Technews

National Dairy Development Board

For Efficient Dairy Plant Operation

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PRACTICAL INSTRUMENTATION -I

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

In this issue

NDDB wishes all readers
A VERY HAPPY AND PROSPEROUS 1999

1. INTRODUCTION

In the modern dairies, the keyword today is productivity, and the future should see even greater emphasis on it.

Increased consumer awareness leading to higher quality standards, processes designed with less excess capacity, more expensive milk and tighter environmental regulations demand more accurate and exact plant operations. Together with the need to conserve energy, they limit the degree of freedom available to operate a plant.

These are the reasons for the interest in process control because plant managers have seen improved control as one route to achieve all the above benefits.

It has thus become necessary to maintain parameters such as temperatures, pressures, flow rates, liquid level and concentrations at certain pre-determined values. The control system comprises transmitters, controllers and control equipment.

The transmitter is a sensing element which measures the actual quantity and converts the measured value to a pneumatic or electric signal. The signal is transmitted to a controller, the 'brain' of the control system, which then compares this with a preset reference or setpoint value and sends signal (pneumatic or electric) to the control device - a variable speed pump motor or a valve plug position - to adjust it suitably. In short, control functions proceed as shown in Fig. 1.

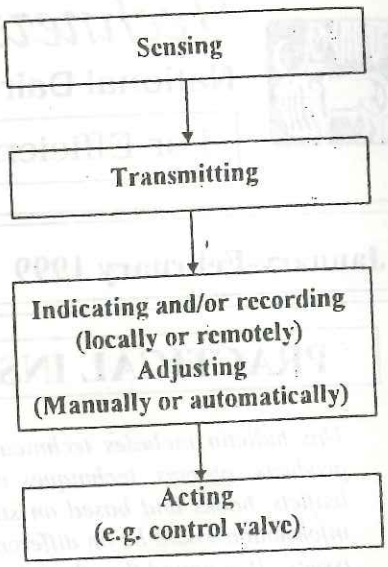

Fig 1 Automatic control system

A high degree of accuracy is required of the control system when comparatively large volumes of products are handled in complicated processes in modern dairies, and automatic control system becomes inevitable. For the optimum and reliable results, it is important to not only employ appropriate control system elements, but also to take due care in their operation and maintenance, which is very often neglected.

In this issue, some useful information is provided for care and maintenance of important instruments and controls.

2. INSTRUMENTS USED IN A DAIRY PLANT

Most commonly used instruments and controls in dairy plants for controlling various parameters in different processes are listed in the Table 1.

Table 1 Instruments and Controls used in Dairy Plant

Section	Equipment	Controlling parameter	Name	Type of instrument
RMRD	Can washer	Detergent strength	Controller	Electric/ Electronic
	Storage tank	Milk temp.	Indicator	Electronic
		Milk level	Indicator	Pneumatic/ Electronic
		Low level/ high level	Alarm	Electric
	Glycol chiller	Milk temp.	Controller	Pneumatic/ Electronic
		Milk flow	Controller	Pneumatic/ Electronic
Process	HTST plant	Milk temp.	Controller	Pneumatic/ Electronic
		Milk flow diversion	Controller	Pneumatic/ Electronic
		Temperatures	Recorder	Pneumatic/ Electronic
	Cream separator (Desludging type)	Desludging	Controller	Electric/ Electronic
Powder plant	Condensing plant	Vacuum	Controller	Pneumatic/ Electronic
		Steam pressure	Controller	Pneumatic/ Electronic
		Density	Controller	Pneumatic/ Electronic
		Turbidity	Controller	Electronic
		Temperature	Recorder	Pneumatic/ Electronic

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Table 1 continued

Section	Equipment	Controlling parameter	Name	Type of instrument
	Drying plant	Inlet air temp.	Controller	Pneumatic/ Electronic
		Outlet air temp.	Controller	Pneumatic/ Electronic
		Time cycle	Controller	Electric/ Electronic
		Extinguisher	Controller	Electric/ Electronic
		Temperature	Recorder	Pneumatic/ Electronic
Refrigeration	Compressor	Discharge pressure	Cut out	Electric/ Electronic
		Suction pressure	Cut out	Electric/ Electronic
		Oil pressure	Cut out	Electric/ Electronic
	Ice water tank	Ice thickness	Controller	Electric/ Electronic
		Liquid level	Controller	Electric/ Electronic
Boiler		Water level	Controller	Electric/ Electronic
		Steam pressure	Controller	Electric/ Electronic
Butter	CBM	Butter moisture	Controller	Electronic
Pouch filling	Sachet machine	Pouch sealing	Controller	Electronic
		Pouch length	Controller	Electronic
		Milk quantity	Controller	Electronic
	Air compressor	Air pressure	Controller	Electric
Hydroflow	Pressure tank	Water pressure	Controller	Pneumatic/ Electronic
		Water level	Controller	Electric

Pneumatic instruments and controls are quite commonly used in dairy plants. The information given in this issue is limited to them only.

