

MODEL CS14-4

CENTRIFUGE THICKENING & DEWATERING EQUIPMENT

TYPICAL SPECIFICATION

PART 1: GENERAL

1.01 DESCRIPTION

- A. Furnish, install, test and place in satisfactory operation centrifugal thickening/dewatering equipment and appurtenances as indicated and as specified.
- B. The drawings and specifications direct attention to certain features of the equipment, but do not purport to cover all details entering into the design and

1.02 SYSTEM DESCRIPTION

- A. General:
 - 1. The centrifuges shall be of the solid bowl, horizontal continuous feed, scroll type, specifically designed to dewater sludge.
 - 2. The centrifuge shall be designed and constructed to operate continuously.
 - 3. The centrifuges shall be capable of performing in accordance with the requirements set forth in these specifications. In order to be assured of meeting the required performance, the centrifuges shall be capable of operating at a speed of 4000 rpm and a G force of 3180. Speed control shall be provided by a solid-state variable frequency drive (frequency inverter).
- B. **Components and Appurtenances:**
 - 1. All equipment shall be furnished by the manufacturer of the sludge dewatering single manufacturer.

2. All components, including but not limited to the following, shall be considered as part of the sludge dewatering package and become the responsibility of the sludge dewatering equipment manufacturer:
 - a. Centrifuge Assembly.
 - b. Main Drive Motor with variable frequency drive.
 - c. Hydraulic Backdrive System.
 - d. Lubrication System.
 - e. Control Panel and Wiring.
 - f. Motor Starters and Appurtenant Enclosures.
 - g. Flexible Connectors, Thickened/Dewatered Sludge, and Centrate Chutes.
 - h. Spare Parts and Special Tools.
3. All equipment, components and appurtenant items shall be furnished and installed as complete assemblies. The interconnecting wiring, conduit, piping shall be furnished by others.

1.03 CONDITIONS OF SERVICE

- A. Sludge dewatering heated building specifically designed for these systems.
- B. The equipment and its appurtenances shall be suitable for exposure to splash and spill conditions, and 100% humidity.
- C. The equipment and its appurtenances shall be capable of receiving, conditioning and thickening the feed sludge specified herein, and discharging the dewatered sludge into the sludge pumps, conveyors or gravity discharge chutes as the case may be. Each unit shall be capable of operating continuously and shall be suitable for thickening/dewatering the specified sludge continuously for up to 24 hours per day, 7 days per week.

D. The feed sludge will have the following characteristics:

1. Sludge Feed Characteristics

Type of Sludge: _____

Sludge Concentration: _____ % TS

Volatile Solids: _____ %

SVI: _____

Temperature: _____ F

pH: _____

Alkalinity as CaCO₃: _____

2. Sludge Quantity (Excluding Polymers)

a. Normal Operating _____ gpm
_____ lbs/hour

b. Design _____ gpm
_____ lbs/hour

1.04 REQUIRED PERFORMANCE

A. Each Centrifuge shall achieve the minimum following performance while thickening the sludge having the characteristics listed under paragraph 1.03D above.

1. Dewatering Performance

Requirement

Hours per day of operation 24

Capacity _____ GPM

Thickened sludge minimum solids concentration _____%

Minimum centrifuge solids capture 95%

Maximum main drive motor energy consumption 0.6 HP/GPM

Solids capture shall be defined as:

- T = Thickened sludge total suspended solids concentration (mg/l).
- F = Feed sludge total suspended solids concentration (mg/l).
- C = Centrate total suspended solids concentration (mg/l).

1.05 QUALITY ASSURANCE

A. Workmanship and Design:

1. All parts of the equipment provided to be amply proportioned for long, continuous and uninterrupted service. All materials to be used to be of best quality and entirely suitable for service required.
2. Provisions to be made for easy lubrication, adjustment or replacement of all parts. A minimum clearance of three feet around all sides of the equipment shall be retained.
3. Centrifuge assembly shall be designed to assure easy disassembly of the unit, including removal of the rotating assembly, within the space and headroom provided.
4. The corresponding parts of the multiple units shall be interchangeable.

B. Services of Manufacturer's Representative:

1. Provide services of factory-trained Service Engineer, specifically trained on type of equipment specified. Submit qualifications of Service Engineer for approval. Man-day requirements listed are exclusive of travel time, and do not relieve Contractor of obligation to provide sufficient service to place equipment in satisfactory operation.
 - a. Installation: to assist in location of anchor bolts; setting, leveling, miscellaneous utility connections: 2 man-days.
 - b. Start-up, testing and calibration: 2 man-days.
 - c. Operation and maintenance instruction: 1 man-days.

