

# GRAVITROL DENSITY ANALYZER

## Mark IV

Model 1373

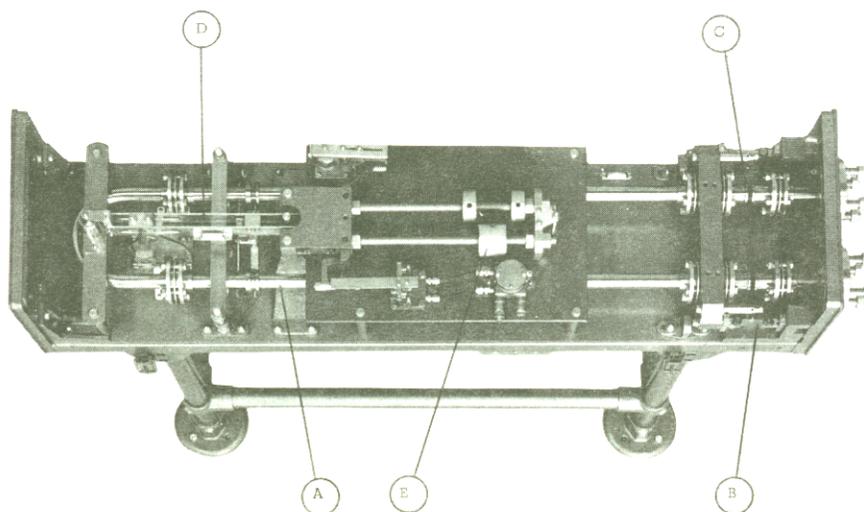
For Measurement or Control of Density  
of Liquids or Slurries

This analyzer, first introduced in 1954, has been successfully applied to a great many industrial density measurement problems. It provides the most practical method of measuring the density of a slurry and, of course, is equally suitable for use with clean liquids. The Mark IV embodies a number of major improvements as a result of field experience:

- \*Robust construction, reliable, simple to maintain with a minimum of servicing
- \*Temperature compensation to maximum of 100% of the working span
- \*Force balance transmission signals, linearly related to the density span
- \*Recalibration on site for any density span within the range of the meter,
- \*Higher sensitivity with long term stability
- \*Sample loop easily cleaned on site

### WORKING PRINCIPLE

The process liquid flows through the tube loop (A) pivoted on flexures (B) about an axis which passes through the flexible connectors (C). The weight of the tube loop and contents is transferred to a weigh-beam (D) and counterpoised by the balance weights (E) which are adjustable along the beam. A change in the density of the process liquid produces a directly proportional change in force on the weigh-beam. This force is measured by a force balance transmission system.



## TRANSMISSION SYSTEMS

Two systems are available and provide a choice of a pneumatic or an electrical output signal, linearly related to the density range. A density change can be measured in liquids or slurries with a nominal density between 0.4 and 2.5 g/ml.

The pneumatic transmission is of the force balance type with nozzle-flapper detection and bellows feedback, providing an output signal of 3-15 p.s.i.g. The density span is adjustable between 0.025 and 0.25 g/ml or alternatively, with a larger feedback bellows, between 0.05 and 0.5 g/ml. The air supply must be capable of delivering 30 cu. ft./hr. of clean dry air at a regulated pressure of 20 p.s.i.g. The electrical transmission is also of the force balance type with capacitive detection and pot coil feedback. Two D.C. output signals are available, both of which have a live zero.

Output Signals MA D.C.	Maximum Output Circuit Resistance Without Repeater Board. Ohms.	Maximum Output Circuit Resistance With Repeater Board. Ohms.
0-10	1000	3000
4-20	600	1500

With electrical transmission only, the density span is adjustable between 0.01 and 0.2 g/ml or alternatively, between 0.05 and 0.3 g/ml. The power supply must be single-phase, 50 or 60 c/s, at either 110-120 or 200-250 volts.

