

# Best Service Technology

## Water Solutions & Equipment's

Cooling Towers – Chillers – Boilers - RO technology





# **COOLING WATER TREATMENT**

- **PURPOSE OF COOLING WATER: REMOVAL OF EXCESS HEAT FROM PROCESS**



# **WHY WATER AS A COOLING MEDIUM?**

- **ABUNDANTLY AVAILABLE**
- **HIGH SPECIFIC HEAT AND THERMAL  
CONDUCTIVITY**
- **MODERATE SPECIFIC GRAVITY AND  
VISCOSITY**

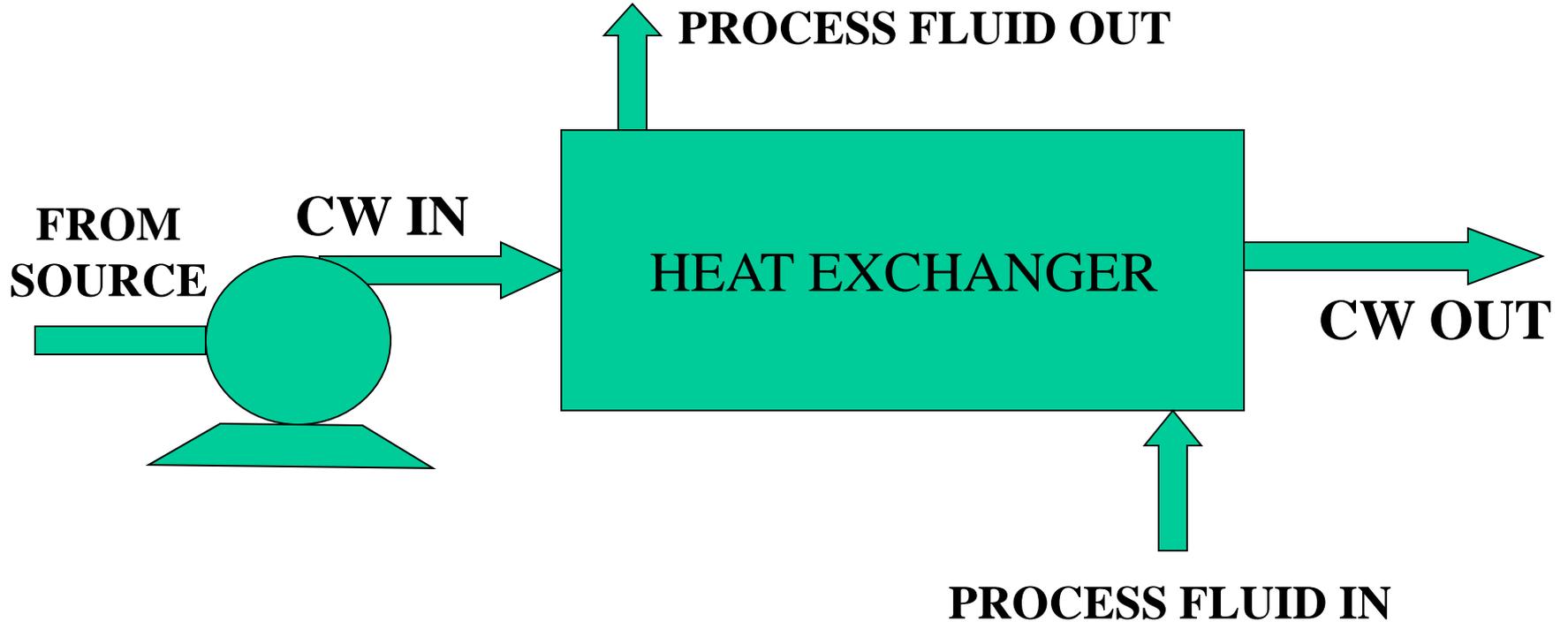


# **TYPES OF COOLING WATER SYSTEMS**

- **ONCE THROUGH**