3. TEMPERATURE CONTROLS : USEFUL TIPS

Local or control-room indicators and automatic-control hardware for temperature can range between a control system and a local dial indicator.

Temperature sensing elements are bimetallic or filled thermal bulb types. Thermocouples, resistance temperature detectors (RTD), which are most commonly used in dairies, thermistors, etc. all detect temperature change by electrical/ electronic means. Mechanical systems are bimetallic strips or filled temperature systems. Whatever type of transmitter, it takes time to respond to any temperature change. Certain precautions will reduce this time and ensure accurate temperature sensing.

Useful Tips

Temperature sensing elements are usually installed within thermowells (protective tubing).

1. For sensors which may come into direct contact with milk and milk products, thermowells should be made of high grade stainless steel (316 Ti). This offers maximum resistance to the effects of chemical attack and corrosion.

2. Sensors in tanks and piping must give representative readings. Hence, **they should normally be located in the liquid space in tanks, close to outlets.** Where two streams of different temperatures meet, such as hot water batteries, a minimum of 10 pipe diameters should be allowed in order to mix the flow and even out differences in temperatures before sensing them.

3. **The thermowell should be protruded into the liquid to the maximum**, and the sensing length should be fully immersed.

4. **The thermowell or the sensor should always be kept clean** to ensure rapid response of the devise and accurate sensing of the temperature.

5. A rapid movement of the fluid over or around the sensor will increase the speed of response.

6. The sensor should be located as close to the place where the temperature is desired as possible, to reduce the time lag, especially in automatic controls.

7. Sensors should be used without thermowells, if possible, with automatic controllers, for more accurate control.

8. Filled thermal system should be handled with care.

Do not twist, kink or stress capillary tubing. **Do not** bend it unduly. **Never** cut tubing or disconnect it from the bulb or case. **Do not** use the tubing to support the instrument.

Protect tubing from mechanical damage by crushing, abrasion, strain or movement. **Support** tubing every 60 cm if attached to wall or pipe.

Tubing should **never** be attached to heated pipe.

Do not cut the excess tubing. Coil any excess tubing in a 20 to 30 cm coil near instrument and tape it in place.

Class I (liquid-filled except mercury) and Class III (gas-filled) systems must be installed to avoid extremes of temperature caused by hot or cold pipes, chimneys, air ducts, open windows or direct sunlight.

4. CONTROLLERS - COMMON TROUBLES

With regular and proper preventive maintenance the temperature controller will usually give trouble-free performance for a long time. If the air supply is clean and dry the instrument should be serviced once a year. If the air supply is dirty or oily, more frequent servicing may be required.

General Precautions. Do not allow a stream of water or jet of steam to come in contact with the instrument.

Do not wash or flush out pipes, tanks or equipment with steam or hot water so as to subject sensor to a higher temperature than maximum chart range unless the instrument is designed to take care of this. If necessary, first remove the sensing bulb.

Do not allow the controller door to remain open any longer than is necessary. Keep the glass clean. If the glass steams up, apply a small quantity of glycerine.

Blow out the air-compressor receivers periodically, to drain the moisture, oil, dirt, etc. from the system.

Blow out air filters daily.

Clean the air relay valve periodically according to instructions from the manufacturer. Wash working parts **in carbon tetrachloride.**

Do not oil the bearings or pivots of the levers in controllers.

The controller **should** be mounted on a wall or panel where it will be free from vibration.

The temperature surrounding the controller case should not be lower than 0°C or else there is a danger of moisture in the air lines freezing and impairing the operation of the instrument. Further, the surrounding temperature should not be higher than 68°C, otherwise, the clock may malfunction.