## PERFORMANCE

Sensitivity or discrimination	0.5% of span
Repeatability	$\pm 0.25\%$ of span
Linearity	$\pm 0.25\%$ of span
Linearity with temperature compensation	$\pm 0.5\%$ of span
Accuracy for spans of 0.03 to 0.5 g/ml over the working pressure range	$\pm 1\%$ of span

For spans between 0.01 and 0.03 g/ml, the accuracy is proportional to the span and pressure range and is within  $\pm 3\%$  of a 0.01 g/ml span over the whole pressure range of 0-150 p.s.i.g. Under atmospheric pressure conditions, the maximum error of true density measurements is  $\pm 1.5\%$  of a 0.01 g/ml span or  $\pm 0.00015$  g/ml. An increase in the process liquid temperature causes a change of approximately 0.000007 g/ml per °C., but the instrument is so designed that the effect of ambient temperature change is negligible. Calibration during manufacture assures that changes in process pressure do not give rise to false density signals and that the instrument leaves the factory, set for the specified density range. However, readjustment on site to a different range is a simple operation with the aid of weights provided.

## CONTACT MATERIALS

The standard tube loop and flexible connectors are made from 316 stainless steel and are suitable for use with any density range available, from either transmission system, up to a maximum working pressure of 150 p.s.i.g. and 300°F. temperature.

P.T.F.E., butyl, silicone and viton rubber flexible connectors can be used with contact materials such as nickel, monel, glass, Karbate, stainless steel or stainless steel lined with P.V.C. or ebonite, but with these connectors, the smallest density span available is 0.05 g/ml. At ambient temperature, the maximum working pressure is 40 p.s.i.g. with rubber connectors or 60 p.s.i.g. with P.T.F.E.



**Gravitrol with Pneumatic Transmission**

## **INSTALLATION**

As the density meter will detect a weight change of 1 part in 100,000, the operational environment is of considerable importance in obtaining optimum performance. Each application should be considered in detail since careful installation will assure accurate, trouble-free operation. Standard tube loop bores of 0.9" and 1.4" are available through which all, or part of the process liquid can be passed. Flange connections are normally 1" or 1½" ASA, 150# RF. To assure that no stress or vibration is transmitted to the instrument, it is recommended that flexible tubing be used for piping between process line and analyzer, or at least for a short distance at the analyzer.

## **AIR AND GAS**

Air and gas entrainment must be minimized for accurate measurement since the instrument operates on a volumetric weight principle.

Since the meter measures the density of the contents in the sample loop, measurement will be unaffected by particle size, provided that the particles are small in comparison with the size of the bore. A slurry must be circulated through the tube loop at a sufficient rate to prevent the deposition of solids. The recommended velocity for slurries is approximately 7 ft./sec., equivalent to a flow rate of 700 gal/h. in a 0.9" bore tube loop, or 1,700 gal/hr. for a 1.4" bore.

For clean liquids, a high velocity is only required on start up to clear the air from the tube loop. The recommended velocity is 3 ft./sec., 300 gal/hr. for a 0.9" bore, or 750 gal/hr. for a 1.4" bore. Once the air has been cleared from the tube loop, the velocity may be decreased, but the mean density of the tube loop contents will then change more slowly.

For cleaning purposes, the density meter may be flushed with any solvent that does not affect the wetted parts.

## TEMPERATURE COMPENSATION

One common density meter application is the measurement or control of the concentration of a solution which requires the suppression of density signals caused entirely by process temperature change. This suppression or compensation is achieved by applying a force change to the measuring system which is equal and opposite to the force change caused by temperature effects. The maximum compensation available is for a temperature change producing a change in density equal to the span of the instrument.

Desired Gravitrol Span  $>$  or  $=$   $T_{\text{compensation}} \times T_c$

$T_{\text{compensation}}$  = Maximum temperature span possible on compensating transmitter (reference temperature must be included in span)

$T_c$  = coefficient of thermal expansion

For example: For an instrument that has a density span of 0.05 g/ml, metering a liquid with a coefficient of thermal expansion of  $0.5 \times 10^{-3}$  per  $^{\circ}\text{C}$ ., compensation can be applied for a maximum temperature change of  $100^{\circ}\text{C}$ .

The temperature compensation unit is an optional addition to the standard instrument. It is available for linear or non-linear coefficients in pneumatic signal units, but linear only in electric.

