Technews
National Dairy Development Board
For Efficient Dairy Plant Operation

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# PRACTICAL INSTRUMENTATION -II

*This bulletin includes technical information, latest development on products, systems, techniques etc. reported in journals, companies' leaflets, books and based on studies and experience. The technical information would be on different areas of plant operation different issues. It is hoped that the information contained herein, if employed in the factory, will help in making dairy plant operations more efficient.*

*Your contributions and suggestions will make the bulletin more useful, and are welcomed.*

*The theme in this issue is* ***Practical Instrumentation****. It may be understood that the information given here is by no means complete.*

**In this issue**

## 1. MAJOR CAUSES OF MEASUREMENT ERRORS

In the last issue of the Technews (Jan-Feb 1999) some important tips were given for trouble-free use of some instruments.

Most of the instrument problems arise due to inadequate care in its installation and to their neglect. This issue provides some more useful guidelines for smooth and accurate operation of instruments.

Table 1 gives the major causes of measurement errors and failures, and reveals that most instrument problems should be prevented by adopting reliable practices for instrument selection and installation.

**Table 1: Major causes of measurement errors**

- Sensing lines that are plugged, or that contain liquid when they should be dry.
- Sensing elements with excessive coating, fouling or abrasion.
- Excessive bubbles or solids in process fluid.
- Sensing elements with deformations, cracks and holes.
- Low Reynolds number for process fluid.
- Gaskets or O-rings that leak.
- Inappropriate materials of construction.
- Sensing, pneumatic or electronic components affected by process ambient temperature.
- Moisture on the sensing element or signal connections.
- Electrical interference.
- High connection – or wiring – resistance.
- Non-representative sensing point.
- Inadequate straight-pipe runs for flow sensor.
- Nozzle flappers that are plugged or fouled.
- Feedback linkages that shift or contain excessive play.
- Incorrect calibrations.

It should also help to minimize plant operators request for calibration, which in itself is costly.

Most of the causes of measurement errors listed in the table themselves suggest the remedial measures. Electrical interference or grounding problem is caused by poor wiring practices or improper selection of enclosures to protect the lead terminations.

## 2. PRESSURE MEASURING INSTRUMENTS : SOME TIPS

All the precautions and care to be taken for temperature instruments are required for pressure instruments, too.

The most common pressure sensing element is the Bourdon tube. Bellows are also used. Diaphragms are widely used as sensing elements in high-accuracy instruments. The U tube manometers are used for low pressure measurements.

Pressure instruments must be properly installed and maintained, and must be handled with care. Some additional tips are given below.

i) A controller should be installed at a location which is free from vibration from pumps, compressors or pipes and corrosive atmosphere. The ambient temperature on the case should not be less than -29°C and more than 82°C.

ii) **A pressure instrument applied to piping and vessels should be mounted in an upright position**, so that particles carried in the liquid stream will drop out of the sensing element before they become lodged there. Care must be taken to avoid corrosion of or deposits on the elements or connecting lines.

iii) Pressure taps are placed in the vapour space of vessels (boiler), on pump-suction and pump discharge nozzles, at a minimum distance in piping upflow to exchangers, control valves and orifices.

iv) After restriction in a pipeline, velocity increases and pressure locally decreases. So for representative readings, **a length equal to five pipe diameter is recommended for locating the pressure point at valves, pipe junctions, throttling valves, and thermowells**.

v) When measuring steam, always install a siphon, as shown in Fig 1. It protects the actuating element from being damaged by high-temperature steam.

