Technews
National Dairy Development Board
For Efficient Dairy Plant Operation
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ENERGY CONSERVATION

This bulletin includes technical information, latest developments on products, systems, techniques etc. reported in journals, companies' leaflets and books, and based on 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 this bi-monthly bulletin more useful, and are welcomed.

The theme of information in this issue is **Energy Conservation** in dairy plants.

It may be understood that the information given here is by no means complete.

In this Issue

1.Some Tips for Savings in Compressed Air System

Approximately 10% of all electrical energy used in industry is used for compressed air. It is estimated that about 15% of energy is unnecessarily wasted in a typical compressed air system. Further, 80% of the remaining energy is discarded as heat.

The following tips will help in considerable savings in compressed air systems.

a) Every ten litres per second of compressed air leakage increases energy use by about 14,000 kWh per annum, costing Rs.42,000 (electricity at an average cost of Rs.3/- per kWh and 4000 hrs per year operation). A typical factory may be wasting upto 20% of its compressed air cost supplying air leaks. Repair all air leaks promptly. Also see item 2

b) Every 0.5 kg/sq cm pressure reduction produces 4% energy saving. Use the pressure regulator (if not there, fit one) to reduce the pressure at each point of use until it is as low as practicable without affecting production or plant reliability. After reducing the pressure required at each point of use, adjust the operating pressure of the compressor to the minimum possible above the highest point of use pressure.

Savings which can be realised annually by reducing pressure settings, are shown in the table below.

c) Every 3 degrees C temperature reduction at the compressor air intake produces 1% energy saving. Ensure that inlet air to the compressor is drawn from a cool source.

d) A 50% increase above the maximum recommended air velocities increases energy use by approx. 2%. Air velocity in the distribution main should not exceed 6 m/s and in branch lines should not exceed 10 m/s.

e) Waste heat recovery can achieve upto 80% energy saving by replacing fuels used for various

Reduction in Air Pressure at Compressor

Comp. Av. Load (kW)	0.5 kg/sq.cm		1 kg/sq.cm.		1.5 kg/sq.cm	
	kWh saving	Rs. saving	kWh saving	Rs. saving	kWh saving	Rs. saving
15	2390	7,170	4780	14,340	7166	21,498
22	3510	10,530	7020	21,060	10530	31,590
30	4780	14,340	9560	28,680	14340	43,020

Note: Above estimation assumes 4000 hrs per annum compressor operation at an initial pressure of 7 kg/sq. cm. and electricity at an average cost of Rs. 3 per kWh.

heating purposes. This heat can be extracted from the compressor cooling system in the form of hot air or hot water which can be used in production process. Water temperature upto 80 degrees C or air temperature upto 50 degrees C can be obtained.

f) The air intake filter should be clean and not damaged. A dirty air filter can produce a 0.01 kg per sq. cm. pressure drop. The air intake has a low pressure differential to force air through the filter, so, a surprisingly small amount of fouling can have a great effect on the compressor efficiency.

Check the area around the air intake to ensure that air drawn in is not contaminated with water spray or oil and dirt from nearby operations.

g) Do not use compressed air to dry instrument panels. Instead, instal a high pressure blower next to the operation and use it to dry the panels. Considerable saving in electricity will be made.

(Source: Compressed Air Savings Manual, 1991, Energy Services Dept., Australia)

2. Are You Losing Money through Air Leakages ?

Air leakages from any hoses or fittings can be very expensive as is clear from the following table :

Quantity of air leaking at 7 kg/ sq.cm (l/s)	Equivalent hole diameter (mm)	Energy wasted annually (kWh)	Cost per year (Rs.)
0.2	0.4	266	798
0.8	0.8	1064	3192
3.2	1.6	4256	12768
12.8	3.2	17024	51072
51.2	6.4	68080	204240
204.8	12.7	272384	817152

Note : 1. Assumes 4000 hours per annum compressor operation.
2. Electricity cost : Rs. 3/- per kWh.

Thus, if air is leaking through only 25 holes of equivalent diameter of 1.6 mm (including through joints etc.), the dairy factory would be losing Rs.3.2 lakh annually!

3. Variable Speed Drive Cuts Cost of Compressed Air

In compressed air plants, the major equipment consuming large amount of energy are compressors, fans, blowers and pumps. Many a time, conditions arise when the output has to be decreased to match the process or the demand. Further, equipment are generally selected with built-in margins, leading to over-sizing. This results in delivering output more than the desired

and in more power consumption.

Most commonly used method today to decrease air output employ throttling by valves or dampers. These result in considerable throttling losses.

The best method for decreasing output is employing variable speed ac drive which makes possible energy savings of as much as 57%.