## TEMPERATURE LAGGING

For process fluids with a high pour point temperature, the Gravitrol may be supplied with internal heating coils to develop an adequate temperature in the loop to keep sample liquid.

## AUTOMATIC CONTROL OF DENSITY

The Gravitrol Density Analyzer Mark 4, designed for continuous operation, is robust and requires an absolute minimum of servicing. Excellent results have been obtained with automatic density control systems due to the high speed of response and adjustable range of this instrument.

## SPECIFICATIONS

Tube diameters: 1" (std.), 1 1/2"

Materials of construction: 316 s. s. (std.), nickel, monel, glass, karbate or s. s. lined with PVC or ebonite

Flexible connectors: s. s., monel, P.T.F.E., nickel, butyl, silicone and viton rubber.

Process connections: Flanged ASA 150# R.F. (std.)

Span: Pneumatic output (3-15 psi)

0.025 to 0.25 gm/ml or 0.05 to 0.5

Electrical output (4-20 MA DC or 0-10 MA DC)

0.01 to 0.20 gm/ml or 0.05 to 0.3 gm/ml

Measureable density: 0.4 to 2.5 gm/ml

Outputs: 3-15 psi, 4-20 MA DC or 0-10 MA DC

Temperature limits: To 390°F. dependent on flexible connectors

Pressure limits: To 150 psi dependent on flexible connectors

Sensitivity or discrimination: 0.5% of span

Accuracy: 1% of span for spans of 0.03 to 0.5 gm/ml

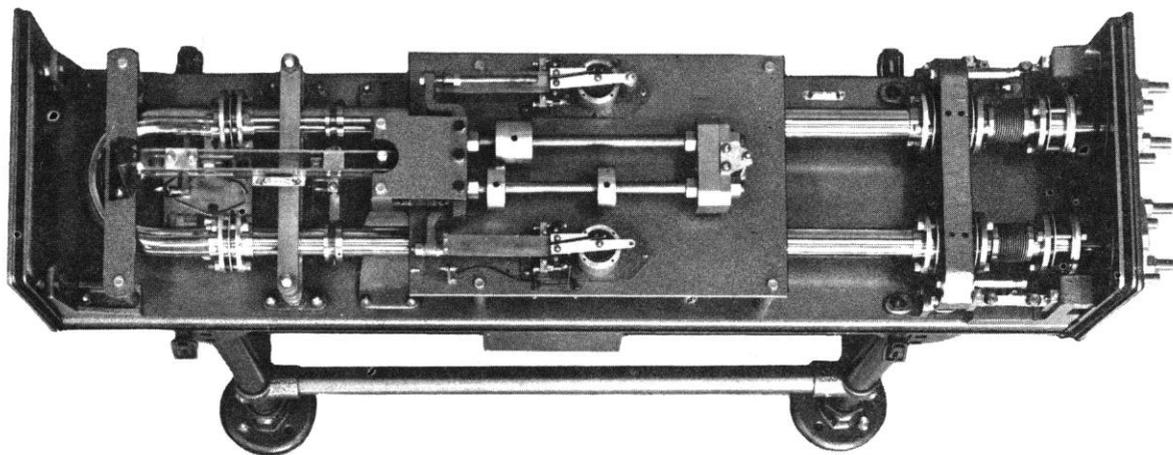
Temperature compensation: To 100% of span

Minimum recommended flow rates through tube: clear fluids, 300 gph; slurries, 700 gph for nominal 1" tube

Net weight: 270 lbs. (approximately)

Gross weight: 500 lbs. (approximately)

Box dimensions for shipping: Approx. 62" x 51" x 25"



**Gravitrol with Electrical Transmission and 1½" Sample Loop**

The reputation which the GRAVITROL rapidly gained for ruggedness and reliability resulted in inquiries from a wide cross-section of industry, ranging from meat extract manufacture to the processing of asbestos/rubber/cement slurries and from the treatment of gold-bearing ores to the control of evaporation rates in the manufacture of condensed milk.

