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QUALITY AND TREATMENT OF WATER FOR DAIRY INDUSTRY

This bulletin includes technical information based on latest developments on products, systems, techniques etc. reported in journals, companies' leaflets and books and based on studies and experience. The technical information in different issues is on different areas of plant operation. It is hoped that the information contained herein will be useful to readers.

The theme of information in this issue is **Quality and Treatment of Water in Dairy Industry**. It may be understood that the information given here is by no means complete.

In this issue:

1. INTRODUCTION

In a dairy plant water, which is an important utility for processing operations, is obtained from a variety of sources. The quality of such water depends upon the source and may not be suitable for direct use. The quality of water not only plays an important role in determining the quality of products, but affects the efficiency of various plant processes and machinery. Therefore, it becomes necessary to treat water appropriately prior to its use in a dairy plant. The nature of such treatment would, however, depend upon the source of water and its intended application.

This issue of *Technews* covers quality requirements of water used for various applications in a dairy plant and various treatment methods employed.

2. APPLICATIONS OF WATER IN DAIRY INDUSTRY [1]

Water has a number of uses in dairy industry, as under:

2.1 Process Water

Process water is water which can come into contact with the product either directly or indirectly, or water used for other purposes in the operation of process equipment.

2.1.1 Water in direct contact or incorporated into products: Examples are:

- Water used for starting-up pasteurizers, evaporators and other process lines
- Water used for flushing-out the product from process equipment at the end of production

- Water used for rinsing equipment after cleaning
- Water used for washing cheese curd and butter
- Water used for dilution of concentrated milk and reconstitution/ recombination of dried milks
- Water used for preparation of cheese brine, dissolving various ingredients, making processed cheese
- Water used for ice production

2.1.2 Water for cleaning and disinfection: Examples are:

- Water used for CIP-cleaning processes. In this case the water used for final rinsing, contact with product is possible
- Water used for cleaning the outside of equipment, walls and floors.

2.1.3 Water for regeneration of water treatment equipment: Large quantities of water are required for regeneration of water softening and demineralization systems.

2.1.4 Water for other technical purposes: Examples are:

- Cooling water for pump seals, including seals of vacuum pumps of evaporators
- Water in closed circuits for hot water systems and heat exchange systems

2.2 Cooling Water

Cooling water is the water used for removal of heat from various process streams and products. Various systems for cooling include:

2.2.1 Cooling water in once-through systems: Water of relatively low temperature is run through the process equipment for cooling purposes and then discharged. Examples are:

- Cooling of product in thermizers, pasteurizers and heat exchangers with ambient temperature water
- Cooling of refrigerant in condensers of refrigeration plants
- Cooling of air compressors etc..

- Cooling water in condensers of evaporators

2.2.2 Cooling water in closed circulation systems: In such systems chilled water from a water tank or ice bank is circulated through the equipment where cooling is required. Examples are:
- Final cooling of product in thermizers, pasteurizers and other heat exchangers
- Cooling of product in jacketed storage tanks
- Cooling of product in cold stores

2.2.3 Cooling water in open circulation systems: Includes cooling towers for cooling of condensers of evaporators and refrigeration system

2.3 Boiler Feed Water

Water is used for steam production in boilers. Such steam may or may not come into contact with products.

3. WATER SOURCES AND RELATED QUALITY CONCERNS [1, 2, 3]

As mentioned in the previous issue of *Technews*, water supply to dairy processing plants varies according to location, but may be from town water, bore water (bore wells, wells), surface water (rivers, dams, lakes etc.) and / or various dairy processes (condensates, permeates etc.). Such water is generally not chemically pure and suitable for dairy plant processes. The quality of water, however, largely depends on its source as under:
- **Town water:** Town water supplies are generally in treated form (soft and potable) and are suitable for use with minimum additional treatments (disinfection etc.).
- **Surface water:** Surface water is generally soft and contains only small quantities of dissolved mineral salts such as those of

calcium, magnesium or sodium. However, it contains high content of dissolved gases (oxygen and carbon dioxide), suspended matter in the form of inorganic silt, and may also be contaminated with organic matter such as algae and other microbial masses. If used without prior treatments, surface water could be responsible for corrosion, due to dissolved gases, and microbial contamination in the plant

