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WARRANTY

Intek, Inc. warrants each *Rheotherm* Model 210 product to be free from defects in material and workmanship under normal use and service; Intek's obligation under this warranty being limited to making good any part or parts thereof which shall, within one (1) year after delivery of such product to the original purchaser, be returned to Intek with transportation charges prepaid and which Intek's examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties, express or implied and all other obligation or liabilities on Intek's part. The purchaser will assume all responsibility and expense for removal, decontamination and reinstallation of equipment.

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1 GENERAL INFORMATION

1.1 INTRODUCTION

Rheotherm precision flow controllers are designed to provide accurate control of fluid flow rate. *Rheotherm* instruments are manufactured exclusively by Intek, Inc. and employ a patented thermal technique used by industry since 1978. The unique sensor designs have protected sensors, are easy to install and require little or no maintenance. The Model 210 is a smart instrument; its unique features and performance characteristics are described in SECTIONS 3, 4, and 6.

The Flow Controller is an add-on to a standard Rheotherm Flow Meter that uses PID control to adjust an integrated valve to a customer selectable setpoint. The PID variables are dependent on fluid type, flow rate, and sensor size. As such they are programmed at the factory and are not user adjustable. The Flow Controller is typically available in any mass flow or volumetric flow units with a 10:1 turndown but can be calibrated to 100:1 with decreased setpoint precision. The Flow Controller displays the current flow rate (PV) and the setpoint (SV) on the display.

Each *Rheotherm* flow controller consists of three elements, a sensor, a transmitter unit, and an adjustable valve. Design selection is based on application constraints or customer preference.

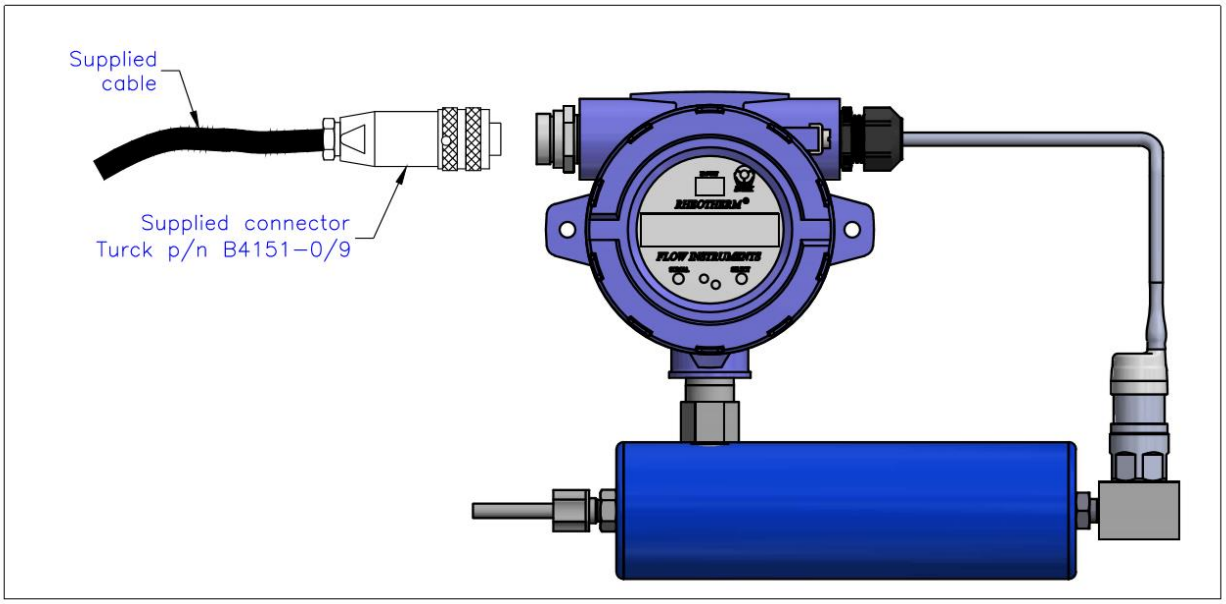
Key features of *Rheotherm* instruments are:

- Nonintrusive flow measurement: For pipe sizes from 1/16 to 1/4 inch, flow sensing can be done from outside the flow tube.
- Chemical compatibility: The wetted surface(s) can be any of a number of corrosion resistant metals, alloys and seals.
- Flexibility: *Rheotherm* meters can be ordered calibrated for mass or volumetric units or in average velocity. Flow rate displays or output signals are available, as well as rangeability up to 100:1.
- Fluid pressure options up to 500 psi (check sensor tag for rating on your unit).
- Withstands over-ranging: No damage or change in calibration will occur due to excessive flow rates many times higher than calibration range.

1.2 DESCRIPTION OF OPERATION

Rheotherm flow controllers are available with various nonintrusive sensor designs, but they all use the same, patented, thermal sensing technique. Two temperature sensors are used, one is in thermal equilibrium with the fluid and provides a fluid temperature reference, while the second temperature sensor is located near a heater so that its temperature is slightly above that of the fluid. In a TU or TUL sensor, the temperature sensors and heater are attached to the outside of the flow tube. The rate at which heat is removed from the heated sensor by the stream is related to fluid velocity. Hence, the measured temperature differential between the reference sensor and heated sensor is a function of flow rate. Intek, Inc. is licensed to use this patented and trademarked flow measurement method.

The Rheotherm Flow Controller is an addition to a standard Rheotherm Flow Meter. It uses a calibrated flow rate measurement to control an adjustable valve to the desired setpoint. The valve and sensor calibration will be sized to your specific application, with the desired set point, if specified, near the center of the calibration range. The setpoint is adjustable with a 10:1 turndown ratio or larger by request. It is recommended to keep the setpoint within 10% to 90% of the range.



Nonintrusive sensor
(TU or TUL)

1.3 PRECAUTIONS

!! CAUTION: Throughout the manual this caution notation indicates that failure to execute the accompanying instructions may cause the instrument or external equipment to malfunction.

!! WARNING: A warning indicates that failure to execute the accompanying instructions may cause permanent damage to the instrument or external equipment.

1. Use proper input power — All Flow Controllers use 24v DC Power

2. Use reasonable care in handling the sensor. Disassemble valve carefully for cleaning

   TU or TUL — Twisting or bending can damage the sensor. The flow tubes are thin-walled tubing. Do not rotate the electronics box or try to disassemble the sensor body tube fittings (at each end of the shell).

3. Check the sensor maximum temperature rating — Do not operate a sensor at or subject it to a temperature above its specified limit.

4. Keep moisture out of the electronic enclosure and sensor junction box. Once cable connections are made in the junction box, make sure the lid is tightly closed. Seal conduit lines if they can become wet inside.

5. Keep sensor wetted surfaces clean and free of permanent layer build-up.

6. Do not exceed pressure limits of the tube or fittings.

7. Maintain a thermally stable environment (short-term) for the sensor and adjacent line (See SECTION 2 — INSTALLATION).

These instructions cover installation, calibration and maintenance of *Rheotherm* meters in standard configurations. Any special information pertaining to your unit is covered under CUSTOM INFORMATION (SECTION 6). Time should be taken to carefully read these instructions prior to installation of the equipment. Should any questions arise or problems occur, call Intek for immediate assistance.

!! WARNING:
Do not leave the instrument powered with no flow and a non-zero set point. This will cause the valve to overheat!

2 INSTALLATION

2.1 SENSOR

> **!! CAUTION:** All sensors have a directional arrow on the tag and/or etched into a metal part. All flow controllers are assembled with the valve on the downstream side. Before installing a sensor, please note proper flow direction. This is critical to instrument performance.

The sensor style supplied with your meter is listed in the model code number in SECTION 6. Proper installation of the sensor is necessary for achieving accuracy and repeatability. Installation suggestions for each type of standard sensor are given here and instrument detail drawings may be included in the appendix. For custom sensor installations, refer to CUSTOM INFORMATION — SECTION 6.

