification of lubricating points; types of lubricants, in particular oils and greases, and the lubrication change intervals;
- list of possible failures that may occur during mixing, with the probable causes and the remedied actions;
- schedule of overhauls
- the properties of the mixed medium.

## 7 Relevant documents

### 7.1 Grupa LOTOS S.A. specifications

Any "Technical Specification" issued by GRUPA LOTOS S.A. listed in Contract Files.

## 8 Record of changes

| No. | Date | Description | Introduced by |
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