- **Bore water:** Bore water is generally 'hard' and contains very high concentrations of dissolved minerals such as calcium and magnesium salts, iron, manganese, sulphates and chlorides. Inorganic and organic impurities in suspended form are usually absent. However, it may still be microbiologically contaminated. High concentrations of dissolved minerals (chlorides, iron, manganese etc.) make bore waters highly corrosive and could also result in scaling if not treated appropriately. The presence of iron and manganese in water can also impair taste and promote chemical deterioration of dairy products.
- **Condensates / permeates from plant processes:** Condensate from 1st stage of multistage milk condensing plants is principally distilled water with a low content of volatile organic substances. However, permeates from reverse osmosis applications could contain organic matter. The amount of organic matter present is influenced by the type of membrane used, the raw material being concentrated and the degree of concentration.

4. WATER QUALITY AND TREATMENT REQUIREMENTS FOR VARIOUS DAIRY PROCESSES [1 - 8]

The quality requirements for water in a dairy plant are diverse and largely depend upon its intended use. However, high quality water, which must meet special standards, is required only in comparatively small quantities and that the bulk of the water can be of comparatively lower standards.

Quality requirements for water used for various applications in dairy processing are given under:

4.1 Process Water

4.1.1 Quality requirements: Process water should be at least of drinking water quality and bacteriologically potable. For special purposes, even higher quality is required. Specific quality parameters for process water, including water of drinking quality, include:

- **Organoleptic:** When water is used for direct consumption or as an ingredient in products (butter, cheese, processed cheese, recombined milk etc.) water of good organoleptic properties (taste, odour etc.) is essential.
- **Physico-chemical:** Water used for cleaning and other applications should be low in hardness, as high levels of hardness cause scaling on metal surfaces.
- **Undesirable and toxic substances:** Levels of undesirable substances like nitrate, nitrite, ammonia, iron, manganese, etc. in water should be low and within limits specified, if any, by regulatory authorities. Toxic substances that could be present in water include inorganic (heavy metals) and organic (cyanides, pesticides, polycyclic aromatic hydrocarbons etc.). Such contamination is generally encountered in ground water obtained from densely populated and industrialized pockets.

Relevant parameters concerning some undesirable and toxic substances for drinking water and water for processed food industry are given in the **Tables 1 and 2**, respectively below:

Table 1: Specifications for undesirable and toxic

substances in drinking water

Parameter	Unit	WHO[5] Guideline value	USA[6] Maximum level	BIS[7] Desirable limit (max.)
Nitrate	mg NO_3 /l	50	10[@]	45
Nitrite	mg NO_2 /l	3	1[@]	-
Iron	µg / l	-	300[£]	300 / 1000[$]
Manganese	µg / l	400*	50[£]	100 / 300 [$]
Copper	µg / l	2000	1000[£]	50 / 1500[$]
Zinc	µg / l	**	5000[£]	5000 / 15000[$]
Arsenic	µg / l	10[#]	10	10
Cadmium	µg / l	3	5	10
Lead	µg / l	10	15[©]	50
Mercury	µg / l	6	2	1
Pesticides	µg / l	-	-	Absent / 1[$]

* Concentrations of the substance even at or below the health-based guideline value may affect the appearance, taste or odour of the water

** Not a health concern but imparts undesirable astringent taste at or above the level of 4000 µg / l

\# Provisional , as there is evidence of a hazard, but the available information on health effects is limited

@ As mg N_2 / l

£ Secondary Standard (Secondary Drinking Water Regulations)

© Action Level (Additional steps to be taken if more than 10% of the tap water samples exceed action level)

$ Permissible limit in the absence of alternate source

Desirable or permitted levels of various other chemical contaminants in drinking water are given in the reference documents 5, 6 and 7.

