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USA market and Industry for Mixing Equipment.

Let’s discuss mixer specification requirements for USA market.

## GENERAL

This specification defines the minimum mechanical requirements of the mixing equipment to be operated outdoors in a process plant. All tanks, basins, or other *mixing* vessels will be provided with anti-swirl baffles to be supplied by others in accordance with the project drawings or as specified elsewhere in this specification.

The intent of this specification is to require that the equipment supplied provide the mixing or aeration process needs, as defined elsewhere in this specification, be a standard product of a manufacturer who is and has been an established commercial supplier of such equipment for not less than 5 years

### Warranty

The equipment seller shall be solely and fully responsible for warranty and mechanical design adequacy of all the components in the scope of supply defined in this section of the specification, including purchased and sub-contracted items.

### SCOPE of Supply

Each assembly shall include as a minimum, an electric motor, flexible *element* motor coupling and guard, speed reducer, mixing impellers, the lower shaft carrying such impeller(s), and the means of shaft attachment to the reducer/drive and impeller(s).

## EQUIPMENT DESIGN

### SPEED REDUCER Helical-Spiral Bevel Type

The lower mixer shaft slides up through a "quill" shaft and is directly connected to the mixer drive by a thrust plate and bolts at the top of the drive. The shaft is drawn up against a split thrust collar located just below the drive, creating a solid connection to the reducer. The bearing support for the lower mixer shaft therefore becomes the upper and lower low speed reducer bearings. Note, these bearings are oversize since their ID is established by the OD of the low speed ***reducer*** shaft. These bearings are normally Timkin or equivalent type bearings with some exceptions. The low speed reducer bearings have a dual purpose, they support the low speed reducer shaft and gearing ***and*** support the mixer shaft. With this type of drive design, all of the loads seen by the mixer shaft are transmitted to the reducer shaft, gears and bearings.

The speed reducer shall be specifically designed for mixing service. To facilitate installation and maintenance the gear drive should be a low headroom right angle type comprised of helical and spiral bevel gearing. Worm gear drives are not acceptable.

*As a minimum, all* helical gearing shall meet the requirements of AGMA Quality No. 10 under AGMA standard 390.03. Spiral bevel gears should be designed in accordance with the latest AGMA standards.

General maintenance, specifically including motor changes, speed changes, replacement of all anti-friction bearings (except the bearing supporting the output shaft), and oil system maintenance, shall not require removal of the speed reducer housing from its foundation.

These right angle speed reducers have efficiency above 96% and incorporate precision-generated, hobbed, shaved and carburized fine-pitch helical gears in the primary reduction. Spiral bevels are used as final reduction gears, and are individually mounted, micrometer-set and match-lapped to assure quietness. As standard, the primary reduction for these drives is a matched set of gears which allows speed changes to be made easily without special tools, without dismantling the mixer or removing it from the tank, and without expensive rebuilding.

Splash lubrication provides a constant flow of oil to all surfaces without the need for pumps or piping. An oil dam around the mixer drive shaft gives positive protection against lubricant leakage down the mixer shaft.

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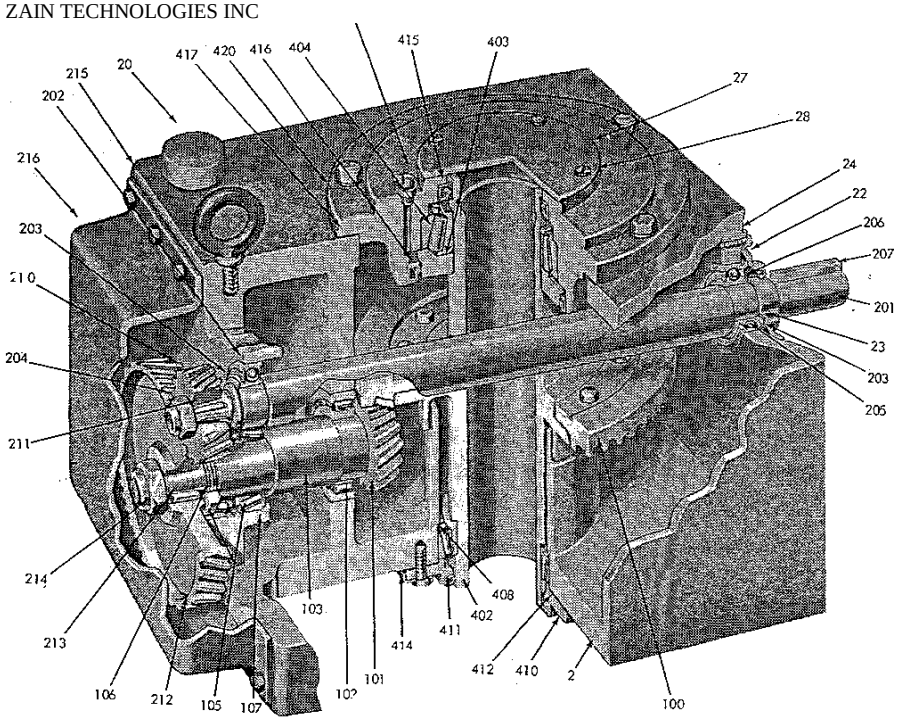