Other benefits to be gained from variable speed drives include a lower level of mechanical noise at operating speeds, and longer equipment service life, because the 'soft' start-up by variable speed drives reduces the shock of peak loading from single speed start-ups.

(Sources : 1 Energy Savings in Cooling Towers by Use of Variable Speed ac Drives - a Case Study, Technical Report - 8605, Gramiya Research Analysis Institute, Baroda. 2. CADDET Energy Efficiency Newsletter, June 1995, the Netherlands)

4. Careful Fuel Handling Cuts Costs

(a) Avoid spillage of oil. Do not allow the oil to overflow the service tank.

(b) Prevent oil leakage from valves, joints, flanges or bends. Oil leakage is costly. A single drop of oil leaking every second will result in a loss of oil of over 334 litres per month or Rs.2505 per month.

(c) Clean oil filters regularly. Also drain water from storage tanks regularly.

5. Save Fuel through Efficient Combustion

(a) Oil should be pre-heated to about 100°C in a heater before supplying it to the burner.

(b) Maintain correct pressure of oil and air at burner as follows :

Burner type	Oil pressure	Air pressure
LAP	0.6-0.8 kg/sq.cm.	60 cm. of water gauge
MAP	6-7 kg/sq.cm	2-3 kg/sq.cm.
Pressure Jet	14-18 kg/sq.cm.	—

(c) Use right amount of excess air in oil combustion. Theoretically, 1 kg of oil requires 14.1 kg of air for complete combustion. However, in practice, about 20-25 percent excess air is required for complete combustion. Maintain this level.

More excess air will result in burner using more fuel. If the flue gas has Carbon Dioxide below 12.5 to 13 % or the Oxygen more than 4-4.5 %, the indication would be that there is more of excess air.

(d) Observe the smoke. Light brown haze from the chimney would indicate that the excess air was at the desired level and the combustion was complete. Black smoke would indicate poor combustion and wastage of fuel, whereas a very clean chimney would indicate use of too much air in combustion.

(e) Burner nozzles should be cleaned regularly, atleast once in a shift.

(f) Keep burner blocks in good condition. Any cracked or damaged block should be immediately repaired because such a block will disturb the shape of the flame and result in poor combustion.

6. Reduce Fuel Consumption through Efficient Steam Generation

(a) Water level. Keep water level between a half and two-third in the gauge glass. It is dangerous if the water level is low. If the water level is high, it will be carried over alongwith the steam.

(b) Use soft water for steam generation. This would increase the boiler efficiency and life. The recommended water quality is given below :

Parameters	Limits not to exceed, ppm	
	Boilers feedwater	Boiler water
Hardness as Ca CO3	10	
Total dissolved solids	4000	3500
Trisodium Phosphate	50-100	
Sodium Sulphate to Sodium Hydroxide ratio not to exceed		2.5
Iron and Copper	0.05	
Si O2		150
Total alkalinity Ca CO3		700
Turbidity		175
Dissolved Oxygen (as O2)	0.05	
pH, not less than	8.5-9.5	10.5-11.5

(Sources: 1. Process Steam Users' Technical Data, Suvens Madras, 1985, 2. Souvenir, Annual Conference on Boiler Water Treatment, Instt. of Energy Management, Bombay, 1981, 3. Perry, J.H.Chemical Engineers Handbook, McGraw Hill, 1950)

(c) Carry out blow-down regularly to reduce water side scale formation. A 1 mm thick scale on the water side would increase fuel consumption by 2-5%. The heat from flue gas can be recovered by using economiser or air preheater.

(d) Flue gas temperature should be maintained at about 180-200 degrees C. Higher temperature indicates soot deposition. A 3 mm thick soot deposited on the heat transfer surface will increase fuel consumption by 5-8%. However, avoid excessive blow-down which wastes fuel. Usually, blow-down should be around 5% of the production.

7. Conserve Energy through Efficient Steam Distribution and Usage

(a) Eliminate steam leakages from joints, valves, fittings, etc, as they are very costly. Avoiding leakages may save steam by upto 5%. Table below shows the loss of steam and furnace oil that takes place through holes of different diameters.

Hole Diameter mm	Loss at 6.9 kg/cm2			Loss at 20.7 kg/cm2		
	Steam loss kg/hr	Furnace oil loss		Steam loss kg/hr	Furnace oil loss	
		kg/mon	Rs/mon		kg/mon	Rs/mon
1	5.31	255	1912	11.88	570	4277
2	11.88	570	4277	24.06	1155	8662
3	20.63	990	7427	43.75	2100	15750
4	32.81	1575	1181	70.31	3375	25312

Note : 1. Assumes 24 hours a day operation.
2. One kg furnace oil produces 15 kg of steam.
3. Furnace oil costs Rs.7.50 per kg.

