Pyrometer is an instrument for measuring temperature engineering essay

Food & Diet

Pyrometer is an instrument for measuring temperature. The pyrometer is can be apply to instruments that measure high temperature only, but some pyrometer is considered to measure low temperature. Thus, the temperature measurement under severe conditions is the most accurate method, and it is established on non-intrusive (indirect) temperature techniques.

The functions of the temperature of the body are the amount of thermal energy, heat leaving a body by radiation and the wavelength of that radiation. The basic of temperature measurement in these instruments is requirement on temperature of the characteristics of radiation.

In a pyrometer, the heat radiated from a hot body is used to measure temperature, and it is through a fixed lens that efforts the heat energy on the thermopile, this is a noncontact device. Thus, furnace temperatures are measured through a small hole in the furnace wall. The distance from the source to the pyrometer can be fixed and the radiation should fill the field of view of the sensor.

Radiation Thermometer

In the top diagram, Radiation thermometers, or pyrometers, make use of the fact that all objects release thermal radiation, when observing at the bars of a light bulb. The Planck law of radiation can be measured the amount of radiation emitted and connected to temperature. When the objects that is very hot in hazardous environments, the sensor will detect the object and measured the temperature.

2. 2. FOUR PRINCIPAL

There are four principal techniques for the measurement of temperature by the radiation from a hot body.

1. Total radiation

2. Pyro-electric

3. Photo-electric

4. Optical Pyrometers

2. 2. 1. TOTAL RADIATION PYROMETERS

The total radiation pyrometer obtains the radiation from a certain hot body. The total radiation contains the visible and invisible radiations. It consists of radiation getting element and a measuring device.

The diaphragm unit with a mirror is used to effort the radiation on a thermocouple. The distance between the mirror and the thermocouple is adjusted for proper focus. The image of the front diaphragm is attentive on the thermocouple by the mirror. Therefore, the temperature measurements are independent of the distance of the target.

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If there is any smoke, dust in the space between the target and transducer, it reduces the radiation, so negative errors. Then, the meter reading will be

high because the hot gases and flames are released. This pyrometer is a non-linear, poor sensitivity and this device is not used for the temperature lower than 600-1200 degree Celsius.

The advantage of the radiation pyrometer is used to measure very high temperature, high output signal, moderate cost, no need to have contact with measuring system and fast response. The disadvantage of the radiation pyrometer is a non-linear scale, error will occur and emissivity of target material affects the measurements.

Then, it is used to measure temperature of moving target where physical contact is impossible, used to measure temperature in corrosive environment and used to measure invisible rays from radiations.

Finally, it is used quartz or glass lens are most used pyrometers in the industry, then it is can used for bodies that are not perfect black bodies or non-black bodies. These pyrometers are often used in electric chamber furnaces, glass tank furnaces and other industrial areas.

2. 2. 2. Pyro-electric

Pyro-electric detectors for thermal radiations are moderately new form of pyro-meters. The structure material is commonly ceramics are materials whose particles have a stable electric dipole because of the point of the electrons in molecules. Usually these molecules invention in a chance “ mish-mash” method all through the substance of the material therefore there is no remaining electrification. Also, the location of these molecules is more or less fixed at ambient temperatures. If the temperature is high

exceeding specific level characteristic to the certain material, the particles start to alternate freely. This is called the Curie temperature.

Uncertainty, the temperature of the ceramic material is increased, and then the molecular dipole will alternate at a higher angle. Thus higher temperature of the radiant object, the angle of oscillation of the molecular dipole will be bigger. Furthermore, the temperature is increased, and then the voltage is increased. Then, the temperature can be measure by this voltage. This is similar to the total radiation thermometer.

Finally, the pyro-electric is used to control the true temperature of an object devising a new emissivity. But the pyro-electric thermometers still have relatively limited applications. The structure of a pyro-electric thermometer and the location of the shutter is shown in the below diagram.

