City Corporation
Russellville – Overall Project

SECTION 11370

LARGE BUBBLE COMPRESSED AIR MIXING SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required, and install a large bubble compressed air mixing system for the purpose of mixing anaerobic and anoxic basins as shown on the Drawings and as specified herein.

B. The air mixing system shall be provided complete with all accessories, special tools, and spare parts required for a complete and operable system.

C. The Contractor shall provide suitable air line piping and fittings to the air mixing system Mixing Valve Controllers (MVCs) as shown on the drawings and as further specified. The contractor shall provide suitable air line piping, from the MVCs into each bubble forming plate in the basin.

D. The Contractor shall furnish, install, test, and place into satisfactory operation the compressed air system as specified herein and shown on the Drawings.

E. The compressed air system shall include a factory packaged air compressor with air receiver, air dryer, controls, and all accessories and appurtenances specified, indicated on the drawings, or otherwise required for a complete, properly operating installation.

1.02 RELATED WORK

A. General Requirements are included in Division 1.

B. Steel Piping is included in Division 15.

C. Maintenance of Plant operation and Sequence of Construction is included in Division 1.

D. Demolition is included in Section 02050.

E. Concrete work is included in Division 3.

F. Instrumentation is included in Division 13.

G. Piping, valves, and appurtenances other than those herein are included in the respective sections of Division 15.

H. Electrical work not specified herein is included in Division 16.

1.03 SUBMITTALS

A. The Contractor shall submit Shop Drawings, Operation and Maintenance Instructions, and other information as specified in accordance with Section 01300. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

B. For the Compressed Air Mixing System, in addition to the submittal requirements specified in Section 01300, submit the following:

1. Compressor support locations and loads that will be transmitted to bases and foundations.

2. Complete electrical schematics and field termination drawings.

3. Complete assembly and installation drawings including overall equipment layout and piping interconnection drawings by the Contractor.

4. Compressor field test results.

5. Detailed specifications and data including the following:

a. Compressor Module

Manufacturer
Type and model
Rotative speed
Dimensions
Weight including motor
Performance data at variable discharge
Bearing data
Separator details
Filter and silencer details
Accessory details
Piping schematic
Control equipment
Sequence of operation

b. Motors

Manufacturer
Enclosure
Horsepower rating and service factor
Voltage
Insulation class and temperature rise
Full load rotative speed
Efficiency at full, 3/4, and 1/2 load
Power factor at full, 3/4, and 1/2 load
Full load current
Locked rotor current

c. Air Dryer

Manufacturer
Model
Pressure drop
Electrical wiring diagram and power requirements

d. Oil Filters

Manufacturer
Model
Pressure drop

C. Operating and Maintenance Data

1. Copies of an operating and maintenance manual shall be furnished to the Engineer as provided for in Section 01730. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc, which are required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes.

1.05 QUALITY ASSURANCE

A. Qualifications

1. The large bubble compressed air mixing system shall be furnished by a single manufacturer who is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall be as manufactured by. Pulsed Hydraulics Inc (PHI) or approved equal.

2. A minimum of five 5years of experience designing and constructing the specified air mixing system and a reference list with at least 5 operating mixing systems for municipal wastewater must be provided.

3. The associated compressed air system shall be supplied as part of this system and shall be manufactured by Kaeser Compressors, or approved equal.

1.06 CONTRACTOR'S RESPONSIBILITY

A. The services of a qualified air mixing system manufacturer's technical representative shall be provided for a total of five (5) days over two (2) site visits as follows:

1. One site visit to check and certify the equipment installation in each basin and perform initial field tests

2. One site visit to supervise initial start-up and operation and to instruct the Owner's personnel in proper operation and maintenance of the equipment.

3. The manufacturer's representative shall sign in and out at the Engineer's Field Office on each day at the project and shall comply with Owner's requirements for visiting the site.

4. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspections and outlining in detail any deficiencies noted.

B. Any additional time required by the manufacturer to achieve successful installation and operation due to the Contractor or scheduling shall be at the expense of the Contractor.

