First ESCO

Heat Exchanger Anti Fouling systems

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What is fouling in Heat Exchangers

Fouling is the accumulation of unwanted material on solid surfaces of heat exchanger tubes affecting the heat transfer

Heat Exchanger Fouling – Why we should be Concerned

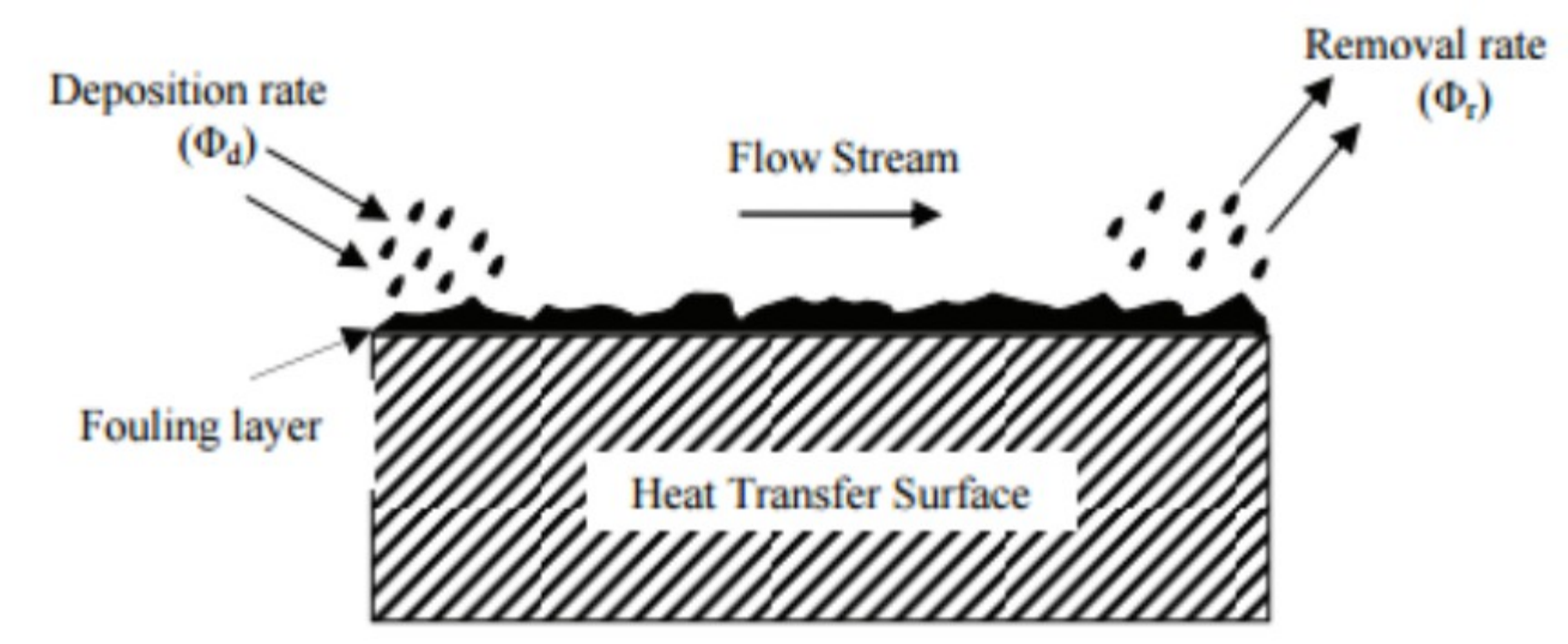
- Increased capital cost due to Over sizing exchangers by 20 to 50%
- Energy Losses due to higher pressure drop
- Energy Loss due to higher fuel consumption
- Increased cost of Maintenance due to frequent cleaning of exchangers
- Production Losses due to planned and unplanned shut downs

Cost of Heat Exchanger Fouling

Country	Fouling Costs (million $)	Fouling Cost /GNP %
US	14175	0.25
UK	2500	0.25
Germany	4875	0.25
France	2400	0.25
Japan	10000	0.25
Australia	463	0.15
New Zealand	64.5	0.15

