SPECIFICATION FOR ADJUSTABLE-SPEED SUBMERSIBLE MIXER SR 4530 WITH GEAR BOX

GENERAL REQUIREMENTS

Furnish and install _____ submersible mixer(s). Each mixer shall be equipped with a rated _____ HP, submersible electric motor connected for operation on _____ volts, _____ phase, 60 hertz, _____ wire service, with 30 ft. of _____ Subcab cable with a chlorinated polyethylene rubber jacket. Each unit shall be fitted with _____ feet (40 ft. minimum) of lifting cable of adequate strength to permit raising and lowering the mixer. Mixers specified herein shall have 3 propeller blades which when inserted into the propeller hub will provide an overall propeller diameter of _____ feet and be capable of a nominal thrust of _____ N with a shaft horsepower not to exceed _____ BHP in clear water. The mixer motor shall be rated at no less than ____ HP.

THRUST TEST (Optional)

If required by the specification, the mixer(s) shall be subjected to a thrust test. The nominal thrust created by the mixer, as measured in clean water, will be _____ Newtons at an input power of _____kW. The test procedure and results shall be in accordance with ISO specification ISO21630:2007.

MANUFACTURER REQUIREMENTS

The mixing equipment specified herein shall be the design and fabrication of a single manufacturer which shall have sole source responsibility for said equipment. The manufacturer shall have mixing equipment of this design and of comparable capacity in successful operation in the field for a minimum period of _____ years. If this requirement is not met, the contractor shall be required to provide a performance bond in the amount of 200% of the value of the bid price for this item and this bond shall remain in effect until two years after final acceptance of the installation.

MIXER DESIGN

The mixer(s) shall be capable of handling raw, screened sewage. The mixer(s) shall be able to be raised and lowered and shall be easily removed for inspection or service without the need for personnel to enter mixing vessel or reactor tank. A sliding guide bracket shall be an integral part of the mixer unit. The entire weight of the mixer unit shall be guided by a single bracket which must be able to handle all thrust created by the mixer. Mixer weight including blades and excluding power cable shall not exceed _____ pounds. The mixer, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 131 ft.

THE MOTOR AND DRIVE TRAIN

The motor shall operate at _____ RPM and in conjunction with a helical gear system in such a manner as to produce a maximum propeller speed of _____ RPM.

MIXER CONSTRUCTION

Each mixer shall be of the integral gear, close-coupled, submersible type. All components of the mixer, including motor and gearbox shall be capable of continuous underwater operation while the mixer blade is completely submerged.

Major mixer components excluding blades and stand shall be of grey cast iron, Class 30, with smooth surfaces devoid of blow holes and other irregularities. The Sliding Bracket and mixer Stand assembly shall be 316 stainless steel. All exposed nuts and bolts shall be of 316 stainless steel. All surfaces coming into contact with the mixed media, other than stainless steel and fiberglass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with an epoxy finish coat on the exterior of the mixer.

All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O-rings without requiring a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used.

CABLE ENTRY
The cable entry shall be an integral part of the stator casing. The cable entry shall be comprised of a double cylindrical elastomer grommet, flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak-proof, torque free seal at the cable entrance. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a brass gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

MOTOR
The mixer motor shall be squirrel cage, induction, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The use of multiple step dip and bake-type stator insulation process is not acceptable. The motor shall be designed for continuous duty, capable of no less than 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum. At the design point the motor shall not draw more than _____ kW in clear water at nominal voltage of utility supply quality. The motor shaft, delivered with the rotor as an integral part, shall be stainless steel.

SENSORS
Thermal sensors, embedded in the stator winding end-turns and wired into the pump control, shall be used to monitor motor over-temperature. These shall be supplemental to the external motor overload protection located in the control panel.

MOTOR BEARING
The mixer motor shaft shall rotate on two permanently lubricated bearings. The inner bearing shall be a single row deep groove ball bearing and the outer bearing a spherical roller bearing, both having 50,000 hours service life.

SEALS
Each mixer shall be provided with three seals to separate the various parts of the mixer. The outer seal on the propeller shaft shall be a lapped end face type mechanical seal containing one stationary and one positively driven rotating, corrosion resistant, tungsten carbide face ring running in the mixed media for cooling and lubrication. All seal face surfaces must be capable of re-lapping. In order to prevent seal spring jamming and failure, the seal spring shall not be exposed to the mixed media. The inner seal on the propeller shaft shall be a nitrile rubber, lip seal isolating the propeller shaft oil chamber from the gearbox oil chamber. The third seal shall be a fluorinated rubber, lip seal mounted on the motor shaft to isolate the gearbox oil chamber from the dry motor stator housing.
Each mixer shall be provided with an oil chamber for the shaft sealing system, and a second separate oil chamber for the gearbox. The drain and inspection plugs, with positive anti-leak seal, shall be easily accessible from the outside.

