

**Appendix-A**

**Specimen form for water analysis report**

**Physical and Chemical Parameters**

Name and address of the laboratory:

Laboratory reference No.:

Name, address and phone No. of sender:

Date of collection:

Sample source and location:

Date and time of receipt at laboratory:

Date and time of completion of examination:

<b>Sr. No.</b>	<b>Parameters</b>
1	Colour , Units of Pt-Co-scale
2	Turbidity, NTU
3	Alkalinity, CaCO <sub>3</sub> , mg/L
4	Hardness, CaCO <sub>3</sub> , mg/L
5	Conductivity, micromhos/cm
6	Total solids, mg/L
7	Anions by chromatography, g/L
8	Cyanide, CN, mg/L
9	Residual Chlorine, Cl, mg/L
10	Chloride, Cl, mg/L
11	Fluoride , F, mg/L
12	Sulphate, SO <sub>4</sub> , mg/L
13	Nitrogen (Ammonia), N, mg/L
14	Nitrogen (Nitrate), N, mg/L
15	Nitrogen (Nitrite), N, mg/L
16	Phosphate, PO <sub>4</sub> , mg/L
17	pH
18	Dissolved Oxygen, O <sub>2</sub> , mg/L
19	Aggregate organic parameters Phenol, µg/L Detergent—surfactants, mg/L Trihalomethane formation potential (TFP), µg/L
20	Metals Aluminium, Al, mg/L Arsenic, As, mg/L Cadmium, Cd, mg/L Chromium, Cr, mg/L Copper, Cu, mg/L Iron, Fe, mg/L Lead, Pb, mg/L Manganese, Mn, mg/L Potassium, K , mg/L

- Sodium, Na , mg/L
- Selenium, Se, mg/L
- Zinc, Zn, mg/L
- Mercury, Hg, mg/L
- 21 Trihalomethanes, µg/L
- 22 Biochemical Oxygen Demand, O<sub>2</sub>, mg/L
- 23 Chemical Oxygen Demand, O<sub>2</sub>, mg/L
- 24 Total Organic Carbon, O<sub>2</sub>, mg/L
- 25 Oil and Grease, mg/L
- 26 Organochlorine Pesticides, µg/L
- 27 Organophosphorus Pesticides, µg/L
- 28 Carbamate Pesticides, µg/L

Date:

Officer-in-charge

### Bacteriological Parameters

Name and address of the laboratory:

Laboratory reference No.:

Name, address and phone No. of sender:

Date of collection:

Sample source and location:

Date and time of receipt at laboratory:

Date and time of completion of examination:

Sl. No.	Parameter	Remarks
1	Coliform bacteria	
2	Faecal coliform	
3	Faecal streptococci	
4	Clostridium perfringens	
5	Pseudomonas aeruginosa	
6	H <sub>2</sub> S producing bacteria	
7	Coliphages and other bacteriophage	

Date:

Officer-in-charge

## Biological Parameters

Name and address of the laboratory:

Laboratory reference No.:

Name, address and phone No. of sender:

Date of collection:

Sample source and location:

Date and time of receipt at laboratory:

Date and time of completion of examination:

<b>Sr. No.</b>	<b>Parameters</b>
1	Total count of phytoplankton, (organisms/mL):
2	Total Count of zooplankton, (organisms/L):

Date:

Officer-in-charge

**Appendix—B**

**Instruments Required for Analysis of Various Physico-chemical and Biological Parameters**

Sl. No.	Parameters	Method of analysis	Instruments used
1	Colour	A. Visual comparison method [Section 10.1.1]	Colour comparator
2	Turbidity	A. Nephelometric method [Section 10.1.2]	Turbidimeter
3	Conductivity	A. Instrumental method [Section 10.1.5]	Conductivity meter
4	Determination of anion by ion chromatography	A. Ion chromatography [Section 10.1.7]	Ion chromatograph
5	Cyanide	A. Colorimetric method [Section 10.1.8]	Spectrophotometer
		B. Cyanide selective electrode method [Section 10.1.8]	Cyanide—ion selective electrode
6	Chlorine (Residual)	A. Syringaldazine (FACTS) method [Section 10.1.9]	Spectrophotometer
		B. SNORT method [Section 10.1.9]	Spectrophotometer
7	Fluoride	A. Ion selective electrode method [Section 10.1.11]	Ion selective electrode
		B. SPADNS method [Section 10.1.11]	Distillation apparatus and spectrophotometer
8	Sulphate	A. Turbidimetric methods [Section 10.1.12]	Nephelometer
9	Nitrogen (Ammonia)	A. Nesslerisation method [Section 10.1.13]	Spectrophotometer
10	Nitrogen (Nitrate)	A. UV Spectrophotometric method [Section 10.1.14]	Spectrophotometer
		B. PDA method [Section 10.1.14]	Spectrophotometer
11	Nitrogen (Nitrite)	Colorimetric method [Section 10.1.15]	Colorimeter
12	Phosphate	A. Stannous chloride method [Section 10.1.16]	Colorimeter
13	pH value	A. Electrometric method [Section 10.1.17]	pH meter
14	Dissolved oxygen	Membrane electrode method [10.1.18]	Membrane electrode
15	Total organic carbon	A. Combustion infrared method [Section 10.6.3]	Total organic carbon analyser
16	Phenols	A. Chloroform extraction method [Section 10.2.1]	Spectrophotometer
		B. Direct photometric	Spectrophotometer

		method [Section 10.2.1]	
17	Detergents— surfactants	A. Anionic surfactants by MBAS [Section 10.2.2]	Spectrophotometer
		B. Anionic surfactants by methyl green [Section 10.2.2]	Spectrophotometer
18	Trihalomethane formation potential (TFP)	A. Liquid-liquid extraction method [Section 10.2.3]	Gas chromatograph equipped with Electron Capture Detector (GC-ECD)
		B. Purge and trap and gas chromatograph/mass spectroscopic detection [Section 10.2.3]	Gas chromatograph—mass spectrometer (GC-MS)
19	Metals	[Section 10.3]	Atomic absorption spectrophotometer (AAS)
			Inductively coupled plasma analyzer (ICP)
			Spectrophotometer
20	Trihalomethanes (THMs)	A. Liquid-liquid extraction method [Section 10.4]	Gas chromatograph with Electron Capture Detector (GC-ECD)
		B. Purge and trap method [Section 10.4]	Gas chromatograph—mass spectrometer
21	Microbiological Analysis	Refer Section 3.4.2	
22	Phytoplankton	A. Density [Section 10.6.1.3]	Microscope
		B. Biomass [Section 10.6.1.3]	Spectrophotometer
23	Zooplankton	A. Density [Section 10.6.2]	Microscope
24	COD	Open Reflux method [10.7.2]	Friedrich's Reflux condenser
25	Organochlorine pesticides (OCIPs)	A. Liquid-liquid extraction method [Section 10.7.5]	Gas chromatograph with Electron Capture Detector (GC-ECD)
26	Organophosphorus pesticides (OPPs)	A. Liquid-liquid extraction method [Section 10.7.6]	Gas chromatograph with nitrogen phosphorous/flame photometric detector (GC-NPD)
27	Carbamate pesticides	A. Liquid-liquid extraction method [Section 10.7.7]	High performance liquid chromatography (HPLC)
28	Mercury	A. Cold vapour AAS [Section 10.7.8]	Atomic absorption spectrophotometer
		B. Dithizone method [Section 10.7.8]	Spectrophotometer
29	Sulphide	Methylene Blue method [Section 10.7.9]	Spectrophotometer