As per 1992 Estimates

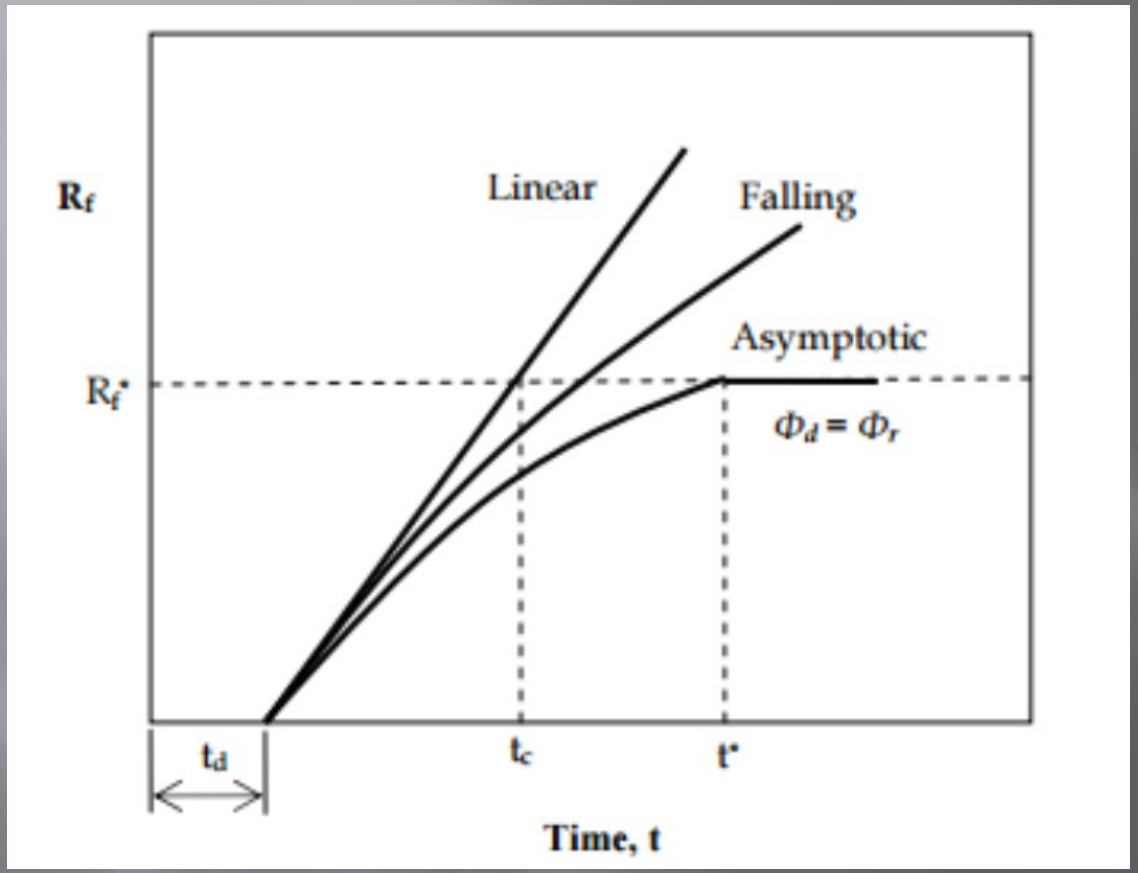
Heat Exchanger Fouling - PROCESS



$$R_f = \Phi_d - \Phi_r$$

The fouling factor, R_f

Heat Exchanger Fouling - PROCESS



Linear

Φ_d = constant, $\Phi_r \approx 0$

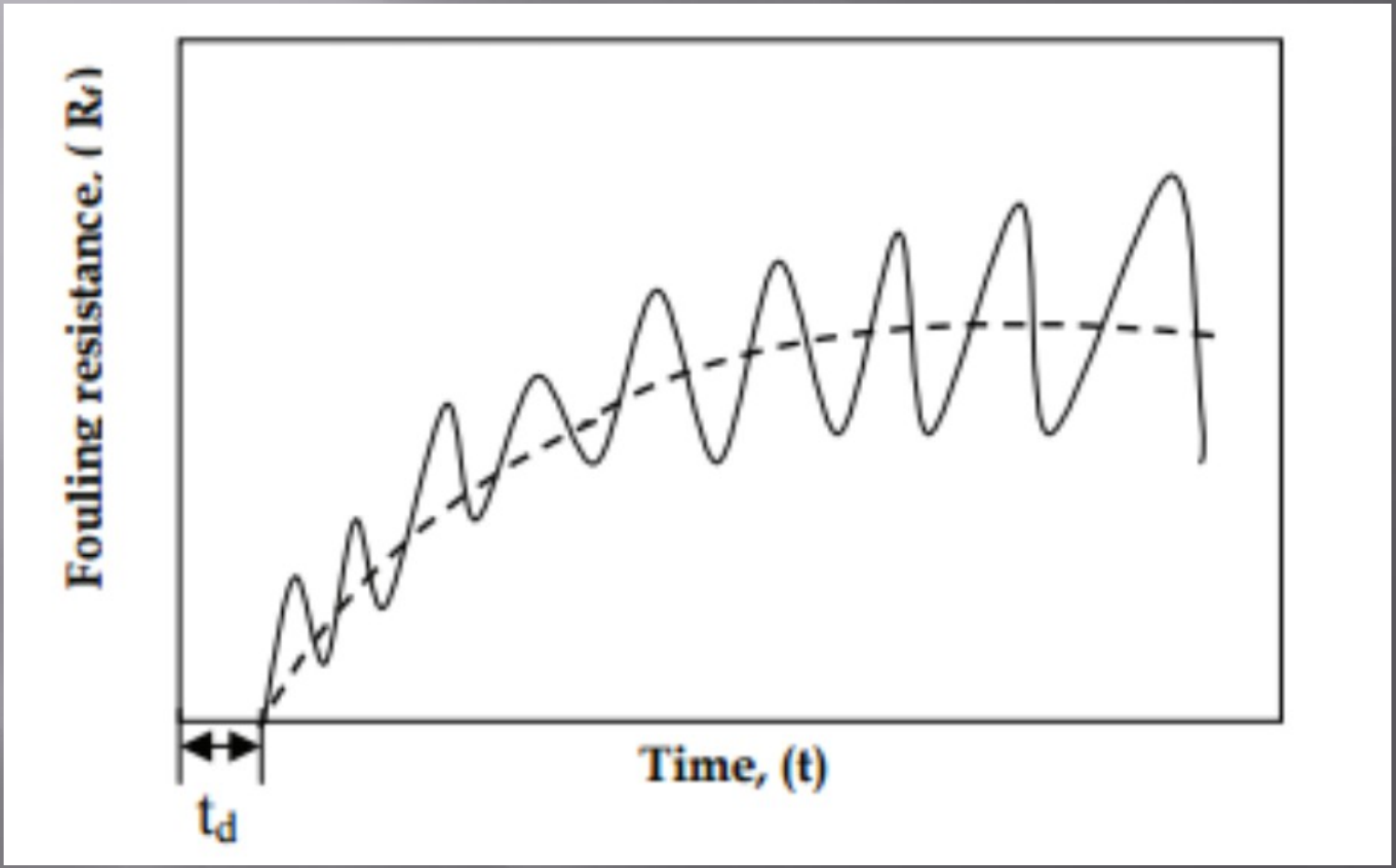
Falling

$\Phi_d - \Phi_r$ = constant

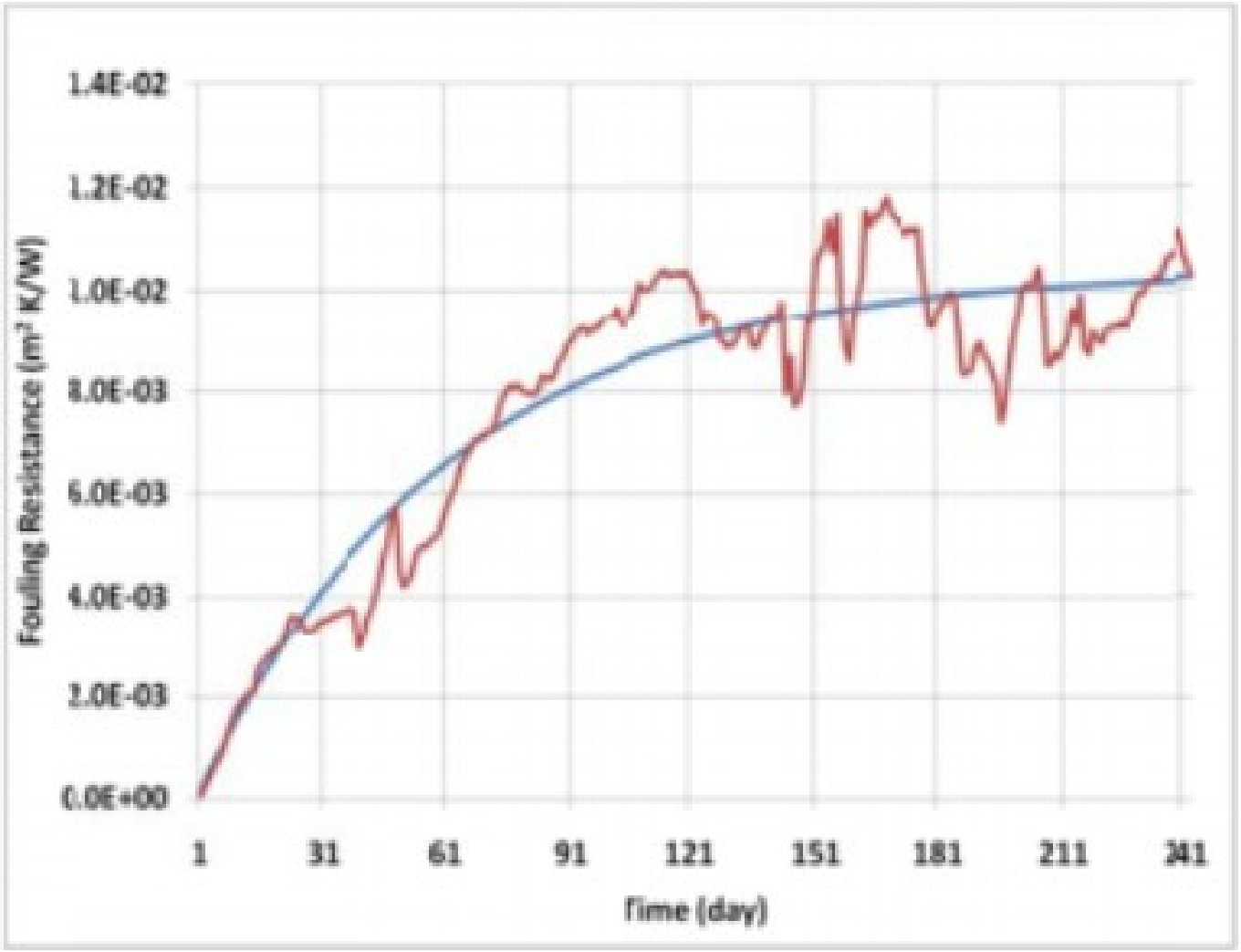
Asymptotic

$\Phi_d = \Phi_r$

Heat Exchanger Fouling - PROCESS



Typical Fouling Curve



Fouling Factor Estimation

$R_d = 1 / U_d - 1 / U \quad (1)$

where

R_d = *fouling factor - or unit thermal resistance of the deposit* (m^2K/W)