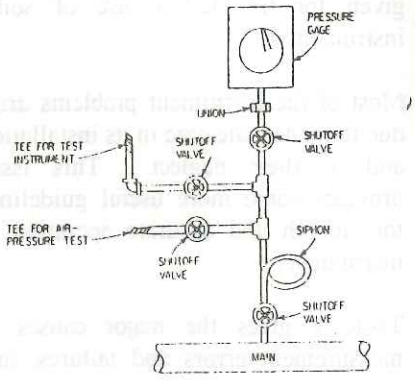


**Fig.1 Connections for measuring steam pressure**

**Pressure gauges should be properly protected from breakage and vibration**. Gauges that are mounted on a wall, instrument panel or otherwise individually supported usually give much less trouble than gauges mounted directly on moving machinery such as pumps, engines or compressors for air or refrigeration. If gauges are used on lines with pulsating or variable pressures, it is particularly important that they be protected by installing tube spirals and/or snubbers in the gauge lines. Also there should preferably be a valve in the gauge line so that the instrument can be easily removed

for cleaning, calibration, repair or replacement.

i) The capillaries must be short, shielded from the sun, rain, and other sources of temperature changes.

ii) Diaphragm seals and remote heads should be flush mounted to eliminate restrictions and cavities where process can accumulate.

iii) Bourdon tube gauges should be inspected and tested periodically : for extreme accuracy once a month may be necessary, otherwise an annual inspection should be adequate. However, they must always be kept clean and protected from damage.

iv) When measuring liquids, if the gauge is installed below the point of pressure measurement, slope the connecting piping at least 8.5% to avoid formation of gas pockets which may cause errors in measurement.

v) A range should be selected so that the maximum operating point is approximately 75% of the full-scale value. Longer life can then be expected.

vi) Simple air-operated pressure controller is used in many plants for reducing steam pressure (Fig. 2).

Air leak determines the steam pressure- more air leak decreases steam pressure. Increasing the air leak will cause the valve to close faster and open slower. If the instrument **fails to function, shut off the air supply** and unscrew the set point adjustment knob, noting the number of exposed threads so it can be replaced to the proper position. **Clean** all the orifices, valve stems, seats, etc. with a suitable solvent. Check to be sure the O-rings are in good condition and that the capsular chamber is not damaged.

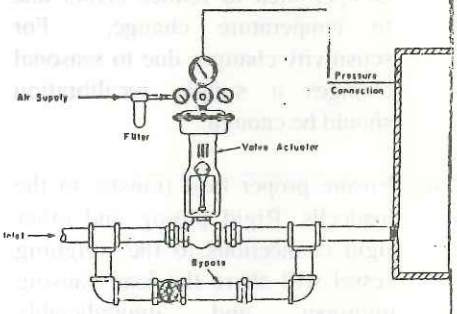


**Fig. 2 Air operated pressure controller**

## 3. WEIGHT MEASURING INSTRUMENTS

For measuring weight of milk and milk products in tanks and silos, pressure transmitters and load cells are most commonly used. Considerations for pressure transmitters have been detailed in Point 4.

Load cells are very widely used for weight measurement. For accurate measurement a top quality transducer or load cell must be selected. Proper installation of load cells, with load being applied at the proper place, is very important for accuracy. Of various types of load cells, shear beam load cells have more advantages than others, and therefore, are more successful.

For trouble-free service of loadcells, the following points must be considered.

i) Most loadcells are temperature compensated to reduce errors due to temperature change. For sensitivity changes due to seasonal changes a simple recalibration should be enough.

ii) Ensure proper load transfer to the loadcells. Rigid piping and other rigid connections to the weighing vessel will share the load causing improper and unpredictable weighment. It must be ensured that the connections to and from the vessel are flexible.

iii) For weighing accuracy the force transmitted to the loadcell should only be the weight. The vibration force of a nearby equipment, if any, should be prevented from entering the loadcells using mechanical dampening methods.

While it is crucial that the loadcells measure only the weight signals it is equally important that the digitising instrument measures only the loadcell electrical output signal. Radio frequency interference (RFI), electro-mechanical interference (EMI), moisture and temperature can all hinder the electrical signal from the loadcell.

iv) Sources of RFI and EMI include lightning, wireless transmitters, large power lines static electricity, solenoids and electromechanical relays. Isolate the loadcells low voltage output signal (which is generally 30 milli volt) in a shielded cable and route the cable in a separate conduit in a major step towards an accurate weighing system. Tie the shield to one point only so as not to form a ground loop. Proper grounding must be ensured.

v) Moisture is the worst enemy of the loadcell. Select loadcells which have adequate protection from moisture with a class of ingress protection specified.