Table 2: Some quality tolerances for water used in processed food industry (BIS [8])

Parameter	Unit	Maximum tolerances
Total solids	mg /l	1000
Total hardness	mg $CaCO_3$ / l	600 / 30 *
Nitrate	mg N /l	20
Iron	µg / l	300 / 100[$]
Manganese	µg / l	200 / 100[$]

Parameter	Unit	Maximum tolerances
Copper	µg / l	1000
Zinc	µg / l	15000
Arsenic	µg / l	200
Lead	µg / l	100
Cadmium	µg / l	10
Mercury	µg / l	1

* For water used for cooling, washing, flushing and general purposes, and for hot water

$ For water used specifically for processing, washing, flushing and other general purposes

- **Microbiological:** Process water used for final rinsing of equipment (pasteurized milk fillers etc.) after cleaning should be of very low bacterial count, which otherwise might lead to re-infection of cleaned surfaces and products. Hence disinfection of such water is indispensable. Microbiological requirements for drinking water and water used for processing are provided in **Table 3** below**:**

Table 3: Some microbiological tolerances for drinking water and water used in processed food industry

Parameter	Maximum concentration / level / tolerance		
	WHO(1)	USA(1)	BIS (8) #
Standard plate count	-	-	50 / ml*
Total coliforms	0 /100ml	‹ 1 /100ml	<1 / 100 ml
Faecal coliforms	0 /100ml	0 / 100ml	-
Proteolytic and lipolytic organisms	-	-	5 / ml $
Slime forming organisms	-	-	Absent @
Thermophilic bacteria	-	-	Absent

\# Quality tolerances for water used in food processing

* Not applicable for cooling water and hot water used in dairy industry

$ Not applicable for cooling water, hot water and for water used for general purposes in dairy industry

@ For cooling water and hot water used in dairy industry

4.1.2 Treatment requirements: As already stated, process water needs to be of drinking water quality. Depending upon the source the following treatments could be used:

- Tap or mains water is generally of drinking water quality and, therefore, could be used without further treatment. However, in certain cases an additional disinfection may be desirable.
- Ground water often requires treatments for removal of iron and manganese, and sometimes treatments for removal of ammonia, nitrite, nitrate and hardness.
- Surface water requires screening or clarification, followed by removal of solids and disinfection. Additionally, when high contents of nitrates are present, suitable treatments for their removal are essential.
- Use of condensates / permeates as process water require adequate disinfection prior to its use.

4.2 Cooling Water

4.2.1 Quality requirements: Quality requirements for cooling water are basically intended to minimize the following problems in cooling systems:

- Corrosion of equipment (due to dissolved oxygen, high or low pH, dissolved salts etc.)
- Biological growth (algae, slime forming bacteria etc.)
- Scaling (due to precipitation of CA and Mg salts, and increasing concentration of dissolved solids on water evaporation)
- Fouling (due to sludge, rust, organic deposits, high iron and manganese contents etc.)

For controlling these problems, conditioning of cooling water is required for conformance to the quality requirements given in the **Table 4** below[1]:

Table 4: Some quality requirements for cooling water

Parameter	Unit	Desired level
Water in circulation		
Hardness	mg Ca / l	‹ 360
Chloride	mg / l	‹ 600
Sulfate	mg / l	‹ 680
Silica	mg / l	‹ 50
Iron	mg / l	‹ 14
Alkalinity	mg / l	500
Dissolved solids	mg / l	‹ 1000
Suspended solids	mg / l	‹ 5000
Make-up water		
Hardness	mg Ca / l	‹ 15

Additionally, in certain applications where there is a possibility of contact between cooling water and product, the cooling water should be of drinking water quality as specified in Section 4.1.1.

BIS[(8)] also species specifies a total hardness (as $CaCO_3$) of 30 mg/l for cooling water which is recirculated and used. It additionally specifies that for waters used in once through and run to waste, carbonate hardness should be absent.

