DIALYSIS WATER AND DIALYSATE

DR. PARIN HEDAYATI

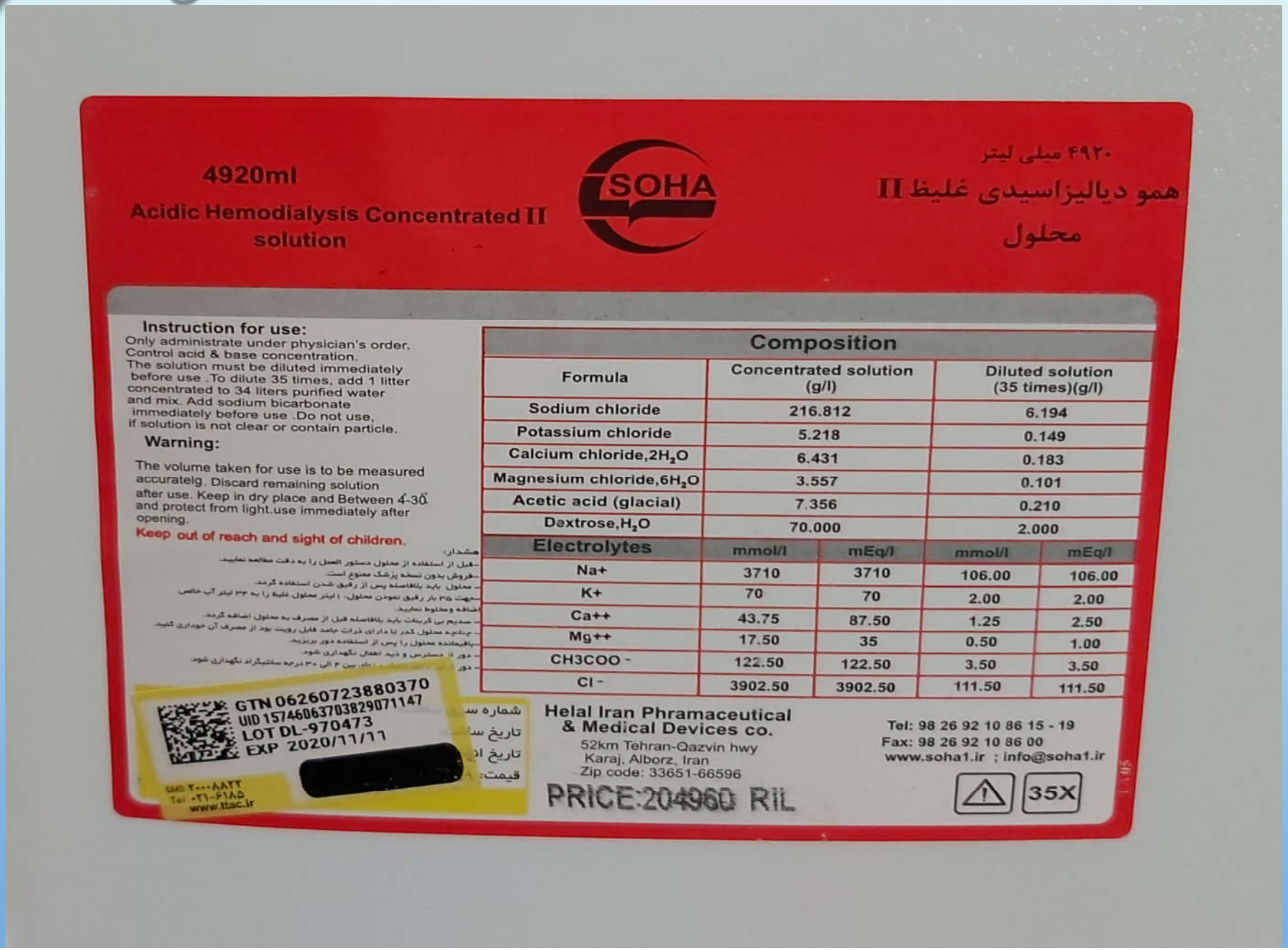
INTRODUCTION

- 120-200 LITRE
- **CHEMICAL & MICROBIOLOGICAL PURITY OF DIALYSIS SOLUTION**
- DIALYSIS SOLUTION : PURIFIED WATER

  CONCENTRATE

CONCENTRATES

- ELECTROLYTES
- COMMERICAL SOURCES



4920ml

Acidic Hemodialysis Concentrated II solution

SOHA

۴۹۲۰ میلی لیتر

همو دیالیزاسیدی غلیظ II

محلول

Instruction for use:

Only administrate under physician's order.
Control acid & base concentration.
The solution must be diluted immediately before use .To dilute 35 times, add 1 litter concentrated to 34 liters purified water and mix. Add sodium bicarbonate immediately before use .Do not use, if solution is not clear or contain particle.

Warning:

The volume taken for use is to be measured accuratelg. Discard remaining solution after use. Keep in dry place and Between 4-30 and protect from light.use immediately after opening.

Keep out of reach and sight of children.

هشدار:
- قبل از استفاده از محلول دستور العمل را به دقت مطالعه نمایید.
- فروش بدون نسخه پزشک ممنوع است.
- محلول باید بلافاصله پس از رقیق شدن استفاده گردد.
- جهت ۳۵ بار رقیق نمودن محلول، ۱ لیتر محلول غلیظ را به ۳۴ لیتر آب خالص اضافه ومخلوط نمایید.
- سدیم بی کربنات باید بلافاصله قبل از مصرف به محلول اضافه گردد.
- چنانچه محلول کدر یا دارای ذرات جامد قابل رویت بود از مصرف آن خودداری کنید.
- باقیمانده محلول را پس از استفاده دور بریزید.
- دور از دسترس و دید اطفال نگهداری شود.
- دور ... بین ۴ الی ۳۰ درجه سانتیگراد نگهداری شود.

Composition				
Formula	Concentrated solution (g/l)		Diluted solution (35 times)(g/l)	
Sodium chloride	216.812		6.194	
Potassium chloride	5.218		0.149	
Calcium chloride,$2H_2O$	6.431		0.183	
Magnesium chloride,$6H_2O$	3.557		0.101	
Acetic acid (glacial)	7.356		0.210	
Dextrose,H_2O	70.000		2.000	
Electrolytes	mmol/l	mEq/l	mmol/l	mEq/l
Na+	3710	3710	106.00	106.00
K+	70	70	2.00	2.00
Ca++	43.75	87.50	1.25	2.50
Mg++	17.50	35	0.50	1.00
CH3COO -	122.50	122.50	3.50	3.50
Cl -	3902.50	3902.50	111.50	111.50

GTN 06260723880370
UID 15746063703829071147
LOT DL-970473
EXP 2020/11/11

[redacted]

SMS ۲۰۰۰۸۸۲۲
Tel :۰۲۱-۶۱۸۵
www.ttac.ir

شماره س...
تاریخ س...
تاریخ ا...
قیمت:...