**Figure 1 – Typical Gear Drive in the USA**

ITEMS 210 & 212, HELICAL PINION AND GEAR ARE MATCHED SETS

NOT SHOWN

| ITEM | PART NAME | ITEM | PART NAME |
|---|---|---|---|
| 204 | LOCKNUT — CHANGE GEAR PI NION | 420 | LOW SPEED BEARING CAGE |
| 203 | RETAINING RING | 417 | SHIM PACK — LOW SPEED BRG. CAGE |
| 202 | INNER BEARING | 416 | OIL SEAL — INNER |
| 201 | HIGH SPEED SHAFT | 415 | OIL SEAL — OUTER |
| 110* | RETAI NER | 414 | LOCK PLATE |
| 109* | SHIM PACK—BEVEL PINION ADJUST. | 412 | SHIM PACK — LOW SPEED RETAINER |
| 108* | SHIM PACK—BEARING ADJUSTMENT | 411 | OIL SEAL — LOWER |
| 107 | BEARING CAGE—BEVEL PINION | 410 | LOW SPEED RETAINER |
| 106 | LOCKNUT & WASHER | 408 | LOWER BEARING |
| 105 | OUTER BEARINGS | 404 | UPPER BEARING |
| 103 | SPACER | 403 | COLLAR |
| 102 | INN ER BEARING | 402 | LOW SPEED SHAFT |
| 1010 | BEVEL PINION | 216 | CHANGE GEAR COVER |
| 1000 | BEVEL GEAR | 215 | GASKET — CHANGE GEAR COVER |
| 28 | GASKET — COVER PLATE | 214 | LOCK NUT -CHANGE GEAR |
| 27 | COVER PLATE | 213 | KEY — CHANGE GEAR |
| 24 | GASKET —H.S. SEAL CAGE | 2120 | CHANGE GEAR |
| 23 | OIL SEAL | 211 | KEY — CHANGE GEAR PINION |
| 22 | HIGH SPEED SEAL CAGE | 2100 | CHANGE GEAR PINION |
| 21* | OIL DIPSTICK | 207 | KEY — HIGH SPEED SHAFT |
| 20 | BREATHER ASSEMBLY | 206 | RETAINING RING |
| 2 | HOUSING | 205 | OUTER BEARING |

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## REDUCER RATING

Drives shall be rated for continuous 24 hour per day operation in accordance with the latest applicable AGMA standards for enclosed gear drives. The thermal rating of the speed reducer shall exceed the design mechanical rating to eliminate the need for external coolers. External cooling devices are not acceptable. The manufacturer shall certify, in writing, that the speed reducer is designed to the applicable AGMA Standards.

Gear drives for units whose impellers are classified by the Impeller Section of this specification as being liquid level sensitive shall have an AGMA mechanical rating not less than 2 times the motor nameplate horsepower.

## REDUCER HOUSING

Each drive unit shall include a heavy duty speed reducer in a cast-iron or fabricated steel housing. All non-machined housing, retainer and cage interior surfaces shall be coated with gear case sealer by spraying or dipping. Assembled drives shall be pressure tested.