4.2.2 Treatment requirements: Normally for cooling water only minimum necessary treatments are carried out, and include chemical conditioning to prevent corrosion, scaling and fouling, biological (algal) growth etc. However, for drinking water quality cooling water, the same treatments as for process water are applicable.

Detailed guidance on cooling water treatment is given in the Bureau of Indian Standard “IS 8188:1999 (First Revision) – Treatment of Water for Cooling Towers: Code of Practice”.

4.3 Boiler Feed Water

4.3.1 Quality requirements: Quality requirements for boiler feed water are targeted to eliminate the following problems:

- Corrosion of the boiler system (due to dissolved oxygen and carbon dioxide, high or low pH, dissolved salts etc.)
- Scaling (due to precipitation of CA and Mg salts, and increasing concentration of dissolved solids in boiler water inside boiler tubes due to water evaporation)

Thus boiler feed water should be free from hardness, scale forming dissolved solids, iron and manganese, corrosive gases. Specific quality requirements for boiler feed water as per Indian Boiler Regulations-1950 (Chapter: XV Feed Water for Boiler) are given in **Table 5** below:

Table 5: Quality requirements for boiler feed water and boiler water

Parameter	Unit	Desired level	
		For up to 20 Bar boiler pressure	For 21-39 Bar boiler pressure
Boiler Feed water			
Total hardness	mg $CaCO_3$ / l	10	1
pH		8.5-9.5	8.5-9.5
Dissolved O_2	mg / l	0.1	0.02
Silica	mg SiO_2/ l	--	5
Boiler water			
Total hardness	mg $CaCO_3$ / l	ND	ND
Total alkalinity ☻	mg $CaCO_3$ / l	700	500
Caustic alkalinity	mg $CaCO_3$ / l	350	200
pH		11.0-12.0	11.0-12.0
Residual sodium sulphite♫	mg Na_2SO_3 / l	30-50	20-30
Residual hydrazine	mg N_2H_4 / l	0.1-1.0 (if added)	0.1-0.5 (if added)

Parameter	Unit	Desired level	
		For up to 20 Bar boiler pressure	**For 21-39 Bar boiler pressure**
Phosphates	mg PO_4 / l	20-40 (if added)	15-30 (if added)
Total dissolved solids	mg / l	3500	2500
Silica	mg SiO_2 / l	Less than 0.4 of caustic alkalinity	Less than 0.4 of caustic alkalinity
Ratio of Na_2SO_4 / caustic alkalinity or	as NaOH	Above 2.5	Above 2.5
Ratio of $NaNO_3$ / caustic alkalinity	as NaOH	Above 0.4	Above 0.4

☻ Total alkalinity should preferably be about 20 percent of total dissolved solids
♫ Shall not apply if reducing agents other than sodium sulphite are used.
ND – Not detectable
(1 Bar = 1.02 kg per square centimeter)

4.3.2: Treatment requirements: Treatments of boiler feed water, irrespective of the source, include softening (except in case of condensates), de-aeration, and chemical conditioning. However, prior to this, treatments like screening and clarification (when surface water is used), and removal of iron and manganese (when ground water is used) are also employed.

Detailed guidance on treatment of boiler water and boiler feed water is given in the Bureau of Indian Standard “IS: 1680-1982 (Reaffirmed 2003) - Code of Practice for Treatment of water for low and medium pressure boilers”.

Steam condensate should always be preferred as boiler feed water as it requires no softening. Condensates from evaporators, when monitored appropriately for presence of organic solids, are also suitable as boiler feed water.

5. WATER TREATMENT PROCESSES [1-5, 9]

5.1 Clarification of Water

Clarification of water normally consists of a number of steps, such as screening, coagulation, floatation, flocculation, sedimentation and filtration. Some common practices for removal of coarse solids and impurities from the water include screening through bar screens, sedimentation and subsequent filtration. Additionally, chemical coagulation is applied for removal of turbidity caused by colloidal impurities such as mud particles.

