

Watson-Marlow 530 Series Variable Speed Peristaltic Pump

Part 1 - General

1.01 Description

- A. Pumps shall be positive displacement peristaltic type complete with spring-loaded pumphead, self-contained variable speed drive, and flexible extruded tube as specified.
- B. Peristaltic pumping action is created by the compression of the flexible tube between the pump head rollers and track, induced forward fluid displacement within the tube by the rotation of the pump rotor, and subsequent vacuum-creating restitution of the tube.
- C. Pumps shall be dry self-priming, capable of being run dry without damaging effects to pump or tube and shall have a maximum suction lift capability of up to 30' vertical water column. Maximum pressure rating: 30 psi.
- D. Pump shall not require the use of check valves or diaphragms and shall not require dynamic seals in contact with the pumped fluid. Process fluid shall be contained within pump tubing and shall not directly contact any rotary or metallic components.
- E. Flow shall be in the direction of the rotor rotation, which can be reversed and shall be proportional to rotor speed.

1.02 Quality Assurance

- A. This specification is the basis for design of peristaltic metering pumps. All pumps, whether named as an acceptable supplier or submitted, as an equal must, at a minimum, meet the following critical design requirements.
 - 1. Maximum two compressing rollers for two compressions per revolution.
 - 2. Tube wall thickness of 2.4 mm and material specified.
 - 3. Large diameter spring-loaded roller set for 2.4mm wall thickness tubing.
 - 4. Max base drive speed of 220 RPM for 2.4mm wall thickness tubing.
 - 5. Track geometry of no less than 180 degrees and rotor geometry with roller 180 degrees apart.
 - 6. For quality purposes, pump tubing must be manufactured by the pump manufacturer themselves. Pumps utilizing third party tubing not manufactured by the pump manufacturer is not acceptable.
 - 7. For chemical compatibility with a broad spectrum of chemicals, the pump housing shall have powder coating per 2.03.C.5.
 - 8. Pumps to be manufacturer's standard product. Manufacturer of tubing pumps must have at least 20 operating installations in domestic water or wastewater treatment plants located in the United States over a period of at least seven years pumping the same fluid as specified.
 - 9. Drive and pumpheads shall be 24 hr continuous duty rated and have a five-year manufacturer's warranty from date of shipment.
 - 10. Pumps must be manufactured under ISO 9001-2015.
 - 11. Pumps shall meet all applicable CE and C ETL US standards per UL61010-1:2010 and the tubing must be NSF61 approved for the chemical being pumped.
 - 12. Pumps shall be 100 % integral in design with the pumphead, motor, controls, and pump case being manufactured by the pump manufacturer themselves. All controls, motors, and gear reduction shall be housed in a single chemically resistant pump case. Pumps that require separate base plates, external gear reducers and /or gear motors, and separate controls– even if mounted on a base plate and pre-wired to the motor- are not acceptable.

1.03 Submittals

A. Submit the following:

1. Certified shop drawings.
2. Characteristic performance curve showing flow rate as a function of RPM and pressure.
3. Dimensional drawings.
4. Operating, maintenance, programming, and wiring instructions

1.04 Delivery, Storage, & Handling

A. Shipping

1. Ship pump and drive assembled complete. Ship tubing separately packed in a continuous length. Required length for installation shall be cut by the Contractor, with the remaining tubing stored for spare replacement.
2. Pack all additional spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
3. Deliver spare parts at the same time as pertaining equipment. Deliver to Owner after completion of work.

B. Receiving

1. Contractor to inspect and inventory items upon delivery to site.
2. Contractor to store and safeguard equipment, material, instructions, and spare parts in accordance with manufacturer's written instructions.

Part 2 - Pump Design

2.01 Manufacturers

A. Watson-Marlow, Inc.

2.02 Pump Process Schedule

Quantity	*(Engineer to specify)*					
Tag Number(s)	*(Engineer to specify)*					
Fluid Viscosity Specific Gravity Fluid Temperature	*(Engineer to specify)*					
Tubing Material	Marprene II *(Alternate material available upon request)*					
Max – Min Capacity (GPH)	*(Engineer to specify)*					
Max Pump RPM for Application	*(Engineer to specify)					
Tubing ID *(Engineer to specify)*	1.6mm	3.2mm	4.8mm	6.4mm	8.0mm	9.6mm
Displacement /Revolution (Gallons)	0.0001	0.0004	0.0010	0.0018	0.0028	0.0040
Min Flow Rate (GPH)	0.0006	0.0027	0.0060	0.0106	0.0174	0.0238
Max Flow Rate (GPH)	1.46	5.86	13.20	23.80	36.50	52.30
Max Discharge Pressure (PSI)	*(Engineer to specify)*					
Suction Head	*(Engineer to specify)*					
Power (VAC, Frequency, Phase)	115VAC, 60 Hz, 1 Phase					