- **OPEN RECIRCULATORY**
- **CLOSED RECIRCULATORY**

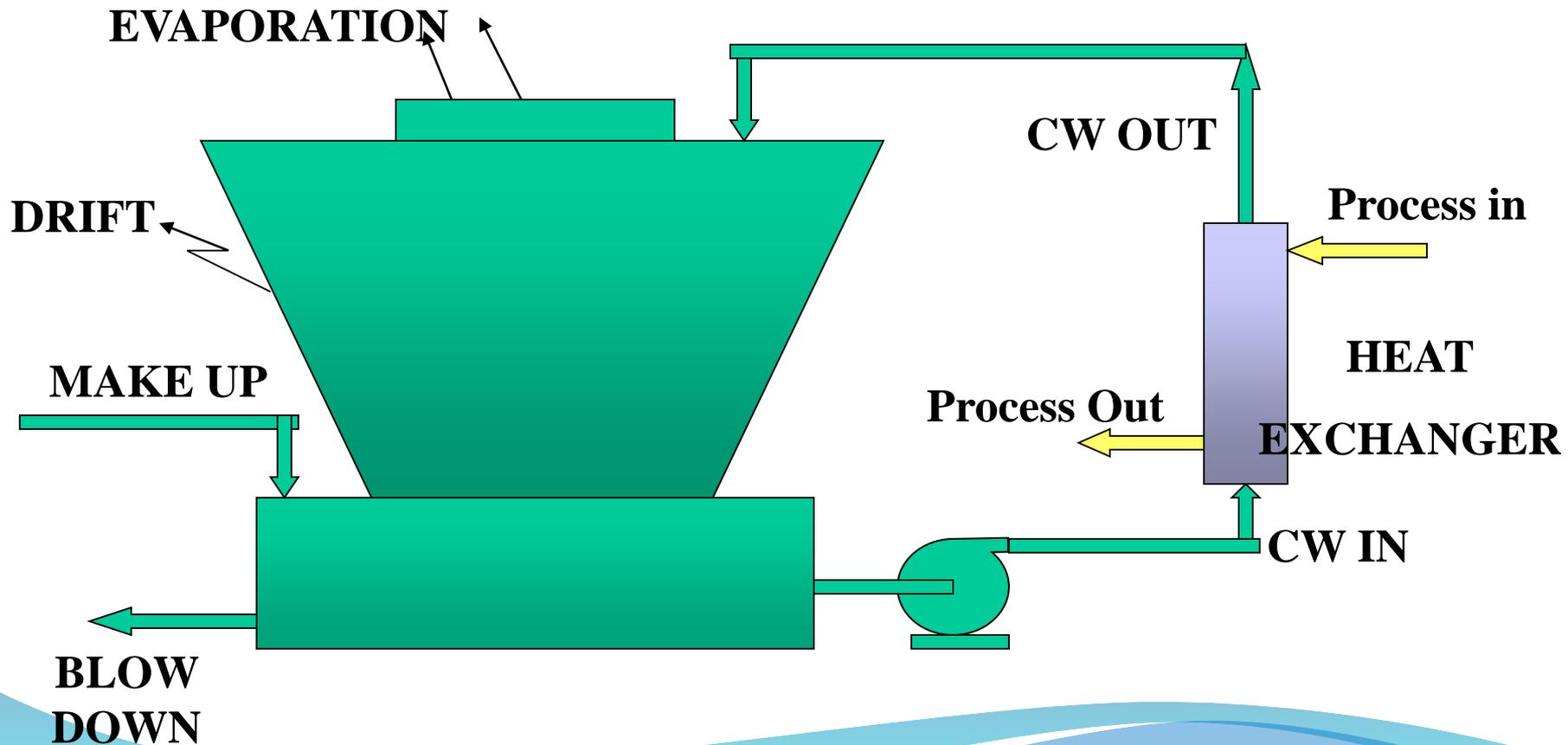


# ONCE THROUGH SYSTEM



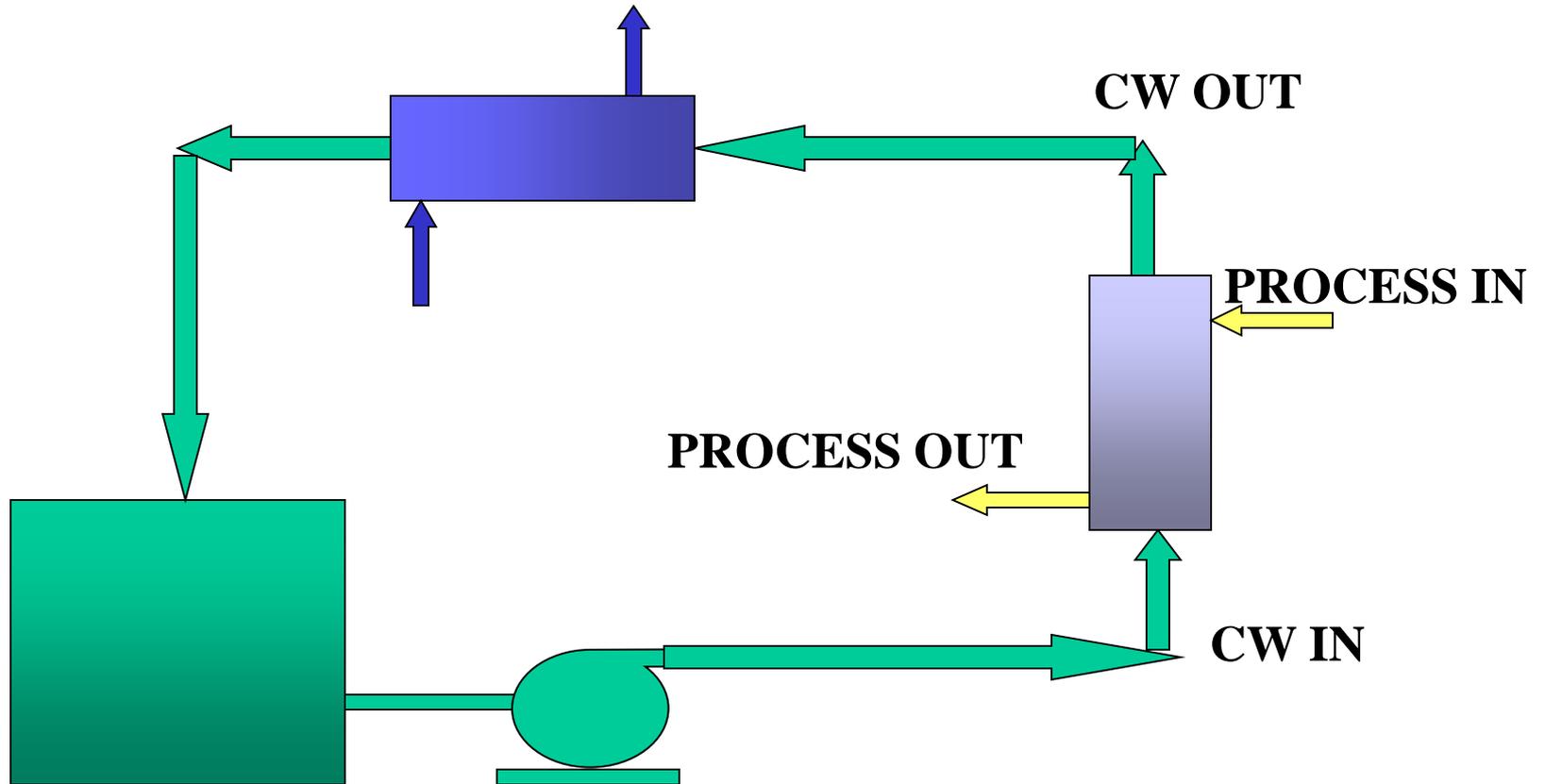


# OPEN RECICULATORY SYSTEM





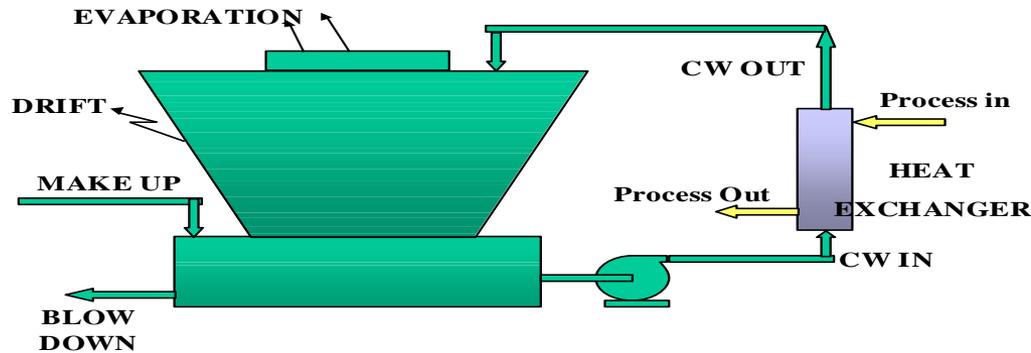
# CLOSED RECIRCULATORY SYSTEM





# OPEN RECIRCULATORY SYSTEM CALCULATIONS

## OPEN RECICULATORY SYSTEM



- $E = R \times \Delta T(\text{deg C}) \times 1.8 / 1000$
- $C = \frac{TH \text{ in C.W.}}{TH \text{ in M.W.}}$