5.1.1 Filtration: Particulate matter can be removed from raw waters by rapid gravity, horizontal, pressure or slow sand filters. Slow sand filtration is essentially a biological process, whereas the others are physical treatment processes. Rapid gravity, horizontal and pressure filters can be used for direct filtration of raw water, without pretreatment. Rapid gravity and pressure filters are commonly used to filter water that has been pretreated by coagulation and sedimentation.

5.1.2 Chemical coagulation: Chemical coagulation-based treatment, which includes coagulation and subsequent removal of floc through sedimentation / flotation / filtration, is the most common approach for treatment of surface waters. Powdered Activated Carbon (PAC) may be dosed during coagulation to adsorb organic chemicals such as some hydrophobic pesticides. Filtered water may be passed to a further stage of treatment, such as additional oxidation and filtration (for removal of manganese), ozonation and/or GAC adsorption (for removal of pesticides and other trace organics), prior to final disinfection before the treated water enters supply. Coagulation is suitable for removal of certain heavy metals and low-solubility organic chemicals, such as certain organochlorine pesticides.

5.1.3 Activated carbon adsorption: Activated carbon is a porous material with a large surface area (500–1500 m^2/g) and a high affinity for organic compounds. It is normally used either in powdered (PAC) or in granular (GAC) form. Different types of activated carbon have different affinities for types of contaminants. Use of PAC is restricted to surface water treatment and GAC is used for taste and odour control.

5.2 Softening of Water

Hardness of water is attributed to presence of bicarbonates of Ca and Mg (temporary hardness) and sulphates and chlorides of Ca and Mg (permanent hardness). When hardness of water exceeds the permissible limits or when the water is desired to be soft, removal of hardness becomes necessary. Various techniques for water softening include:

- Lime soda process: The hardness of water is precipitated at high pH by addition of lime, or lime plus sodium carbonate / sodium hydroxide.
- Ion exchange: Water softening is achieved by cation exchange. Cation exchange can also be used for removal of certain heavy metals. Potential applications of anionic resins, in addition to nitrate removal, are for removal of arsenic and selenium species.
- Pellet reactor
- Chemical binding of hardness
- Reverse osmosis (*see 5.8.1)*
- Other physical methods such as magnetic, electronic, electrostatic or ultrasonic treatment of water. These could be applied in hot water systems and cooling systems but are not advised for boiler feed water as their effectiveness depends upon various unknown factors.

5.3 Removal of chemical impurities such as iron, manganese ammonia and nitrite

These are removed by adequate aeration of water followed by sand filtration. Removal of iron and manganese may require use of strong oxidizers such as chlorine dioxide, potassium permanganate or ozone to enhance the process. Complex bound iron and manganese, e.g. complex bound with humic acids, can be very difficult to remove. In this case oxidation with ozone can be a solution.

5.4 Removal of Nitrate

Nitrate removal from water could be obtained through the following techniques:

Physico-chemical methods: These include:
- Ion exchange with a nitrate specific resin
- Demineralization by ion exchange
- Reverse osmosis of water
- Electrodialysis of water

Biological techniques: These involve denitrification of water by reduction of nitrate to nitrogen gas by bacteria in absence of oxygen.

5.5 Chemical Conditioning of Cooling Water

- **Prevention of corrosion:** Corrosion is inhibited by:
  - i) use of chemicals like sodium molybdate and sodium nitrate in systems containing soft water
  - ii) raising pH to about 10-11 by addition of NaOH in small closed circulation systems; and
  - iii) using zinc chromates and zinc polyphaspahtes and phosphonates combined with dispersants in open circulation systems. However, discharge of these chemicals lead to considerable environmental problems.
- **Prevention of scaling:** Scaling (fouling due to precipitation of Ca

and Mg salts) is prevented by addition of phosphates and polyphosphates. Specialized inhibitors based on organic polymers, such as acrylates and sulfonized copolymers are also used for prevention of corrosion and scaling.

- **Prevention of biological growth:** Growth of algae and bacteria like *Legionella* cause problems in cooling water systems. Biological growth could be controlled by active chlorine, ozone or chlorine dioxide. Other biocides used include organic chlorine, active bromine, bromine derivatives, quarternary ammonium compounds, polyamines and organic sulphur derivatives. However, bromination of cooling water systems is not preferred due to environmental implications.