2. 2. 3. Photo-electric

The photo-electric pyrometers are used measure the radiations of the object are shorter wavelength at very high temperatures. A photodiode is usually a semiconductor diode; it could be made of germanium. When the diode is applied to a voltage in reverse, it would influence the electrons do not have enough energy to cross the energy block of the junction. However, when the incident radiations are directed towards them, some electrons gain enough energy to cross the junction; it will obtain this energy by crash with photons. The energy of photons is inversely proportional to the wavelength.

Besides, the radiant energy crushed upon the surface of the photoelectric diode increase, more electrons cross the block and hence more voltage

reading will be gained. This will observably occur at higher temperature, and then the temperature is measured indirectly by measuring the voltage reading.

Finally, the photoelectric are used in the industry mainly as a mention instrument to determine the true temperature of an object having unknown emissivity. Photoelectric instruments are very precise and are thus changing the above mentioned optical type pyrometers. In additional, it is can be use a photoelectric sensor to warn of smouldering fires which is smoke detector.

2. 2. 4. Optical Pyrometers

The optical radiation thermometers or pyrometers are a simple in structure and it is accurate for temperature measurement between 600 oC ~3000 oC, because the decision making of the operator, so it is not a suitable device for control determinations. In opposite, it is very effective for calibration of total radiation thermometers and point measurements.

The temperature as well as the resistance of the filament is recognized. Therefore, the temperature of the radiant object is the similar as they are the same; this is one of the main disadvantages of this apparatus, the element that the measured temperature is reliant on the operators' decision when the filament has disappeared from the image. The optical pyrometer is shown in the below diagram.

Optical Pyrometers are normally used in the process industry for special measurement. It has a high precision and used as a mention instrument. The accuracy and precision of extra pyrometers are measured by comparing with

it. They are also used for temperature measurement of non-black bodies. Their temperature range is high; they are the most commonly used high temperature measuring devices used in the laboratory. One of the drawbacks is the fact that they can only be used by experienced personnel. But they are being gradually replaced by the modern photoelectric pyrometers.

Question 3

3. 1. What (electrically) is being measured?

The Electrocardiogram (ECG) is normally used to test for heart conditions and that is a simple test that takings about 10 minutes. The electrocardiogram machine records the heart's rhythm against paper through sticky electrodes which are located on the people's chest, arms and legs. If the heart muscle is injured or short of oxygen, the recording will display it out. The electrocardiogram (ECG) is normally used to different test for the heart conditions, such as exercise ECG (also called a treadmill test or exercise stress test), Holter monitoring (also called ambulatory ECG), echocardiogram, blood test, echocardiogram stress test, transoesphageal echocardiogram (TOE), cardiac catheterisation (Angiography), electrophysiological studies (EPS), tilt table test and CT angiography,

3. 2. How is the electrical signal capture? What is the sensor? How does it work?

3. 2. 1. How is the electrical signal capture?

An electrocardiogram (ECG) is the simplest and fast techniques used to estimate the heart. Electrodes are placed on the chest, legs and arms. The

electrical activity of the heart is measured, prints out and understood for the doctor’s information and further understanding when the electrodes are joined to an ECG machine.

During this practice, many ECG tracings are found over a period of around 20 minute estimating numerous hundred cardiac cycles to sense indirect abnormalities that growth risk for cardiac arrhythmias. These indirect abnormalities are commonly not sensed preceding a plain ECG. A computer captures the electrical signal from the heart and the doctor will get more detail for the heart’s electrical conduction system is functioning.

Then, the heart’s pumping act is controlled by an electrical conduction system that manages the reduction of the several chambers of the heart. An electrical stimulus is produced by the sinus node and it is a specialized tissue situated in the right atrium of the heart.

The sinus node produces an electrical stimulus frequently at 60~ 100 times per minute in normal condition. This electrical stimulus move down by the conduction way and the heart’s lower chambers to contract and bleeding out blood. The left and right atria are moved first and contract a short period of time before the left and right ventricles.