2.03 Pump Construction

A. Pumphead

1. Pumphead shall consist of a fixed track, a hinged guard door, two spring-loaded tube clamp mechanisms, and spring-loaded roller rotor assembly. Pump tubing shall be in contact with the inside diameter of the track through an angle of 180 degrees and be held in place on the suction and discharge by a spring loaded self-adjusting clamp mechanism. At all times, one roller shall be fully engaged with the tubing providing complete compression and preventing back flow or siphoning. Tube occlusion and spring tension shall be factory set to accommodate 2.4mm wall thickness tubing and shall not require adjustment for accommodating tubing of 1.6mm to 9.6mm ID.
2. Pumphead guard shall be transparent for the purpose of viewing direction of rotation. When closed, the pumphead guard shall seal against the pump track for leak containment and controlled waste through the pumphead waste port in the event of a tube failure. For operator and environmental safety, pumps in which the direction of rotation cannot be visually verified and/or do not have a controlled waste port are not acceptable.
 - a. Pumphead Assembly
 - 1) Pump Track Geometry must have a minimum 96.6mm swept diameter through a minimum track angle of 180 degrees.
 - 2) Provide high corrosion/impact-resistant materials as specified.
 - a) Track Construction: polyphenylene sulfide (PPS)
 - b) Guard Construction: hinged impact-resistant polycarbonate breakaway guard, tool unlockable for operator safety.
 - c) Rotor Construction: polyphenylene sulfide (PPS)
 - b. Tube Retainer Mechanism
 - 1) Provide two spring-loaded adjustable tube retainer mechanism to secure the tubing at the entry and exit points of the pumphead.
 - c. Rotor Assembly
 - 1) Provide rotor assembly that ensures gradual tube occlusion and compensates for tube tolerance:
 - a) Twin spring-loaded roller arms located 180 degrees apart, each fitted with stainless steel helical springs and compressing roller for occlusion of the tube twice per rotor revolution.
 - 1) Compressing Rollers: 316SS with low friction stainless steel bearings and PTFE seals, minimum diameter of 18mm
 - b) Provide non-compressing guide rollers constructed of corrosion resistant Nylatron.
 - 2) Clutch: Equip rotor with a central handgrip hub and manually activated clutch to disengage the rotor from the drive for manual rotor rotation during tube loading. Clutch shall automatically reengage rotor to gearbox upon one complete revolution.
 - 3) Mounting: To prevent slip, the rotor assembly shall be axially secured to the dogged output shaft of the gearmotor via a slotted collet and central retaining screw.
 - 4) Pumpheads requiring disassembly or special tools for tube changing are not acceptable.

B. Tubing

1. Pump tubing shall be in contact with the inside diameter of the track (housing) through an angle of 180 degrees and be held in place on the suction and discharge by tube retainer clamps. The tubing shall be replaceable without the use of tools and with no disassembly of the pumphead. To achieve maximum flow per revolution, pump heads with a track angle of less than 180 degrees are not acceptable. See 1.02.
2. Pump tubing shall be constructed of Marprene II, a thermoplastic elastomer with a 64 Shore A durometer and 2.4mm wall thickness. Pump manufacturer must manufacture Marprene tubing in-house. Pump manufacturers who purchase third party tubing are not acceptable.
3. Tubing must meet NSF61 for the chemical being pumped.
4. Pump shall readily accept tubing ID's of 1.6mm, 3.2mm, 4.8mm, 6.4mm, 8.0mm or 9.6mm without pump adjustment or replacement. Tubing with a wall thickness less than 2.4mm is not acceptable. See 1.02.
5. Tubing must be replaceable with the rotor in the stopped position. For operator safety, pumps that require the rotor to be rotating and/or requiring special pulling tools are not acceptable.
6. Supply 15-meter roll of specified tubing size.