- $M = E + B + W$
- $B + W = E / (C - 1)$



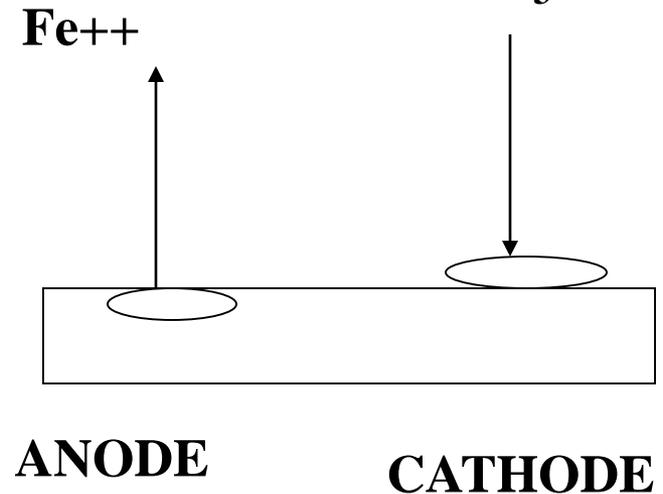
# **PROBLEMS IN COOLING WATER SYSTEMS**

- **CORROSION**
- **SCALING**
- **FOULING**
- **MICROBIOLOGICAL GROWTH**

# CORROSION

- **ELECTROCHEMICAL REACTION**
- **REQUIRES:**
- **CATHODE**
- **ANODE**
- **ELECTROLYTE**

- **CORROSION REACTION**  
 $\text{Fe}(\text{OH})_3$





# **FACTORS AFFECTING CORROSION**

- **pH → Low → Corrosion High**
- **DISSOLVED GASES : O<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>S, Cl<sub>2</sub>**
- **DISSOLVED SOLIDS --> High --> Corrosion High**
- **TEMPERATURE --> High --> Corrosion High**
- **WATER VELOCITY**
- **SUSPENDED SOLIDS**
- **MICROBIOLOGICAL GROWTH**



# **SCALING**

- **PRECIPITATION AND DEPOSITION OF SPARINGLY SOLUBLE SALTS**
- **EXAMPLES : CARBONATES, SULFATES, PHOSPHATES OF Ca & Mg ; PHOSPHATE OF IRON; OXIDES AND HYDROXIDES OF OF IRON AND MANGANESE; SILICATES**