U_d = *thermal conductance of heat exchanger after fouling* (W/m^2K)

U = *thermal conductance of clean heat exchanger* (W/m^2K)

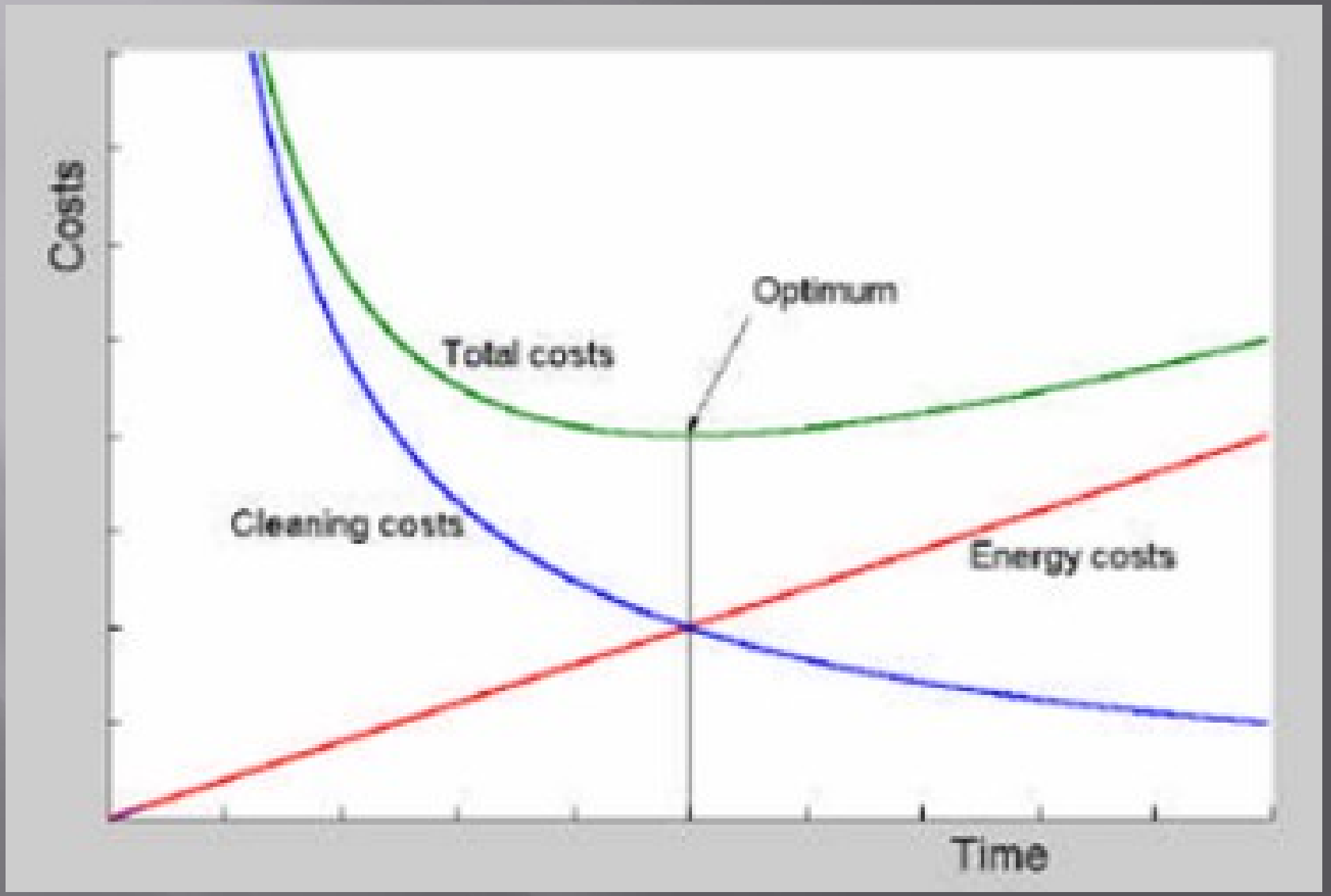
$$U_d = 1 / (R_d + 1 / U)$$

Effect of Fouling on heat Transfer

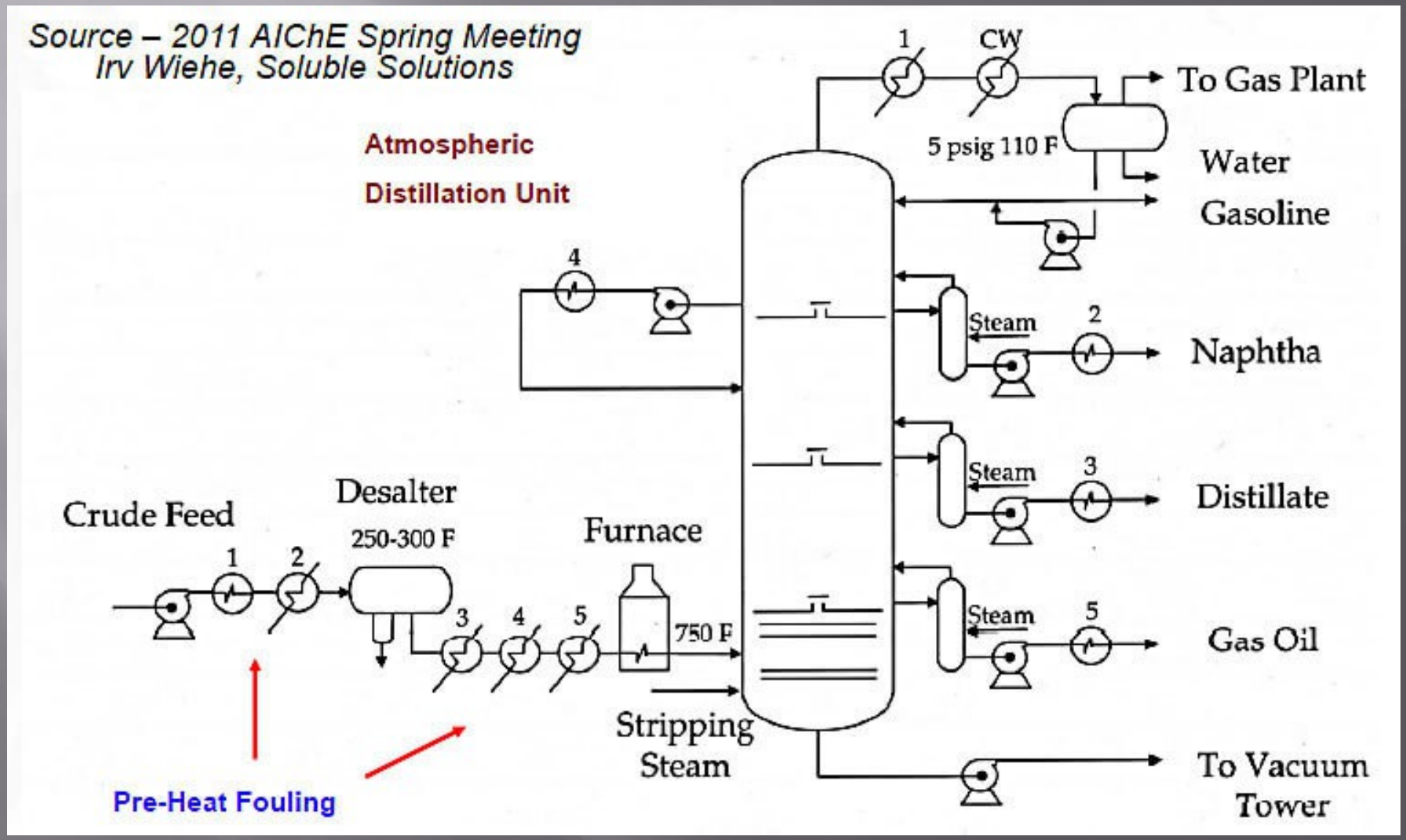
$$q = U \cdot A_o \cdot LMTD$$

$$\frac{1}{U \cdot A_o} = \left\{ \frac{1}{h_o \cdot A_o} + \frac{1}{h_I \cdot A_I} + \frac{R_W}{A_W} \right\} + \left\{ \frac{R_{F,I}}{A_I} + \frac{R_{F,O}}{A_O} \right\}$$

Cleaning Schedule Optimisation (Present Operation)



HEAT EXCHANGERS – CRUDE DISTILATION



Fouling of Crude Preheat Train Exchangers

- Atmospheric Furnace has 4% of energy consumption in a Refinery
- Due to Fouling of these exchanger 8 to 12 Deg c drop in Coil inlet temperature is observed
- If CIT is reduced, there is need for burning additional fuel to meet the process requirements