5.6 De-aeration of Boiler Feed Water

Removal of gases like oxygen and carbon dioxide from boiler feed water is performed by:

- Physical de-aeration by heating water to a temperature above boiling point (104ºC) in a de-aerator. At this temperature the non-condensable gases are almost completely removed. De-aeration is much less effective at temperatures below 100ºC and also could lead to heavy corrosion of de-aerator.
- Chemical deoxygenation by addition of chemical reducing agents such as sodium sulphite, hydrazine, hydroxylamine derivatives, ascorbic acid etc. Chemical de-oxygenation is generally used for low capacity boilers and sometimes also in large boilers after initial physical de-aeration. In food industry, use of hydrazine is, however, not allowed.

5.7 Chemical Conditioning of Boiler Feed Water

Use of additional safety chemicals in boiler feed water, following other treatments, include:

- **Phosphates and polyphosphates:** These products neutralize any residual hardness in water after softening by making insoluble precipitates which are dispersed and removed during blow-down process.

- **Dispersants and sludge conditioners:** Natural dispersants (lignosulphonates, tannins and starches) and synthetic dispersants (polyacrylates, maleic acrylate copolymer, polystyrene sulphonates etc.) are used. These dispersants break up the formed particles in boiler feed water into smaller particles and keeping them suspended.
- **Sequestering agents:** Sequestering agents such as organic phosphates are used in boiler feed water to inhibit scaling and corrosion.
- **Antifoaming agents**: Certain surface-active agents are used for removal of foam and prevention of carry-over of fine water droplets in steam.

5.8 Membrane Processes

The membrane processes of most significance in water treatment are reverse osmosis, ultrafiltration, microfiltration and nanofiltration. These processes have traditionally been applied to the production of water for industrial or pharmaceutical applications but are now being applied to the treatment of drinking-water.

5.8.1 Reverse osmosis: Reverse osmosis rejects monovalent ions and organics of molecular weight greater than about 50 (membrane pore sizes are less than 0.002mm). The most common application of reverse osmosis is desalination of brackish water and seawater.

5.8.2 Nanofiltration: Nanofiltration membranes allow monovalent ions such as sodium or potassium to pass but reject a high proportion of divalent ions such as calcium and magnesium and organic molecules of molecular weight greater than 200. Nanofiltration may be effective for the removal of colour and organic compounds.

5.8.3 Ultrafiltration: Ultrafiltration membranes reject organic molecules of molecular weight above about 800 and usually operate at pressures less than 5 bar.

5.8.4 Microfiltration: Microfiltration does not separate molecules but reject colloidal and suspended material. It is capable of sieving out particles greater than 0.05mm. It has been used for water treatment in combination with coagulation or PAC to remove dissolved organic carbon and to improve permeate flux.

Table 6 summarizes the effectiveness of various treatment processes for removal of some important chemical impurities in water [5]:

Table 6: Relative effectiveness of various treatment processes for removal of some important chemical impurities in water

Impurity → Process ↓	Manganese	Nitrate	Nitrite	Most pesticides
Coagulation	++	-	-	-
Ion exchange	-	+++ (‹5)	-	-
Activated carbon	-	-	-	++ to +++ for different pesticides
Chlorination	+++ (‹0.05)	-	+++ (‹0.1)	-
Ozonation	+++ (‹0.05)	-	+++ (‹0.1)	+ to +++ for different pesticides
Advanced oxidation	-	-	+++ (‹0.1)	-
Membranes	+++ (‹0.05)	+++ (‹5)	-	+++ for some pesticides
Biological treatment	-	+++ (‹5)	-	-

\+ Limited removal
++ 50% or more removal
+++ 80% or more removal
( ) Figures in parenthesis indicate the concentration of the impurity (in mg/litre) that should be achievable through most effective processes
\- Blank entries in the table indicate either that the process is completely ineffective or that there are no data on the effectiveness of the process.