C. Drive

1. Rating: Continuous 24-hour operation, 40° C ambient.
2. Supply: 110-120V 50/60 Hz and 220-240V 50/60 Hz, 1-Phase field switch able. Supply nine-foot length mains power cord with standard 115V three-prong plug.
3. Max drive power consumption: 135VA.
4. Enclosure: NEMA 4X
5. Housing: Pressure cast aluminum with Alocrom pre-treatment and exterior grade corrosion resistant polyester powder coat. By nature of the environmental conditions, unpainted housings, including 316SS, are not acceptable.
6. Drive motor- brushless DC motor with integral gearbox and tachometer feedback.
 - a. Speed Control Range of 2200:1 from 0.1 to 220 rpm +/- 0.1 rpm throughout the range.
 - b. Closed loop microprocessor-controlled drive with pulse width modulation at speeds above 50 rpm and synchronous mode with magnetic field rotation control below 50 rpm.
7. Leak Detector: Pump manufacturer shall supply optical-type leak sensor mounted to the drain port of the pump head for leak detection and pump shut down in the event of a tubing failure.
8. Mounting: Drive shall be self-supporting and shall not require anchoring.
9. Chemical Resistant Metering Pump Shelf (Optional)
 - a. Material of Construction: HDPE
 - b. Mounting Hardware & Installation to be supplied by the Contractor.

D. Manual Interface & Control

For Applications requiring Analog Process Control Engineer to specify per below:

1. Pumps must meet the following minimum requirements for operator interface functionality. Pumps not meeting this minimum functionality will not be accepted.
 - a. Display: Backlit graphical TFT Display capable of up to 8 lines of text with up to 26 characters per line to display flow rate and programming instructions. Display shall also provide visual indication of running status via screen color: Grey = Running, White = Stopped and Red = Warning.
 - b. Keypad: Keypad for start, stop, speed increment, speed decrement, forward/reverse direction, rapid prime, and programming.

- c. Flow units: Programmable in following units: $\mu\text{l}/\text{min}$, ml/min , ml/hr , l/min , l/hr , l/day , $\text{gallons}/\text{hr}$, $\text{gallons}/\text{day}$, g/min , kg/hr , or lb/day .
- d. Security: Programmable keypad lock and PIN security for optional lockout of all keys except emergency start/stop.
- e. Auto Restart: feature to resume pump status in the event of power outage interruption.
- f. Multilingual menu: include programming menus in eleven languages, including at a minimum English, Spanish, and French.
- g. Programmable “Maximum Speed” to allow operator to set the maximum speed of the pump within 0.1-220 rpm.
- 2. Supply auto control features to meet the following minimum functionality requirements. Pumps not meeting this minimum functionality will not be accepted.
 - a. Remote Control Inputs
 - 1. Speed Control:
 - a) Primary Analog 4-20mA or 0-10VDC speed input, with input signal trim able and speed scalable over any part of the drive speed range.
 - b) Provisions for alternative remote accessory potentiometer (if supplied by others)
 - 2. Start/Stop Control: via 5V TTL, 24V industrial logic, dry contact, or powered 110VAC contact as required per the process and instrumentation drawings- Configurable command sense allowing open to equal run or open to equal stopped.
 - 3. Forward/Reverse Control: via 5V TTL, 24V industrial logic, dry contact, or powered 110VAC contact as required per the process and instrumentation drawings.
 - 4. Auto/Man Mode Control: via 5V TTL, 24V industrial logic, dry contact, or powered 110VAC contact as required per the process and instrumentation drawings.
 - 5. Leak Detector Run/Stop Control: via optical style leak detector.
 - b. Status Outputs
 - 1. Four relay contacts rated for 30 VDC with a maximum load of 30W, NO or NC or four relay contacts rated for 130VAC as required by the process and instrumentation drawings software configurable to indicate the following:
 - a) Running/Stopped status
 - b) Forward/Reverse status
 - c) Auto/Manual status
 - d) General Alarm status
 - e) Leak Detected status
 - 2. Speed output –
 - a. Analog 4-20mA or 0-10 VDC
 - c. Termination: supply screw down terminals suitable for up to 18 AWG field wire and accessible through four glanded cable entry points on the pump

For Applications requiring Profibus Process Control Engineer to specify per below:

- 1. Pumps must meet the following minimum requirements for operator interface functionality. Pumps not meeting this minimum functionality will not be accepted.