- Results in additional cost and additional green house gas emissions
- Up to 15% of fuel can be saved by reducing fouling
- As per US Doe survey

Fouling prevention methods - PRESENT

- By design of exchangers as per TEMA . This adds more heat transfer area than the actual requirement

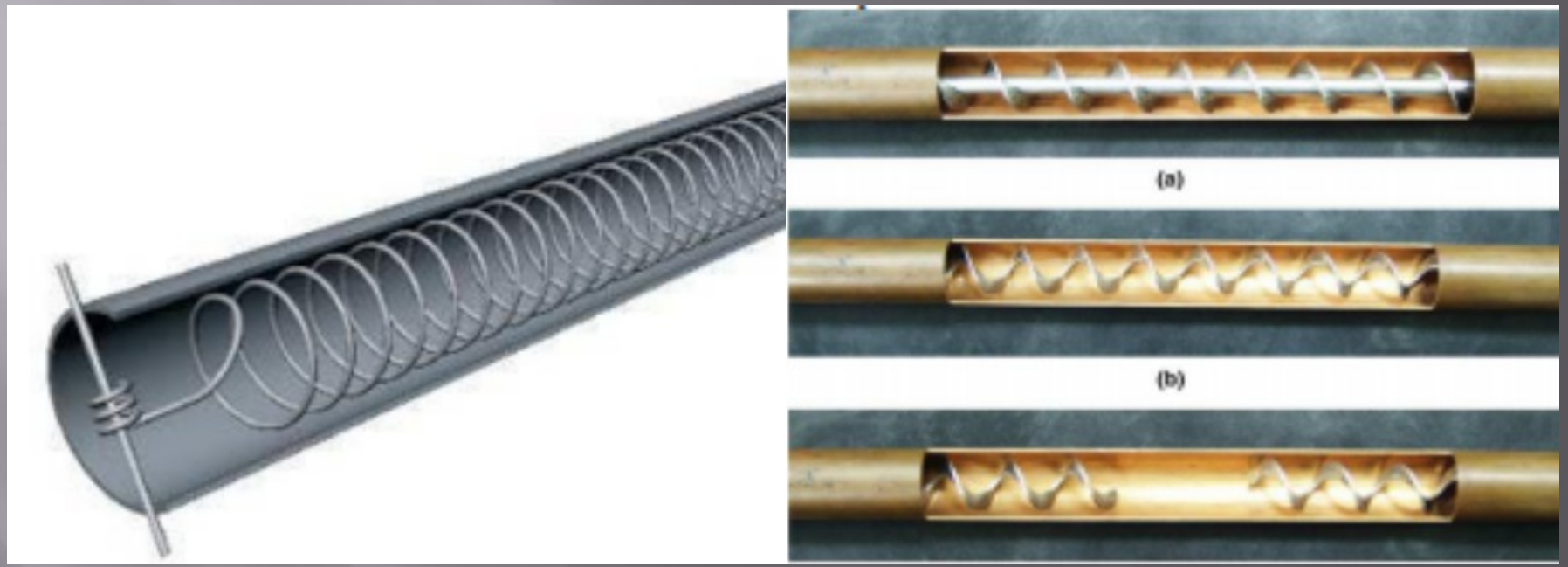
  Adds to the cost and eventually fouling take place
- Design of exchangers with higher flow velocities to help in removal of foulants

  Results in higher energy cost for pumping
- Using helical tube inserts to create turbulent flow conditions inside the tube to avoid fouling

  Very high cost of Exchangers and fouling eventually happens
- Removing the bundle and cleaning the tubes by hydrojetting or other mechanical tube cleaning methods at periodic intervals

  Results in loss of pre heat during the outage of the pre heat train. Through put also may be reduced