1.07 SYSTEM DESCRIPTION

A. The equipment specified herein shall be a large bubble compressed air mixing system designed to mix activated sludge by the discharge of high pressure air through bubble forming plates mounted on the floor of anoxic basins. The resulting bubbles shall cause sufficient turbulence in each as in to keep the sludge well mixed to the minimum requirements described in testing procedures described herein. High pressure air will be supplied by the contractor and installed as shown in the Drawings.

B. Each anoxic basin shall be capable of storing 11,200 to 22,400 gallons of thickened activated sludge with a solids content of 1.5 to 4.0 percent.

1.08 MAINTENANCE

A. The following spare parts shall be provided:

1. Four (4) Air Control Valves and four (4) pressure transducers

2. Two (2) pressure regulators, air filter elements, and one air filter assembly.

1.09 WARRANTY

A. The air mixing system manufacturer shall guarantee the performance of the air mixing system, and shall guarantee the equipment for a period of 18 months against defects in materials and workmanship and against problems attributable to ordinary wear under normal operation of the equipment.

B. The compressor manufacturer shall guarantee the equipment for a period of one (1) year against defects in materials and workmanship and against problems attributable to ordinary wear under normal operation of the equipment.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Mixing Valve Controller (MVC)

1. The enclosure shall be FRP with a NEMA 4X rating (as shown in PHI drawing 11-095-001). The enclosure maintains its NEMA 4X rating by utilizing Roxtex gland seal assembles for each air pipe entry. The enclosure is thermally insulated and contains a thermostatically controlled heater to allow operation to zero degrees F.
2. The injection valves are solenoid controlled and air operated. The minimum opening/closing cycle shall be less than 50 milliseconds at 80 psig. The valve body shall be silicon aluminum. Seals shall be Nitrile/Buna-N. Valve life is rated at 30 million cycles.
3. An air filter with a 5 micron element and auto drain is installed ahead of the regulator and injection valves.
4. A manually adjustable pneumatic pilot-operated regulator with pressure gage provides constant pressure to the injection valves. (factory setting 50 psig) All air components are factory tested for leaks and function.
5. Each MVC utilizes an AB MicroLogix 1100 PLC. The PLC program sets the pulse duration time at one-halve second, and allows the operator to select pulse frequency by way of a 3 position front mounted NEMA 4X selector switch. The switched is labeled LOW/MED/HIGH and the number of pulses per minute is determined by the start-up technician. (factory setting is 1,2 and3 pulses per minute)

B. Air Delivery Elements

1. Eighteen 8-inch bubble forming plates made from 304 stainless steel are required to mix all four anoxic basins. The location of each plate is shown in PHI application drawing 12-061. The construction of the bubble bubble forming plate is shown in PHI drawing DEP-8SS

C. Air Piping

1. Air piping to the bubble forming plates shall be 1 inch and be rated for 175 psig. The pipes shall be made of 304 stainless steel. All the piping from the MVC to the bubble forming plate must be leak free for proper mixing.
2. Air delivery piping from the compressor to the MVC's must be plumbed in a loop and be two inches with one inch tee's to the MVC's to prevent air starvation (see drawing). Piping must be rated at 175 psig and be of 304 stainless steel.

Comment [BH1]:

2.02 AIR COMPRESSOR MODULE (KAESER COMPRESSORS DUAL 25 HP PACKAGE)

A. The air compressor module shall include an inlet air filter, compressor with a TEFC AC inverter duty rated motor, air/oil separator reservoir, air cooled oil cooler, air cooled aftercooler, cooling fan, separator pressure relief valve, discharge check valve, moisture separator, controls, control panel complete with compressor VFD, base, valves, piping, and unloading system.

B. The compressor module shall be completely factory assembled requiring only field connection of electrical power and air, and condensate drain piping.

C. The compressor shall be of the single stage, positive displacement, oil-flooded, rotary screw type. The compressor shall be provided with an integral skid or lifting lugs for unloading and placement.