# **FACTORS AFFECTING SCALING**

- **pH → HIGH → SCALING HIGH**
- **TEMPERATURE**
- **CONCENTRATION OF SCALE FORMING SALTS**
- **WATER VELOCITY**



# **FOULING**

- **DEPOSITION OF SUSPENDED PARTICLES**
- **EXAMPLES : DIRT, INSOLUBLE SILICA, SILT**



# **FACTORS AFFECTING FOULING**

- **SUSPENDED SOLIDS**
- **WATER VELOCITY**
- **MICROBIOLOGICAL GROWTH**



# **MICROBIOLOGICAL GROWTH**

- **ALGAE**
- **FUNGII**
- **BACTERIA**



## **ALGAE**

- **GREEN GROWTH SEEN ON OPEN AREAS**
- **REQUIRES SUNLIGHT**
- **GROWS ON THE DECK AND LOUVERS**
- **CHOKES DISTRIBUTION NOZZLES**  
**CAUSING REDUCTION IN WATER FLOW**
- **INCREASES LOAD ON COOLING TOWER**



## **FUNGII**

- **GROWS ON WOODEN STRUCTURE**
- **REQUIRES CARBONACEOUS MATERIAL**
- **WEAKENS WOODEN STRUCTURE OF COOLING TOWER**



# **BACTERIA**

- **MAIN TYPES :**

- 1. AEROBIC**

- 2. ANAEROBIC**



# **AEROBIC BACTERIA**

- **REQUIRE OXYGEN FOR SURVIVAL AND GROWTH**
- **REFLECTED IN TPC ANALYSIS**
- **SECRETE SLIME CAUSING FOULING**



# **AEROBIC BACTERIA IN COOLING WATER SYSTEMS**

- **PSEUDOMONAS**
- **NITROBACTOR**
- **IRON OXIDISERS**



# **PSEUDOMONAS**

- **GIVE RISE TO VOLUMINOUS BIOMASS**
- **SECRETE SLIME CAUSING FOULING**



# **NITROBACTOR**

- **OXIDIZE AMMONIA TO NITRIC AND NITROUS ACID REDUCING pH**
- **RESULTS IN HEAVY CORROSION**
- **CAN SURVIVE UPTO 5.5 pH**



## **IRON OXIDIZERS**

- **DIRECTLY ATTACK STEEL SURFACE**
- **CAUSE SEVERE CORROSION**  
**(PITTING)**



# **ANAEROBIC : SULFATE REDUCING BACTERIA**

- **REDUCE  $\text{SO}_4$  IONS TO  $\text{H}_2\text{S}$**
- **$\text{H}_2\text{S}$  CAUSES DIRECT CORROSION OF METAL**
- **PITTING CORROSION CAUSED DUE TO SRB CONTINUES UNDER DEPOSITS**



# **TREATMENT PROGRAMS**

- **CORROSION CONTROL**
- **SCALE CONTROL**
- **FOULING CONTROL**
- **MICROBIOLOGICAL GROWTH CONTROL**



# CORROSION CONTROL

- **BASIC PRINCIPLE: PREVENT THE ELECTROCHEMICAL REACTION OF CORROSION**



# **CORROSION INHIBITORS**

- **ANODIC**
- **CATHODIC**
- **GENERAL**



## **ANODIC INHIBITORS**

- **FORM PROTECTIVE LAYER ON ANODIC SURFACE**
- **CHROMATE, NITRITE, MOLYBDATE, ORTHOPHOSPHATE**
- **LOWER THAN REQUIRED DOSAGE GIVES RISE TO SEVERE PITTING**



# **CATHODIC INHIBITORS**

- **FORM PROTECTIVE LAYER ON CATHODIC SURFACE**
- **METAPHOSPHATE, SILICATES, ZINC, BICARBONATES**
- **LOWER THAN REQUIRED DOSAGE GIVES RISE TO GENERAL TYPE OF CORROSION**