**Appendix-C**

**CPCB Guideline Values for Classification of Inland Surface Water (1982)**

S. No.	Characteristics	A'	B'	C'	D'	E'
1.	Dissolved Oxygen, mg/L, Min	6	5	4	4	-
2.	Biochemical Oxygen Demand, mg/L, Max	2	3	3	-	-
3.	Total Coliform Organisms*, MPN/100 ml, Max	50	500	5000	-	-
4.	Total Dissolved Solids, mg/L, Max	500	-	1500	-	2100
5.	Chlorides (as Cl), mg/L, Max	250	-	600	-	600
6.	Colour, Hazen Units, Max	10	300	300	-	-
7.	Sodium Absorption Ratio, Max	-	-	-	-	26
8.	Boron (as B), mg/L, Max	-	-	-	-	2
9.	Sulphates (as SO <sub>4</sub> ), mg/L, Max	400	-	400	-	1000

\*If the coliform count is found to be more than the prescribed tolerance limits, the criteria for coliforms shall be satisfied if not more than 20 percent of samples show more than the tolerance limits specified, and not more than 5 percent of samples show values more than 4 times the tolerance limits. Further, the faecal coliform should not be more than 20 percent of the coliform. Source: Indian Standard (IS: 2296-1982).

- A' Drinking water source without conventional treatment but after disinfection
- B' Outdoor bathing (organised)
- C' Drinking water source with conventional treatment followed by disinfection
- D' Propagation of wild life, fisheries
- E' Irrigation, industrial, cooling, controlled waste disposal.

Appendix-D

Bureau of Indian Standards/Specifications for Drinking Water (IS: 10500, 1992)

Sl. No.	Substance or characteristic	Requirement desirable limit	Undesirable effects outside the desirable limit	Permissible limit in the absence of alternate source	Remarks
Essential Characteristics					
1	Colour (Hazen Units, max)	5	Above 5, consumer acceptance decreases	25	Extended to 25 only if toxic substances are not suspected in absence of alternate sources
2	Odour	Unobjectionable	-	-	test cold and when heated b) test are several dilutions
3	Taste	Agreeable	-	-	Test to be conducted only after safety has been established
4	Turbidity (NTU) Max	5	Above 5, consumer acceptance decreases	10	-
5	pH value	6.5 to 8.5	Beyond this range the water will affect the mucous membrane and/or water supply system	No relaxation	-
6	Total hardness (mg/L, CaCO <sub>3</sub> ) Max.	300	Encrustation in water supply structure and adverse effects on domestic use	600	-
7	Iron (mg/L, Fe) Max	0.3	Beyond this limit taste/appearance are affected; has adverse effects on domestic uses and water supply structures and promotes iron bacteria	1	-

(Contd....)

Sl. No.	Substance or characteristic	Requirement desirable limit	Undesirable effects outside the desirable limit	Permissible limit in the absence of alternate source	Remarks
8	Chlorides 250 (mg/L, Cl) Max	250	Beyond this limit taste, corrosion and palatability are affected	1000	-
9	Residual free chlorine (mg/L), Min	0.2	-	-	To be applicable only when water is chlorinated. Tested at customer end. When protection against viral infection is required, it should be min. 0.5 mg/L
Desirable characteristics					
10	Dissolved solids, (mg/L), Max	500	Beyond this, palatability decreases and may cause gastro-intestinal irritation	2000	-
11	Calcium (mg/L, Ca) Max.	75	Encrustation in water supply structure and adverse effects on domestic use	200	-
12	Magnesium (mg/L, Mg) Max.	30	Encrustation in water supply structure and adverse effects on domestic use	100	-
13	Copper (mg/L, Cu) Max.	0.05	Astringent taste, dis-coloration and corrosion of pipes fittings and utensils will be caused beyond this	1.5	-
14	Manganese (mg/L, Mn) Max	0.1	Beyond this limit taste/appearance are affected, has adverse effect on domestic use and water supply structure	0.3	-

(Contd. ....)

Sl. No.	Substance or characteristic	Requirement desirable limit	Undesirable effects outside the desirable limit	Permissible limit in the absence of alternate source	Remarks
15	Sulphate (mg/L, SO <sub>4</sub> ) Max	200	Beyond this causes gastro-intestinal irritation when magnesium or sodium are present	400	May be extended up to 400 provided magnesium (as Mg) does not exceed 30
16	Nitrate (mg/L, NO <sub>3</sub> ) Max	45	Beyond this methaemoglobinemia takes place	100	-
17	Fluoride (mg/L, F) Max	1	Fluoride may be kept as low as possible. High fluoride may cause fluorosis	1.5	-
18	Phenolic compounds (mg/L C <sub>6</sub> H <sub>5</sub> OH) Max	0.001	Beyond this, it may cause objectionable taste and odour	0.002	-
19	Mercury (mg/L, Hg) Max	0.001	Beyond this the water becomes toxic	No Relaxation	To be tested when pollution is suspected
20	Cadmium (mg/L, Cd) Max	0.01	Beyond this the water becomes toxic	No Relaxation	To be tested when pollution is suspected
21	Selenium (mg/L, Se) Max	0.01	Beyond this the water becomes toxic	No Relaxation	To be tested when pollution is suspected
22	Arsenic (mg/L, As) Max	0.05	Beyond this the water becomes toxic	No Relaxation	To be tested when pollution is suspected
23	Cyanide (mg/L, CN) Max	0.05	Beyond this the water becomes toxic	No Relaxation	To be tested when pollution is suspected
24	Lead (mg/L, Pb) Max	0.05	Beyond this the water becomes toxic	No Relaxation	To be tested when pollution/plumbosolvency is suspected
25	Zinc (mg/L, Zn) Max	5	Beyond this limit it can cause astringent taste and an opalescence in water	15	To be tested when pollution is suspected

(Contd....)

Sl. No.	Substance or characteristic	Requirement desirable limit	Undesirable effects outside the desirable limit	Permissible limit in the absence of alternate source	Remarks
26	Anionic detergents (mg/L, MBAS) Max	0.2	Beyond this limit it can cause a light froth in water	1	To be tested when pollution is suspected
27	Chromium (mg/L, Cr6+) Max	0.05	May be carcinogenic above this limit	No relaxation	To be tested when pollution is suspected
28	Polynuclear aromatic hydrocarbons (mg/L, PAH) Max	-	May be carcinogenic	-	-
29	Mineral oil (mg/L) Max	0.01	Beyond this limit, undesirable taste and odour after chlorination takes place	0.03	To be tested when pollution is suspected
30	Pesticides (mg/L) Max	Absent	Toxic	0.001	-
31	Radioactive materials:				
	Alpha emitters (Bq/L) Max	-	-	0.1	-
	Beta emitters (pCi/L) Max.	-	-	1	-
32	Alkalinity (mg/L) Max	200	Beyond this limit, taste becomes unpleasant	600	-
33	Aluminium (mg/L, Al) Max	0.03	Cumulative effect is reported to cause dementia	0.2	-
34	Boron (mg/L) Max	1	-	5	-