D. The compressor rotors shall be asymmetrical, steel or high strength ductile iron integral shafts, and dynamically balanced. Housings shall be cast iron. Rotors and housings shall be precision machined for accurate bearing positioning and running clearances. The male rotor shall be connected with a belt to the drive motor in a manner which will ensure permanent alignment.

E. Radial bearings shall be cylindrical roller type. Thrust bearings shall be in accordance with the manufacturer's recommendations. Bearing life shall be in excess of 90,000 hours.

F. Positive pressure lubrication shall be provided by an inherent pressure differential system. Lubricant shall be provided as recommended by the manufacturer. A lubricant filter shall have a high-capacity 5 micron rating.

G. An air/oil separator reservoir shall be provided. The reservoir shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels and shall bear the code stamp. The reservoir shall include two-stage filtration to remove oil from air stream. Oil carry-over downstream of compressor modules shall not exceed 5 mg/m^3.

H. Each air compressor module shall have automatic controls integral to the unit for modulating speed to deliver appropriate volume to meet demand and maintain system target pressure. On sensing a low demand, below the speed control range, the compressor will stop immediately and restart when required. Operating at part load, and without the need to raise operating pressure, the variable speed control will avoid load cycling and maintain a steady-state of operation. Controls shall provide a variable speed or auto start/stop control selector toggle switch.

I. A spring-loaded minimum pressure check valve shall be located in the final discharge line of the compressor. The valve shall also prevent backflow of air from the system piping.

J. Each baseplate shall be constructed of one-piece folded 316 stainless steel with structural members and shall be designed for no measurable deflection with the equipment mounted thereon and the baseplate supported around its perimeter. Each base shall be designed so that all equipment bolted to it can be removed without access to the underside of the plate and with a flat top surface for ease of cleaning. Structural stiffeners shall be located under the compressors at the compressor anchor points.

K. Valves and piping within the enclosure shall be the compressor manufacturer's standard. Relief valves shall be provided for equipment protection on the air and coolant systems as required. A check valve shall be furnished in the air discharge line.

L. Each compressor shall be provided with a dry type intake filter supported by the suction pipe and close-coupled to the compressor intake connection. Intake filters shall have an outer cover and replaceable filter element. Particle arrestance shall be not less than 99 percent at 10 micron size.

M. The compressor shall be provided with a moisture separator rated for the compressor capacity and pressure. Each separator shall be provided with an automatic float operated condensate drain trap.

N. The compressor shall be supplied in a sound attenuated enclosure. The enclosure shall reduce the measured sound to a maximum of 70 decibels while the compressor is operating and the sound level is measured a distance of three feet from the enclosure.

2.03 AIR DRYER

A. The air dryer shall be of the regenerative desiccant type and shall produce a -40 F pressure dew point at the dryer exit when operating continuously at the design conditions.

B. The dryer shall be capable of continuously drying the maximum discharge capacity of the air compressor.

C. The air dryer shall be as manufactured by Kaeser Compressors, or equal.

2.04 AIR RECEIVER

A. The receiver shall be a horizontal tank integrally-mounted to the compressor. The receiver shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels and shall bear the code stamp.

B. The receiver shall be factory-finished painted with one quart touch-up paint provided.

C. The receiver shall be provided with mounting feet and lifting bars running the length of the receiver.

2.05 COMPRESSOR SYSTEM OIL REMOVAL FILTERS

A. A replaceable-cartridge high-efficiency after-filter and activated carbon oil-removal secondary filter shall be provided and installed at the locations indicated on the drawings. The filters shall remove 100 percent of the solids and liquids 0.025 micron or larger in size. The filter and prefilter shall be oversized to fit the piping sizes indicated on the drawings.

B. The oil removal filters shall be provided by the compressor manufacturer.

2.06 COMPRESSOR SYSTEM ACCESSORIES

A. The compressed air equipment package shall be furnished with the following accessory equipment.

1. All shutoff valves shall be ball valves. Shutoff valves in stainless steel tubing shall have Type 316 stainless steel bodies and balls and reinforced Teflon seals and seats. Valves in the compressor discharge piping shall be suitable for the maximum compressor discharge air temperature.