5.9 Disinfection of Water

Disinfection of water for various critical applications in a dairy plant could be done through the following systems:

- **Disinfection with chlorine (chlorination):** Chlorination can be achieved by using liquefied chlorine gas, sodium hypochlorite solution or calcium hypochlorite granules and on-site chlorine generators. Chlorination of water is cheap, provides broad biocidal effect and remains active for long periods after application. However, biocidal efficiency is adversely affected in the presence of organic matter. Use of chlorine runs the risk of corrosion of equipment, and formation of toxic chlorinated organic compounds.
- **Disinfection with chlorine dioxide:** Chlorine dioxide, is used for disinfection of condensate and drinking water on large scale. It is more potent than hypochlorites and is effective at low concentrations (less than 1mg/litre).
- **Disinfection with ultraviolet light:** UV radiation (180 and 320nm) is biocidal and inactivates protozoa, bacteria, bacteriophage, yeast, viruses, fungi and algae. It is, therefore, used for disinfection of water in modern water treatment systems. Its use is harmless as no toxic compounds are produced. However, the efficiency of its application is adversely affected by turbidity and presence of suspended solids, which provide a protective effect to microorganisms, and high iron content in water.
- **Disinfection with ozone:** Ozone is a powerful oxidising agent and is used for disinfection of drinking water. It has a broad biocidal spectrum and exhibits residual activity in clean water. However, due to its powerful oxidizing nature, it degrades organic material into components which serve as nutrients for bacteriological growth. To avoid undesirable bacterial growth in distribution, ozonation is normally used with subsequent treatment, such as filtration or GAC, to remove biodegradable organics, followed by a chlorine residual, since it does not provide a disinfectant residual. Ozone is effective for the degradation of a wide range of

pesticides and other organic chemicals.

- **Katadyne process:** It is a process of disinfection of water by silver ions, added in the form of a silver compound, which exhibit biocidal activity against entire range of bacteria and algae. However, it is rarely used in food industry. Disinfection activity is dependent upon contact time (minimum I hour, and less in case of higher water temperature or pH values). The process provides effective protection from possible recontamination.
- **Microfiltration of water:** Microfiltration of water, which ensures removal of bacteria, is used for disinfection for special purposes e.g. in the preparation of sterile water.

Every disinfection technique has its specific advantages and its own application area. In **Table 7** below [9], relative advantages (+) and disadvantages (-) of some common disinfection techniques are shown:

Table 7: Relative advantages and disadvantages of some common disinfection techniques

Treatment → Effectiveness ↓	**Hypochlorite / chlorine gas**	**Chlorine dioxide**	**Ozone**	**UV light**
Environment friendly	--	+/-	+	++
By-products	--	+/-	+	++
Effectivity	-	++	++	+
Investment	+	++	-	+/-
Operational costs	++	+	+	++
Fluids	+/-	++	++	+
Surfaces	--	--	++	++

5.10 Considerations in Selection of Appropriate Treatment Techniques:

- Many of the treatments outlined are designed for larger treatment plants and may not necessarily be appropriate for smaller treatment plants or individual type treatment. In these cases, the choice of technology must be made on a case-by-case basis.

- Actual process performance will depend on the concentration of the contaminant in the raw water and on general raw water quality. For example, chlorination and removal of organic chemicals and pesticides using activated carbon or ozonation will be impaired if there is a high concentration of natural organic matter.
- For many contaminants, potentially several different processes could be appropriate, and the choice between processes should be made on the basis of technical complexity and cost, taking into account local circumstances. For example, membrane processes can remove a broad spectrum of chemicals, but simpler and cheaper alternatives are effective for the removal of most chemicals.

A qualitative ranking of treatment processes based on their degree of technical complexity is given in **Table 8** below(5). The higher the ranking, the more complex the process in terms of plant and/or operation. In general, higher rankings are also associated with higher costs.