pCi = PicoCurie

## Appendix-E

## CPHEEO (Ministry of Urban Development, Govt. of India) Regulations for Drinking Water Quality (1991)

## I) Physical and chemical standards

Sl. No.	Characteristics	*Acceptable	**Cause for rejection
1.	Turbidity (Units on J.T.U. scale)	1	10
2.	Colour (Units on platinum cobalt scale)	5	25
3.	Taste and Odour	Unobjectionable	Unobjectionable
4.	pH	7.0 to 8.5	< 6.5 to > 9.2
5.	Total dissolved solids (mg/L)	500	2000
6.	Total hardness as CaCO <sub>3</sub> (mg/L)	200	600
7.	Chlorides as Cl (mg/L)	200	1000
8.	Sulphates as SO <sub>4</sub> (mg/L)	200	400
9.	Fluorides as F (mg/L)	1	1.5
10.	Nitrates as NO <sub>3</sub> (mg/L)	45	45
11.	Calcium as Ca (mg/L)	75	200
12.	Magnesium as Mg (mg/L)	<30	150
13.	Iron as Fe (mg/L)	0.1	1
14.	Manganese as Mn (mg/L)	0.05	0.5
15.	Copper as Cu (mg/L)	0.05	1.5
16.	Aluminium as Al (mg/L)	0.03	0.2
17.	Alkalinity (mg/L)	200	600
18.	Residual Chlorine (mg/L)	0.2	>1.0
19.	Zinc as Zn (mg/L)	5	15
20.	Phenolic compounds as Phenol (mg/L)	0.001	0.002
21.	Anionic detergents as MBAS (mg/L)	0.2	1
22.	Mineral Oil (mg/L)	0.01	0.03
Toxic Materials			
23.	Arsenic as As (mg/L)	0.01	0.05
24.	Cadmium as Cd (mg/L)	0.01	0.01
25.	Chromium as Hexavalent Cr (mg/L)	0.05	0.05
26.	Cyanides as CN (mg/L)	0.05	0.05

27.	Lead as Pb (mg/L)	0.05	0.05
28	Selenium as Se (mg/L)	0.01	0.01
29	Mercury as Hg (mg/L)	0.001	0.001
30	Polynuclear aromatic hydrocarbons (PAH) ( $\mu\text{g/L}$ )	0.2	0.2
31	Pesticides (total, mg/L)	Absent	Refer to WHO guidelines for drinking water quality, 2004
Radioactivity			
32	Gross Alpha activity (Bq/L)	0.1	0.1
33	Gross Beta activity (Bq/L)	1.0	1.0

Notes:

\* The figures indicated under the column “Acceptable” are the limits up to which the water is generally acceptable to the consumers.

\*\* Figures in excess of those mentioned under “Acceptable” render the water not acceptable, but still may be tolerated in the absence of alternative and better source but up to the limits indicated under column “Cause for Rejection” above which the supply will have to be rejected.

# If there are 250 mg/L of sulphates, magnesium content can be increased to a maximum of 125 mg/L with the reduction of sulphates at the rate of 1 unit per every 2.5 units of sulphates.

+ It is possible that some mine and spring waters may exceed these radioactivity limits and in such cases it is necessary to analyse the individual radionuclides in order to assess the acceptability or otherwise for public consumption.

## II) Virological quality of drinking water

It is recommended that to be acceptable, drinking water should be free from any viruses infectious for man. This objective may be achieved (i) by the use of water supply from a source which is free from wastewater and is protected from faecal contamination; or (ii) by adequate treatment of a water source that is subject to faecal pollution.

Adequacy of treatment cannot be assessed in an absolute sense because neither the available monitoring techniques nor the epidemiological evaluation is sufficiently sensitive to ensure the absence of viruses. However, it is considered at present that contaminated source water may be regarded as adequately treated when the following conditions are met.

- A turbidity of 1 NTU or less is achieved.
- Disinfection of the water with at least 0.5 mg/L of free residual chlorine after a contact period of at least 30 minutes at pH below 8.

The turbidity condition must be fulfilled prior to disinfection if adequate treatment is to be achieved. Disinfection other than by chlorination may be applied provided the efficacy is at least equal to that of chlorination as described above. Ozone has been shown to be effective viral disinfectant, preferably for clean water, if residuals of 0.3–0.4 mg/L are maintained for 4 minutes. Ozone has advantages over chlorine for treating water containing ammonia, but unfortunately, it is not possible to maintain ozone residual in the distribution system.

When virological facilities can be provided, it is desirable to examine the raw water sources and the finished drinking water for the presence of viruses. This will provide baseline data to evaluate the health risk faced by the population. A reference method should be used for the concentration and detection of viruses in large volumes of drinking water (e.g. 100-1000 litres).

## Appendix-F

### WHO Guideline Values for Chemicals of Health Significance in Drinking Water (2004)

#### i) Industrial resources and human dwellings

Inorganics	Guideline value, (mg/L)
Cadmium	0.003
Cyanide	0.07
Mercury	0.001

#### ii) Naturally occurring chemicals

Chemicals	Guideline values <sup>a</sup> , (mg/L)
Arsenic	0.01 (P)
Barium	0.7
Boron	0.5 (T)
Chromium	0.05 (P)
Fluoride	1.5
Manganese	0.4 (C)
Molybdenum	0.07
Selenium	0.01
Uranium	0.015 (P,T)

<sup>a</sup>P=provisional guideline value, as there is evidence of a hazard, but the available information on health effects is limited; T=provisional guideline value because calculated guideline value is below the level that can be achieved through practical treatment methods, source protection, etc; C=concentrations of the substances at or below the health-based guideline value may affect the appearance, taste or odour of the water, resulting in consumer complaints.

#### iii) Pesticides

Pesticides used in water for public health purpose <sup>a</sup>	Guideline value (µg/L)
Chlorpyrifos	30
DDT and metabolites	1
Pyriproxyfen	300

<sup>a</sup>Only pyriproxyfen is recommended by WHO for addition to water for public health purposes.

## iv) Chemicals from agricultural activities

Non-pesticides	Guideline value (mg/L)
Nitrates (as NO <sub>3</sub> <sup>-</sup> )	50
Nitrite (as NO <sub>2</sub> <sup>-</sup> )	30.2 (P)
Pesticides used in agriculture	Guideline value (µg/L)
Alachlor	20b
Aldicarb	10
Aldrin and dieldrin	0.03
Atrazine	2
Carbofuran	7
Chlordane	0.2
Chlorotoluron	30
Cyanazine	0.6
2,4-D(2,4-dichlorophenoxy acetic acid)	30
2,4-DB	90
1,2-dibromo-3-chloropropane	b1
1,2-dibromoethane	0.4(P)
1,2-dibromopropane (1,2-DCP)	40 (P)
1,3-dichloropropane	20b
Dichlorprop	100
Dimethoate	6
Endrin	0.6
Fenoprop	9
Isoproturon	9
Lindane	2
MCPA	2
Mecoprop	10
Methoxychlor	20
Metolachlor	10
Pendimethalin	20
Simazine	2
2,4,5-T	9
Terbutylazine	7
Trifluralin	20

P=Provisional guideline value, as there is evidence of a hazard, but the available information on health effects is limited

a For substances that are considered to be carcinogenic, the guideline value is the concentration in drinking water associated with an upper-bound excess lifetime cancer risk of 10<sup>-5</sup>. Concentrations associated with estimated upper-bound excess lifetime cancer risks of 10<sup>-5</sup> can be calculated by multiplying and dividing, respectively, the guideline value by 10.