Helal Iran Phramaceutical & Medical Devices co.
52km Tehran-Qazvin hwy
Karaj, Alborz, Iran
Zip code: 33651-66596

Tel: 98 26 92 10 86 15 - 19
Fax: 98 26 92 10 86 00
www.soha1.ir ; info@soha1.ir

PRICE:204960 RIL

35X

WATER CONTAMINANTS

- ALUMINIUM
- CHLORAMINE
- FLOURIDE
- COPPER
- ZINC
- LEAD
- BACTERIA & ENDOTOXINS
- TOXINS FROM BLUE –GREEN ALGAE

ALUMINIUM

- FLOCCULATING AGENT
- AL SULFATE
- BONE DX , ANEMIA , ENCEPHALOPATHY SYNDROME

CHLORAMINE

- PREVENTION OF BACTERIAL PROLIFERATION
- HEMOLYTIC ANEMIA

FLOURIDE

- REDUCTION OF TOOTH DECAY
- SEVERE PRURITUS , NAUSEA , VF

COPPER & ZINC

- LEACHING FROM METAL PIPES
- HEMOLYTIC ANEMIA

BACTERIA & ENDOTOXINS

TOXINS FROM ALGAE

- TOXIC FOR HEMODIALYSIS PATIENTS

Water contaminants harmful for dialysis patient

Sign or Symptom Possible Water Contamination-Related Cause

- Anemia - Aluminum, chloramines, copper, zinc
- Bone Disease - Aluminum, floride
- Hemolysis - Aluminum, copper, nitrates, chloramines
- Hypertension - Calcium, sodium
- Hypotension - Bacteria, endotoxins, nitrates
- Metabolic Acidosis - Low pH, sulfates
- Muscle Weakness - Calcium, Magnesium
- Nausea and Vomiting - Bacteria, calcium, copper, endotoxin, low pH, magnesium, nitrates, sulfates, zinc
- Neurological deterioration - Aluminum
- Fever, chills - Bacteria, endotoxin, copper, zinc

FLUIDE QUALITY STANDARDS

ردیف	نوع آزمایش		واحد	حداکثر مجاز	نتیجه آزمایش
۱	کدورت		NTU	۵	0.42
۲	pH		pH	۶/۵-۹	7.5
۳	کلر باقیمانده		میلی گرم در لیتر	۰/۲-۰/۸	-
۴	هدایت الکتریکی		میکروزیمنس بر سانتیمتر	-	422
۵	کل مواد جامد محلول		میلی گرم در لیتر	۱۵۰۰	295
۶	شوری		p.p.t	-	0.1
۷	سختی کل	$Caco_3$	میلی گرم در لیتر	۵۰۰	202
۸	قلیائیت کل	$Caco_3$	میلی گرم در لیتر	-	186
۹	کربنات	$Caco_3$	میلی گرم در لیتر	-	0
۱۰	بیکربنات	$Caco_3$	میلی گرم در لیتر	-	226.92
۱۱	کلراید	Cl^-	میلی گرم در لیتر	۲۰۰	23
۱۲	سولفات	so_4^{--}	میلی گرم در لیتر	۲۰۰	36.4
۱۳	فلوراید	F^-	میلی گرم در لیتر	۰/۵-۱/۵	0.19
۱۴	نیترات	NO_3^-	میلی گرم در لیتر	۵۰	8.2
۱۵	نیتریت	No_2^-	میلی گرم در لیتر	۳	0
۱۶	کلسیم	Ca^{++}	میلی گرم در لیتر	۲۰۰	49.64
۱۷	منیزیم	Mg^{++}	میلی گرم در لیتر	۳۰	19.17
۱۸	سدیم	Na^+	میلی گرم در لیتر	۲۰۰	14.8
۱۹	پتاسیم	K^+	میلی گرم در لیتر	-	0.5

Contaminant	Maximum Concentration mg/L	Test Methodology
Calcium	2 (0.1 mEq/L)	EDTA or Atomic Absorption
Magnesium	4 (0.3 mEq/L)	Atomic Absorption
Potassium	8 (0.2 mEq/L)	Atomic Absorption, or Flame Photometri
Sodium	70 (3.0 mEq/L)	Atomic Absorption or Flame Photometric
Antimony	0.006	Atomic Absorption (platform)
Arsenic	0.005	Atomic Absorption (gaseous hydride)
Barium	0.10	Atomic Absorption (electrothermal)
Beryllium	0.0004	Atomic Absorption (platform)
Cadmium	0.001	Atomic Absorption (electrothermal)
Chromium	0.014	Atomic Absorption (electrothermal)
Lead	0.005	Atomic Absorption (electrothermal)
Mercury	0.0002	Flameless Cold Vapor (Atomic Absorption)

Contaminant	Maximum Concentration mg/L	Test Methodology
Selenium	0.09	Atomic Absorption (gaseous, or electrothermal)
Silver	0.005	Atomic Absorption (electrothermal)
Aluminum	0.01	Atomic Absorption (electrothermal)
Chloramines	0.10	DPD Ferrous Titrimetric Method
Total chlorine	0.50	DPD Ferrous Titrimetric Method
Copper	0.10	Atomic Absorption (direct aspiration)
Fluoride	0.20	Ion Selective Electrode Method
Nitrate (as N)	2.00	Cadmium Reduction Method
Sulfate	100.00	Turbidimetric Method
Thallium	0.002	Atomic Absorption (platform)
Zinc	0.10	Atomic Absorption (direct aspiration)

Association for the Advancement of Medical Instrumentation. *Dialysate for hemodialysis* (ANSI/AAMI RD52:2004). Arlington (VA). American National Standard. 2004

FLUID QUALITY STANDARDS

PRODUCT WATER

- BACTERIA <100 CFU/ML
- ENDOTOXIN < 0.25 EU/ML

FLUID QUALITY STANDARDS

FINAL DIALYSIS SOLUTION

- BACTERIA ≤ 100 CFU/ML
- ENDOTOXIN ≤ 0.5 EU/ML

ULTRAPURE DIALYSIS SOLUTION

CHRONIC INFLAMMATION

ULTRAPURE DIALYSIS SOLUTION

- BACTERIA < 0.1 CFU/ML
- ENDOTOXIN < 0.03 EU/ML

ULTRAPURE DIALYSIS SOLUTION

- CRP
- IL-6
- IMPROVED RESPONSE TO EPO
- BETTER NUTRITION ALBUMIN

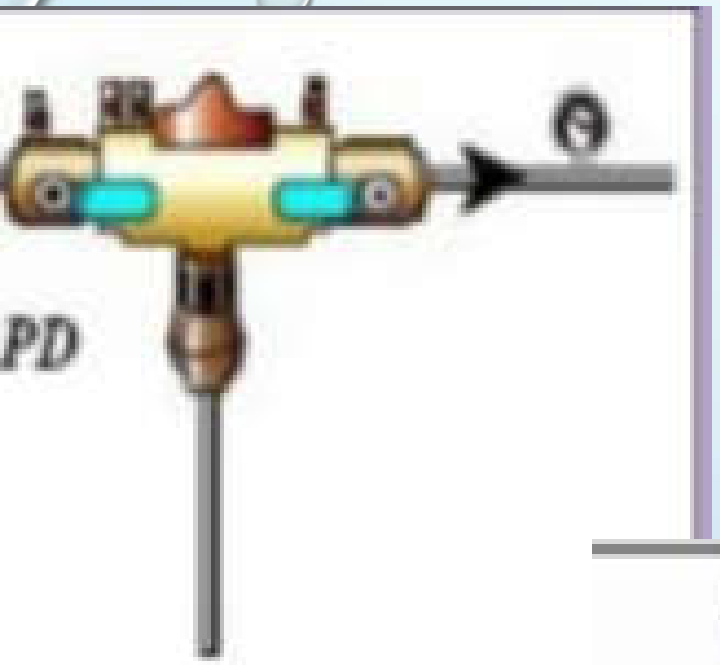
  MIDARM CIRCUMSTANCE
- B2MICROGLOBULIN
- RRF
- CV MORBIDITY