Lastly, an electrocardiogram is used to measure the electrical activity of the heart. A graphic representation and tracing of the electrical activity can be getting from the placing electrodes at specific positions. The normal tracing or several hearth related conditions can be show from the ECG.

3. 2. 2. What is the sensor?

ECG sensor is use to detect the electrical signal produced by the hearth and detected at the body’s surface. It is use the three electrode patch good contact with skin. The electrodes must be kept in refrigerator with air-tight container, but it is cannot be preserve more than 1 year.

Firstly, peel first electrode from the backing paper and place it on the inside of the right elbow. Secondly, place a second and third electrode on the right wrist left wrist. Thirdly, connect the clips from sensor to the tabs on the edges of the electrode patches. Lastly, connect white clip to right elbow electrode patch, red clip to right wrist electrode patch and blue clip to left wrist electrode patch.

Then, the ECG is use to monitor the resting ECG, show the wave forms, monitor ECG after mild exercise, investigating ECG with different body position and investigating ECG changes after mild stimulants.

Using the ECG sensor, it is can be record an ECG of a person who is initially at rest. Disconnect the sensor wires from the electrode patches, but leave the patches on the person being monitored. Have the person exercise for a few minutes like jogging. Reattach the sensor wires to the electrodes on the person when they have finised exercising and record a new EKG. Compare the resting EKG to the EKG after mild exercise.

3. 2. 3. How does it work?

In the top diagram, the basic functions of an ECG machine include ECG waveform display, either through LCD screen or printed paper media, and

heart rhythm indication as well as simple user interface through buttons. More features, such as patient record storage through convenient media, wireless/wired transfer and 2D/3D display on large LCD screen with touch screen capabilities, are required in more and more ECG products. Multiple levels of diagnostic capabilities are also assisting doctors and people without specific ECG trainings to understand ECG patterns and their indication of a certain heart condition. After the ECG signal is captured and digitized, it will be sent for display and analysis, which involves further signal processing.

Question 5

A voltage to frequency and frequency to voltage converters is very useful in the industries area. A voltage to frequency converter is usually use in measurement and signal conditioning systems. Its uses can be finding in sensor based data acquisition systems and data conversion circuit. Then, the converters receive an adaptable analog input signal to generate the pulse train output, whose frequency is linearly proportional to the input voltage. The voltage to frequency counter is free of missing codes and monotonic. It can consume very small of power and mixes some noise. For example,

The frequencies to voltage converters are used in any input frequency waveform and provide a linearly proportional voltage outputs. It is can be apply in power control, instrumentation, measurement system and communication. The frequencies to voltage frequency are usually established on low pass filter or stable duration at a rate set by the input frequency. Also, it can count the amount of narrow pulses over a fixed period

time. Moreover, the signal should be higher frequency than input signal. For example,

TC9400 V/F Circuit

The TC9400 V/F converter is used to operate on the principal of charge balancing. The operation of the TC9400 is easy to understand by refer to the below diagram.

The input voltage is converted to a current by input resistor. The current is converted to a charge arranged the integrating capacitor and come as a linearly decrease the voltage at the output. The output swing is set by the threshold detector, which is the voltage is applied to the capacitor for a time to charge the capacitor to the voltage. This action can be reduces the charge on the integrating capacitor. And, a stable amount (q = CREF x VREF), cause the Op Amp output to establish a limited amount.

AT the end of the charge, the CREF will be shorted out. Besides, the output again crosses zero and the system is ready to recycle. In this way, the constant discharging of the integrating capacitor through the input is stable from the reference voltage. The input voltage is increased, the number of reference pulses increases. It is causes the output frequency to increase. Subsequently each charge increase is fixed; the frequency is increase by voltage is linear. Furthermore, the precision of the output pulse width will not direct disturb the linearity of the voltage to frequency.

The TC9400 operates small power CMOS handling for small input bias and balance currents, with very small power dissipation. The open drain N-channel output FETs offer great voltage and great current sink ability.