**v) Bacteriological quality of drinking water**

<b>Organisms</b>	<b>Guidelines</b>
All water intended for drinking	
E.coli or thermotolerant coliform bacteria b,c	Must not be detectable in any 100 mL sample
Treated water entering the distribution system	
E. coli or thermotolerant coliform Bacteria b	Must not be detectable in any 100 mL sample
Total coliform bacteria	Must not be detectable in any 100 mL sample
Treated water in the distribution system	
E.coli or thermotolerant coliform Bacteria	Must not be detectable in any 100 mL sample
Total coliform bacteria	Must not be detectable in any 100 mL sample.
In the case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12-month period.	

a Immediate investigative action must be taken if either E.coli or total coliform bacteria are detected. The minimum action in the case of total coliform bacteria is repeat sampling; if these bacteria are detected in the repeat sample, the cause must be determined by immediate further investigation.

b Although E.coli is the more precise indicator of faecal pollution, the count of thermotolerant coliform bacteria is an acceptable alternative. If necessary, proper confirmatory tests must be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of rural water supplies, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies.

c It is recognised that, in the great majority of rural water supplies in developing countries, faecal contamination is widespread. Under these conditions, the national surveillance agency should set medium-term targets for progressive improvement of water supplies, as recommended in Volume 3 of Guidelines for drinking-water quality.

## Appendix - G

### Determination of optimum dose of coagulants: Jar Test

A qualitative method used extensively to determine the quantity of coagulant required for effective coagulation in the water treatment industry is the jar test. In this test, environmental engineers add different coagulant doses to several rapidly mixing samples of water & continue mixing for about 1 min. The sample is then slowly mixed (to simulate flocculation) for 10 to 30 min. Environmental engineers then makes qualitative observation such as time for visible floc formation, floc size, and floc settling rates.

A direct or indirect measurement of the supernatant Suspended Solids concentration is made and the coagulant dose requirement is decided. The effective use of jar test information is an art & does not represent a true model of prototype operations.

#### Purpose of the test

The coagulation and flocculation of water is influenced by a number of inter related variables such as temperature, turbidity, colour, pH, alkalinity, the period and degree of agitation during flocculation and the characteristics of the coagulant used. Therefore the optimum dose of coagulant cannot be determined from the result of the water analysis but must be based on a well defined test with any given water. Since alum is commonly used coagulent, the most effective doses for specific water at a filtration plant, is determined through Jar test which is conducted daily and more specifically when water quality fluctuates rapidly.

#### Sampling

A large volume of sample of the raw water under study should be collected so that all tests will be performed on the same sample. At least 25 Litres of water should be available, to permit a series of jar tests.

#### Equipment

- Laboratory stirring or mixing device to provide controlled agitation equivalent in degree to plant-scale flocculation (usually provided by 30 to 100 r.p.m. stirring paddles).
- Six glass jars or beakers holding 1litre of sample.
- Glass funnels
- Filter paper

- 100-ml pipette
- Equipment for colour, turbidity, pH, and alkalinity measurements
- Stock alum solution (1 g of the filter alum to be used at the plant dissolved in 1 lit distilled water, 1 ml = 1 mg.)

### **Laboratory stirring equipment for coagulation and flocculation or jar test**

This device includes a small electric motor with speed-reducing gears. The driven pulleys have independent bearings, and are perforated at their center for the vertical brass rods to which the paddles are attached. The brass rods have a brass disk attached to the upper end so that they may be raised vertically when beaker is removed.

The area of the paddles should not be more than one-fourth the vertical cross-section of the liter of water in each beaker. The paddles should revolve at speeds in the range of 20-100 rpm.

### **Procedure**

1. Determine the colour, turbidity, pH and alkalinity of the raw water.
2. Measure 1-litre of the sample into each of the six jars or beakers and place them in the stirring equipment.
3. Start the motor of the stirrer.
4. Add as quickly as possible, graded doses of alum to the six beakers.
5. Agitate for 1 minute at 100 rpm as flash mix and then for 20 minutes at 20 rpm which matches for the period of time provided for flocculation at the plant.
6. Observe and note the time of first appearance of visible floc in each of the six portions of the samples, and also the appearance, size and quantity of the floc at the end of the agitation.
7. Let all portions settle for 30 minutes in the jars or beakers.
8. Observe the extent of sedimentation and residual turbidity

9. Determine the colour, turbidity, pH and alkalinity of the supernatant settled water using a large pipette to withdraw the water without disturbing the settled floc.
10. Repeat the test with another range of chemical doses if necessary, until expected residual turbidity is obtained.
11. Determine the colour, turbidity and alkalinity of the filtered water. The filter paper influences the pH of the filtered water, so determine the pH of the settled water.

### **Interpretation**

The test results giving the best flocculation and reduction of colour and turbidity by sedimentation and filtration will indicate the optimum doses of alum for the specific sample under test.

Coagulated water at pH of 5.4 and below will be corrosive. The additional lime dose needed for corrosion prevention should be added. In other words, the marble test would be made on the settled water to indicate the pH and alkalinity prevailing at calcium carbonate equilibrium. The separate lime dose needed for this purpose can then be computed.

### **Reference**

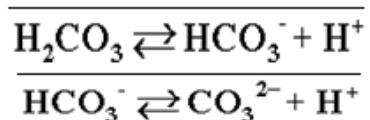
Operation And Control Of Water Treatment Processes - Charles R. Cox

## Appendix H

### Langelier Saturation Index (LSI)

The Langelier Saturation index (LSI) is an equilibrium model derived from the theoretical concept of saturation and provides an indicator of the degree of saturation of water with respect to calcium carbonate. It can be shown that the Langelier saturation index approximates the base 10 logarithm of the calcite saturation level. The Langelier saturation level approaches the concept of saturation using pH as a main variable. The LSI can be interpreted as the pH change required to bring water to equilibrium.

Water with a Langelier saturation index of 1.0 is one pH unit above saturation. Reducing the pH by 1 unit will bring the water equilibrium. This occurs because the portion of total alkalinity present as  $\text{CO}_3^{2-}$  decreases as the pH decreases, according to the equilibria describing the dissociation of carbonic acid:



- If LSI is negative: No potential to scale, the water will dissolve  $\text{CaCO}_3$
- If LSI is positive: Scale can form and  $\text{CaCO}_3$  precipitation may occur
- If LSI is close to zero: Borderline scale potential. Water quality or changes in temperature, or evaporation could change the index.

The LSI is probably the most widely used indicator of cooling water scale potential. It is purely an equilibrium index and deals only with the thermodynamic driving force for calcium carbonate scale formation and growth. It provides no indication of how much scale or calcium carbonate will actually precipitate to bring water to equilibrium.

It simply indicates the driving force for scale formation and growth in terms of pH as a master variable. In order to calculate the LSI, it is necessary to know the alkalinity (mg/l as  $\text{CaCO}_3$ ), the calcium hardness (mg/l  $\text{Ca}^{2+}$  as  $\text{CaCO}_3$ ), the total dissolved solids (mg/l TDS), the actual pH, and the temperature of the water ( $^{\circ}\text{C}$ ). If TDS is unknown, but conductivity is, one can estimate mg/L TDS. LSI is defined as:

$$\text{LSI} = \text{pH} - \text{pH}_s$$

Where:

pH is the measured water pH

pH<sub>s</sub> is the pH at saturation in calcite or calcium carbonate and is defined as:

$$\text{pH}_s = (9.3 + A + B) - (C + D)$$

Where:

$$A = (\log_{10} [\text{TDS}] - 1) / 10$$

$$B = -13.12 \times \log_{10} (^\circ\text{C} + 273) + 34.55$$

$$C = \log_{10} [\text{Ca}^{2+} \text{ as CaCO}_3] - 0.4$$

$$D = \log_{10} [\text{alkalinity as CaCO}_3]$$

1. Sample calculation - The calculation is best illustrated by working through an example. Assume that calcite controls CaCO<sub>3</sub> Solubility and Determine the SI for a water of the following composition:

Constituent	Concentration		
	mg	$\frac{\text{mg}}{\text{mole}}$	= g - moles / L
Calcium	152	40 000	$3.80 \times 10^{-3}$
Magnesium	39	24 312	$1.60 \times 10^{-3}$
Sodium	50	22 989	$2.18 \times 10^{-3}$
Potassium	5	39 102	$1.28 \times 10^{-3}$
Chloride	53	35453	$1.49 \times 10^{-3}$
Alkalinity (as CaCO <sub>3</sub> )	130	50 000	$2.60 \times 10^{-3}$ *
Sulphate	430	96 060	$4.48 \times 10^{-3}$
Silica (as SiO <sub>2</sub> )	15	60 084	$2.50 \times 10^{-4}$

\* g-equivalents.