GEAR UNIT
The gearbox shall be a two-stage, cylindrical, helical gearbox equipped with high precision, low loaded gears designed for infinite life. The motor shaft shall be provided with an integral driving gear. The gearbox intermediate shaft containing the first driven gear shall mate with the motor shaft driving gear. The intermediate shaft shall rotate in two spherical roller bearings and contain the second driving gear. The propeller shaft shall contain the second driven gear and rotate in one single row and one double row,

angular contact set of ball bearings. All bearings shall be designed for a minimum of 50,000 hours operation.

PROPELLER
The propeller shall consist of three Stainless steel, ASTM 316L blades. Since the mixer blades must handle changing hydraulic load conditions across their surface, they must be capable of "flexing" and absorbing loads which would otherwise be transmitted to the gearbox and motor. Thus, metal blades of other material will not be acceptable due to their inelasticity. Each blade shall be mounted into a socket in the side of the hub and will be held in place by a keyed propeller shaft to resist torsional forces, as well as a bolt and lock washer system along the axis of the propeller shaft. Overall propeller diameter shall be _____. The blade shape shall be a non-clogging, backward curved design which starts at the hub leaving no part of the shaft exposed. The propeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in normal sewage applications.

MIXER TEST
The mixer manufacturer shall perform the following inspections and tests on each mixer before shipment from the factory:

1. Propeller, motor rating, and electrical connections shall first be checked for compliance to the customer's purchase order.

2. A dielectric test shall be carried out in accordance to IEC 60034-1 (two times rated voltage plus 1000 V). This test shall be done after assembly but before any performance tests. No records shall normally be provided.

3. Prior to shipment, the mixer shall be run dry to establish correct rotation and mechanical integrity.
A written report stating the foregoing steps have been done may be supplied with each mixer at the time of shipment (upon request).

PARALLEL GUIDE BAR SYSTEM
See separate specification entitled "Paralock System".

TRIPOD GUIDE BAR SYSTEM
See separate specification entitled "Tripod Mixer Mounting System".

DAVIT AND WINCH ASSEMBLY
A manual winch assembly shall be provided at each mast assembly station to raise and lower the mixer (or mixers) for installation and service. It shall consist of a lifting davit, winch, hook and 40 feet of 316 stainless steel lifting cable.

VARIABLE FLOW AND VELOCITY CONTROL (Optional)
The system(s) shall be capable of operating all or some portion of the mixers at lower speeds. Each mixer station (mast assembly) shall have an independent control box mounted next to the mixer mast assembly for easy access.

The mixer's output shall be adjusted by means of a variable speed control. It shall be possible to infinitely vary the propeller speed between 0 and maximum RPM by a simple adjustment of the mixer control. Variable acceleration and deceleration rates for blade rotation shall be possible. Said controls shall be provided by the mixer manufacturer.

Low energy consumption over the life of the operating plant is an essential component of the system's design intent. Therefore, hydraulically driven mixer types will not be an acceptable substitute because of their low overall efficiency.

CFD (Computational Fluid Dynamics) Analysis

The Contractor shall submit the following information for review and approval:

License and Software

Proof of the employed CAD, CFD or any additional CFD Pre/Postprocessing software shall be shown on demand. This can include a copy of a paid license receipt or any other document supporting the claim. Finite volume based CFD software capable of multiphase modelling shall be used.

CFD model

Turbulence effects shall be represented with the help of realizable k-e (or other) model that provides an improved prediction for the spreading rate of both planar and round jets.

Submersible mixer shall be modelled appropriately and correctly account for generated thrust, torque and radial forces.

Apparent viscosity of the liquid shall lie between 1-10 cP based on the given TS concentration. Computational mesh shall adequately represent relevant internal obstacle and tank geometry with 0.1 m as a maximum size of the computational element.

Wall effects shall be well resolved with the corresponding y+ value below 100. Gas-liquid two-way coupling shall be applied.

Reported results shall correspond to a converged numerical solution. Proof of convergence in a form of residual plot and volume average velocity magnitude shall be presented.

The volume average velocity shall be proven converged. The total air mass imbalance shall be maximum 5%. The total mass imbalance for net through flow cases shall be maximum 3%.

CFD results

The report shall describe problem at hand, agreed work scope and analysed scenarios. This shall include setup for each scenario, corresponding running conditions, flow rates, chosen mixer equipment and other relevant information.

For the sake of clarity, geometry shall be shown in different perspective (side, top and isometric), important dimensions shall be specified, and all relevant internal objects and obstacles shall be shown.

Boundary conditions and other modelling assumptions shall be presented and justified. Presented results shall build a solid understanding of the resulting flow pattern. Important flow features shall be visualized. Sedimentation risks shall be evaluated and, if necessary, addressed.
Air entrainment risks near mixers shall be evaluated. Volumetric mean age distribution shall be provided for net through flow cases in order to evaluate short-circuiting/stagnation risks.

To allow for independent audit of the numerical solution and to eliminate CFD model propriety risks, result files shall be, on demand, submitted in a format that is compatible with the Tecplot visual analysis tool.