Fouling prevention methods - PRESENT



Fouling prevention methods - Hydrojetting

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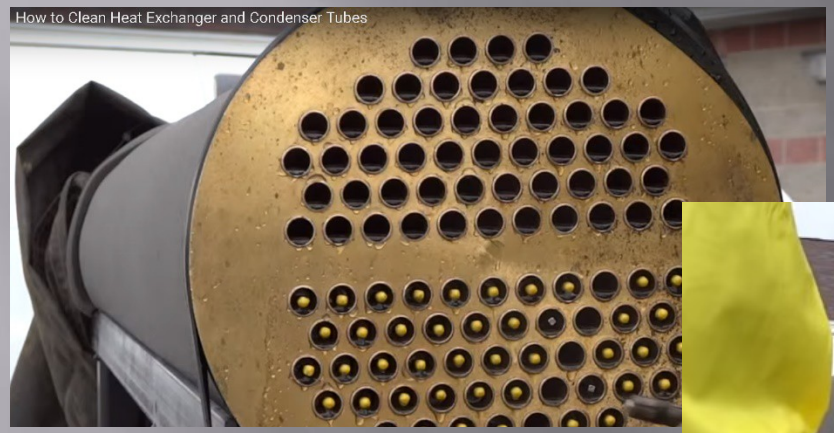
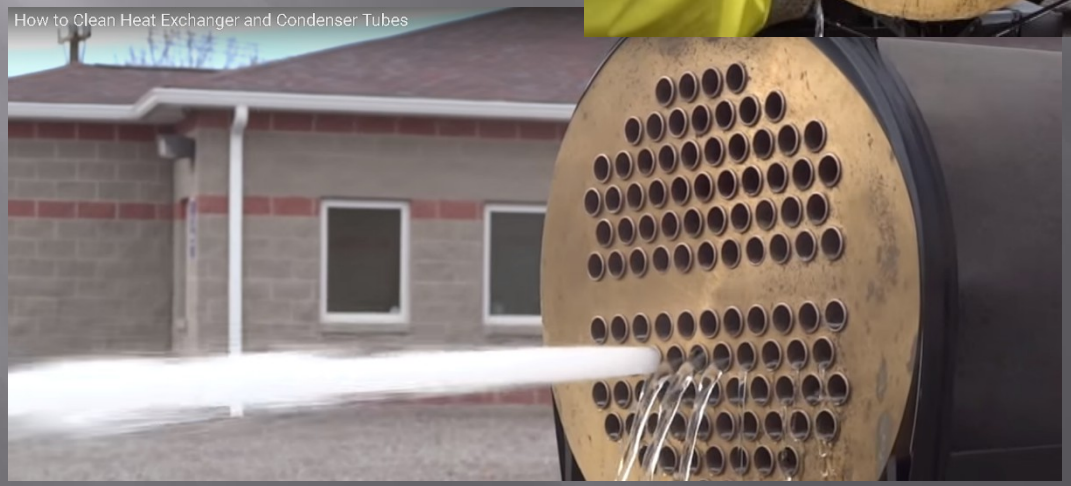
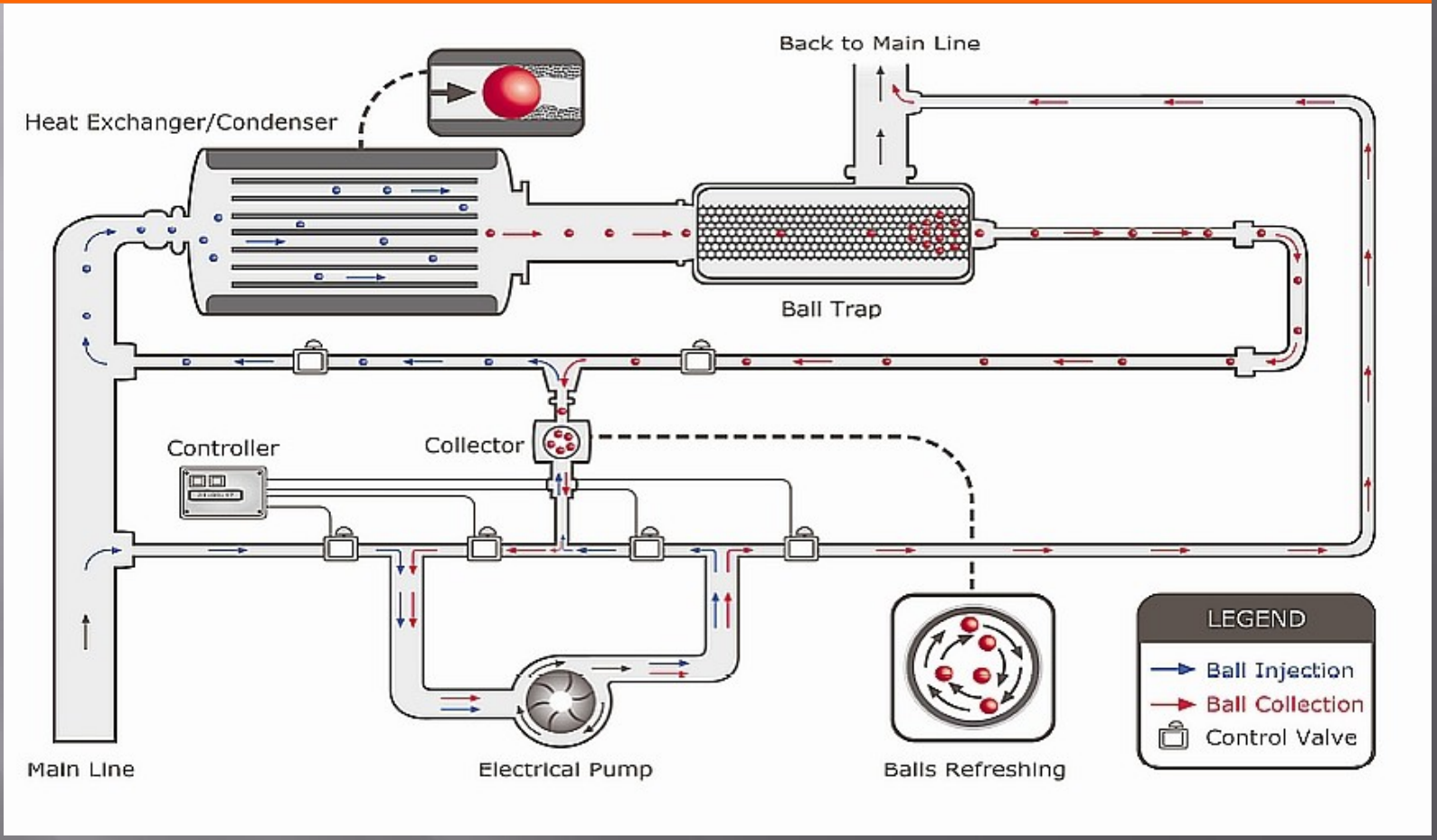
Fouling prevention methods - Hydrojetting