Water temperature = 20°C ( 293.2 °K): pH = 9.00

However, there is some controversy concerning the correlation of these indices, and particularly the LSI, with the corrosivity of waters. While some sectors of the water management industry squarely use the indices as a measure of the corrosivity of their waters.

Precalculated values for pK and A at selected temperature

Temperature of water		pK <sub>s</sub>			pK <sub>w</sub>	A
°C	pK <sub>2</sub>	Calcite	Aragonite	Vaterite		
5	10.55	8.39	8.24	7.77	14.73	0.494
10	10.49	8.41	8.26	7.80	14.53	0.498
15	10.43	8.43	8.28	7.84	14.34	0.502
20	10.38	8.45	8.31	7.87	14.16	0.506
25	10.33	8.48	8.34	7.91	13.99	0.511
30	10.29	8.51	8.37	7.96	13.83	0.515
35	10.25	8.54	8.41	8.00	13.68	0.520
40	10.22	8.58	8.45	8.05	13.53	0.526
45	10.20	8.62	8.49	8.10	13.39	0.537
50	10.17	8.66	8.54	8.16	13.26	0.537
60	10.14	8.76	8.64	8.28	13.02	0.549
70	10.13	8.87	8.75	8.40	-	0.562
80	10.13	8.99	8.88	8.55	-	0.576
90	10.14	9.12	9.02	8.70	-	0.591

### Water Corrosiveness Determination

#### Langlier Index Calculation

Temp oF = TV	Calcium Hardness = HV	Total Alkalinity = AV
320 = 0.0	5 = 0.3	5 = 0.7
370 = 0.1	25 = 1.0	25 = 1.4
460 = 0.2	50 = 1.3	50 = 1.7
530 = 0.3	75 = 1.5	75 = 1.9
600 = 0.4	100 = 1.6	100 = 2.0
660 = 0.5	150 = 1.8	150 = 2.2
760 = 0.6	200 = 1.9	200 = 2.3
840 = 0.7	300 = 2.1	300 = 2.5
940 = 0.8	400 = 2.2	400 = 2.6
1050 = 0.9	800 = 2.5	800 = 2.9
1280 = 1.0	1000 = 2.0	1000 = 3.0

$\text{pH} + \text{TV} + \text{HV} + \text{AV} - 12.1 = \text{Langlier Index}$

If Index is between - 0.5 and + 0.5 the water is Balanced

If Index is less than - 0.5 the water is Corrosive

If Index is greater than + 0.5 the water is Scale Forming

Swimming Pool Calcium Temperature °F = TF		Hardness (CH) Expressed as ppm CaCO <sub>3</sub> = CH		Total Alkalinity (TA) Expressed as ppm CaCO <sub>3</sub> = TA	
32	0.0	5	0.3	5	0.7
37	0.1	25	1.0	25	1.4
46	0.2	50	1.3	50	1.7
53	0.3	75	1.5	75	1.9
60	0.4	100	1.6	100	2.0
66	0.5	150	1.8	150	2.2
76	0.6	200	1.9	200	2.3
84	0.7	300	2.1	300	2.5
94	0.8	400	2.2	400	2.6
105	0.9	800	2.5	800	2.9

### Saturation Index by Experimental Determination

Saturometry : Saturometers were developed to measure the relative saturation of seawater with respect to CaCO<sub>3</sub>. A water of known calcium and pH is equilibrated with CaCO<sub>3</sub> in a sealed flask containing a pH electrode. The water temperature is controlled with a constant - temperature bath. During equilibration the pH decreases if CaCO<sub>3</sub> precipitates and increases if CaCO<sub>3</sub> dissolves. When the pH stops changing, equilibrium is said to have been achieved. The initial pH and calcium values and the final pH value are used to calculate the relative saturation (RS).

A major advantage of this method is that the approach to equilibrium can be tracked by measuring pH, thus minimizing uncertainty about the achievement of equilibrium. The method is most sensitive in the range of minimum buffering intensity (pH 7.5 to 8.5).

The saturometry calculations use K<sub>s</sub> (Solubility product constant for CaCO<sub>3</sub> at the water temp) phase assumed to control solubility. Uncertainties occur if the identity of the controlling solid is unknown. Resolve these uncertainties by measuring K<sub>s</sub> of the controlling solid. It is equal to the CaCO<sub>3</sub> activity product, [Ca<sup>2+</sup>] x [CO<sub>3</sub><sup>2-</sup>], at equilibrium. Calculate the latter from the equilibrium pH and initial calcium, alkalinity, and pH measurements.

**Appendix-I**

**McCrary's Statistical Table**

**Most Probable Number (MPN) Values/100 mL of sample, for a set of tests of one 50 mL, five 10 mL, and five 1 mL volumes**

Sl. #	1x50 mL	5x10 mL	5x1mL	MPN/ 100mL	Sl. #	1x50 mL	5x10 mL	5x1 mL	MPN/ 100mL
1	0	0	0	<1	22	1	2	1	7
2	0	0	1	1	23	1	2	2	10
3	0	0	2	2	24	1	2	3	12
4	0	1	0	1	25	1	3	0	8
5	0	1	1	2	26	1	3	1	11
6	0	1	2	3	27	1	3	2	14
7	0	2	0	2	28	1	3	3	18
8	0	2	1	3	29	1	3	4	21
9	0	2	2	4	30	1	4	0	13
10	0	3	0	3	31	1	4	1	17
11	0	3	1	5	32	1	4	2	22
12	0	4	0	5	33	1	4	3	28
13	1	0	0	1	34	1	4	4	35
14	1	0	1	3	35	1	4	5	43
15	1	0	2	4	36	1	5	0	24
16	1	0	3	6	37	1	5	1	35
17	1	1	0	3	38	1	5	2	54
18	1	1	1	5	39	1	5	3	92
19	1	1	2	7	40	1	5	4	161
20	1	1	3	9	41	1	5	5	>180
21	1	2	0	5					

**MPN values per 100 mL of sample and 95% confidence limits for various combinations of positive and negative results (when five 10 mL, five 1 mL and five 0.1 mL test portions are used)**