The need for versatility combined with high accuracy and increased sensitivity has led to constant improvements, both in design and performance. The Mark 4 Density Analyzer has been engineered to incorporate the knowledge gained over many years of experience from the diverse requirements of customers. The GRAVITROL is capable of long years of service under arduous plant conditions, maintaining laboratory standards of accuracy and sensitivity with minimum of attention.

The list that follows gives a cross-section of materials at present being handled. If your application is one which is not listed, please do not hesitate to contact us on your requirements.

## ACIDS AND STRONG ALKALIS

### Acids

Adipic Acid  
Alkyl/Benzene/Sulphonic Acid  
Hydrochloric Acid  
Hydrochloric/Hydrofluoric Acids  
Nitric Acid  
Oleum  
Phenoxy Acetic Acid  
Phosphoric Acid  
Spin Acid  
Sulphuric Acid

### Alkalis

Caustic Lye  
Potassium Hydroxide  
Sodium Hydroxide  
Sulphite (Black) Liquor  
(Note: The above acids and alkalis are being measured under the following variables:—  
Concentrations ..... 10% to 100%  
Temperatures ..... 0°C to 100°C  
Pressures ..... up to 100 p.s.i.g.)

## BREWERIES AND DISTILLERIES

Beer  
Fermentation Products  
Grain Spirit  
Lager  
Stout  
Whisky  
Wort (Beer)  
Yeast Extract Liquor

## CHEMICAL AND GENERAL INDUSTRIAL PRODUCTS

### Dense Slurries

Aluminum Powder/Methylated Spirit  
Brine  
Crystal Magma  
Detergent Slurries  
Glass Fibre/Resin  
Latex/Soap  
Magnesia  
Milk of Lime  
Nitro-Cellulose

## Liquids and Light Slurries

Acetone  
Alky/Benzene/Oleum  
Aluminum Sulphate  
Ammonia Liquor  
Ammonium Nitrate  
Ammonium Sulphate  
Chlorinated Brine  
Chlorinated Hydrocarbons  
Demineralized Water  
Emulsion Paint  
Ethyl Chloride  
Ferrous Sulphate  
Heavy Water (Nuclear)  
Hexamethylene/Diamine/Salt  
Hydrogen Peroxide  
Ilmenite Sulphuric Acid  
Liquid Cordite  
Lithium Chloride  
Oleum Benzene  
Organic Acid  
Sodium Silicate  
Titanium Hydrate/Sulph. Acid  
Titanium Oxides

## MILK AND DAIRY PRODUCTS

Condensed Milk (Sweetened)  
Evaporated Milk  
Milk  
Milk Skim  
Whey Liquor (Milk Sugar)

## MINING AND MINERAL SLURRIES

Alkaline Arsenic Solution  
Blast Furnace Slag  
Cement  
China Clay  
Clay  
Coal Dust  
Coal Washery Water  
Copper Ore  
Flotation Media  
Gold Ore  
Lead Ore  
Mineral Pulp  
Oil Well Drilling Mud  
Organic Tin  
Raw Coal  
Rouge

## OIL REFINERY AND LIQUID FUEL PRODUCTS

Butanol  
Crude Oil  
Diesel Oil  
Ethanol  
Ethylene  
Ethylene Oxide  
Gas Oil  
Heavy & Light Fuel Oils  
Heavy & Light Lube Oils  
Heavy Hydrocarbons  
Kerosene  
Light Distillates  
Methanol  
Naphtha  
Octanol  
Straight Run Gasoline  
Tetra/Methyl/Lead/Toluene  
Wax/Lube Oil  
White Spirit

## SOFT DRINKS, EXTRACTS, CONFECTIONERY, ETC.

Citric Acid  
Fruit Juices  
Gelatine  
Glycerine  
Liquid Coffee (Concentrate)  
Liquid Starch  
Lemonade, etc.  
Meat Extracts  
Sweet Water

## SUGAR REFINING AND PROCESSING

Beet Sugar Juice  
Diffusion Juice  
Glucose  
Molasses  
Saccharinate  
Sugar Liquor  
Sugar Syrup  
Thick Sugar Juice