Fouling prevention methods – Projectile jetting

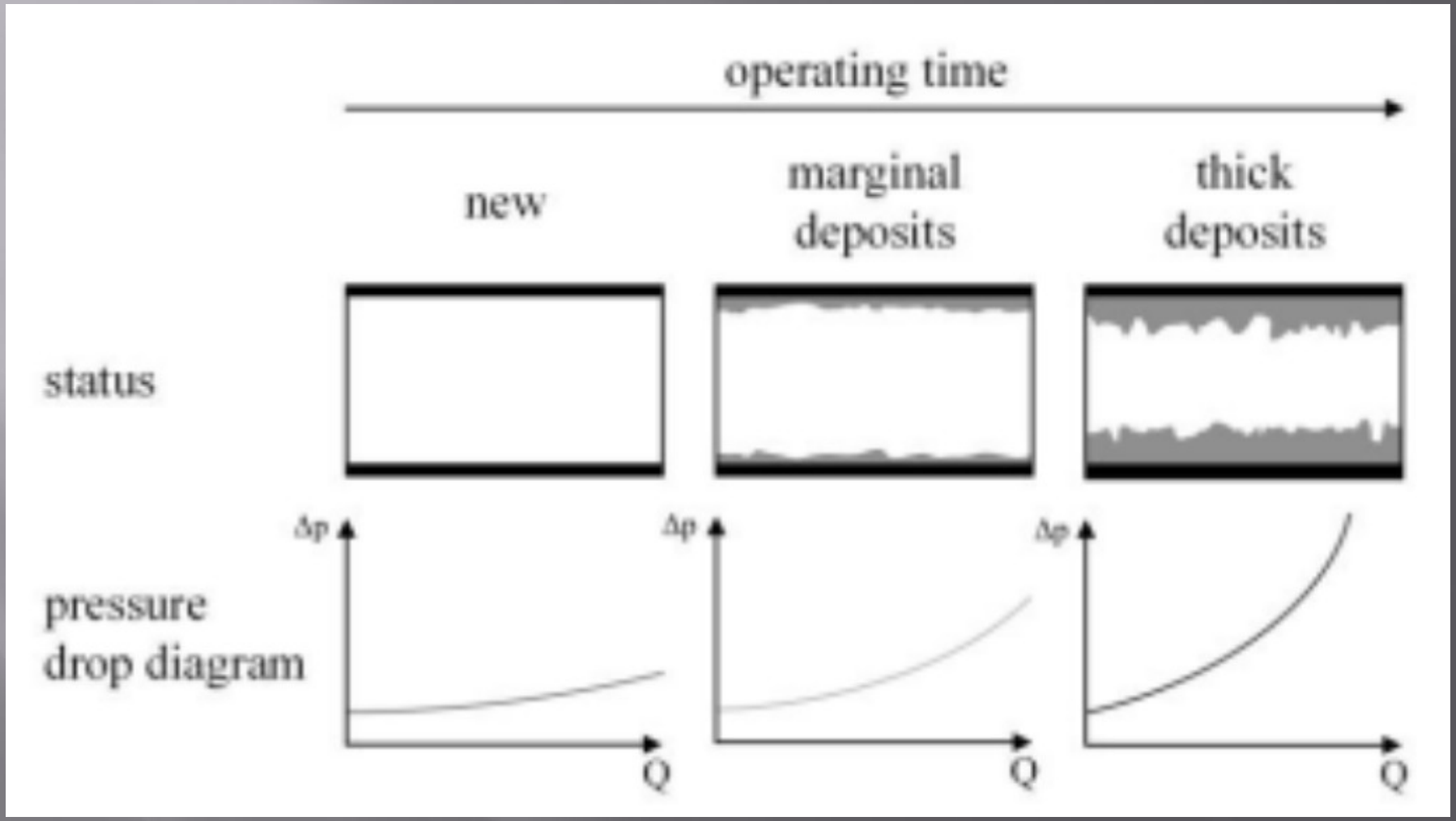




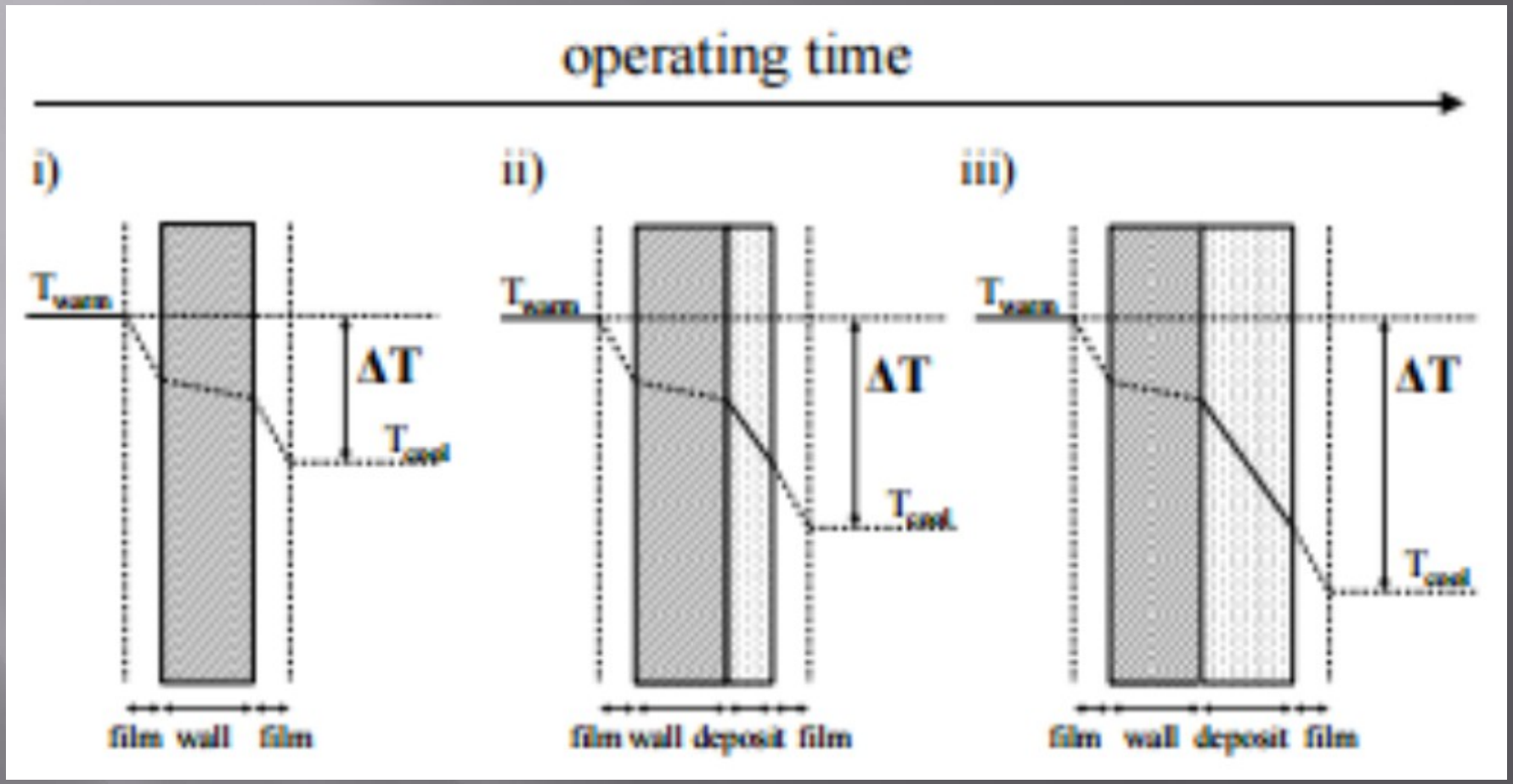
Fouling prevention methods – Online cleaning



Fouling progression



Fouling progression



ANTI FOULING SYSTEM

Main Features

- Obviates the need for Physical Cleaning of Heat exchangers
- Reduces Cleaning and Maintenance cost
- Reduces Frequent planned and unplanned shut downs
- Reduces capital cost of exchangers as the same can be designed for lower fouling resistance
- Easy and Faster to implement
- Very short pay back period

ANTI FOULING TECHNOLOGY

HOW IT WORKS

- CAVITATION inside and out side the tubes disturb the boundary layer and the foulant film

- CAVITATION bubbles burst on the tube surface removing the foulant

- CAVITATION is created by propagation of sound waves.

- CAVITATION strength is precisely designed as per the fluid characteristics and foulant

WHAT IS CAVITATION

HOW IT WORKS

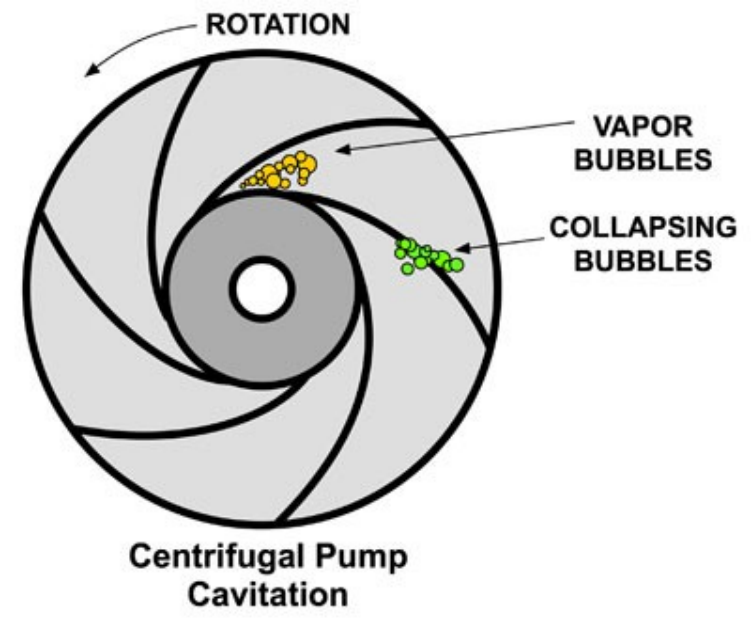
- CAVITATION is a Physical phenomenon occurring in Liquids when the static pressure is reduced below the liquid vapour pressure