The TC9400 F/V circuit

The TC9400 is used to generate an output linearly proportional to the input frequency waveform. A precise amount of charge (q = CREF âˆž VREF) to be distributed into the op Amp's summing junction is caused by each zero intersection at the threshold detector's input. This is flow by the feedback resistor and generates voltage pulses at the output of the Op Amp. A capacitor (CINT) through RINT averages the pulses into a DC voltage; hence it is linearly proportional to the input frequency. The output voltage is connecting to the input frequency through the transfer equation:

VOUT = FIN

The response time to an alteration in FIN is equal to (RINTCINT). The total of the ripple on voltage's output is inversely proportional to CINT and the input frequency. CINT can be increase to lower the ripple. The low frequencies are the value of 1µF to 100µF. The VREF is definite as the voltage difference between pin 7 and pin 2 when the TC9400 is used in the single supply mode.

In top diagram, the input voltage levels for the TC9400 are ±400mV in ±5V applications. If the frequency source is used to measured is unipolar which are TTL or CMOS functioning from a +5v source, formerly an AC coupled level shifter must be used.

In single supply F/V applications, the resistor divider will make sure the input threshold will track the supply voltages. The diode clamp avoids the input from working distant enough in the negative direction to chance on the start-up comparator. The diode is onward voltage reductions by 2. 1mV/°C, hence for high ambient temperature operation; two diodes in series are suggested.

Question 6

The purpose of the differential pressure flow meter

The differential pressure flow meter is used to measure the flow of fluid in a pipe which is used the Bernoulli's equation to measure it. Thus, the differential pressure flow meter has flow a constriction into the pipe which is constructs a pressure fall through the flow meter. When the flow is increasing, and the pressure drop is more to form. The flow meter to the transmitter which are measure the differential pressure to control the fluid flow by impulse piping route the upstream and downstream pressure.

In Bernoulli's equation defines the protection of hydraulic energy through a compression in a pipe. It is also defines the sum of the static energy (pressure head), kinetic energy (velocity head), and potential energy (elevation head) upstream and downstream of the compression are equivalent.

In Bernoulli's equation, the pressure drop through the compression which is proportional to the square of the flow rate. The meaning of the Bernoulli's equation, when the full scales flow produces 10 percentages, and the full scale differential pressure is produces 1 percentage. Differential pressure transmitter accuracy is classically despoiled at low differential pressure in its

range, thus flow meter accuracy can be similarly despoiled. Consequently, this non-linear relationship can have a damaging effect on the precision and rejection of differential pressure flow meter.

The basic operation principle of the differential pressure flow meter

The differential pressure flow meter is used to measure the flow of gases, liquids and air in pipes. Besides, the differential pressure flow meter are usually apply into the industries such as wastewater industries, mining, pulp and paper, petroleum, chemical, petrochemical, water , mineral processing, air industrial gases, steam and cryogenic liquids. When using differential pressure flow meter must be careful especial for fluids with high viscosity which are some hydrocarbons and foods, since their precision can be despoiled when Reynolds amount is low.

This flow meter can be functional to moderately clean fluids. In the chemical industry, the flow of corrosive fluids can be measured because with proper consideration to material of construction. Then, when using differential pressure flow meters must be careful in dirty service because it can be cause incorrect measurements.

The basic operating principle of differential flow meter is referring on the principle that the pressure decrease through the meter is proportional to the square of the flow rate. The flow rate is attained through removing the square root and measuring the pressure differential.

Then, the differential pressure flow meter have a primary and secondary element. In the primary element, it is builds the differential pressure in the

pipe that will causes an adjustment in kinetic energy. The pipe size, liquid’s properties and flow conditions must be matched to the unit. The differential pressure and offers the signal or display that is changed to the actual flow value had been measured by secondary element. In addition, the differential pressure flow meters have included the orifice plate, venturi, nozzle and pitot tube.