- a. Display: Backlit graphical TFT Display capable of up to 8 lines of text with up to 26 characters per line to display flow rate and programming instructions. Display shall also provide visual indication of running status via screen color: Grey = Running, White = Stopped and Red = Warning.
 - b. Keypad: Keypad for start, stop, speed increment, speed decrement, forward/reverse direction, rapid prime, and programming.
 - c. Flow units: Programmable in following units: $\mu\text{l}/\text{min}$, ml/min , ml/hr , l/min , l/hr , l/day , $\text{gallons}/\text{hr}$, $\text{gallons}/\text{day}$, g/min , kg/hr , or lb/day .
 - d. Security: Programmable keypad lock and PIN security for optional lockout of all keys except emergency start/stop.
 - e. Auto Restart: feature to resume pump status in the event of power outage interruption.
 - f. Multilingual menu: include programming menus in eleven languages, including at a minimum English, Spanish, and French.
 - g. Programmable "Maximum Speed" to allow operator to set the maximum speed of the pump within 0.1-220 rpm.
2. Pumps must be capable of two-way digital communication over a PROFIBUS DP network with bus communication speeds from 9.6 to 12,000 kbits/s and meet the following minimum functionality requirements. All control signal features must be located internally to the pump. Pumps not meeting this minimum functionality or that require additional external control boxes with gateways are not acceptable.
- a. Control Inputs
 - 1. Speed Control, Start/Stop, Direction of Rotation and Flow Calibration all configurable via digital command.
 - 2. Leak Detector Run/Stop Control: via optical style leak detector.
 - b. Control Feedback
 - 1. Measured Speed, Running Status, PROFIBUS Control Enabled status, Leak Detected Status, and Current Calibration Information being utilized by the pump.
 - c. Extended Diagnostic Feedback
 - 1. Continuous monitoring and feedback of the following:
 - a) General Error
 - b) Motor Stalled
 - c) Over Current
 - d) Under Voltage
 - e) Over Voltage
 - f) Overload
 - g) Over Temperature
 - h) Speed Error
 - i) Signal Out of Range
 - j) Over Signal
 - k) Tacho Fault
 - l) Leak Detect

For Applications requiring Ethernet Control, Engineer to specify per below:

- 1. Pumps must meet the following minimum requirements for operator interface functionality. Pumps not meeting this minimum functionality will not be accepted.

- a. Display: Backlit graphical TFT Display capable of up to 8 lines of text with up to 26 characters per line to display flow rate and programming instructions. Display shall also provide visual indication of running status via screen color: Grey = Running, White = Stopped and Red = Warning.
 - b. Keypad: Keypad for start, stop, speed increment, speed decrement, forward/reverse direction, rapid prime, and programming.
 - c. Flow units: Programmable in following units: $\mu\text{l}/\text{min}$, ml/min , ml/hr , l/min , l/hr , l/day , $\text{gallons}/\text{hr}$, $\text{gallons}/\text{day}$, g/min , kg/hr , or lb/day .
 - d. Security: Programmable keypad lock and PIN security for optional lockout of all keys except emergency stop.
 - e. Auto Restart: feature to resume pump status in the event of power outage interruption.
 - f. Multilingual menu: include programming menus in eleven languages, including at a minimum English, Spanish, and French.
 - g. Programmable "Maximum Speed" to allow operator to set the maximum speed of the pump within 0.1-265 rpm.
2. Pumps must be capable of two-way digital communication over an Ethernet/IP network with baud rate of 10/100 mbps full/half duplex operation and meet the following minimum functionality requirements. All control signal features must be located internally to the pump. Pumps not meeting this minimum functionality or that require additional external control boxes with gateways are not acceptable.
- a. Control Inputs
 - 1. Speed Control, Start/Stop, Direction of Rotation and Flow Calibration all configurable via digital command.
 - 2. Leak Detector Run/Stop Control: via optical style leak detector.
 - 3. Remote Pressure/Flow Sensor: via analog 4-20 mA signal
 - b. Control Feedback
 - 1. Measured Speed, Running Status, Ethernet Control Enabled status, Leak Detected Status, Flow Totalizer, Remote Pressure, Remote Flow and Current Calibration Information being utilized by the pump.
 - c. Extended Diagnostic Feedback
 - 1. Continuous monitoring and feedback of the following:
 - a) General Error
 - b) Motor Stalled
 - c) Over Current
 - d) Under Voltage
 - e) Over Voltage
 - f) Overload
 - g) Over Temperature
 - h) Speed Error
 - i) Signal Out of Range
 - j) Over Signal
 - k) Tacho Fault
 - l) Leak Detect

E. Spares

- 1. Supply one spare pumphead assembly.

- **(Under 2.03.B.3 one 15-meter pack of tubing is provided for each different chemical service. For regular preventative maintenance and normal corrective maintenance, only tubing needs be stocked and is supplied with the pump in sufficient quantity for this purpose. For additional corrective maintenance, it is advisable to have a spare pump head stocked.)**

Part 3 – Execution

3.01 Installation (By Contractor)

- A. Contractor shall install items in accordance with manufacturer's printed instructions and as indicated and specified.
- B. Contractor to supply hose barb-to-process line adapters for connection of pump tubing to process lines. Hose barbs to be secured to the pump tubing via a hose clamp tightened around the OD of the tubing.