# **GENERAL INHIBITORS**

- **FORM PROTECTIVE LAYER ON SURFACES  
IRRESPECTIVE OF ANODE OR CATHODE**
- **PHOSPHONATES, AZOLES, SPECIFIC  
POLYMERS**
- **SHOULD BE USED IN CONJUNCTION WITH  
OTHER INHIBITORS**



## **SYNERGESTIC EFFECT**

- **USING TWO DIFFERENT TYPES OF INHIBITORS GIVES MUCH BETTER PROTECTION**



# **SCALE INHIBITORS**

- **SEQUESTRATION**
- **THRESHOLD INHIBITION**
- **CRYSTAL DISTORTION**
- **DISPERSION**



# **SEQUESTRATION**

- **CHEMICALLY COMBINE TO FORM WATER SOLUBLE COMPLEX**
- **VERY HIGH CONCENTRATION REQUIRED**



## **THRESHOLD INHIBITION**

- **ALLOW HIGH CONC OF SCALE FORMING SALT WITHOUT PRECIPITATION**
- **ADSORPTION ON NUCLEUS OF SCALE FORMING CRYSTAL & PREVENTING ITS GROWTH**
- **VERY LOW DOSE POSSIBLE**



# **CRYSTAL DISTORTION**

- **ADSORPTION ON ALREADY FORMED CRYSTAL**
- **CAN NOT FORM COMPACT SCALE**
- **SCALE EASILY REMOVED BY WATER VELOCITY**
- **LOW DOSAGE**



# **DISPERSION**

- **KEEPING PARTICLES IN SUSPENDED FORM**



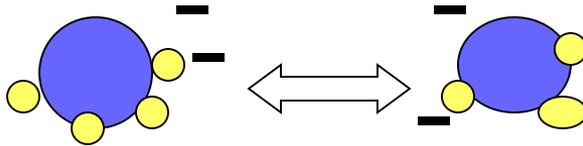
## **ANTISCALANTS**

- **POLYPHOSPHATES: UNSTABLE, FOOD FOR MICROBES**
- **PHOSPHONATES: STABLE, HIGHLY EFFECTIVE, DO NOT PROMOTE MICROBIAL GROWTH**
- **DISPERSANTS: STABLE, HIGHLY EFFECTIVE, DO NOT PROMOTE MICROBIAL GROWTH, DISPERSION**



# ANTIFOULANTS

- **DISPERSION OF SUSPENDED PARTICLES**



- **LOW MOLECULAR WEIGHT POLYMERS**



# **MICROBIOLOGICAL CONTROL**

- **MICROBIOCIDES**
- **BIO-DISPERSANTS**



# **MICROBIOCIDES**

- **OXYDIZING**
- **NON-OXYDIZING**

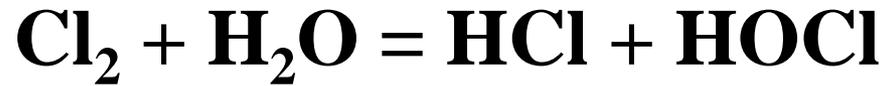


# **OXYDIZING BIOCIDES**

- **OXIDIZE THE CELL MATERIAL**
- **MICROBES CAN NOT GET IMMUNED**
- **LACK OF PENETRATING POWER**
- **CHLORINE, BROMINE, OZONE**



# ACTION OF OXIDIZING BIOCIDES





# **NON-OXIDIZING BIOCIDES**

- **DIFFERENT COMPOUNDS HAVE DIFFERENT MODES OF ACTION**
- **INTERFERRING WITH ENERGY TRANSFER MECHANISM**
- **CELL RUPTURE**
- **INTERFERRING WITH METABOLISM REACTIONS**