C. Shop Test:

1. Upon completion of manufacture of centrifuge and appurtenances to be installed on this project, conduct shop tests which shall be witnessed by the Engineer:
 - a. Centrifuge:
 - (1) of 4 hours of continuous operation at proposed design manufacturer.
 - (2) operation in satisfactory manner without mechanical vibration.
 - (3) obtained.
 - (4) compensation.

- b. routine commercial test as well as additional electrical tests as
NEMA and
standard 112 "Test Procedure for Polyphase Induction Motors and
Generators." The additional tests, beyond commercial tests, are
as follows:
 - (1) efficiencies and temperature rise.
 - (2) Tests to establish starting characteristics.
 - (3) Tests to establish noise pressure levels.
- 2. All facilities, lubrication oil, instruments, equipment and electric power
shall be supplied by the Contractor at his expense.
- 3. Upon completion of the tests, provide six copies of the certified shop test
results to the Engineer.

1.06 SUBMITTALS

- A. Shop drawings, catalog cuts, and other materials required to completely describe
and specify system and equipment shall be submitted to Engineer for review.
These will include:
 - 1. Submission of certified shop and erection drawings, including complete
motor data.
 - 2. Foundations, installations, and grouting.
 - 3. Services of manufacturer's representative.
 - 4. Operating and maintenance instructions and parts lists.
 - 5. Lubricants.
 - 6. Special tools.
 - 7. Bolts, anchor bolts, and nuts.

8. Sleeves and inserts.
9. Electric motors.
10. Voltage rating of motors.
11. Equipment drive guards.
12. Vibration isolators.
13. Nameplates.
14. Noise level data.

B. Detailed shop drawings include, but not necessarily limited to:

1. Detailed drawings and specifications of all items of equipment showing all dimensions, parts, and construction details and materials, and installation details and requirements.
2. Performance specifications of all items of equipment.
3. Instrument layout of control panels.
4. Complete instrumentation and control and wiring diagrams in sufficient detail to allow installation of instrumentation and controls, and electrical components. Specifically, the following required:
 - a. Complete instrumentation and control schematics.
 - b. Complete electrical circuit schematics, including all motor control, instruments, etc. Schematics include termination points in various numbers. Also, in schematics, every termination point assigned number, and number or identifier assigned to each terminal strip.

terminal strip identifier appear on the schematics for each wiring termination shown.

c.

control panels and field junction boxes. (Note these are to be supplied prewired.) Schematics to provide complete information on terminal strips and panel instruments.

5. Certified shop testing results as set forth under "Quality Assurance."
6. Certified acceptance test results.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Ship items as complete assemblies except where partial disassembly is required
- B. Spare Parts:
 1. Packed in containers bearing labels clearly designating contents and pieces of equipment for which intended.
 2. Deliver at same time as pertinent equipment.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The Equipment specified herein shall be furnished by sludge thickening equipment manufacturer, who shall assume complete responsibility for conformance to the design documents.
- B. Like items of equipment shall be the product of one manufacturer to achieve standardization of operation, spare parts, maintenance and manufacturer's service.
- C. Manufacturer's standard equipment sizes shall be used unless otherwise specified.

- D. The equipment provided shall be complete in all respects including, but not limited to, lubricants, components, calibration, alignment, and adjustments as necessary to place the equipment in operation to perform its intended functions.

2.02 MANUFACTURERS

- A. The sludge thickening equipment shall be manufactured by Centrisys Corporation.

2.03 MATERIALS OF CONSTRUCTION

- A. Unless otherwise specified all parts of the centrifuge in contact with the sludge shall be made of 316 stainless steel, except o-rings, seals or abrasion resistant materials.
- B. The o-ring and seals shall be manufactured of the following:
 - 1. O-rings: Buna-N
 - 2. Lip Type Seals: Buna-N
- C. All equipment guards shall be constructed of aluminum, fiberglass or painted steel.

2.04 CENTRIFUGE ASSEMBLY

- A. Bowl:
 - 1. The bowl shall consist of a horizontal cylindrical-conical assembly. Solids are discharged at the small end of the conical section. The bowl shall have a minimum diameter of 14 inches I.D., and a minimum length of 58 inches and shall be supported by spherical roller bearings mounted in pillow blocks.

Fabricated bowls shall be manufactured per ASME Pressure Vessel Code, Section 8.

Centrifugally cast bowls shall be manufactured per ASME Pressure Vessel Code, Section 8 and shall be 100% dye penetrant inspected.

The minimum acceptable thickness for the cylindrical and conical sections of the bowl wall shall be .6 inches.

The centrifuge bowl shall be fabricated from 316L stainless steel.