Be sure wetted surfaces are clean before installing. If cleaning is needed, use non-residue solvent and wipe dry. Some sensor terminations are enclosed in an aluminum housing and if it is not sealed properly can easily be damaged by moisture and corrosion. Make sure the lid is tightly sealed and the gasket, if supplied, is in place.

TU or TUL (nonintrusive) — capillary (C), $^{1}/_{16}$, and $^{1}/_{8}$ TU or TUL sensors particularly require special care in handling and installing to avoid damage to sensor tube and tube stubs.

!! WARNING: TU and TUL sensors are made with thin-walled tubing — use care when installing.

All TU and TUL sensors should have a straight line input sections, typically 20 pipe diameters. If installed vertically, the direction of flow should be up through the sensor. Connection in the line is via compression fittings, hose with clamp, threaded fittings or flanges, whichever is appropriate. Care must be taken not to transmit a twisting force through the sensor's midsection. The TU and TUL sensors, whether flanged or not, must not be used to pull other piping together or to make up angular mismatch of fittings. The sensor mounted enclosure should never be rotated for any reason.

TU and TUL sensors 1/16 or smaller may be sleeved with a tube for added support. Connection should always be made to the flow tube, as there is no assured seal between the flow tube and the sleeve.

Fluid temperatures other than ambient require special attention. Thermal gradients from one end of the sensor to the other, as well as along the radius of the connection pipe, are undesirable. Therefore, effective insulation should be installed around the inlet and outlet straight line runs. Gradients which may exist in the line further up stream can be removed if an insulated elbow is installed in the line prior to entering the straight line portion of the plumbing. Metallic support braces for the sensor or adjoining plumbing can act as a heat sink and cause indication errors in high temperature applications. The support braces should be thermally isolated from the line to avoid heat loss effects. The adjustable valve is attached to the downstream side of the sensor. It generates heat when used and should not be insulated.

Flow stream conditioning must also be considered to maximize meter performance. Avoid upstream protrusions and short distance straight runs. Flow pulsations, such as those created by metering pumps, may cause the instrument to differ from the factory calibration. Furthermore, if the flow is varied by stroke and by pump speed adjustment, the indication will most likely be non-repeatable. If

you are using a pump of this type, it is recommended that a pulsation dampening device be used to provide smooth continuous flow.

For liquid measurement systems using high pressure gas to force flow, the effects of the absorbed gas must be considered. In these cases, sudden pressure drops up stream of the sensor such as line size expansions, control valves, and pressure dropping regulators must be avoided. Sudden pressure drops can cause the absorbed gas to release into the liquid, making the flow sporadic and difficult to measure.

The ideal installation will provide the sensor with well established smooth flow, uniform system temperature and consistent fluid media.

2.2 TRANSMITTER ELECTRONICS

The Rheotherm Flow Controller is available in 2 configurations, FCP and FCE.
Note: For best results it is recommended to set the setpoint withing 10-90% of the calibrated flow range

FCP:

This version has a potentiometer adjustable setpoint. This is set to the specified flow rate at the factory. To adjust the setpoint in the field, first open the cover, then turn the potentiometer until the desired value is displayed on the screen. The cover should only be opened in safe environments.
In this configuration the Flow Controller outputs a calibrated analog flow rate signal (0-5V, 0-10V, 4-20mA) over the blue and white wires. White is positive and blue is ground.

FCE:

This version has an externally controlled setpoint. A 0-5 V analog input signal is sent over the blue and white wires, with white as the signal wire and blue the ground. A PWM signal will not work. When the flow controller is powered off, the external control signal must also be powered off or the controller will draw power through the signal input line.

!! WARNING:
Connecting input wires to higher than 5 V (or less than 0 V) will void the warranty and damage the instrument!

The instrument is designed to be watertight (non-submersible) when the covers are properly seated. The housing(s) should be mounted such that wire/cable ports are located at the back, bottom, or sides of the housing(s) to reduce risks associated with water spray, condensation and settling of dust and dirt. All exposed parts are stainless steel (unless a special alloy has been specified), painted cast aluminum or steel, polycarbonate, or quartz glass (display window) These materials tolerate most corrosive environments.