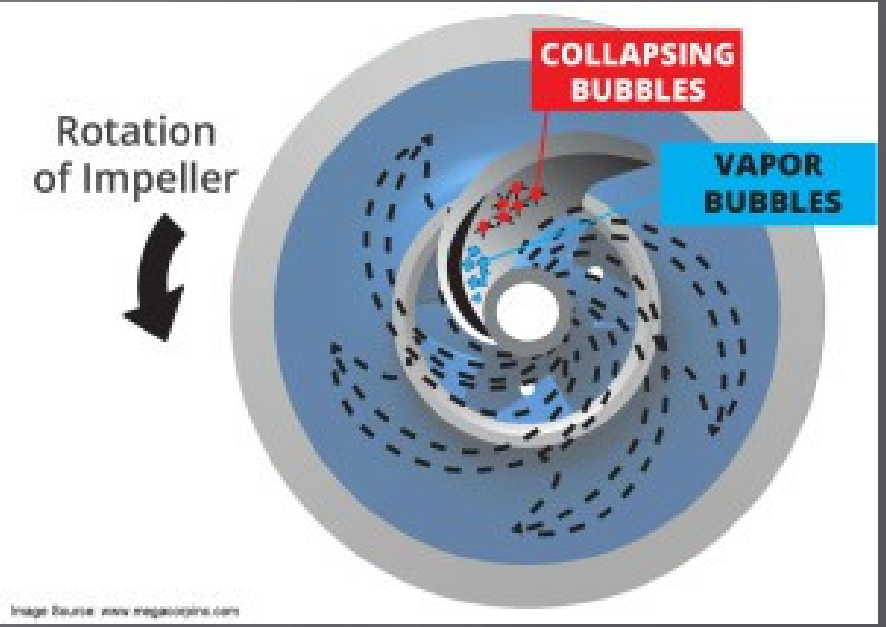
- Example : Centrifugal pump operating at Lower NPSH than the design will have cavitation

- CAVITATION is created by propagation of sound waves in Liquid media through alternating Compression and rarefaction

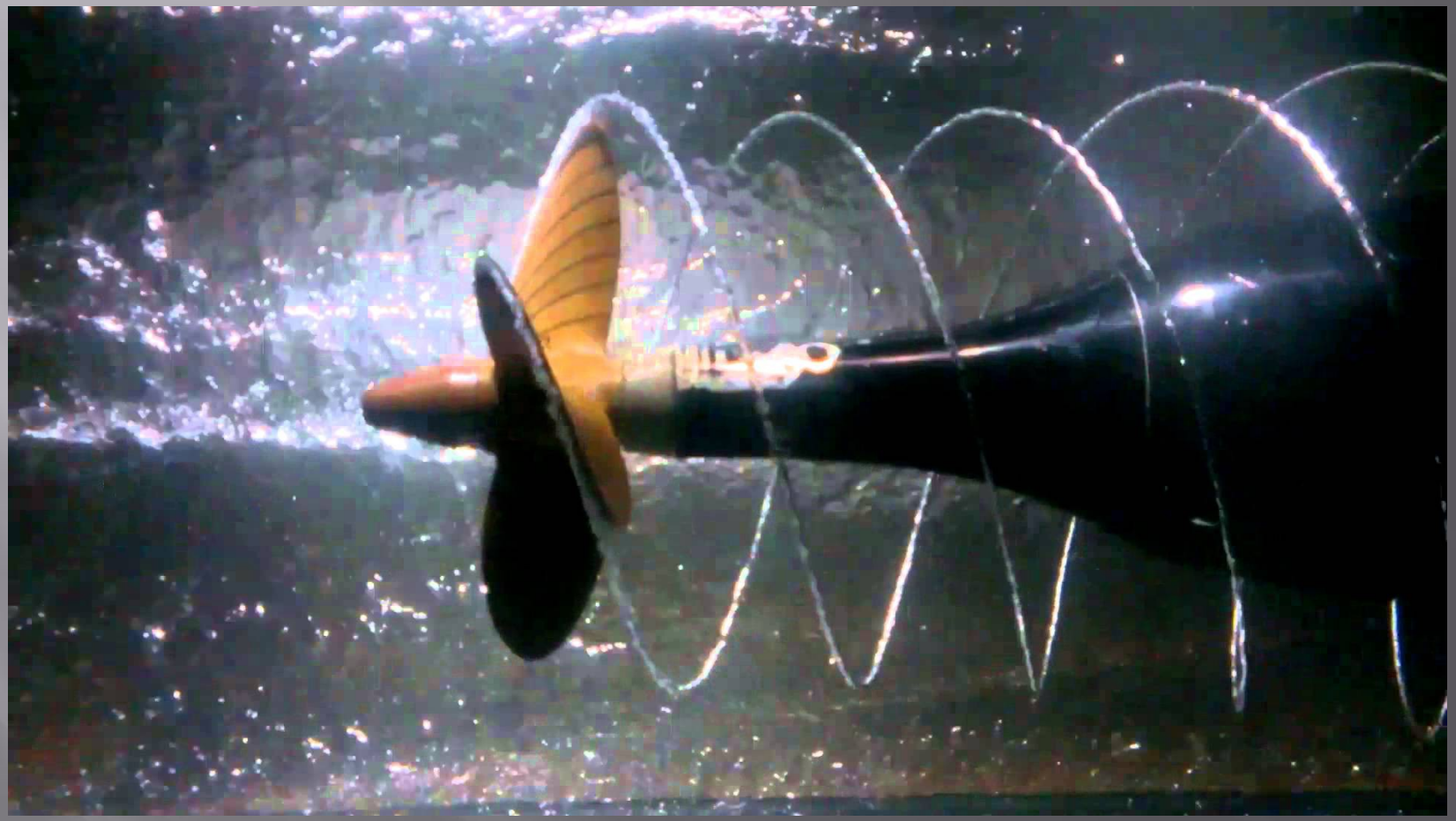
- CAVITATION strength is determined by wave length of sound