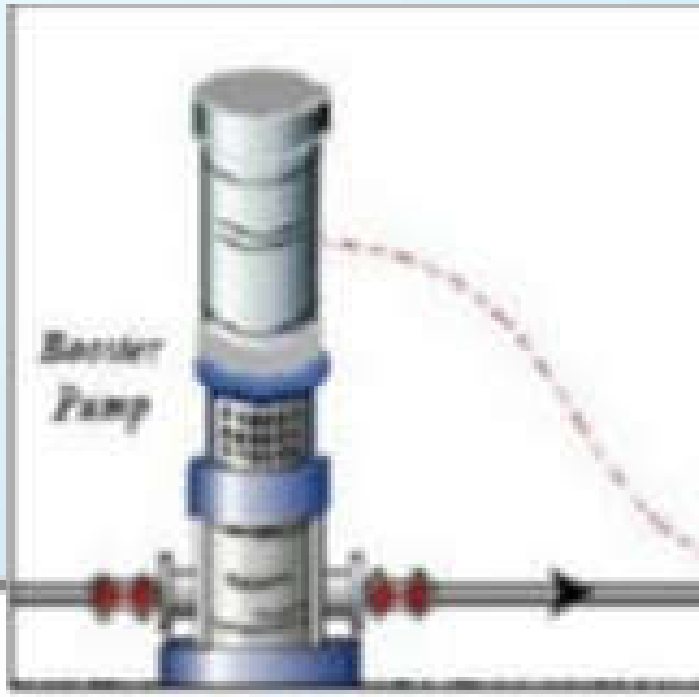
METHODS OF PURIFYING WATER FOR HD

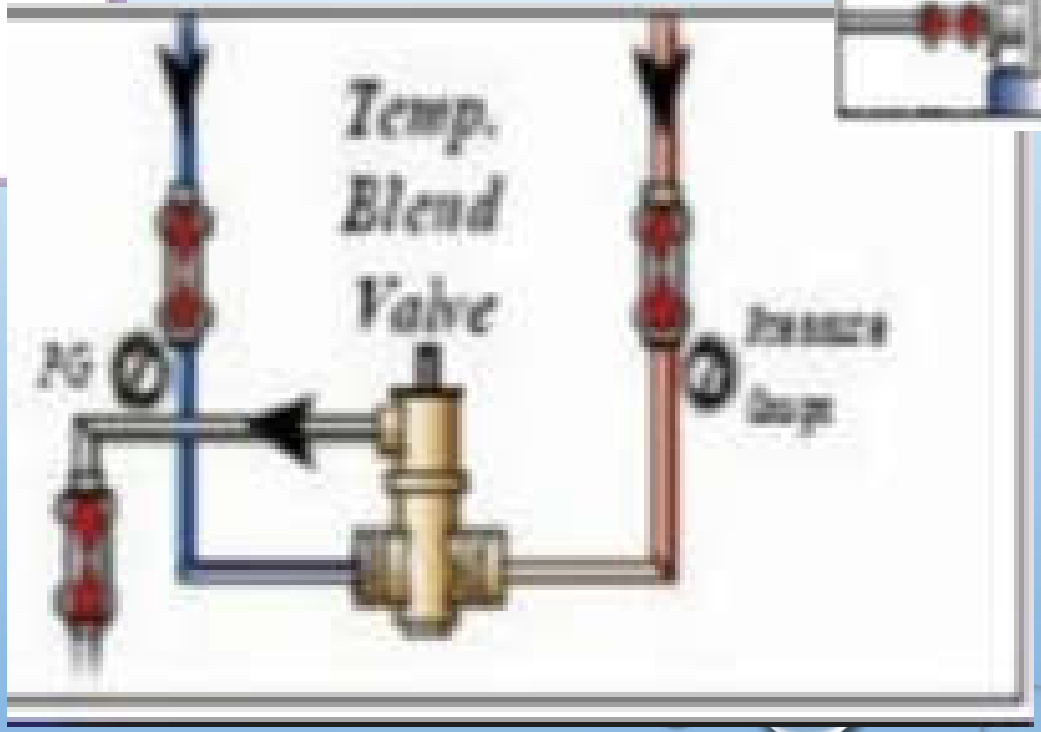
- PRETREATMENT
- PRIMARY PURIFICATION
- DISTRIBUTION TO THE POINT OF USE

PRETREATMENT

- BLENDING HOT AND COLD WATER
- WATER SOFTENING
- FILTRATION THROUGH ACTIVATED CARBON
- CORRECTION OF PH


PD

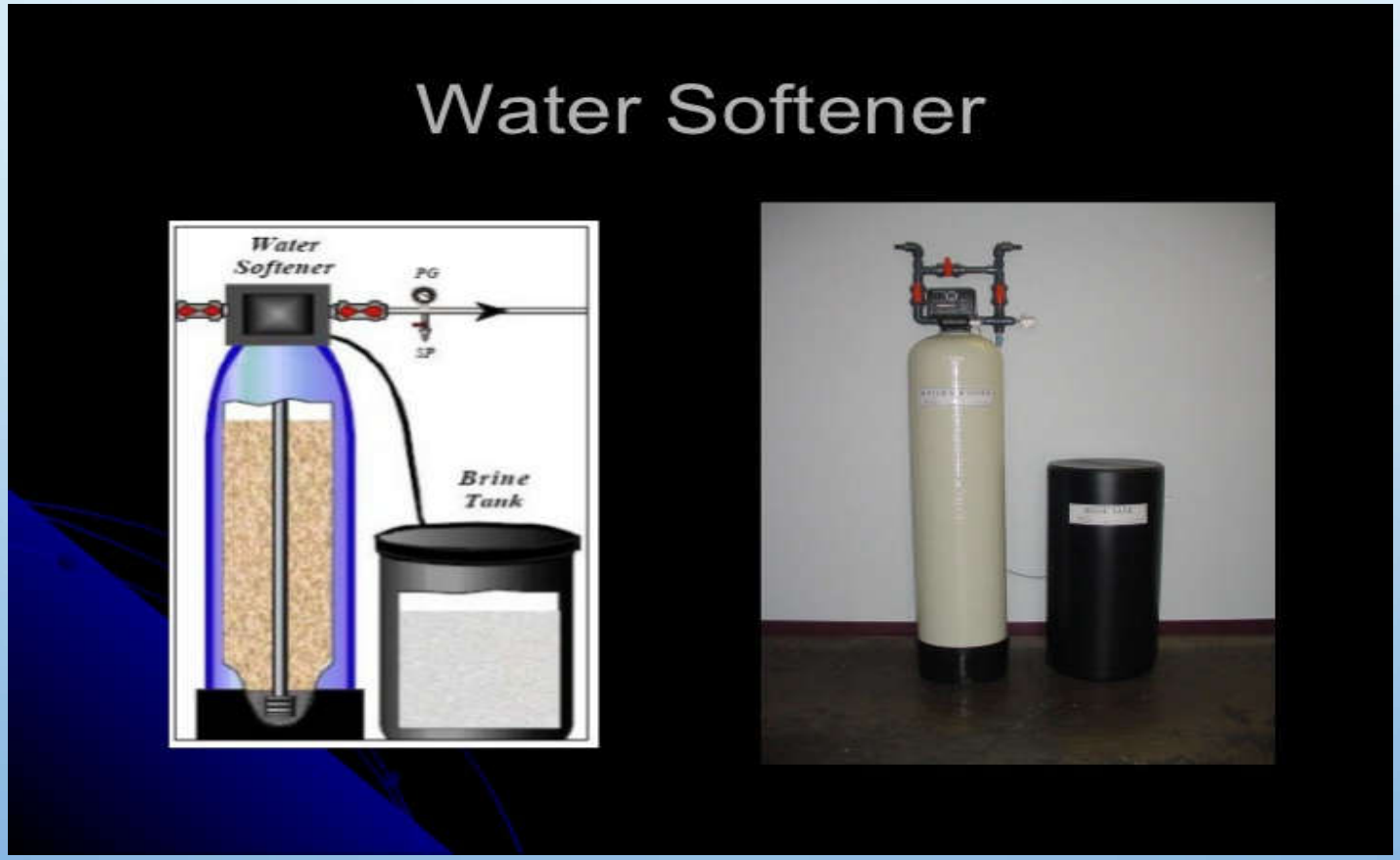

Pump


Temp.
Blend
Valve

WATER SOFTENER

- REMOVING CA AND MG BY EXCHANGE FOR NA BOUND IONICALLY TO A RESIN BED
- BACKWASHING AND REGENERATION OF RESINS

WATER SOFTNER



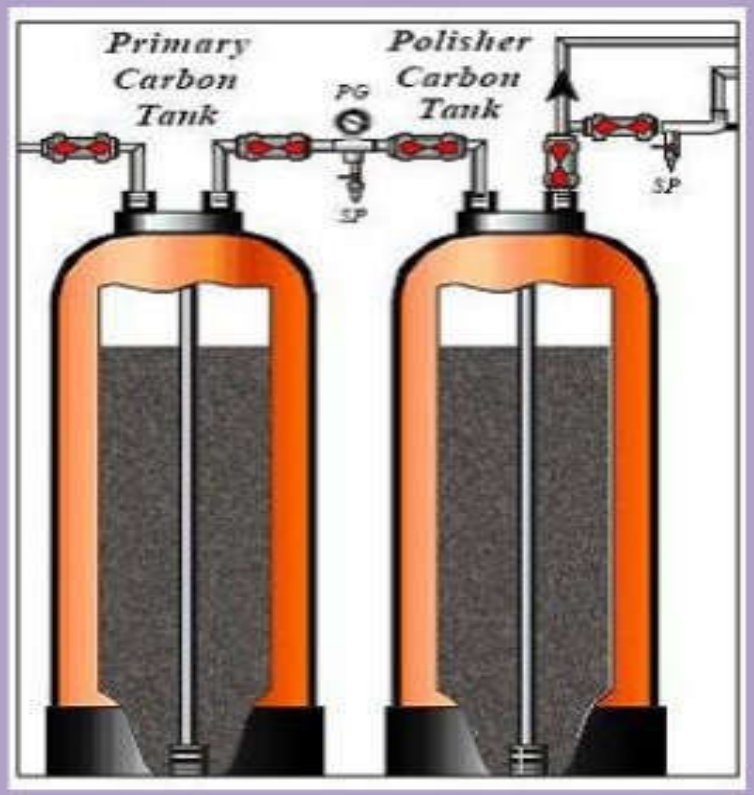
CARBON BEDS

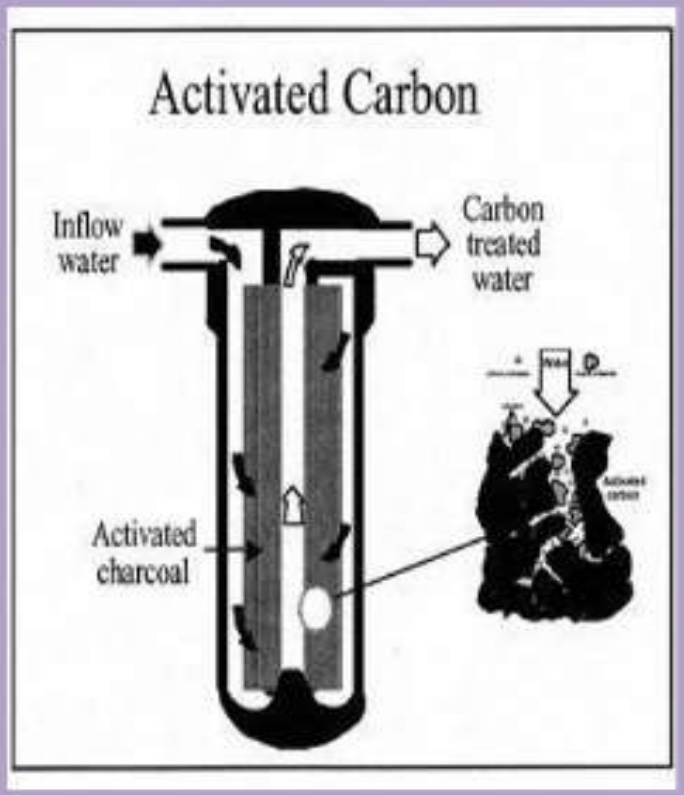
- REMOVING CHLORINE AND CHLORAMINE
- ORGANIC COMPOUNDS