Unless otherwise specified, normal ambient environment for the transmitter is 0-120 F.

2.3 ELECTRICAL CONNECTIONS

1. Verify/configure the input power. The input power requirement is listed on the tag on the transmitter enclosure. Be sure the input power source to be used is properly selected in the unit. Unless specifically ordered otherwise, the input power requirements are 24±2Vdc @ 0.25A typical. ***Do not apply power to the instrument until all connections are made and all enclosure covers are in place.***

   !! CAUTION: Use supply wires suitable for 10℃ above ambient.
   !! CAUTION: The output signal is isolated from the power ground. If you are connecting the 4-20 mA output to an isolated input device, it may be advisable to ground the incoming signal at the input device. Refer to the input device manufacturer's recommendations.

2. Check the analog output configuration of the transmitter and your input device. Typically the 4-20 mA output is configured to actively supply the loop current. If another output type has been ordered it will be listed in SECTION 6.3 - SPECIAL INSTRUCTIONS. (Active: current to the loop is sourced by transmitter. Passive: output receiver sources the current.)

3. Pull wires through the conduit. Wire for the power connection must be no smaller than 22 gauge or as required by applicable local or company wiring codes. After pulling the wire, pot the conduit or wires near the enclosure if there is any possibility of water from condensation or spray entering the enclosure through the conduit. With the "blind" option, a single cable that contains two internal twisted-shielded pairs is included and is used for both the input power and the output signal.

   !! WARNING: The transmitter unit is not protected against condensed liquid water inside the enclosure. Be sure conduit interfaces are dry or sealed at the instrument to prevent condensation that may be present in conduit lines from entering the enclosure.

4. Make wiring connections. ***Power should be off at this time***.

   !! WARNING: Verify the wiring. The equipment can be permanently damaged if not wired as instructed in this manual. Applicable code requirements should also be met when connecting the conduit to the enclosure.

5. Secure the enclosure cover(s). Make sure it is tight enough to make a good seal against the gasket if supplied, and ensure all other enclosure openings are completely watertight

6. Connect functional ground. To assure EMC compliance, ground the sensor and the windowed enclosure (if applicable) to earth ground using 3/8" wide ground straps or equivalent. EMC compliance testing has been successfully completed using these straps and ungrounded tubing. However, if the flow tubing and electrical conduits are reliably grounded by other means, these straps may not be necessary. These straps may also be required to supply a reliable or redundant ground path for operation in hazardous locations. Consult your plant's safety engineer.

3 OPERATION

3.1 START UP

Typically, the instruments have been configured by the factory for the flow range of interest specified by the customer. After installation has been completed all that is required is to switch on power and initiate flow in the measurable flow rate range. Flow sensors that are not calibrated directly on the fluid to be measured are so indicated in this manual (SECTION 6).

When power is first turned on, the 4-20 mA output will be low (alarm condition while booting), followed by the output starting near 100. After fifteen to sixty seconds (depending on flow meter response) the reading will stabilize.

3.2 GENERAL INFORMATION

The *Rheotherm* instrument is compensated for a wide range of both ambient and flowing media temperatures. However, abrupt changes in the temperature of the flow stream can cause the instrument output to deviate from the true representation of flow rate. An accurate reading is obtained only when the sensor is in thermal equilibrium with the flowing liquid or gas. Typically, a 10 C abrupt change in temperature may require 40 seconds to stabilize. To maintain optimum accuracy, temperature ramps should be kept below 1 C/minute.

Rheotherm instruments are calibrated for a particular fluid, either at the factory or in the field. If the fluid changes properties, the calibration changes. Therefore, once calibrated, do not allow fluid properties such as density and viscosity to change (other than the intrinsic changes which occur with temperature variation). If the fluid is changed, a factory recalibration will be required.