Common Troubles. Common controller troubles are caused by dirty air resulting in plugged orifice in relay valve, dirt in relay valve and on baffle and in nozzle (see Fig 2), and air leak in the system. Proper care in supplying clean dry air at correct pressure at all time (see point 5) and ensuring that there is no leakage of air in the system

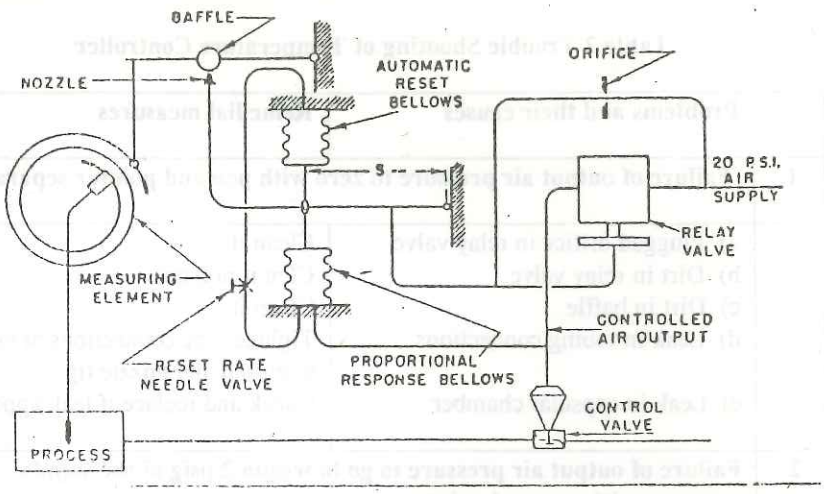

Fig 2 Schematic layout of a temperature controller

such as in tubing connections, from instrument, in bellows from valve, most of the troubles can be controlled.

The nozzle and baffle of the controller should be cleaned with solvent such as trichloroethylene at least every six months or more often if needed. Some common troubles, their possible causes and remedial measures are given in Table 2.

Air-operated Diaphragm Valve. Such valves are used in conjunction with pneumatic controllers. For heating services, most commonly used type is air-to-open one. Whatever type, these valves are efficient in performance, and do not require elaborate maintenance. However, normal care should be taken to ensure trouble-free operation.

The valve stem must move freely in response to change of air pressure above the diaphragm. If jerky motion is noted, check the following :

1. Check whether the rubber diaphragm is in good condition. If it is not pliable, replace it.

2. Check whether the packing is compressed too tightly. Only finger-tip tightness of the packing nut is desirable.

3. Check the valve disc and the seat for leakage and determine whether foreign material is lodged between them, thereby restricting the travel of the valve stem.

Diaphragm control valves should be regularly serviced with particular attention to air diaphragm and to the free movement of the valve spindles. Spindle glands and packings should be regularly renewed, and spindle lubricators, if fitted, should be regularly charged with the appropriate lubricant.

Self-acting Controller. In some services, such as milk preheater, can washers or jacket water temperature

Table 2 Trouble Shooting of Temperature Controller

	Problems and their causes	Remedial measures
1.	**Failure of output air pressure to zero with pen and pointer separated.**	
	a) Plugged orifice in relay valve	Clean it.
	b) Dirt in relay valve	Clen it properly.
	c) Dirt in baffle	Clean it.
	d) Leak in tubing connections	Tighten tube connections at nozzle, manifold and nozzle tip.
	e) Leak in capsular chamber	Check and replace if leak appears.
2.	**Failure of output air pressure to go to within 2 psig of the supply pressure with pen and pointer separated.**	
	a) Dirt in relay valve	Clean it properly.
	b) Dirt in nozzle	Clean it in grease removing solvent.
	c) Leak in air line from instrument to diaphragm valve.	Check the air line and arrest leak.
	d) Leak in back sealing bellows	Check it; replace, if it leaks.
3.	**Reset rate needle valve doest not respond**	
	a) Leak downstream of the valve	Reset the sensitivity knob and adjust the set pointer knob with output pressure gauge.
	b) Leak in back sealing bellows	Check and replace, if leak appears.

control, where less accurate control is acceptable, self-acting temperature controllers are used. If a source of heat is to be controlled, a direct action valve closes by increased bulb temperature. On the other hand, if a cooling liquid is to be controlled, a reverse action valve which opens in response to an increased temperature is needed.

Fig 3 shows a self-acting controller.

The controller should be installed with the valve system, *28* (see Fig 3), in vertical position with the mechanism above (preferably) or below the valve body.

It should also be ensured that the flow of heating or cooling medium through the control valve is in the direction indicated by the arrow on the valve body, *16*.