2. Pressure gauges shall have a range of 0 to 200 psig.

2.07 COMPRESSOR SYSTEM ELECTRICAL

A. All electrical and control equipment for the air compressor module shall be furnished as required for a complete installation, requiring only field connection of 480 VAC, three phase power supply.

B. The electric motor shall conform to the requirements of the Section (01 60 01) (01170). Motor shall be rated 480 volts, 60 Hz, three phase.

C. Power supply to the dryer will be 120 V, 60 Hz, single phase.

2.08 COMPRESSOR SYSTEM CONTROL PANEL

A. An enclosure-integrated control panel mounted on the compressor module shall include:

1. Full voltage, nonreversing, circuit breaker type combination motor starters sized as required by the manufacturer.

   a. Starters shall include auxiliary contacts as required plus one spare NO and one spare NC contact wired to the terminal strip. One normally open auxiliary contact shall be provided for RUN status.

   b. Magnetic motor circuit protectors shall be 3 phase, 480 volts, molded-case circuit breakers with instantaneous trip elements. The breakers shall be manually operated with quick-make, quick-break, trip-free toggle mechanism.

   c. One thermal overload relay shall be provided in each phase lead. Each starter shall be provided with an external manual reset push button for reset of the thermal overload relays. Overloads shall be bimetallic ambient compensated type, matched to motor current, and shall be provided with a manual reset pushbutton.

   d. The complete starter shall have an interrupting rating of at least 22,000 amperes at 480 volts.

2. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.

3. Terminal blocks for all system wiring. Internal panel wiring shall be neatly bundled and tied and shall be identified with suitable wire markers.

4. A service and maintenance indicator, start button, and power on (green) push button.

5. An emergency stop pushbutton.

6. A protection control system with fault indicator to stop the compressor on high discharge air temperature.

7. The control module shall indicate discharge air pressure, hour meter, time clock, service due warning, service overdue.

8. LED indicator clearly identified to indicate the following alarm conditions.

9. Two normally open contacts which close under alarm conditions shall be provided for the compressor for remote "FAIL" alarm. Both contacts shall close when any alarm occurs for the compressor. Contacts shall be rated 10 amperes at 120 volts, 60 Hz, single phase.

2.09 COMPRESSOR SYSTEM SHOP PAINTING

A. All components of the compressed air equipment system shall be shop primed and finish painted with the manufacturer's premium paint system prior to shipment to the site.

B. Stainless steel, nonferrous, and nonmetallic surfaces shall not be painted.

C. One quart of finish paint shall be provided with the equipment package for field touch-up painting.

2.10 COMPRESSOR SYSTEM SHOP TEST

A. Prior to shipment each compressor module and dryer shall be operated to check alignment; faulty equipment and controls; proper wiring; leaks in piping, seals, or wells; and proper operation of the safety and operating controls. Compressor pressure controls shall be adjusted to the specified pressures. Defective equipment and controls disclosed by such tests shall be replaced and the package placed in satisfactory operating condition before shipping. A statement from the package supplier certifying that the specified shop test has been performed shall be submitted to the Engineer prior to shipment. A test report showing capacity, differential pressure, power requirements, and other data shall be submitted for Engineer approval prior to shipment.

2.11 COMPRESSOR SYSTEM PERFORMANCE AND DESIGN REQUIREMENTS

A. The compressed air equipment shall be designed for the following operating conditions:

Ambient Conditions

Max Air temperature, F	104
Min Air temperature, F	36
Relative humidity, percent	36