Suppose a valve spindle is badly packed so that there is a space of a quarter of a millimeter (mm) between the spindle and the packing. If the spindle is about 20 mm diameter, the area of the leaking ring will be nearly the equivalent of a 4 mm hole. It may then be noted that the loss through a single 4 mm hole at 6.9 kg/sq.cm. steam pressure will be 32.81 kg steam per hour which is equivalent to 1575 kg furnace oil per month or Rs.11812 per month. Suppose there are 50 such leaks in the plant. Thus, a total monthly loss through 50 such holes would be equal to 78750 kg furnace oil which is equivalent to Rs.5.9 lakh !!

(b) Use proper safety valves. Wrong safety valves often waste steam. The plain safety valves always breathe and are very wasteful in the steam as they generally have to be set so that they are breathing at a normal working pressure in order to give a safe relief to the boiler and give a sufficient flow at not too high a pressure. The replacement of plain safety valves by pop valves is often a more fruitful way of saving the steam.

(c) Use dry steam as wet steam provides less heat and hence more steam would be required in the process. Further, the moisture will increase resistence to heat transfer and would also overload the traps and other condensate handling equipment. Hence to minimise condensation, due attention must be paid to the boiler operation and lagging of the pipe lines. However, the condensation cannot be entirely eliminated unless the steam is super-heated.

A very practical method to improve the quality of the steam going to the user equipment is to employ steam separator or steam drier. A steam separator is installed on the steam

main as well as on the branch lines. A separator removes the entrained water particles which are drained away as condensate through a steam trap, and delivers dry steam.

(d) It is economical to generate and distribute steam at the boiler's maximum designed pressure, but utilise it at as low a pressure as possible since it then has higher latent heat. For reducing the steam pressure, a pressure reducing valve (PRV) is used between the steam distribution line and heat transfer equipment. There are basically 2 types of PRVs; direct - acting and pilot operated ones. The direct operating PRVs are the simplest available and are used where accurate pressure control is not critical. The pilot-operated PRVs, on the other hand, are more accurate than the direct-acting ones and should be used when very accurate pressure control is required.

(e) Insulation of steam and process pipelines and hot process equipment. Thermal insulation of steam pipe lines, flanges and valves and hot equipment is an important way of conserving energy. It is important to provide sufficient thickness of insulation properly on the surfaces. The following table gives an idea of heat loss from un-insulated surfaces.

Heat loss from uninsulated flanges and valves is approximately equal to that from 0.5 meter and 1 meter of bare pipe, respectively.

While increasing the insulation thickness decreases the heat loss, it increases the insulation and maintenance costs. Therefore, it is a good practice to calculate the most economical thickness of insulation for each application separately. Selection of good insulation material and its proper installation are important to keep maintenance requirement minimum and to achieve maximum advantage.

(f) Proper air venting from steam pipe line is important as the air in the system offers heat resistence and thereby increases the consumption

Equivalent fuel loss from uninsulated surface
Litres of furnace oil/annum - metre length

Tempera-ture (oC)	Pipe dia 25 mm	Pipe dia 50 mm	Pipe dia 75 mm	Pipe dia 100 mm	Pipe dia 150 mm
50	15	28	40	50	68
100	74	133	190	250	360
150	160	288	410	472	680
200	248	426	620	786	1136
250	340	628	916	1182	1713
300	482	895	1290	1628	2428

Assumptions :

a) Ambient temperature 30 degrees C for still air
b) Hr. of operation : 8100
c) Pipe external surface : mild steel

of steam. The air venting is commonly done by 2 ways : by installing vents on top of the heat transfer equipment, or by using steam traps with thermostatic sensors. The air vents should be properly sized and located at appropriate position. The air vent should be positioned at the stagnant corner, remote from steam inlet point.

Hand operated cocks are quite frequently used to remove air from steam insulations. It is however observed that they are often abused. Very frequently the vents remain open and are not shut, thereby wasting steam continuously.

8. Steam Trap Leak Detector

Steam trap is supposed to be a necessary evil in the industry. One leaking steam trap can cause over Rs.50,000/- per year. Since most of the traps are installed in closed systems, it is difficult to pin-point the faulty trap. The detector detects these faulty traps externally. The payback period could be less than 50 days per faulty trap. It is simple to use and can be given to maintenance personnel immediately without any specific training. Regular monitoring of steam trap with detector will lead to high production and prevent money down the drain.

(Source : Chemical Engineering World, August 1995).

1 kcal/hr = 1.58×10^{-3} hp = 1.16×10^{-3} kW = 3.97 Btu/hr
= 4.19 k Joules/hr
1 kcal/kg = 1.8 Btu/ib = 4.14 k Joules/kg

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