3.3 OPERATIONAL INTERFACES

By default, *Rheotherm* Flow Controllers include a 4-20 mA analog output flow signal. When used in the optional external setpoint control orientation (FCE), the flow output signal is replaced by an input signal to control the setpoint. The flow controller display shows the PV or process variable and the SV or setpoint variable. The process variable is the current flow rate measured by the flow controller. The setpoint variable is the flow setpoint and displays the target value. The flow process variable is a linear, temperature compensated value. The output signal is scaled such that 4 mA (0 Vdc for voltage output) represents zero flow and 20 mA (10 Vdc) represents 100% of the rated full-scale flow. The factory set full-scale value is shown on the output curve at the end of the manual.

1. Analog Output — Instruments with FCP in the serial number will have a 4-20 mA, 0-5 Vdc, or 0-10 Vdc signal for remote flow indication. The default configuration for the output is 4-20 mA active transmitter. The flow output covers 0 to 100% of full scale flow and abruptly drops to zero (4 mA) below the instrument's calibrated low flow value. Refer to the Output Curve (Figure in Custom Information Section). The instrument output will extend outside of the 4-20 mA range to signify an alarm condition. A low value will indicate a problem has been detected with the sensor. All other error types will produce an output value higher than 20 mA. The only expected time the signal will be outside the 4-20 mA level is for a few seconds after powering on the instrument.

2. Local OLED Display —The display shows the PV or current flow rate, and the SV or target flow rate.

3. Setpoint Adjust — Instruments with an FCP in the serial number are controlled by an onboard potentiometer. To adjust this potentiometer, unscrew the enclosure window and use a small tweaker or screwdriver to turn the dial up or down. Instruments with an FCE in the serial number use a 0-5v analog input to control the setpoint. This signal is sent over the blue and white wires, with blue as ground and white as the signal wire.

3.4 OUTPUT CURVE

The Figure in the Custom Information Section is the final linearized flow output curve for your unit. The instrument has been calibrated over the actual flow rate range indicated on the ordinate (Y axis).

4 MAINTENANCE

4.1 GENERAL MAINTENANCE

Certain precautions should be taken to ensure proper performance of all models of flow instruments. Since the measurement technique involves a signal resulting from heat transfer to the flowing medium, care should be exercised to prevent build-up of varying layers on the walls of the sensor. Layers such as bacterial growth, dried paints, gas bubbles and non-solubles can result in measurement below actual flow rates. Periodic checks and cleaning should be performed to ensure a clean pipe interior.

It should be part of a normal maintenance procedure to check the system for proper functioning. Experience and other observable conditions should be utilized to determine the frequency of inspection. Long term drift in the unit calibrations is not expected, but if a recalibration is required, contact the factory.

If the valve becomes clogged it can be removed for cleaning. First unscrew the valve from the baseplate, while being careful not to damage the control wires. Then unscrew the valve baseplate from the flow meter. Clean and then reassemble in reverse order.

> **!! WARNING:** When removing valve block from sensor place a wrench on the sensor endcap hex. This will ensure torsion is not transmitted down the flow tube. Placing stress on the flow tube can cause damage.

4.2 FLOW CALIBRATION ADJUSTMENT

Occasionally over time or due to process condition changes a slight realignment of the calibration may be required to maintain the desired indication accuracy. Periodically verify the instrument calibration by comparing the indication versus another accurate flow measurement or against a trusted primary standard. After characterizing the drift tendencies and considering the accuracy requirements, determine a regular calibration verification cycle. Otherwise, an annual verification is recommended for typical installations. Recalibration can be done by returning the instrument to the factory.

4.3 SPARE PARTS

The sensor and transmitter electronics are calibrated as a set, and cannot be randomly interchanged with others. For critical applications, a complete spare flow controller (sensor and electronics) should be stocked. A spare sensor can be stocked, if it is ordered and calibrated at the same time as the flow meter.

4.4 TROUBLESHOOTING

This *Rheotherm* instrument functional operation is monitored automatically by the Model 210 processor. If loss of function or erratic performance is experienced and detected by the processor the

4-20 mA output will be set either below 4 mA or above 20 mA depending on the type of problem found.