Table 8: Ranking of technical complexity and cost of water treatment processes

Ranking	Examples of treatment processes
1	• Simple chlorination • Plain filtration (rapid sand, slow sand)
2	• Pre-chlorination plus filtration • Aeration
3	• Chemical coagulation • Process optimization for control of disinfection by-products
4	• Granular activated carbon (GAC) treatment • Ion exchange
5	• Ozonation

Ranking	Examples of treatment processes
6	• Advanced oxidation processes • Membrane treatment

- It is normal practice to use a series of unit processes to achieve desired water quality objectives (e.g., coagulation, sedimentation, filtration, GAC, chlorination). Each of these may contribute to the removal of chemicals. It may be technically and economically advantageous to use a combination of processes (e.g., ozonation plus GAC) to remove particular chemicals.

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NEWS SECTION

Indian Food laws

- **Notifications GSR 1 (E) of 2 January and 267 (E) of 2 April 2007 of the Ministry of Health and Family Welfare:** These notifications are corrigenda to the notification GSR 398 (E) of 3 July 2006 that revised the compositional and labelling provisions pertaining to the infant milk foods and was scheduled to become effective from 3 January 2007 (See also *Technews* Issue 63, July-August 2006).

  The GSR 1 (E) makes several corrections to the contents of the GSR 398 (E), the important one being that the minimum requirement of 10 % casein has been corrected to 10 % milk protein *(includes casein plus whey proteins*).

  The date of enforcement of the GSR 398 (E) has been deferred by 6 months vide GSRs 1 (E) and 267 (E). Therefore, it would now be applicable w.e.f. 3 July 2007.

- **Notification GSR 242 (E) of 28 March 2007 of the Ministry of Health and Family Welfare:** It is a corrigendum to the GSR 773 (E) of 29 December 2006 of the Ministry of Health and family Welfare that amended Sub-rule (2) of Rule 57-A pertaining to 'Crop Contaminants' by specifying a maximum limit of aflatoxin M1 in milk as 0.5 µg/kg which was scheduled to become applicable from 30 March 2007. The GSR 242 (E) extends the date of enforcement of GSR 773 (E) by about nine months. Therefore, it would now be applicable w.e.f. 1 January 2008.

- **1st International Food Regulatory Summit 2007: Aligning India to the World:** The '1st International Food Regulatory Summit 2007: Aligning India to the World' was held at New

Delhi on 10-11 April 2007. The summit focused on issues related to up-gradation of food regulatory system in India, rational harmonisation of domestic standards with those of Codex, capacity building, risk based standards, database creation, applicability of food regulations to entire food chain including primary production etc.

Codex Alimentarius Commission

The 30th meeting of the Codex Alimentarius Commission is scheduled during 2-7 July in Rome, Italy. The meeting would consider various draft standards forwarded by Codex Committee on Food Labelling (labelling provision for cheeses), and various other committees.

International Dairy Federation (IDF)

The IDF has published the following Bulletins / Standards recently:

- IDF Bulletin No.410/2007: Proceedings of the 1st ParaTB Forum
- IDF Bulletin No.411/2007: Selective Enumeration of Bifidobacteria in Dairy Products: Development of a Standard Method
- IDF Bulletin No.412/2007: IDF Guiding Principles for Traceability/Product Tracing (also available free of cost) (This new IDF publication is available free of cost from the IDF Internet homepage:http://www.fil-idf.org/WebsiteDocuments/412-2007.pdf)
- Bulletin of the IDF No.413/2007: Health-enhancing milk components: Technological advances and health benefits.
- IDF 147 - ISO 11868: Heat-treated milk - Determination of lactulose content - Method using high-performance liquid chromatography
- IDF 209 - ISO 22160: Milk and milk-based drinks - Determination of alkaline phosphatase activity - Enzymatic photo-activated system (EPAS) method

For purchasing the IDF publications, contact Mr. Oscar Chavez, Office Manager, IDF, Brussels, Belgium (Email: OChavez@fil-idf.org).

QUALITY AND TREATMENT OF WATER FOR DAIRY INDUSTRY

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