- CHLORINE + ORGANIC COMOUNDS 

CANCER CAUSING COMPOUNDS

- CHLORINE  CHLORAMINE
- CHLORAMINE : HEMOLYTIC ANEMIA

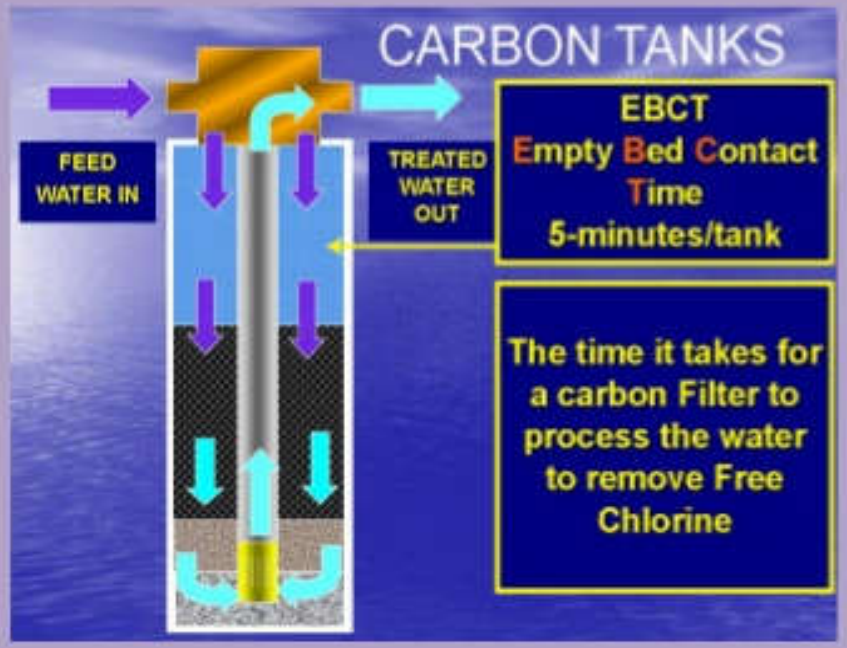

Primary
Carbon
Tank
PG
Polisher
Carbon
Tank
SP
SP


Activated Carbon
Inflow
water
Carbon
treated
water
Activated
charcoal

CARBON BEDS

Carbon Tank

- Removes chlorine and chloramine
- These are high level oxidative chemicals. They are added to municipal water systems to kill bacteria, but they also cause hemolysis



CARBON BEDS

- TOTAL CHLORINE LEVEL

CRITICAL ASPECT TO PROPER FUNCTIONING OF CARBON BEDS

- CONTACT TIME 10 MIN
- REGULAR BACKWASHING OF CARBON BEDS
- ADJUSTMENT OF THE PH OF THE FEED WATER
- CORROSION INHIBITORS