Barometric pressure, psia	14.3
Compressors	
Number required	2
Minimum discharge pressure, psig	85
Maximum discharge pressure, psig	110
Capacity of compressor when operating at 40 psi, cfm	17-42
Motor size, hp (max)	20
Max motor speed, rpm	4670
Max free field noise level measured at 3 feet, dBA	80
Receivers	
Number required	1
Design pressure, psig	225
Nominal volume, gal	120
Air Dryer	
Type	Cycling, Refrigerated
Number required	2, (Integral to Compressor Package)
Max Pressure Dew Point (^{o}C)	7
Filters	
Type	Particulate, High Efficiency Oil Removal
Number required	4, (Integral to Compressor Package)
Primary Filter Detail (at 21^{o}C)	Particulate- 1 micron
	Liquid- 0.6 mg/m^{3}
Final Filter Detail (at 21^{o}C)	Particulate- 0.01 micron
	Liquid- 0.01 mg/m^{3}

2.12 AIR MIXING SYSTEM CONTROL AND OPERATION

A. Pulse rate will be adjustable using the front panel selector switch provided by the mixing system manufacturer. Discrete outputs from the PLC shall actuate the Air Control Valves furnished by the air mixing system manufacturer. Duration of the opening and closing of the Air Control Valves are factory set. The air pressure is manually adjustable.

B. An output shall be provided from each MVC to the existing Plant SCADA system indicating that the air mixing system has a fault.

C. Specific fault location shall be identifiable through observation of the respective MVC, and the nature of the failure shall be visually identifiable through observation of the Air Control Valves within the MVC.

PART 3 EXECUTION

3.01 INSTALLATION

A. The Contractor shall furnish and install the air mixing systems and all associated equipment and accessories as required and specified herein in accordance with manufacturer's instructions.

B. The Contractor shall install all of the in-basin components using the details shown on the Drawings; bubble forming plates attached to the basin floor shall be level.

C. All panels and enclosures shall be mounted as shown on the Drawings using Type 304/ 316 stainless steel hardware using the mounting holes or brackets supplied by the manufacturer of the mixing system.

D. The panels shall be pre-wired and the Contractor shall provide power and control connections to each of these panels as required by the manufacturer and the contract documents.

3.02 TESTING AND START-UP

A. The Contractor shall demonstrate to the Engineer that the completed systems meet the functional requirements intended and that all components of the system are properly calibrated.

B. All field assembled air piping shall be tested by Contractor for leaks by capping of the in basin air piping at the bubble forming plates. The system will be pressurized to 50 psi and the air pressure will hold at 50 psi for 60 minutes. .

3.03 EQUIPMENT IDENTIFICATION

A. Each component of the air mixing system shall be provided with a durable nameplate, securely fastened in a conspicuous place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

3.04 FIELD ACCEPTANCE TEST

A. After installation and the specified start-up procedures, each basin shall be tested as follows:

1. The Contractor shall pay all costs for an independent laboratory to conduct total suspended solids (TSS) analysis for all samples. The analysis shall be performed in accordance with "Standard Methods for the Examination of Water and Wastewater".

2. Prior to performing the tests, the basins which will be tested must have been in normal operating mode for at least two days with TSS in typical operating ranges as defined above.

3. All mixer systems shall be tested with the respective basins full to the maximum water surface elevation with activated sludge and with no flow entering or exiting the respective basin for two hours prior to and during the test.

4. A representative of the mixing equipment manufacture will be in attendance during the acceptance test.

5. Testing Procedure:

    a. Three sample sites for each mixed zone to be tested shall be selected by the Engineer. At each sample site, three samples shall be collected as follows: 24-inches from the surface, mid-depth and 24-inches off the basin bottom. Each sample site must be a minimum of 18 inches away from any structure within the tank. The nine samples for each location shall be analyzed as described above.

    b. The Coefficient of Variation (Cv) shall be calculated for each set of nine (9) samples collected per zone as follows:

        Cv = (100 x Standard Deviation of All Nine Samples)/(Mean Value of Nine Samples)

    c. If the Cv is less than or equal to 10%, then the mixer performance shall be acceptable for that location.

    d. If the Cv is greater than 10%, then the mixer performance shall be unacceptable for that location and the Contractor and/or Manufacturer shall make all necessary improvements (at no additional cost to the owner) and repeat the testing procedure at no additional cost to the Owner until the Cv is less than or equal to 10% for that location.

END OF SECTION