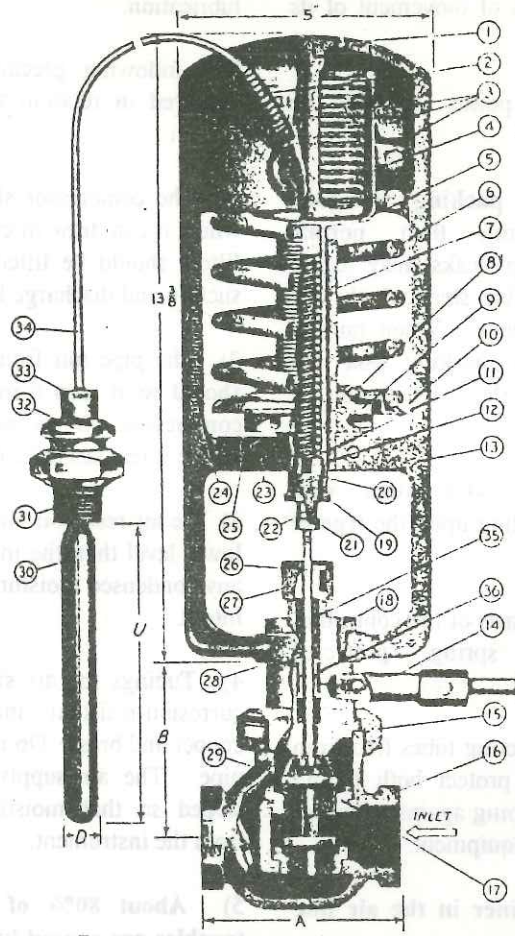

Fig. 3 . Cross section of self-acting controller.

1. Drain and Vent Hole
2. Tubing Guard Reinforcing Spring
3. Alignment Correcting Rings
4. Bellows
5. Bellows Housing
6. Main Spring
7. Spring Adjustment Screw
8. Non-Rusting Ball Bearings
9. Spring Adjusting Nut
10. Spring Cup Disk
11. Safety Spring
12. Drive Stem
13. Chassis or Spider
14. Grease-Seal Lubricator
15. Stuffing-Box Nut
16. Valve Body
17. Valve Seat Rings
18. Spider Clampnut
19. Stem Coupling Locknut
20. Stem Coupling
21. Valve-Stem Locknut
22. Wrench Flat
23. Cap Screws
24. Arbitrary Scale
25. Clamp Block
26. Packing Gland
27. Packing Gland Adjusting Nut
28. Valve Stem
29. Valve Disk
30. Bulb
31. Separable Bushing
32. Union-Connection Swivel Nut
33. Ferrule
34. Flexible Tubing
35. Molded Packing Rings
36. Lantern Spacer

For continuous good operation of the controller, freedom of movement of its valve is important.

The following points should be observed:

1. **Keep the packing in good condition.** More than normal tightening to stop leaks may cause abrasion of the valve stem which will decrease its efficiency. When normal adjustment of the packing box nut cannot stop leaks, the valve should be repacked.

2. **Keep the valve stem well lubricated**, depending upon the type of packing.

3. Keep exposed parts of the controller, particularly the spring, protected against corrosion.

4. Keep the connecting tubes free from sharp bends, and protect both tubing and bulb from rubbing against adjacent vibrating parts of equipment.

5. **Keep the strainer in the air line clean.**

5. AIR SUPPLY TO INSTRUMENTS

Supply of clean, dry air at required constant pressure is essential for smooth, trouble-free opertion of controllers and control valves. The best practice is to use a separate air compressor especially designed for instrument air service. The compressor is of dry type and does not require lubrication.

The following precautions should be observed in relation to the air supply system :

1) The compressor should be situated where it can draw in clean cool air, and filters should be fitted in both the air suction and discharge lines.

2) The pipe-run from the compressor should be at least 6 m long to cool the compressed air as much as possible before it reaches the control panel.

3) The air reservoir should be sited at a lower level than the instruments so that any condensed moisture will drain back into it.

4) Tubings for air should be of only corrosion-resistant material such as copper and brass. Do not use black iron pipe. The air supply line should be sloped so that moisture drains away from the instrument.

5) **About 80% of all instrument troubles are caused by dirty air.** The restricted passages of controllers are easily plugged, making dirt and fluids the big maintenance problem. The expansive effect of air issuing from restrictors tends to cause the deposit of moisture and oil from vapours and can completely disrupt controller operation.

To remove dirt, rust and liquid globules of water and oil from air, an intake filter is installed before the

compressor. Another filter is used before the air pressure reducing valve in the supply lines leading directly to the controllers. **The air filters should be drained daily.** If, during operation, it is found necessary to drain water from the filter often than once a day, this indicates that additional mositure traps are needed.

The filters should be cleaned daily or replaced, depending upon the type of filter used.

6) All the output air connections should be correctly made, and should be free from leaks. Check for leaks at all fittings should be made with a soap solution regularly, and when in doubt.

Proper care and precautions in use of instruments and controls as suggested above will ensure their accurate and trouble-free operation.

LOOK FOR THE NEXT ISSUE OF 'TECHNEWS' FOR MORE INFORMATION ON CARE AND PRECAUTIONS IN USING INSTRUMENTS AND CONTROLS.