PRIMARY PURIFICATION PROCESS

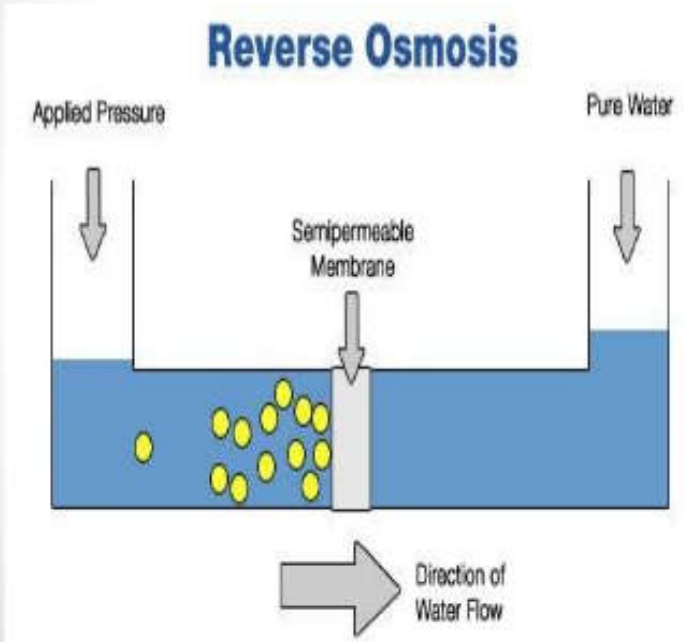
- REVERSE OSMOSIS
- DEIONIZATION

REVERSE OSMOSIS

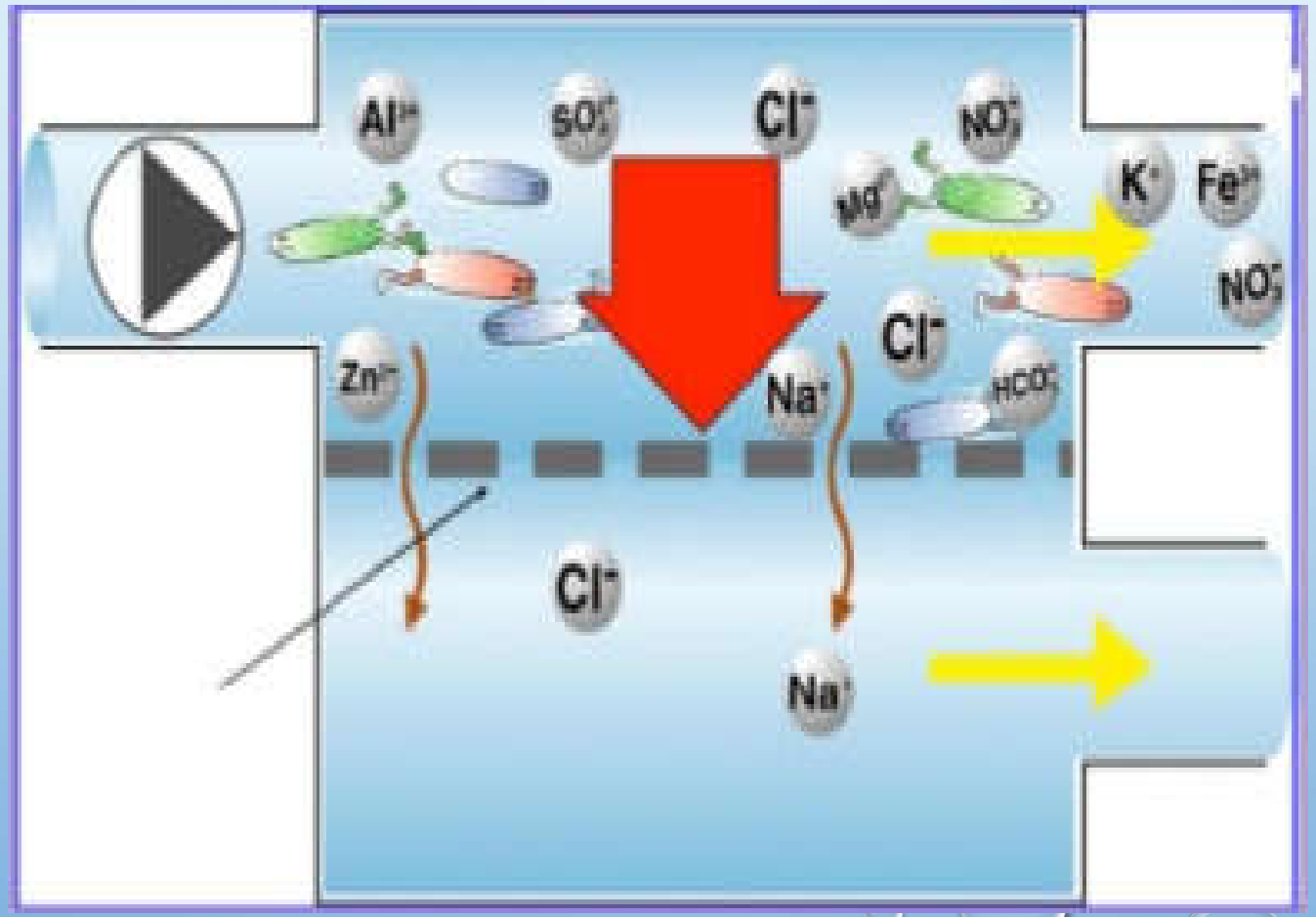
1000 LPH

REVERSE OSMOSIS

Primary purification process



REVERSE OSMOSIS



REVERSE OSMOSIS

- HIGH PRESSURE FILTRATION OF WATER THROUGH A SEMIPERMEABLE MEMBRANE
- DISSOLVED SOLUTES
- > 95%
- EFFECTIVE BARRIER AGAINST BACTERIA AND ENDOTOXINS

DEIONIZATION

- DO NOT REMOVE NONIONIC CONTAMINANTS , BACTERIA , ENDOTOXINS
- BOTH CATIONS AND ANIONS

DEIONIZATION

- **CATIONIC RESIN :**

SULFURIC GROUPS : H+ → NA, CA, AL.

- **ANIONIC RESIN** : AMMONIUM

OH- → CHLORIDE , PHOSPHATE, FLUORIDE.