To prevent oil leakage along the drive output shaft, a drywell will be provided to exclude oil from the output portion of the gear drive. Where manometer type wells are used radial clearances shall be not less than one half inch to prevent oil pumping.

The speed reducer breather shall be located above possible oil foam level. All speed reducer openings below the operating oil level shall be positively sealed with compressible gaskets.

No 0-ring seals will be allowed. The speed reducer shall be provided with lifting lugs. The speed reducer shall be spin-tested prior to shipment.

## NOISE LEVELS

The expected overall noise level is below 80 dBA at a distance of 3 feet or more than the unit. This noise level is measured on a test stand, and applies to units with a maximum nominal input speed of 1750 RPM and output speeds of 155 RPM maximum.

## REDUCER OUTPUT SHAFT

The speed reducer output shaft shall be constructed and supported so that the shaft deflection caused by operating loads does not affect alignment of the anti-friction bearings or cause misalignment of gearing during mixer operation.

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## BEARINGS

Bearings throughout the design shall be anti-friction type of ball, roller, or tapered roller design. Pressed-on type or sliding, journal type bearings are not acceptable. Replacement of any gear drive anti-friction bearing, except the bearing supporting the output shaft, shall not require removal of the speed reducer housing from its foundation.

## BEARING LIFE

All speed reducer output shaft and independent mixer shaft support bearings shall have a minimum L-10 life of 100,000 hours as calculated by the latest AFBMA standard. Other bearings shall be of a type appropriate to the nature and size of the torsional thrust and lateral loads encountered. In addition to the design torsional and thrust loads created by the gearing, bearing life calculations shall include the bending loads caused by the forces acting at the mixing impeller. The type and magnitude of the forces used in the calculation shall be substantiated by the equipment supplier, on request.

## SHAFT BEARINGS

The output shaft bearings shall be grease-lubricated with grease inlet and relief accessible from the mounting surface .
Grease fittings serving the mixer and output shaft bearings are to be plainly marked and each grease fitting shall be protected with a removable cover.

## LUBRICATION

The speed reducer oil shall have a splash lubrication system suitable for all-weather starting and operation. Splash lubrication by means of an oil slinger or by gears running in an oil bath is preferred.

Grease lubrication of some working parts is permissible, providing adequate separation is made of these parts from the oil lubricated parts.

All oil lubricated bearings shall be located above the top of the main lubricant drain and sufficiently above the speed reducer oil sump to prevent life-shortening particulate matter and sludge from entering the bearings. No oil seals will be permitted below the operating oil level for rotating elements.

A dip stick shall be provided to measure oil levels for all systems.

Alternate pumped oil lubrication systems that require any lifting, or disassembly of the drive for oil pump or lubrication system maintenance are not acceptable. Pump systems shall provide an external oil filter on each gear drive to protect the pump and the gear drive from dirt and sludge. There shall be a gauge on the filter outlet indicating lubricant flow. Protective devices to notify the plant operator and stop the drive motor in the event of pump failure, or low oil level chill be provided with gear drives having pumped lubrication systems.

**OIL DRAIN**

A single extended oil drain shall be provided, positioned for easy access, and located to leave not more than 1/4' of residual oil within the drive housing. Following the initial run-in period, oil changes sha11 not be required at less than 2500-hour intervals when operated continuously at ambient conditions above freezing. Instruction manuals shall include a list of acceptable lubricants, and recommended change intervals for low temperature operation.

**MIXER SHAFT**

The output shaft shall be totally overhung, the use of submerged or steady bearings is not permitted. When turned over by hand, impeller shaft runout or deflection shall not exceed 1/4' per 10' of length.

Separation of the shaft supporting the turbine from the speed reducer shall not require disassembly or other disturbance of the speed reducer internal gearing. A bolted connection to a hollow output shaft or a flanged coupling joining the reducer output and impeller shafts may be used. Flanged connection for impeller assembly is an acceptable alternate.

**CRITICAL SPEED – FREQUENCY OF VIBRATION**

When stabilizing devices are used in conjunction with mixing impellers, the rotating speed of the unit shall not exceed 80% of the first natural frequency, in air, of the shaft and impeller assembly. The rotational speed shall not exceed 40% of the natural frequency when impellers operate for prolonged periods at or near the liquid surface or when impellers without;: stabilizing devices are used.