Combination of positives	MPN index per 100 mL	95 % confidence limits		Combination of positives	MPN index per 100 mL	95 % confidence limits	
		Upper	Lower			Upper	Lower
0-0-0	<2	-	-	4-2-0	22	9.0	56
0-0-1	2	1.0	10	4-2-1	26	12	65
0-1-0	2	1.0	10	4-3-0	27	12	67
0-2-0	4	1.0	13	4-3-1	33	15	77
				4-4-0	34	16	80
1-0-0	2	1.0	11	5-0-0	23	9.0	86
1-0-1	4	1.0	15	5-0-1	30	10	110
1-1-0	4	1.0	15	5-0-2	40	20	140
1-1-1	6	2.0	18	5-1-0	30	10	120
1-2-0	6	2.0	18	5-1-1	50	20	150
				5-1-2	60	30	180
2-0-0	4	1.0	17	5-2-0	50	20	170
2-0-1	7	2.0	20	5-2-1	70	30	210
2-1-0	7	2.0	21	5-2-2	90	40	250
2-1-1	9	3.0	24	5-3-0	80	30	250
2-2-0	9	3.0	25	5-3-1	110	40	300
2-3-0	12	5.0	29	5-3-2	140	60	360
3-0-0	8	3.0	24	5-3-3	170	80	410
3-0-1	11	4.0	29	5-4-0	130	50	390
3-1-0	11	4.0	29	5-4-1	170	70	480
3-1-1	14	6.0	35	5-4-2	220	100	580
3-2-0	14	6.0	35	5-4-3	280	120	690
3-2-1	17	7.0	40	5-4-4	350	160	820
4-0-0	13	5.0	38	5-5-0	240	100	940
4-0-1	17	7.0	45	5-5-1	300	100	1,300
4-1-0	17	7.0	46	5-5-2	500	200	2,000
4-1-1	21	9.0	55	5-5-3	900	300	2,900
4-1-2	26	12.0	63	5-5-4	1,600	600	5,300
				5-5-5	>1,600	-	-

## Appendix-J

## Minimum Frequency of Sampling and Analysis of Un-piped Water Supplies

Source and mode of supply	Minimum frequency of sampling and analysis		Remarks
	Bacteriological	Physical/chemical	
Open wells for community supply	Sanitary protection measures; bacteriological testing only if situation demands	Once initially for community wells	Pollution usually expected to occur
Covered dug wells and shallow tubewells with hand-pumps	Sanitary protection measures; bacteriological testing only if situation demands	Once initially, thereafter as situation demands	Situations requiring testing: change in environmental conditions, outbreak of waterborne disease, or increase in incidence of waterborne diseases
Deep tubewells with hand-pumps	Once initially, thereafter as situation demands	Once initially, thereafter as situation demands	Situations requiring testing: change in environmental conditions, outbreak of waterborne disease, or increase in incidence of waterborne diseases
Protected springs	Once initially, thereafter as situation demands	Periodically for residual chlorine if water is chlorinated	Situations requiring testing: change in environmental conditions, outbreak of waterborne disease, or increase in incidence of waterborne diseases
Community rainwater collection systems	Sanitary protection measures; bacteriological testing only if situation demands	Not needed	-

Source: Ministry of Environment and Forests Notification, New Delhi, the 16th December, 2005.

## Appendix-K

### Minimum Sample Numbers for Piped Drinking Water in the Distribution System

Population served	No. of monthly samples
<5000	1
5000-100 000	1 per 5000 population
>100 000	1 per 10000 population, plus 10 additional samples

Source: Ministry of Environment and Forests Notification, New Delhi, the 16th December, 2005.

## Appendix-L

## Waterborne Pathogens and Their Significance in Water Supplies

Pathogen	Health significance	Persistence in water supplies <sup>a</sup>	Resistance to chlorin <sup>b</sup>	Relative infectivity <sup>c</sup>	Important animal source
<b>Bacterial pathogens</b>					
Burkholderia pseudomallei	Low	May multiply	Low	Low	No
Campylobacter jejuni, C. coli	High	Moderate	Low	Low	Yes
Escherichia coli - Pathogenic <sup>d</sup>	High	Moderate	Low	Low	Yes
E. coli - Enterohaemorrhagic	High	Moderate	Low	High	Yes
Legionella spp.	High	Multiply	Low	Moderate	No
Non-tuberculous mycobacteria	Low	Multiply	High	Low	No
Pseudomonas aeruginosae	Moderate	May multiply	Moderate	Low	No
Salmonella typhi	High	Moderate	Low	Low	No
Other salmonellae	High	May multiply	Low	Low	Yes
Shigella spp.	High	Short	Low	Moderate	No
Vibrio cholerae	High	Short	Low	Low	No
Yersinia enterocolitica	High	Long	Low	Low	Yes
<b>Viral pathogens</b>					
Adenoviruses	High	Long	Moderate	High	No
Enteroviruses	High	Long	Moderate	High	No
Hepatitis A	High	Long	Moderate	High	Potentially
Hepatitis E	High	Long	Moderate	High	Potentially
Noroviruses and Sapoviruses	High	Long	Moderate	High	No
Rotavirus	High	Long	Moderate	High	No
<b>Protozoan pathogens</b>					
Acanthamoeba spp.	High	Long	High	High	No
Cryptosporidium parvum	High	Long	High	High	Yes
Cyclospora cayetanensis	High	Long	High	High	No
Entamoeba histolytica	High	Moderate	High	High	No
Giardia intestinalis	High	Moderate	High	High	Yes
Naegleria fowleri	High	May multiply <sup>f</sup>	High	High	No
Toxoplasma gondii	High	Long	High	High	Yes
<b>Helminth pathogens</b>					
Dracunculus medinensis	High	Moderate	Moderate	High	No
Schistosoma spp.	High	Short	Moderate	High	Yes

a Detection period for infective stage in water at 20 °C: short, up to 1 week; moderate, 1 week to 1 month; long, over 1 month.;

b When the infective stage is freely suspended in water treated at conventional doses and contact times. Resistance moderate, agent may not be completely destroyed.

c From experiments with human volunteers or from epidemiological evidence..

d Includes enteropathogenic, enterotoxigenic and enteroinvasive.

e Main route of infection is by skin contact, but can infect immunosuppressed or cancer patients orally.

f In warm water.

## Appendix-M

### Biochemical reactions of key species of the family Enterobacteriaceae\*

Species	Lactose fermentation	ONPG Hydrolysis	Indole Production	Methyl Red	Voges-Praskauer	Simon's Citrate	Ornithine Decarboxylase	Lysine Decarboxylase	Sorbitol Fermentation	Cellobiose Fermentation	Motility (35-37°C)	Yellow Pigment
Citrobacter diversus	35	96	99	100	0	99	99	0	99	99	95	0
Citrobacter freundii	50	95	05	100	0	95	20	0	98	55	95	0
Enterobacter aerogenes	95	100	0	05	98	95	98	98	100	100	97	0
Enterobacter agglomerans	40	90	20	50	70	50	0	0	30	55	85	75
Enterobacter cloacae	93	99	0	05	100	100	96	0	95	99	95	0
Escherichia coli	95	95	98	99	0	01	65	90	94	02	95	0
Escherichia coli (inactive)	25	45	80	95	0	01	20	40	75	02	05	0
Escherichia ferfusonii	0	83	98	100	0	17	100	95	0	96	93	0
Escherichia hermannii	45	98	99	100	0	01	100	06	0	97	99	98
Escherichia vulneris	15	100	0	100	0	0	0	85	01	100	100	50
Hafnia alvei	05	90	0	40	85	10	98	100	0	15	85	0
Klebsiella oxytoca	100	100	99	20	95	95	0	99	99	100	0	01
Klebsiella ozaenae	30	80	0	98	0	30	03	40	65	92	0	0
Klebsiella pneumoniae	98	99	0	10	98	98	0	98	99	98	0	0
Klebsiella rhinoscleromatis	0	0	0	100	0	0	0	0	100	100	0	0
Serratia fonticola	97	100	0	100	09	91	97	100	100	06	91	0
Serratia marcescens	02	95	01	20	98	98	99	99	99	05	97	0

\*Percentage of isolates positive in 1 to 2 days; Reactions that become positive after 2 days are not considered.