To ensure noise free passage of the loadcell signal check the environment where the loadcell cables run. Moisture should not be allowed to enter the loadcell cable and junction box. Moisture lowers the capacitance between signal lines and causes coupling between the excitation and signal lines. To ensure this use certified class junction boxes (Nema 4 or IP 65) and plug all unused outlets.

vi) In case cables run over long distances (30 metres or longer) or are subject to large temperature changes, it is preferred to use a six wire loadcell cable.

vii) Select a good quality digitiser.

## 4. LEVEL TRANSMITTERS

Pressure transmitters are used for continuous level measurement of milk in tanks or silos. These transmitters are mounted to the side of the tank near the bottom or to the bottom (see Fig. 3). These devices have accuracies to within ± 0.25%.

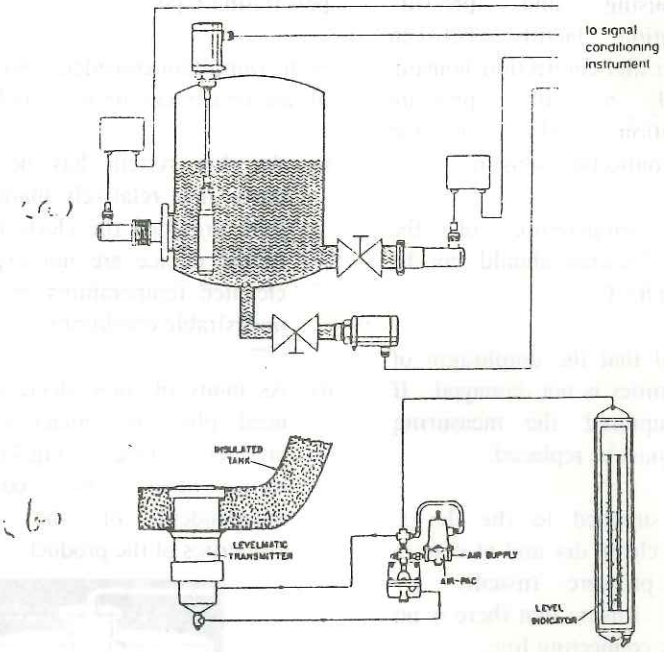


**Fig. 3 Mounting of level transmitter on a tank**

Some important points in using these devices are given below :

i) When mounting the connecting housing ensure the cable entries point downward to avoid water ingress.

ii) Where voltage spikes are expected, overvoltage arresters should be used.

iii) If the level in the tank does not correspond to the indicated values the atmospheric pressure

compensation and then the power to the measuring system should be checked.

iv) For monitoring the atmospheric pressure compensation, open pressure sensor or connection housing. The measured value should not change when opening the housing. If the indicated value changes, the atmospheric pressure compensation is being impaired.

In this case check the breather in the housing and pressure compensation facility between transducer and connection housing as well as the pressure compensation facility on the external connection housing.

v) Ambient temperature of the mounting location should not be more than 82°C.

vi) Be careful that the diaphragm of the transmitter is not damaged. If it is ruptured, the measuring element must be replaced.

vii) The air supplied to the device should be clean, dry and at correct required pressure (usually 1.4 kg/sq.cm). Ensure that there is no leak in the connecting line.

viii) When a clear, dry air supply is used, the transmitter should be serviced once a year. If the air supply is dirty or oily, more frequent servicing may be required.

ix) The output bleed orifice should be cleaned periodically. Likewise, nozzle tip, baffle and screens should be cleaned regularly.

## 5. ULTRASONIC LEVEL SENSORS

Ultrasonic devices are used for level measurement as well as level control of liquids and powders. These devices could be penetrating type or non-penetrating type.