- H+ + OH- → H2O

DEIONIZATION

- **MONITORING**

CONDUCTIVITY OF OUTFLOW WATER

DEIONIZATION

- LARGE SURFACE AREA FOR BACTERIAL PROLIFERATION

❖**ULTRAFILTER**

❖**UV LIGHT :** LIPOPOLYSACCHARIDE & PEPIDOGLYCAN

DISTRIBUTION OF PURIFIED WATER

- INERT MATERIAL : CHEMICAL CONTAMINANTS
- MICROBIAL CONTAMINANTS :
- APPROPRIATE DESIGNED PIPING SYSTEMS

DISINFECTION

DISTRIBUTION OF PURIFIED WATER

- LOOP
- NO MULTIPLE BANCHING AND DEAD ENDS
- STORAGE TANKS : MINIMUM SIZE , TIGHT LID , EASE OF DISINFECTION

DISTRIBUTION OF PURIFIED WATER

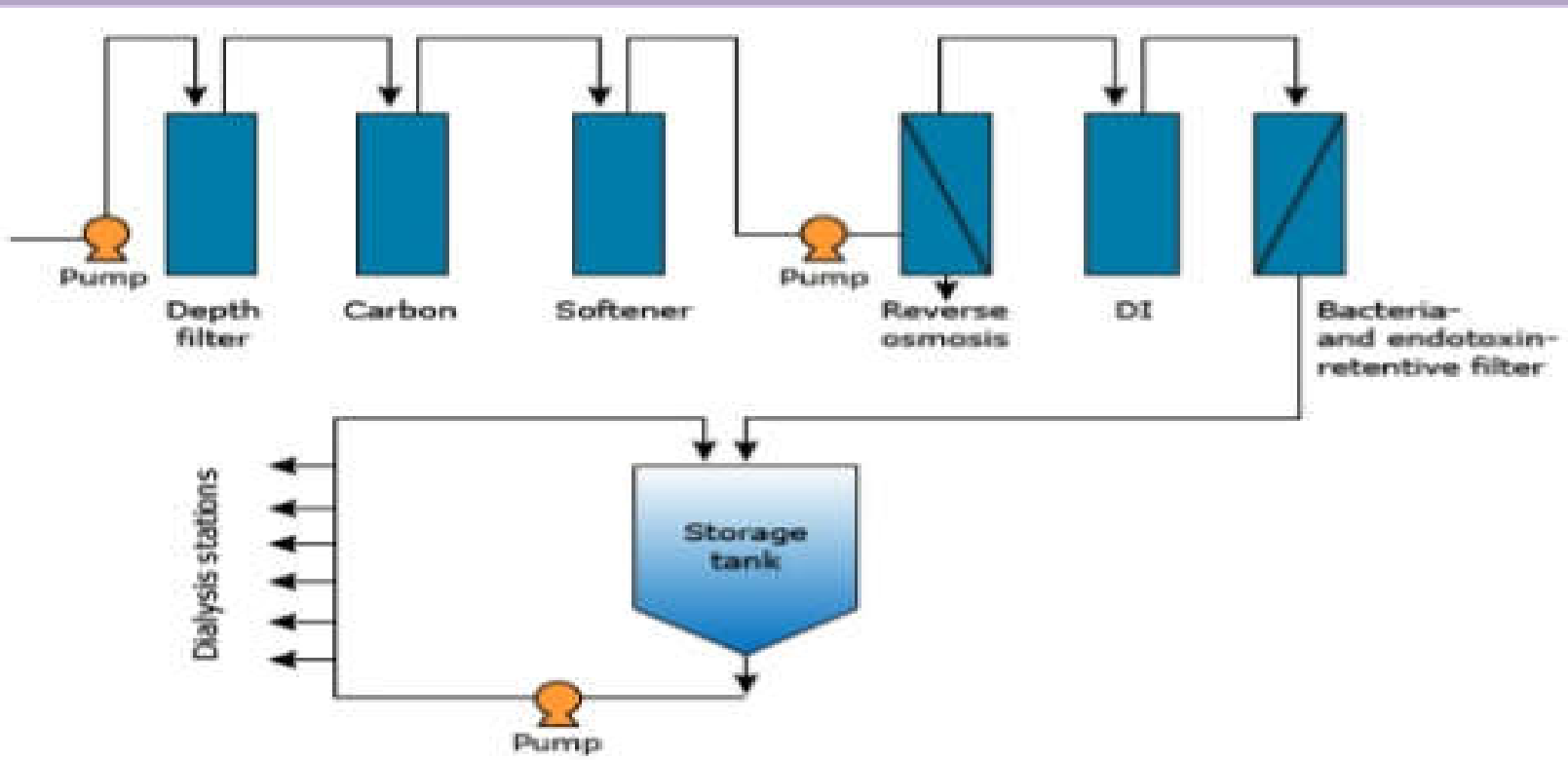
- ❖ REGULAR DISINFECTION

  CHEMICAL GERMICIDE : MONTHLY

  HOT WATER OR OZONE

- SOLUTION CULTURE
- ENDOTOXIN TESTS

Schematic diagram example of a water treatment system for hemodialysis



Purification Processes

Process	Contaminant
Carbon Adsorption	Chloramine, organics
Softener	Calcium, Mg
Reverse osmosis	Inoic contaminants, bacteria, endotoxin
Deionization	Ionic contaminants
Ultrafiltration	Bacteria, endotoxin

Testing of samples

sting of water samples shall be carried out by
ined and accredited persons or accredited
oratories.

e dialysis unit shall maintain records of persons
o have been trained and accredited and full
tails of accredited laboratories.

e records shall be maintained within the dialysis
t.

Sample collection

Water sample sites

Samples are to be taken at **outlets of the water distribution system**.

Prior to sampling, the inside of the outlet can be disinfected, especially if no hemodialysis machine is attached. The reason for such disinfection is that, over time, residual water in an outlet will support microbial growth. The disinfection can be made by flushing the inside of the **outlet with 70 % ethanol** or iso-propanol. A sterile cotton swab wetted with alcohol can also be used. Exposure time is to be >15 s.

It is sufficient to let out enough water to **rinse off the alcohol** (200 ml to 500 ml) prior to sampling.

Alternatively, hoses can be disconnected from the tap and the taps opened and allowed to flush for 2 min to 3 min before aseptically collecting a sample.

Sample for **cultivation and endotoxin analysis**: Sample volume 5 ml to 1,000 ml or volume a specified by the laboratory..

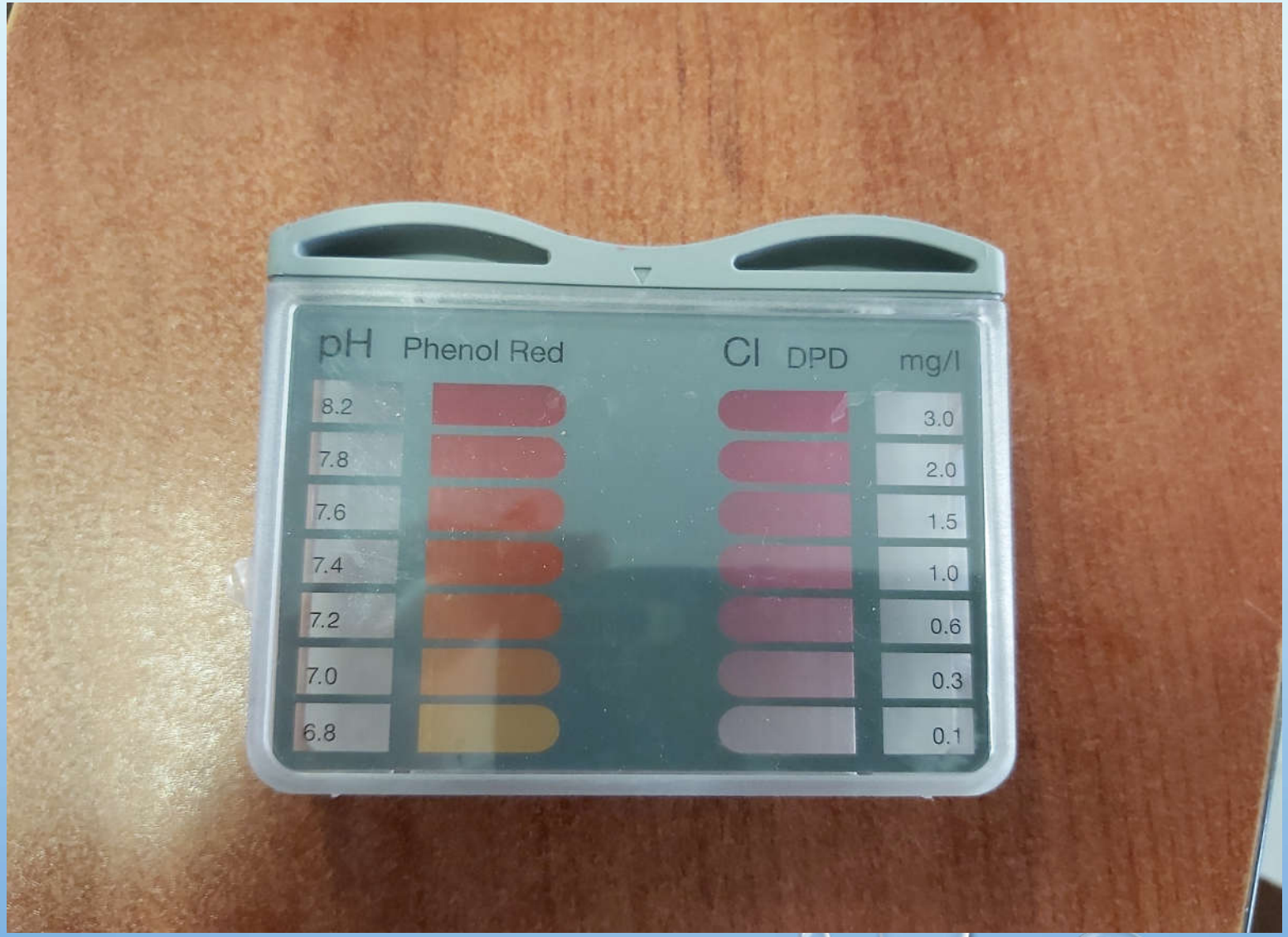
Storage of samples

Heterotrophic plate count

Storage of samples

Microbial analysis of water and dialysis fluid samples **should be conducte as soon as possible** after collection to avoid unpredictable changes in the microbial population. If samples cannot be analyzed within 4 h of collection, **follow the laboratory's instructions** for shipping. Samples intended for colony counts should not be frozen.