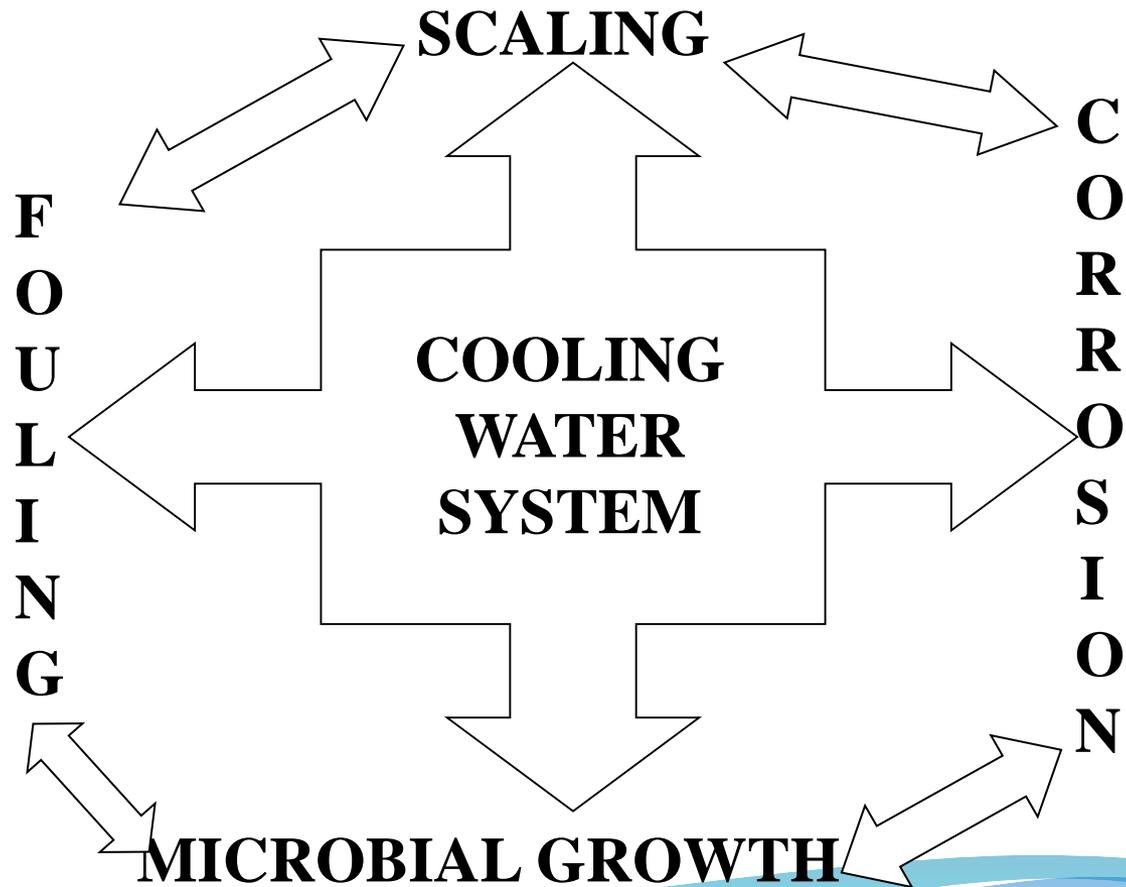


# **NON-OXIDIZING BIOCIDES**

- **QUATERNARY AMINES**
- **ALDEHYDES**
- **ISOTHIAZOLINES**
- **METHYLENE BIS THIOCYANATE**



# **COMPLETE TREATMENT PROGRAM**





# **PRODUCTS FOR COOLING WATER TREATMENT**

- **CORROSION/ SCALE INHIBITORS**
- **CORROSION INHIBITORS**
- **ANTISCLANTS**
- **DISPERSANTS**
- **MICROBIOCIDES**
- **SPECIFIC PRODUCTS**



# **SPECIFIC PRODUCTS**

- **TAILORMADE SPECIAL  
FORMULATIONS**