2. The liquid pool depth in the bowl shall be adjustable through the use of plate dams at the large diameter end of the bowl where liquid is discharged. Solids shall be discharged from the small diameter end of the bowl. The plate dams shall be manufactured from 304 stainless steel.
3. The bowl wall shall be protected by, longitudinal wear strips which cause formation of a protective feed solids layer.
4. The solids discharge ports shall be protected by specially designed inserts hard surfaced with tungsten carbide.
5. Sludge feed shall be introduced into the centrifuge feed zone by means of a 2 inch diameter 316L stainless steel feed pipe. The feed shall be uniformly distributed into the centrifuge and the feed zone shall have accelerators and contact surfaces protected from abrasion by fused tungsten carbide.

B. Scroll Conveyor

1. The centrifuge shall include a horizontal cylindrical-conical scroll conveyor supported by oil lubricated cylindrical roller bearings and grease lubricated angular contact anti-thrust ball bearings and equipped with helical flights independently mounted concentrically within the centrifuge bowl. The conveyor shall be 316L stainless steel.
2. Conveyor bearings shall be protected by seals and shall be externally lubricated by means of a forced oil lubrication system.
3. The feed compartment within the conveyor shall be constructed of 316L stainless steel or by flame sprayed and fused Nickel-Chrome-Boron alloy containing tungsten carbide particles. The feed nozzles or ports shall be protected by tungsten carbide.

4. The edge and face of the conveyor flights shall be protected against abrasion with Eutalloy cake discharge end. The hard surfacing shall be guaranteed against failure for 15,000 hours of operation.

C. Case:

1. The centrifuge casing shall consist of a 304 stainless steel lower casing and a one piece upper casing. The purpose of the case shall be to contain and direct the solids and liquid discharge from the centrifuge, to act as a protective guard and to provide a complete enclosure for noise reduction.
2. The lower casing shall be constructed with all process contact material of galvanized carbon steel. The upper casing shall be manufactured of 304 stainless steel.
3. A sound proof panel system will be provided as specified to limit the noise generated by the centrifuge to 85 dBA or less 1 meter from the unit
4. The centrifuge case shall be vented as recommended by the manufacturer. Lifting hooks shall be provided for lifting the casing.
5. To limit splashing and air leakage, the casing shall be provided with seals where the bowl hubs intersect the casing and a gasket on the machine flanges where the upper and lower casings join.

D. Base:

1. The centrifuge shall be supported on a fabricated carbon steel base with 304 / 316 stainless steel wetted parts. The base shall be mounted on vibration isolators.
2. Machined surfaces shall be provided at all points where support loads are transferred to the base. The bottom portion of the base shall be provided concentrate flexible connectors and chutes and other appurtenant connections.
3. Lifting hooks or solid lifting bars shall be provided for lifting the base.

E. Main Bearings:

1. The main bearing shall be pillow block ball type. The bearings shall have an L-10 life of 100,000 hours minimum at 24 hours per day service.
2. The bearings shall be lubricated by a forced lubrication system.

2.05 MAIN DRIVE MOTOR

A. The main drive motor shall be designed, manufactured and tested in accordance with the latest NEMA, IEEE and ANSI standards and have the following characteristics:

- | | | |
|-----|-----------------------------|--|
| 1. | Type: | Squirrel-Cage, Single-Speed |
| 2. | Horsepower: | 30 |
| 3. | Synchronous Speed: | 3600 rpm |
| 4. | Service Factor: | 1.15 |
| 5. | NEMA Design: | B |
| 6. | Insulation Class: | F or H |
| 7. | Code Letter: | G |
| 8. | Voltage: | 460 volts |
| 9. | Phase: | 3-phase |
| 10. | Ambient Temperature Rating: | 40 degrees C |
| 11. | Maximum Temperature Rating: | 120 degrees C |
| 12. | Mounting: | Horizontal |
| 13. | Enclosure: | TEFC |
| 14. | Duty Cycle: | Continuous |
| 15. | Starting Method: | Reduced voltage |
| 16. | Bearing Life: | 100,000 Hrs. as defined by AFBMA B-10 Standards. |

17. Full Load Efficiency: Not less than 94 percent power factor of 0.88.
18. Sound Level: Maximum 80 dBA at 3 feet from outside the sound proof panels.
- B. The motor shall be equipped with a thermal protection system to protect the motor from temperatures damaging the stator windings resulting from motor overload, too frequent starting and locked-rotor current and a variable frequency inverter.

2.06 BACKDRIVE SYSTEM

- A. A Hydraulic Backdrive speed variation between the conveyor and the bowl.
- B. Hydraulic Backdrive and scroll conveyor shall be produced by a 15-HP, water cooled hydraulic system which shall independently drive the scroll conveyor. The hydraulic scroll conveyor drive system shall be designed such that no mechanical gear reducer is required in the scroll conveyor drive train. The hydraulic drive system shall be capable of operating in either a manual or automatic mode. In the manual mode it shall provide for operation at a specific, adjustable scroll differential speed with internal torque allowed to vary up to the maximum allowable scroll shaft torque.