Storage of samples for **endotoxin** analysis may be different from what is given above, provided the complete procedure **follows the manufacturer's instructions** for use of the LAL assay.


pH
Phenol Red
Cl
DPD
mg/l
8.2
7.8
7.6
7.4
7.2
7.0
6.8
3.0
2.0
1.5
1.0
0.6
0.3
0.1


CHLORINE
FREE - DPD
55959 AB 5
Tear..Tear..
DPD No.1 DPD No.1
RAPID RAPID
DPD No.1 DPD No.1
RAPID RAPID
DPD No.1 DPD No.1
RAPID RAPID
DPD No.1
RAPID


VAHEB
Chemical company
TH
1
30 ml
VAHEB
Chemical company
TH
2
30 ml
VAHEB
Chemical Co.
10 ml

Water treatment unit

TDS, and conductivity daily

Microbiological culture and endotoxin assay. Monthly

Chemical assay every 6 months

Water treatment unit

- There is no limit for RO product TDS/conductivity.
- Values that are acceptable in one location may not be acceptable in another location.
- TDS in some areas of 50 ppm is acceptable and other areas where 10 ppm is NOT acceptable. It all depends on your raw water.
- A slight change in the amount of Fluoride injected into the water can cause the RO product water to go less than a 1 ppm TDS increase.

DIALYSIS SOLUTION PREPARATION

- **PROPORTIONING MACHINES**
  - FIXED VOLUMES OF DIALYSATE CONCENTRATE WITH FIXED VOLUME OF WATER
  - CONDUCTIVITY BASED SYSTEMS

DIALYSIS SOLUTION PREPARATION

- DUAL CONCENTRATE SYSTEM

BICARBONATE : PH 8.0

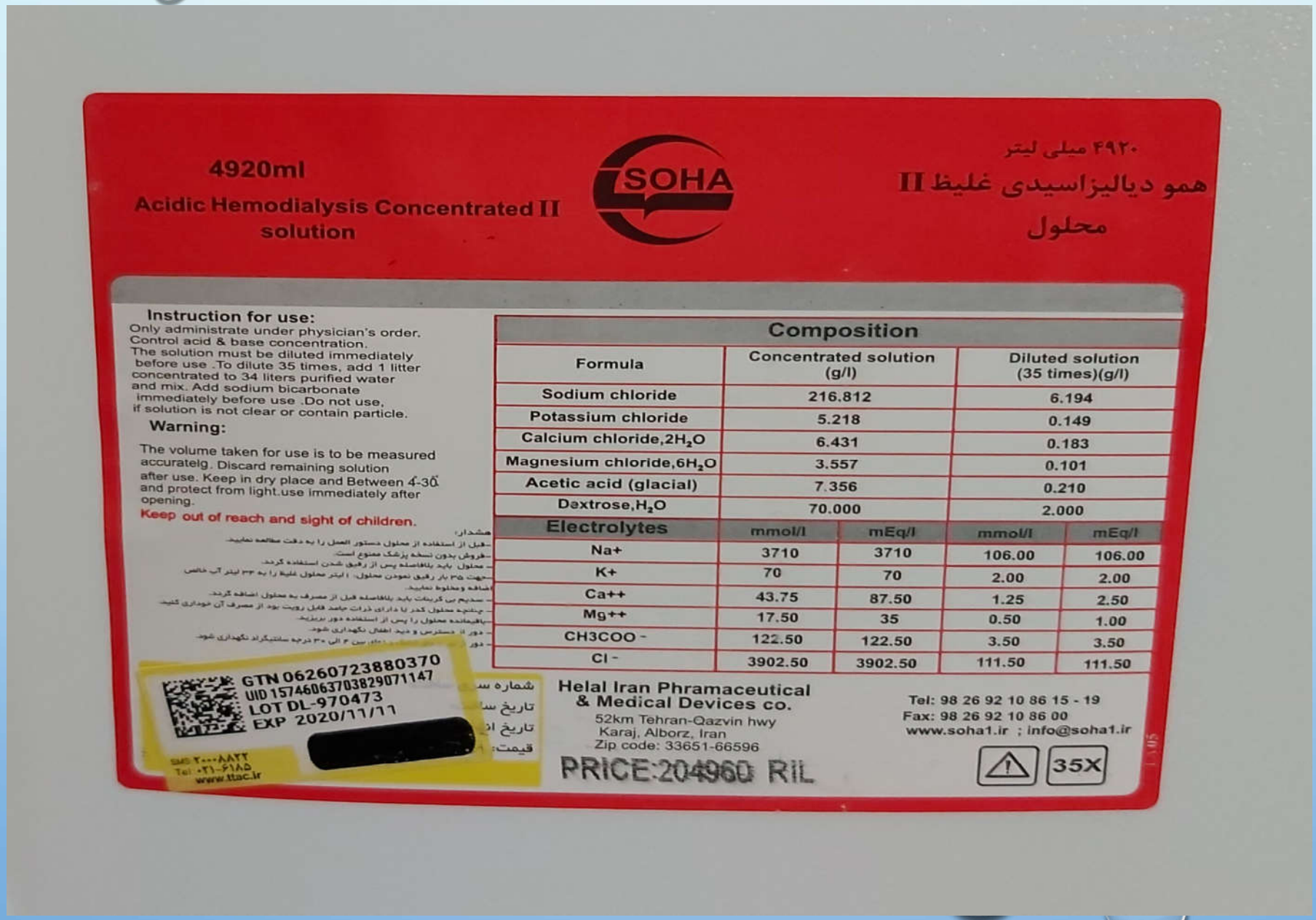
CA AND MG PRECIPITATION

- **2 CONCENTRATES** : BICARBONATE

ACID(CITRIC ACID OR ACETIC ACID)

DIALYSIS SOLUTION PREPARATION

BICARBONATE LEVEL ON THE MONITOR



4920ml

Acidic Hemodialysis Concentrated II solution

SOHA

۴۹۲۰ میلی لیتر

همو دیالیزاسیدی غلیظ II

محلول

Instruction for use:

Only administrate under physician's order.
Control acid & base concentration.
The solution must be diluted immediately before use .To dilute 35 times, add 1 litter concentrated to 34 liters purified water and mix. Add sodium bicarbonate immediately before use .Do not use, if solution is not clear or contain particle.

Warning:

The volume taken for use is to be measured accuratelg. Discard remaining solution after use. Keep in dry place and Between 4-30 and protect from light.use immediately after opening.

Keep out of reach and sight of children.