Some important considerations in using ultrasonic devices are given below :

i) As this system has no moving parts, it is relatively maintenance-free, provided the electronic parts of the device are not exposed to elevated temperatures or to other undesirable conditions.

ii) As many of these devices do not need physical contact with the product (see Fig.4), the measurement is completely independent of the physical properties of the product.

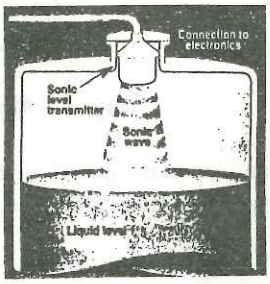


**Fig. 4 Ultrasonic level gauge on a tank**

iii) As the sonic velocity depends on physical properties of the air, changes in tank/silo space temperature and other variables will affect the measurement reading.

iv) If the liquid surface is turbulent, or covered with froth or foam, it may not adequately reflect sound to the receiver. The system should have provision for user-adjustment of the frequency of transmitted sound.

v) The sensors of these devices are not affected by vibrations normally encountered in silo/tank walls.

vi) In powder applications, slight product build-up on ultrasonic level detectors, typically 0.2 to 13 mm in thickness, can normally be tolerated.

## 6. CAPACITANCE LEVEL GAUGE

This device consists essentially of an electrical probe-bare, insulated or with concentric shield depending on the requirement – normally inserted down the centre of the tank. This creates a capacitor, with the probe serving as one plate and the metallic tank walls as the other, see Fig. 5.

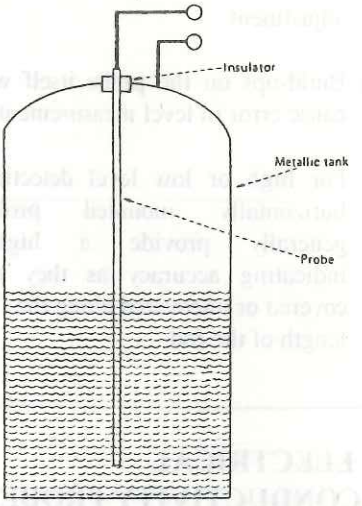


**Fig. 5 Capacitance level gauge in a tank**

These detectors are reliable, and - assuming that no build-ups or similar problems occur on the probe – they are almost maintenance -free. Following points, however, may be noted :

i) This device requires a non-conducting seal between the probe and the tank. Also, grounding problems sometimes, occure in the head assembly, which should be properly attended to.

ii) Any process change that affects the dielectric constant of the liquid/ powder will cause an error in the level measurement. Severe or abrupt changes in humidity, temperature or concentration are such factors. In case of

temperature. however. the system normally has provision for suitable adjustment.

iii) Build-ups on the probe itself will cause error in level measurement.

iv) For high or low level detection. horizontally mounted probes generally provide a higher indicating accuracy as they are covered or uncovered along the full length of the rod.

## 7. ELECTRICAL CONDUCTIVITY PROBES

These controllers are used for high or low level control of electrically conductive liquids such as milk. These systems are very simple and least expensive.

The following important points should be noted :

i) Conductivity probes should never be mounted horizontally. since the liquid film that bridges the probe insulation will not run off. Also. probe build-up adversely affects operation.

ii) A common problem encountered is that the material is often charged. Appropriate conductivity adjustment should be made.

iii) Attention needs to be paid to foaming, splashing and turbulence. There are special probes available for foaming applications. For turbulence or splashing. a still well can be employed.

iv) Linear velocity of the liquid should not be great enough to damage the cell.

v) Location of the cell should not become air bound or gradually filled with solid particles.

vi) The device should be inspected once a month.

There are other level monitors which are successfully used for level monitoring and need little maintenance. Radar level monitors are mounted at the top outside of the tank making them both non-contact and non-intrusive. These dev ices' operation is independent of the presence of the vapour or foam in the tank.

It is thus seen that proper selection and installation of instruments are important for trouble-free operation of most of them. The maintenance need of the instruments is not great. and with some care. the instruments will give accurate results for a long time.

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