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## IMPELLERS

Impellers whose power consumption, side load, and pumping characteristics have not been fully documented by the equipment manufacturer will not be acceptable. Such impellers shall include the affects of liquid level variation on power investment, basin hydraulic stability, blade loading, and process performance.

A liquid level sensitive impeller is defined as any impeller for which a 3 inch change in elevation of the liquid surface at the shaft centerline causes a change of electrical power consumption of 15 percent or more. Each unit fitted with such impeller shall have a minimum AGMA service factor of 2, or include a protective device to stop the motor if transient overload occurs caused by such things as change in basin throughput or wind created waves.

Impellers whose power consumption is less than 15 % during such change are classed as Liquid Level Insensitive.

The impeller shall be of such design, and operate at such rotational speed that dynamic balancing is not required to prevent damaging vibration.

Impellers shall be removable from the shaft by means of a detachable hub, detachable blades or a flange type coupling connection.

Impellers intended to be operated at the liquid surface shall be connected to the shaft by a square hook type key, designed to transmit full motor torque and to support the impeller assembly on the shaft. An extended keyway **shall** be provided of sufficient length to permit adjustment of the axial position 6 inches up or down from the *design* location. When a flanged coupling or a liquid level sensitive type impeller is used, the drive will be provided with a means of changing the elevation of the impeller from the mounting platform.

Materials of the impeller shafts, impeller hubs and blades shall be as specified. The minimum material thickness for impeller fabrication is 1/8 inch.

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## MOTORS

The driver shall be a (TEFC) totally enclosed, fan cooled, electric induction motor with insulation meeting Class B, and a weather tight junction box. The manufacturer's standard starting code will apply unless otherwise specified. The insulation shall be non-hygroscopic. The maximum motor speed shall be 1800 rpm. Unless otherwise specified, the electrical characteristics **shall** be 460 volts/3 phase/60 Hertz. (575 V in Canada)

A flexible coupling and coupling guard **shall** be provided between the electric motor driver and the gear box input shaft.

## TESTING

Prior to shipment, each drive unit shall be run with a polarizing, rust-inhibiting oil during the reducer spin test at the manufacturer's facility to verify that it is correctly manufactured and assembled and is free of oil leaks. After installation, each unit shall be run to demonstrate its ability to operate without overheating, jamming or excessively vibrating during normal operation.

## PAINTING

Normally, painted surfaces not subject to continuous wetting by the process liquid shall include motors and speed reducers. Surfaces of the drive assembly to be painted shall be commercially blast-cleaned prior to application of the manufacturer's standard primer. Preparation shall meet Steel Structures Painting Council Surface Preparation Specification and Pictorial Vis 1 (Latest Editions), SSPC-SP6. All blast cleaning **shall** take place before any assembly occurs. Painting requirements elsewhere in this specification shall not require or permit abrasive blasting of final assemblies with rotating components.

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**PREPARATION FOR SHIPMENT - CORROSION PROTECTION**

Special measures shall be taken to treat all mixer internal and external mild steel parts that are without permanent coatings, e.g., paint, etc., for resistance to corrosion from water vapor. Under ordinary conditions these procedures will assure adequate protection of mixers during shipment (domestic or export).
A vapor phase inhibitor shall be sprayed into each gear drive through one of the openings. Care will be taken to maintain the spray propellant free of water and water vapor. Holes in the gear drive for the dipstick and breather shall be plugged and the dipstick and breather will be shipped loose.

The inside surface of the tubular shafts shall be coated with a protective molybdenum rich anti-seize compound and the open ends will be sealed off with plastic plugs.

The entire upper portion of the mixer shafts which are to be field installed in the gear drive, including the top end and tapped holes, shall be coated with anti seize compound. A tightly wrapped layer of inhibitor coated paper shall be applied to this portion which will then be covered with waterproof export paper and sealed with waterproof tape.

Impellers, In-tank all exposed parts such as shafts, impeller assemblies, shafts, & misc. steady bearing assemblies, flexible coupling hubs, motor components and gear drive shaft extensions, mixer bearing assemblies, etc. shall be protected with a waxy film moisture excluding coating such as CRC Industries SP 400 sprayed on or hand applied.