### **IMViC Test**

Enterobacteriaceae (enterics) are Gram-negative bacteria that grow in the intestinal tract of humans and other animals. The IMViC tests are frequently employed for identification of this group of microbes which includes such organisms as Klebsiella, Enterobacter, and Escherichia coli. The presence of E. coli is used in bacteriological water testing as an indicator of fecal contamination water supplies. While Enterobacter and Klebsiella resemble E.coli in being lactose fermenters, their presence does not necessarily indicate fecal contamination because they are widespread in soil and grass. The IMViC tests can be used to differentiate these three organisms.

IMViC represents the first letter of each individual test within the series of the following four tests:

1. Indole
2. Methyl Red
3. Voges-Proskauer
4. Citrate

This series of tests has been used for many years to differentiate gram-negative enteric bacteria (Enterobacteriaceae).

- Pathogenic (Salmonella, Shigella)
- Occasionally pathogenic (Proteus, Klebsiella)
- Normal Flora (Escherichia, Enterobacter)

Results are recorded in the same order as the name sequence.

For example:

- i.     ++ -- or
- ii.    - ++

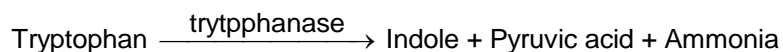
Which means,

- i.     Positive in indole test, positive in methyl red test, negative in Voges-Proskauer test, and negative in citrate test;
- ii.    Negative in indole test, negative in methyl red test, positive in Voges-Proskauer test, and positive in citrate test

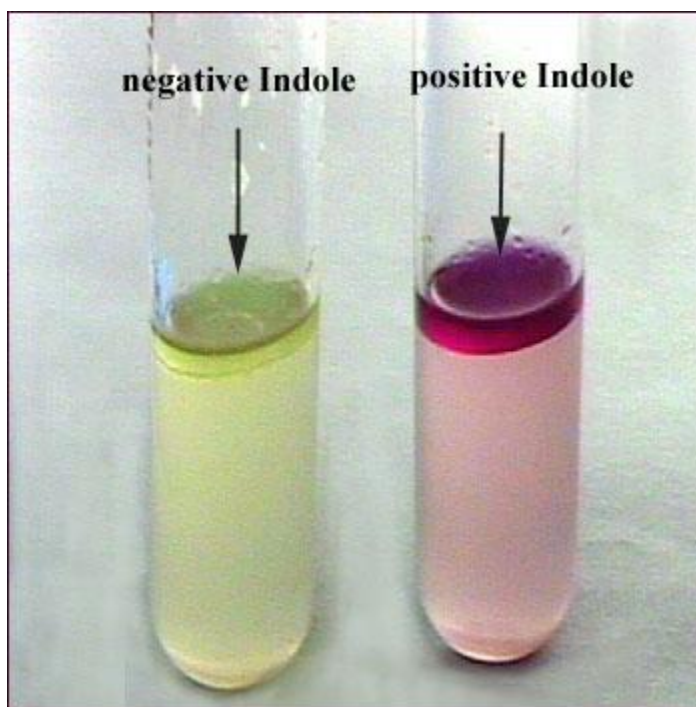
## Individual tests of the IMViC:

### 1. Indole Test

Tryptophane, an essential amino acid, can be oxidized by some organisms.



**Test Method:** The test organism is inoculated into tryptone broth, a rich source of the amino acid tryptophan. Indole positive bacteria such as *Escherichia coli* produce tryptophanase, an enzyme that cleaves tryptophan, producing indole and other products. When Kovac's reagent (p-dimethylaminobenzaldehyde) is added to a broth with indole in it, a dark pink color develops. The indole test must be read by 48 hours of incubation because the indole can be further degraded if prolonged incubation occurs. The acidic pH produced by *Escherichia coli* limits its growth.



## 2. Methyl Red Test

- Qualitative test of acid produced from oxidation of glucose. Used primarily to differentiate *E. coli* from *E. aerogenes*.
  - i. *E. coli* – produces large amounts of acid.
  - ii. *E. aerogenes* – produces neutral or non-acidic end products.
- Organism is grown in MR-VP broth. Methyl red indicator is added to culture to identify amount of acid present. When organism is *E. coli*, medium pH=4 and is red (positive). When acid is present, but at a much lower concentration, pH = 6, the medium turns yellow.

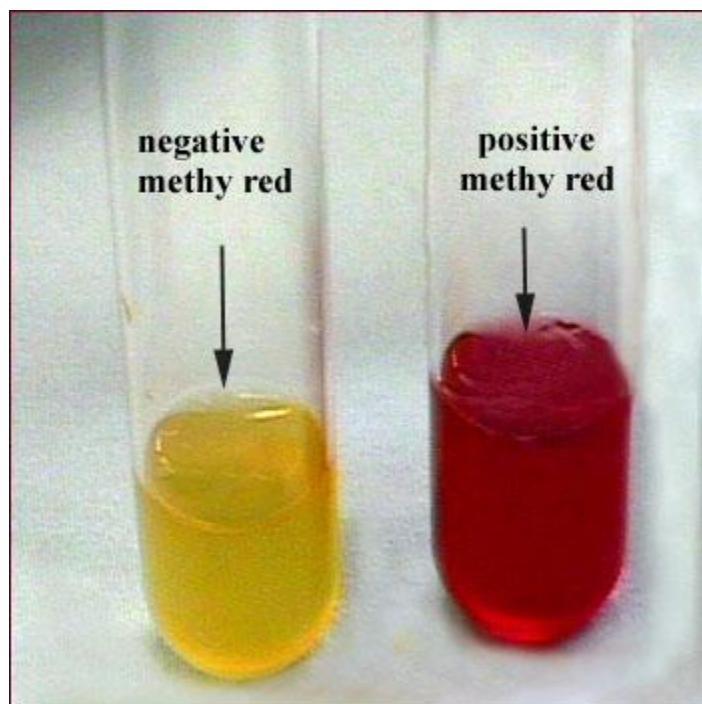
## 3. Voges-Proskauer Test

- Performed simultaneously with Methyl Red Test.
- Determines ability of an organism to produce non-acid or neutral end products from organic acids present following glucose metabolism.
- Organism is grown in MR-VP broth. Barritt's reagent is added to culture. Pink/red color indicates presence of acetylmethylcarbinol (positive reaction).

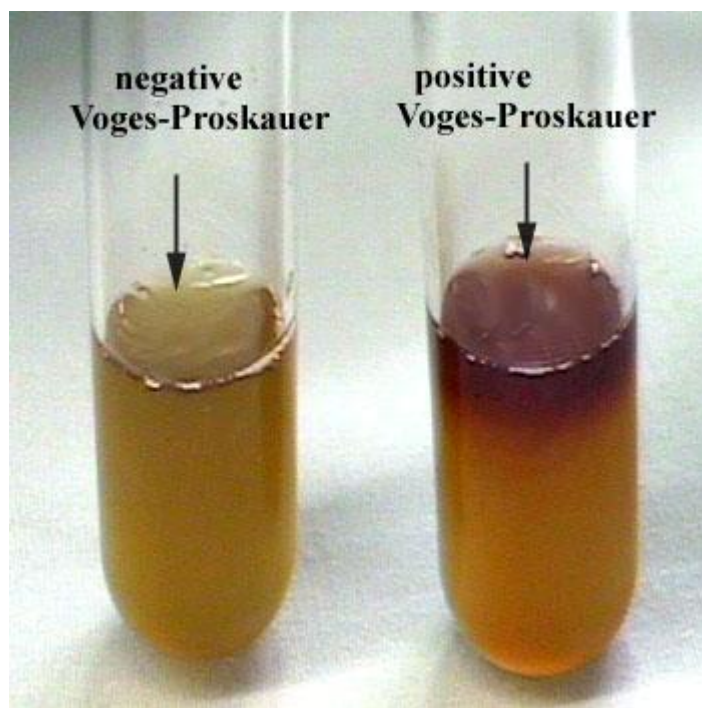
### The Methyl Red and Voges-Proskauer Tests

The methyl red (MR) and Voges-Proskauer (VP) tests are read from a single inoculated tube of MR-VP broth. After 24-48 hours of incubation the MR-VP broth is split into two tubes. One tube is used for the MR test; the other is used for the VP test.