هشدار:

- قبل از استفاده از محلول دستور العمل را به دقت مطالعه نمایید.
- فروش بدون نسخه پزشک ممنوع است.
- محلول باید بلافاصله پس از رقیق شدن استفاده گردد.
- جهت ۳۵ بار رقیق نمودن محلول، ۱ لیتر محلول غلیظ را به ۳۴ لیتر آب خالص اضافه و مخلوط نمایید.
- سدیم بی کربنات باید بلافاصله قبل از مصرف به محلول اضافه گردد.
- چنانچه محلول کدر یا دارای ذرات جامد قابل رویت بود از مصرف آن خودداری کنید.
- باقیمانده محلول را پس از استفاده دور بریزید.
- دور از دسترس و دید اطفال نگهداری شود.
- دور [illegible] بین ۴ الی ۳۰ درجه سانتیگراد نگهداری شود.

Composition

Formula	Concentrated solution (g/l)		Diluted solution (35 times)(g/l)	
Sodium chloride	216.812		6.194	
Potassium chloride	5.218		0.149	
Calcium chloride,$2H_2O$	6.431		0.183	
Magnesium chloride,$6H_2O$	3.557		0.101	
Acetic acid (glacial)	7.356		0.210	
Dextrose,H_2O	70.000		2.000	
Electrolytes	**mmol/l**	**mEq/l**	**mmol/l**	**mEq/l**
Na+	3710	3710	106.00	106.00
K+	70	70	2.00	2.00
Ca++	43.75	87.50	1.25	2.50
Mg++	17.50	35	0.50	1.00
CH3COO -	122.50	122.50	3.50	3.50
Cl -	3902.50	3902.50	111.50	111.50

GTN 06260723880370
UID 15746063703829071147
LOT DL-970473
EXP 2020/11/11

شماره س
تاریخ س
تاریخ ا
قیمت:

Helal Iran Phramaceutical & Medical Devices co.
52km Tehran-Qazvin hwy
Karaj, Alborz, Iran
Zip code: 33651-66596

Tel: 98 26 92 10 86 15 - 19
Fax: 98 26 92 10 86 00
www.soha1.ir ; info@soha1.ir

PRICE:204960 RIL

35X

FLUID DIALYSIS SOLUTION COMPOSITION

- NA SODIUM PROFILING
- K
- CA
- BICARBONATE

FLUID DIALYSIS SOLUTION COMPOSITION

DIALYSIS SOLUTION CALCIUM LEVELS

- **ACUTE DIALYSIS** : 3-3.5 MEQ/L
- CA< 3 → HYPOTENSION DURING DIALYSIS
- PREDIALYSIS HYPOCALCEMIA : ACIDOSIS CORRECTION →

  LOWERING CA LEVEL → SEIZURE

  ↑ QT DISPERSION

DIALYSIS SOLUTION CALCIUM LEVELS

- CHRONIC DIALYSIS : 2.5 MEQ/L

DIALYSIS SOLUTION CALCIUM LEVELS

- DIALYTIC TREATMENT OF ACUTE HYPERCALCEMIA

ADDING 2.5 MEQ/L CALCIUM TO THE HEMODIALYSIS SOLUTION TO PREVENT RAPID DECREASE IN IONIZED CALCIUM LEVEL

❖FREQUENT MEASUREMENT AND P/CA DURING DIALYSIS

DIALYSIS SOLUTION POTASSIUM LEVEL

- ACUTE DIALYSIS : 2-4.5 MEQ/L
- PREDIALYSIS K < 4.5 MEQ/L → DIALYSIS SOLUTION K≥ 4 MEQ/L
- PREDIALYSIS K > 5.5 MEQ/L → DIALYSIS SOLUTION K 2 MEQ/L
- AT RISK OF ARRYTHMIA OR DIGOXIN → DIALYSIS SOLUTION K 2.5-3.5 MEQ/L
- PREDIALYSIS K > 7 MEQ/L → DIALYSIS SOLUTION K < 2 MEQ/L

DIALYSIS SOLUTION POTASSIUM LEVEL

- CHRONIC DIALYSIS : 2MQ/L
- EXCEPTION : USUAL PREDIALYSIS PLASMA K < 4.5 MQ/L(MALNOURISHED PATIENTS)

DIGOXIN

: DIALYSIS K 3 MQ/L

BUT : INTERDIALYSIS PLASMA K MEASUREMENT : ? KAYEXALATE

DIALYSIS SOLUTION SODIUM LEVEL

- **ACUTE DIALYSIS : 145 MQ/L**
- HYPONATREMIA : PREDIALYSIS NA < 130

MINIMUM NA & SLOW BFR(50-100) & NO LONGER THAN 1 HOUR & CHECK NA 30-60 MIN

OR DELAY DIALYSIS

- HYPONATREMIA : PREDIALYSIS NA > 130

NA:< 10 MQ/L ABOVE SERUM NA

NA: 140-145MQ/L

DIALYSIS SOLUTION SODIUM LEVEL

- HYPERNATREMIA
- DIALYSIS : DANGEROUS
- MAXIMUM : 3-5 MQ/L

DIALYSIS SOLUTION SODIUM LEVEL

- CHRONIC DIALYSIS :
- 135-145 MEQ/L
- > 138 : THIRST
- < 135: HYPOTENSION

NA PROFILING

- THE SODIUM CONCENTRATION IN THE DIALYSIS FLUID, INSTEAD OF BEING CONSTANT, FOLLOWS A TIME-DEPENDENT PROFILE OVER THE COURSE OF A HEMODIALYSIS SESSION.
- AVOID OSMOTIC DISEQUILIBRIUM BY KEEPING PLASMA OSMOLALITY IN THE PHYSIOLOGICAL RANGE.
- REDUCTION IN THE INCIDENCE OF MUSCLE CRAMPS, IMPROVED SODIUM REMOVAL, AND IMPROVED VASCULAR STABILITY.

NA PROFILING

- THERE CAN BE NEGATIVE CONSEQUENCES TO A HIGH DIALYSATE SODIUM CONCENTRATION.
- SODIUM CAN ACCUMULATE IN THE PATIENT : INCREASED POST-DIALYSIS THIRST, INCREASED INTERDIALYTIC WEIGHT GAIN AND THE DEVELOPMENT OF HYPERTENSION.
- SVS WAS DEVELOPED TO ACHIEVE THE BENEFITS OF HIGH PLASMA SODIUM LEVELS WHILE AT THE SAME TIME AVOIDING UNNECESSARY HIGH INTRADIALYTIC SODIUM UPTAKE BY THE PATIENT .

DIALYSIS SOLUTION BICARBONATE LEVEL

- **ACUTE DIALYSIS**
- DIALYSIS MACHINES : FIXED : BICARBONATE : 32 MEQ/L

  CHANGEABLE : BICARBONATE : 20 MEQ/L

❖4-8 MEQ/L

DIALYSIS SOLUTION BICARBONATE LEVEL

- **ACIDOSIS :**

METABOLIC : BICARBONATE < 10MEQ/L : 20-25 (SERUN BICARBONATE : 15-20)

RESPIRATORY : HIGHER BICARBONATE RANGE

DIALYSIS SOLUTION BICARBONATE LEVEL

- ACUTE DIALYSIS :
- ALKALOSIS:

METABOLIC: SERUM BICARBONATE >28 : DIALYSIS BICARBONATE : LOW : 20-28

RESPIRATORY : DIALYSIS BICARBONATE : 15-20

DIALYSIS SOLUTION BICARBONATE LEVEL

- CHRONIC DIALYSIS :
- GOAL : SERUM BICARBONATE : 20-23

ACID : ACETATE : BICARBONATE : 32 + 4

CITRATE : BICARBONATE : 28+ 8

Water treatment for HD Unit

DR Samir Sally, MD

Consultant Internal Medicine & Nephrology,

MUNC, Mansoura University, Egypt

THANK YOU