The following tables provide easy-to-follow instructions to troubleshoot flow indication problems and interpret instrument fault codes.

TABLE I. Troubleshooting Guide - Flow Indication Problems

OBSERVATION	PROBABLE CAUSE	REMEDY
Flow indication continually drifting downward with constant flow.	1. Coating forming on wetted surface of sensor.	1. Clean sensor periodically.
Flow indication saturates high or low — will not respond to flow change.	1. Flow rate not within range of meter. 2. Calibration out of range of actual flow. 3. Partially failed component in sensor or transmitter. 4. Setpoint set to High or Low Flow	1. Check flow range requirements. 2. Return to factory for recalibration. 3. Consult factory. 4. Adjust setpoint away from High or Low range
Flow indication varies with flow setpoint but is not stable.	1. Fluid temperature not stable. 2. Fluid mixture not properly blended. 3. Gas mixed with liquid. 4. Flow not fully developed.	1. Tune temperature controller, add insulation and/or add static mixer in front of sensor. Monitor temperature indication. Refer to Installation Section for discussion on thermal stabilizing flow system. 2. Add static mixer in front of sensor. 3. Reduce gas pressure or check for air ingress on suction side of pump. Refer to Installation Section. 4. Check inlet for proper straight line length & freedom from obstructions.
Display frozen, showing NaN, display scrambled, or black	1. Unable to communicate with flow sensor	1. Cycle power to instrument. 2. Contact factory for further assistance.
Flow never reaches setpoint.	1. Not enough pressure in flow system.	1. Increase motive force, i.e. centrifugal pump speed or air pressure.
Slow response on startup	1. Setpoint is set close to low end of range	1. Increase setpoint temporarily or wait for flow to stabilize.

5 CUSTOMER SERVICE

Intek's corporate philosophy is to solve our customer's difficult flow measurement problems. This means that each instrument is custom configured and calibrated for the application. When you purchase a *Rheotherm* instrument you also receive Intek's outstanding customer service. For sales or product service, call your local representative or Intek directly at (614) 895-0301, 8AM to 5PM EST/EDT weekdays or fax us anytime at (614) 895-0319. E-mail inquiries should be sent to *sales@Intekflow.com* or *techsupport@Intekflow.com*. Our customer service staff will provide assistance promptly.

5.1 QUESTIONS ON EXISTING HARDWARE

To allow us to help you more quickly, please have the serial number of the equipment available before you call. If your company is not the original purchaser, the identity of the original recipient will also be helpful.

5.2 TROUBLESHOOTING

If you have reviewed SECTION 4.4 TROUBLESHOOTING and have questions, please call our experienced engineers for assistance. In many cases we can solve a problem over the phone. Please provide as complete a description as possible of the problems encountered.

5.3 FACTORY AND FIELD SERVICE

If you request field service, Intek has experienced engineers available to meet your needs. Many of the repairs or recalibrations will require returning the instrument to the factory. If a problem cannot be solved over the phone, with your help, we will determine if factory service or field service will be the best solution.

To request factory service, a Return Material Authorization (RMA) and purchase order is required. Our customer service staff will assist you with the required information to return instruments for service.

5.4 DECONTAMINATION OF EQUIPMENT

For the safety of your personnel and ours, any hardware that has been in contact with potentially hazardous liquids or gases must be properly decontaminated before shipment to Intek.

5.5 QUESTIONS ON NEW EQUIPMENT

For a new *Rheotherm* application or any liquid or gas flow measurement need, contact your local *Rheotherm* representative or the Intek technical sales department at (614) 895-0301, 8AM to 5PM EST/EDT weekdays or fax us anytime at (614) 895-0319. Our staff will be pleased to answer all questions and provide quotations. Additional information is also available on our website: *www.IntekFlow.com*.

6 CUSTOM INFORMATION

6.1 UNIT IDENTIFICATION

6.2 CONFIGURATION

6.3 SPECIAL INSTRUCTIONS