MR-VP media contains glucose and peptone. All enterics oxidise glucose for energy; however the end products vary depending on bacterial enzymes. Both the MR and VP tests are used to determine what end products result when the test organism degrades glucose. *E. coli* is one of the bacteria that produces acids, causing the pH to drop below 4.4. When the pH indicator methyl red is added to this acidic broth it will be cherry red (a positive MR test).



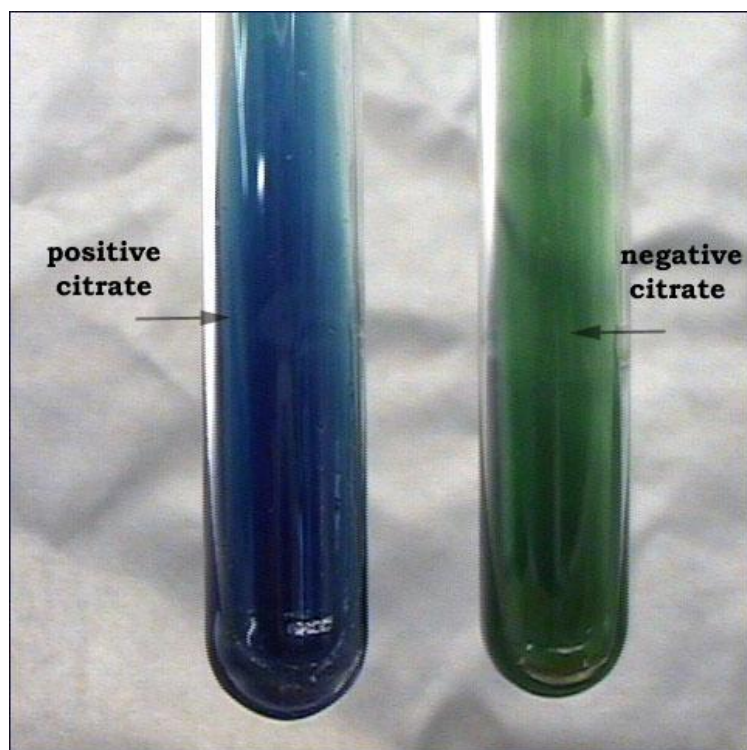
*Klebsiella* and *Enterobacter* produce more neutral products from glucose (e.g. ethyl alcohol, acetyl methyl carbinol). In this neutral pH the growth of the bacteria is not inhibited. The bacteria thus begin to attack the peptone in the broth, causing the pH to rise above 6.2. At this pH, methyl red indicator is a yellow color (a negative MR test).



The reagents used for the VP test are Barritt's A (alpha-naphthol) and Barritt's B (potassium hydroxide). When these reagents are added to a broth in which acetyl methyl carbinol is present, they turn a pink-burgundy color (a positive VP test). This color may take 20 to 30 minutes to develop. *E. coli* does not produce acetyl methyl carbinol, but *Enterobacter* and *Klebsiella* do.

### The Citrate Test

- Some organisms use citrate as a carbon source for energy when glucose or lactose is not present. These organisms have two primary
- Simmon's Agar Slants are used. Bromthymol blue indicator is incorporated in the medium. If culture grows (citrate positive, pH 7.6) media turns blue. If no growth, medium is green (pH 6.9) and culture is citrate negative.



The citrate test utilises Simmon's citrate media to determine if a bacterium can grow utilising citrate as its sole carbon and energy source. Simmon's media contains bromthymol blue, a pH indicator with a range of 6.0 to 7.6. Bromthymol blue is yellow at acidic pHs (around 6), and gradually changes to blue at more alkaline pHs (around 7.6). Uninoculated Simmon's citrate agar has a pH of 6.9, so it is an intermediate green color. Growth of bacteria in the media leads to development of a Prussian blue color (positive citrate). *Enterobacter* and *Klebsiella* are citrate positive while *E.coli* is negative.

## Appendix-O

### Major Indian Suppliers of Media, Reagents, Kits and Equipment

❖ **Himedia Laboratories**

(Dehydrated culture media, media products, supplements, lab chemicals etc.)

Corporate Office:

A-406, Bhaveshwar Plaza,  
LBS Marg, Mumbai - 400 086, India

Registered Office:

23, Vadhani Industrial Estate,  
LBS Marg, Mumbai - 400 086, India

Phone: 91-22-2500 0970, 2500 3747, 2500 1607, 2500 0653

Fax: 91-22-2500 5764, 2500 2468, 2500 2286

Email: [Info@himedialabs.com](mailto:Info@himedialabs.com)

❖ **Millipore (India) Pvt. Ltd.**

(Membrane filters, filtration equipment etc.)

Head Office :

50 A, II Phase, Ring Road,  
Peenya, Bangalore 560058

(Regional offices in New Delhi, Mumbai, Kolkata and Hyderabad)

Ph.: 91-80-28396320, 28394657

Fax: 91-80- 28396345

E-mail: [millipore@vsnl.com](mailto:millipore@vsnl.com)

❖ **Becton Dickinson (India) Pvt. Ltd.**

(Dehydrated culture media, media products, supplements, etc.)

Head Office:

6th Floor Signature Tower - B

South City I,

122001, Gurgaon, Haryana  
India

Telephone 91-124-2383566-71

Facsimile 91-124-2383224-25-26

E-mail: [bd\\_india@bd.com](mailto:bd_india@bd.com)

❖ **Swan Environmental Pvt. Ltd.,**

(Portable water analysis systems for testing physical, chemical and microbiological parameters)

401 & 402, Nagasuriplaza,  
Plot no: 8, Gayathri Nagar,  
Behind: Huda-Maithrivanam  
Ameerpet, Hyderabad - 500 038, India

Phone: +91-40-23743384, 23743385

Fax: +91-40-23748764

e-mail: [swan\\_epl@satyam.net.in](mailto:swan_epl@satyam.net.in)

❖ **Farsons Products Pvt. Ltd.**

(Autoclavable/disposable laboratory plasticware)

856 Marshal House  
33/1 Netaji Subhash Road,  
Kolkata 700001.

Telephone: 22204022, 22209025

Fax: 033- 2221 1014

E-mail: [tarsons@satyam.net.in](mailto:tarsons@satyam.net.in)

❖ **Riviera Glass Pvt. Ltd.**

(Laboratory glassware, accessories, thermometers, liquid dispensers etc.)

2116, Oberoi Garden Estates,  
Chandivili Studio Road,  
Chandivili, Andheri (East),  
Mumbai- 400 072, India

Phone: 28475228, 28473297

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