Orifica plate

The orifice plate is usually used in gas, clean liquid, and steam service. It is obtainable for all pipe sizes, and if the pressure decrease it involves is free, it is very economical for calculating flows in bigger pipes. The orifice plate is also permitted by numerous standards administrations for the protection transferal of liquids and gases.

Then, it is measured over the difference in stress from the upstream side to the downstream side of a moderately blocked pipe. The plate checking the flow is measured block that constricts the pipe and services the flowing fluid to constrict.

The orifice is a flat piece of metal with a precise sized hole tired in it. Greatest orifices are of the conical (quadrant), segmental and concentric type, but eccentric designs are also accessible.

Formerly, the orifice plates are cheap, simple construct and can be supplied for some application in some material.

The concentric orifice plate takes a sharp concentric drag that offers the pure line connection among the fluid and the plate, with slight friction strain

at the border. The diameter of concentric orifice plates is from 0. 25 to 0. 75 ranges. The highest velocity and lowest static pressure happens at certain 0. 35 to 0. 85 pipe diameter downstream from the orifice plate. It is called the vena contract. Determining the differential pressure by a location near to the orifice plate reduces the influence of pipe coarseness, subsequently the pipe wall and the fluid has effect by the friction.

Venturi

The venturi tube flow meter is used in application of lower pressure drop or higher turn down rates. In the Venturi tube, the fluid flow rate is used to measure the cross sectional flow area in the flow path, creating a pressure difference. After the restricted area, the fluid is passes over a pressure retrieval withdrawal section; it is up to 80% of the differential pressure caused at the restricted area.

Through flow calibrating and proper instrumentation, the Venturi Tube flow rate can be decrease around 10% of full scale range with proper precision. This offers a turn down rate 10: 1. Then, it is can pass 25%~ 50% flows than an orifice with the similar pressure drop.

The primary cost of venturi tubes is high, so it is used on higher flows or difficult flow applications. Venturis are oblivious to velocity outline effects and then need less straight pipe path than an orifice. It will be combined with the self- cleaning action of the flow over the tube, makes the device resistant to corrosion, internal scale build up and erosion. In regardless of its high primary cost, the overall cost of ownership can still be approving because of savings in operating, maintenance and costs installation.

Nozzle

The flow nozzle is stable than the orifice plate, mostly in high velocity and high temperature services. It has used to measure high flow rates of heated vapour. The flow nozzle has a larger flow capacity than the orifice plate and involves a lower initial venture than a venturi tube, but it is also offers low pressure recovery. A main weakness of the nozzle is hard to change than the orifice except it can be impassive as part of a spool unit.

The flow nozzles are used in measurement for gas and air flow in industrial applications. This is a simple design, cheap, and it is available for many applications in various materials

Flow Nozzles is can handle around 60% liquid flows than orifice plates consuming the similar pressure drop at high velocities. Suspended solids with liquids can be metered. Though, it is not suitable for high viscous liquid or enclosing bigger amount of sticky solids.

Pitot tube

The pitot tube are used to measure fluid flow, principally in air applications as HVAC systems and ventilation , it is used in airplanes for the speed measurement.

The pitot tube measures the kinetic energy of the flow into potential energy is convert by the fluid flow velocity. The pitot tube is used to constrained to point measuring. Through the “ annubar” or multi-orifice pitot probe, the dynamic pressure can be measured through the velocity profile and the annubar finds an averaging influence.

Pitot tubes sense two pressures instantaneously, static and impact. The impact unit involves of a tube through one end focused at right angles to the flow direction. The static tube’s end is locked, but a small slot is placed in the side of the unit. The tubes can be attached individually in a pipe or joint in a particular casing.

Pitot tubes are usually installed by welding a join on a pipe and injecting the probe through the join. Use of most pitot tubes is restricted to particular point measurements. The units are disposed to plug by overseas material in the liquid. Advantages of pitot tubes are lack of moving parts, low cost, minimum pressure drop and easy installation.