In the automatic mode it shall continuously monitor changes in internal torque created by variations in influent feed solids and automatically maintain a preset torque input to the scroll by allowing the differential speed to vary. The hydraulic drive shall operate in a manner such that, as the reactive torque of scroll shaft increases due to an increase in solids inventory in the bowl, the scroll differential speed shall gradually increase and, conversely, as the inventory of solids in the bowl and resultant reactive torque decreases, the scroll differential speed shall decrease. The net effect of this system, when operated in the automatic mode, shall be to maximize the time that cake solids are under the influence of accelerated gravitational force to ensure that the driest possible dewatered cake product is produced without plugging the centrifuge.

The system shall use a hydraulic pumping group and hydraulic motor. Torque-based adjustment shall be a function of input to the driven unit. The

maximum torque input and rate of change of scroll differential speed shall be adjustable.

The system shall be designed such that automatic centrifuge shutdown is initiated in the event that excessive torque is detected. Two (2) sets of contacts shall be provided.

In the event that torque exceeds the normal operating range, the sludge feed pump shall be automatically stopped to allow the centrifuge to clear itself and shall automatically restart when the torque drops to the normal operating range. In the event that the torque approaches the limit of the drive, the second set of contacts shall automatically initiate shutdown of both the feed pump and centrifuge. In this instance manual reset of the hydraulic drive is required before the centrifuge can be restarted.

2.07 VIBRATION ISOLATORS

- A. The equipment manufacturer shall furnish vibration isolators which shall be capable of dampening vibration in all directions created during normal and emergency operation of the equipment.
- B. The vibration isolators shall be provided for the centrifuge assembly.

2.08 CONNECTIONS

- A. All piping and discharge chute connections to the centrifuge assembly, main drive motor and lubrication system, including but not limited to the feed sludge, wash water, polymer, drain, centrate, discharge, thickened sludge discharge and power and control connections, shall be equipped with flexible connections.

The flexible connections shall isolate the equipment from fixed rigid piping, chutes or other connections

- B. No exterior loads are to be transferred to any of the equipment.
- C. The centrate matching the flange of the flexible liquid discharge connection. The chute shall include a 2-inch connection as a vent flange.

The chute shall maintain the shape of the centrifuge casing discharge connection and shall be 12-inches long. The chute shall be independently supported so as to impose no weight on the centrifuge casing flange. The chute is to be manufactured from 304 stainless steel.

The thickened sludge discharge chute shall be rectangular with a top flange which matches the flange of the solids flexible discharge connection. The chute is to maintain the shape of the centrifuge casing discharge connection and is to have

sides as straight as possible to prevent solids from bridging or hanging up. The chute is to be independently supported so as to impose no weight on the centrifuge casing manufactured of 304 stainless steel.

2.09 CONTROLS

- A. A complete central system shall be furnished for each centrifuge to include all controls, instrumentation and interlocks necessary for the operation of the centrifuge and ancillary equipment.
- B. Local Control Panel.

NEMA 12 enclosure.

The control panel shall be equipped with the following:

1. Main circuit breaker.
2. Variable frequency inverter for the main drive motor.
3. Motor starter for the hydraulic drive system.

4. Pushbuttons and running lights for:
Main Drive Motor
Backdrive Motor
5. Ammeter and Hours-run meter for main drive motor.
6. Indication of the following malfunctions:
 - (a) High main drive motor temperature.
 - (b) High backdrive motor temperature.
 - (c) High vibration in main bearings.
 - (d) High backdrive torque (hydraulic pressure).
7. Audible alarm with re-set.

2.10 PAINTING

Shop and field painting shall be manufacturers standard.

2.11 SPARE PARTS

The following spare parts shall be furnished with the centrifuges and back drive systems.

- 1 Set Bearings and Seals.
- 1 Set O-Rings and Seals.
- 1 Set Matched Drive Belts.

2.12 SPECIAL TOOLS

One set of the following tools will be furnished.

- 1 Set Wrenches.
- 1 Bowl Lifter.
- 1 Bearing Puller.

PART 3

3.01 SERVICE

The centrifuge manufacturer shall furnish the services of an authorized representative to inspect the equipment installation, check out the equipment mechanically, and instruct plant operating personnel in the operation, optimization and maintenance of the

equipment. This service shall be for a period of TWO 8-hour days and shall be completed within TWO trips to the job site and shall be rendered within one (1) year after the equipment is shipped to the job site. The cost of this service shall be included in the centrifuge manufacturer's proposal.