CAVITATION IN PUMPS

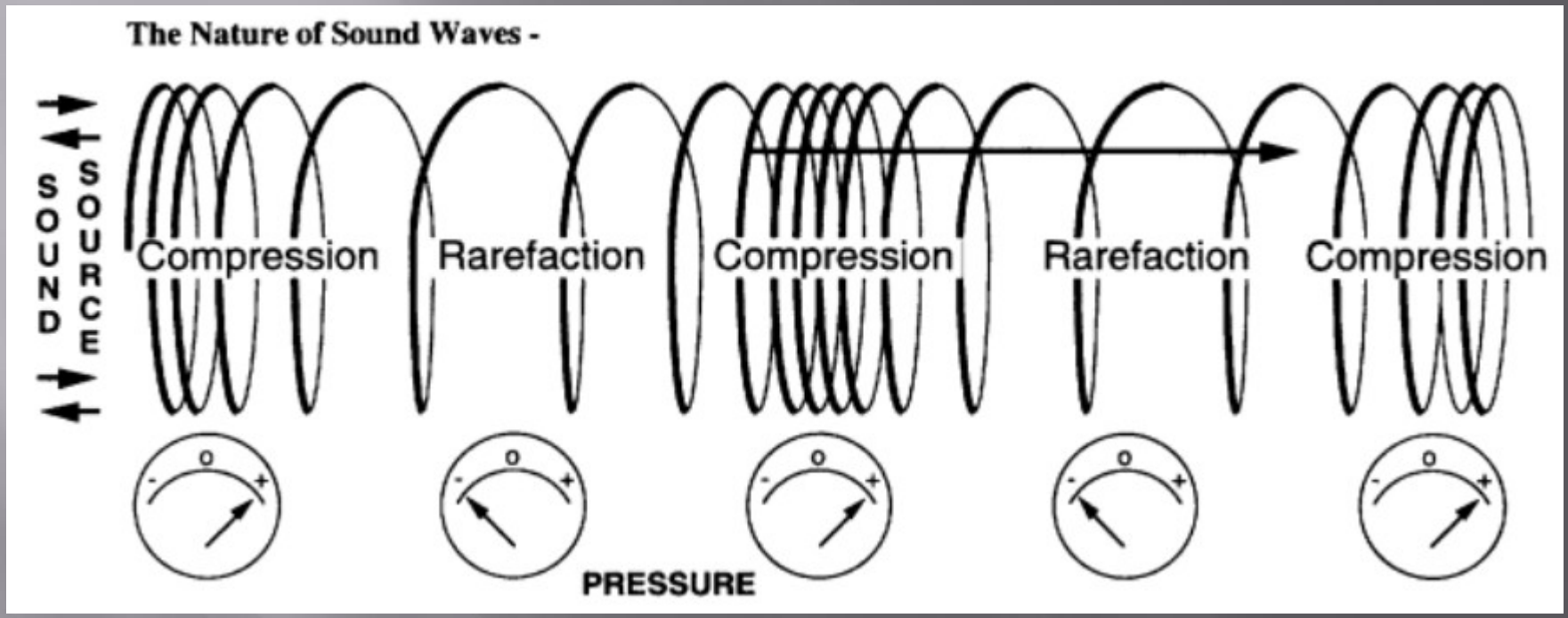




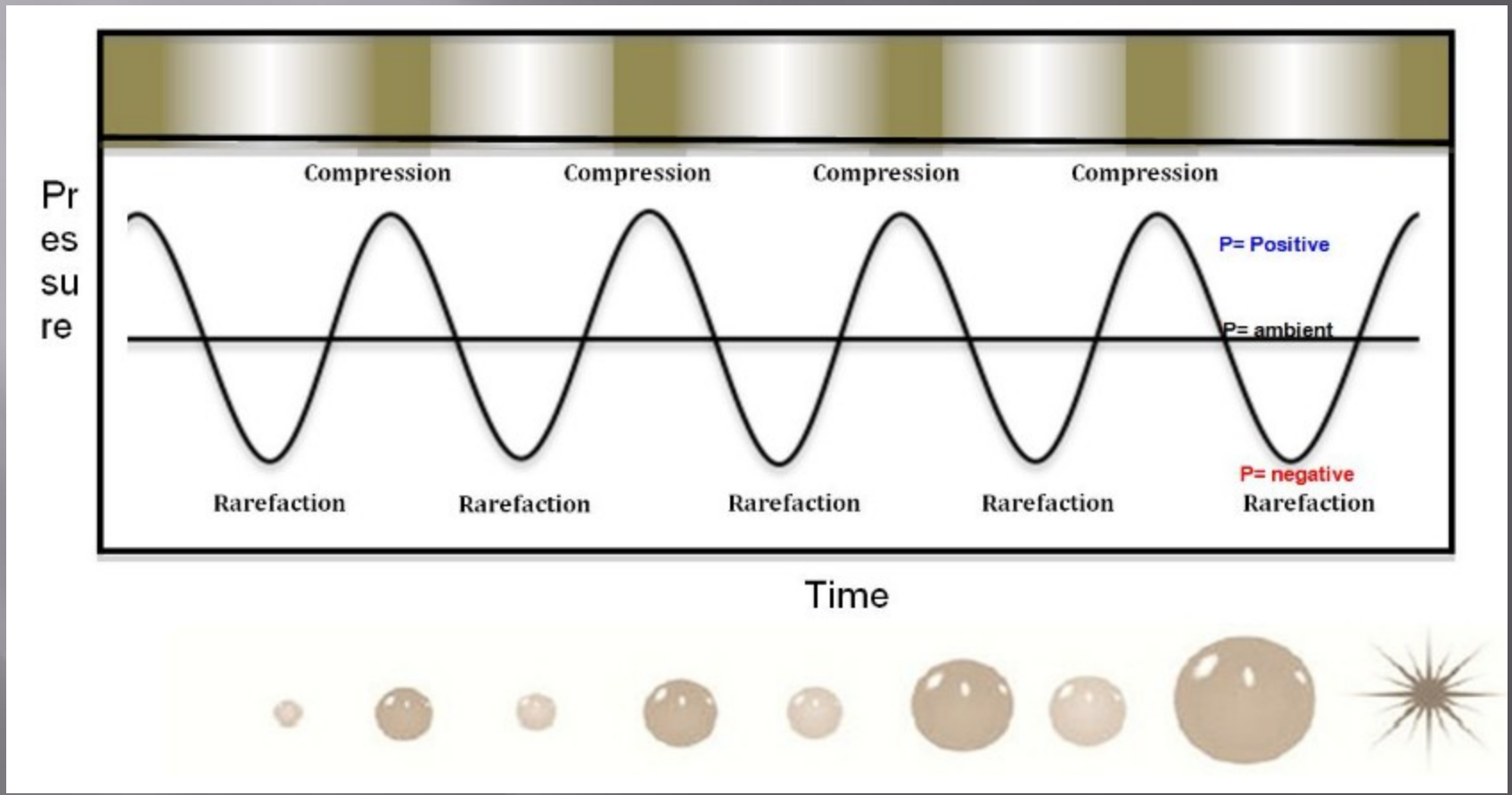
CAVITATION IN SUBMARINE PROPELLER



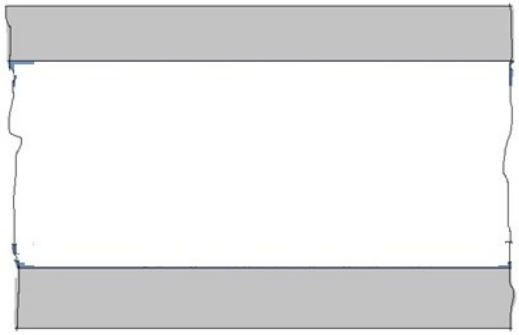
SOUND WAVES IN LIQUID



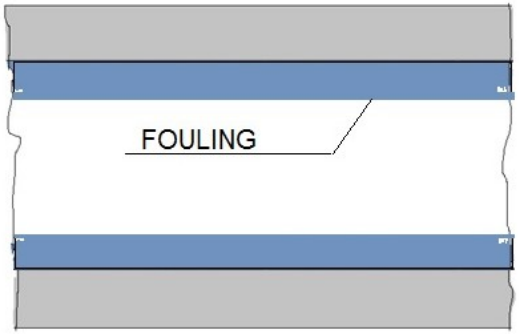
SOUND WAVES IN LIQUID- BUBBLE FORMATION



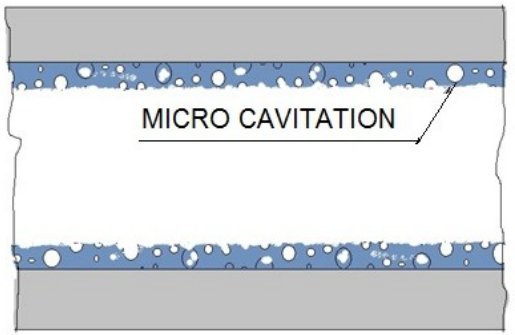
Tube Fouling Mitigation With Cavitation



CLEAN TUBE



TUBE FOULING
AFTER 6 MONTHS

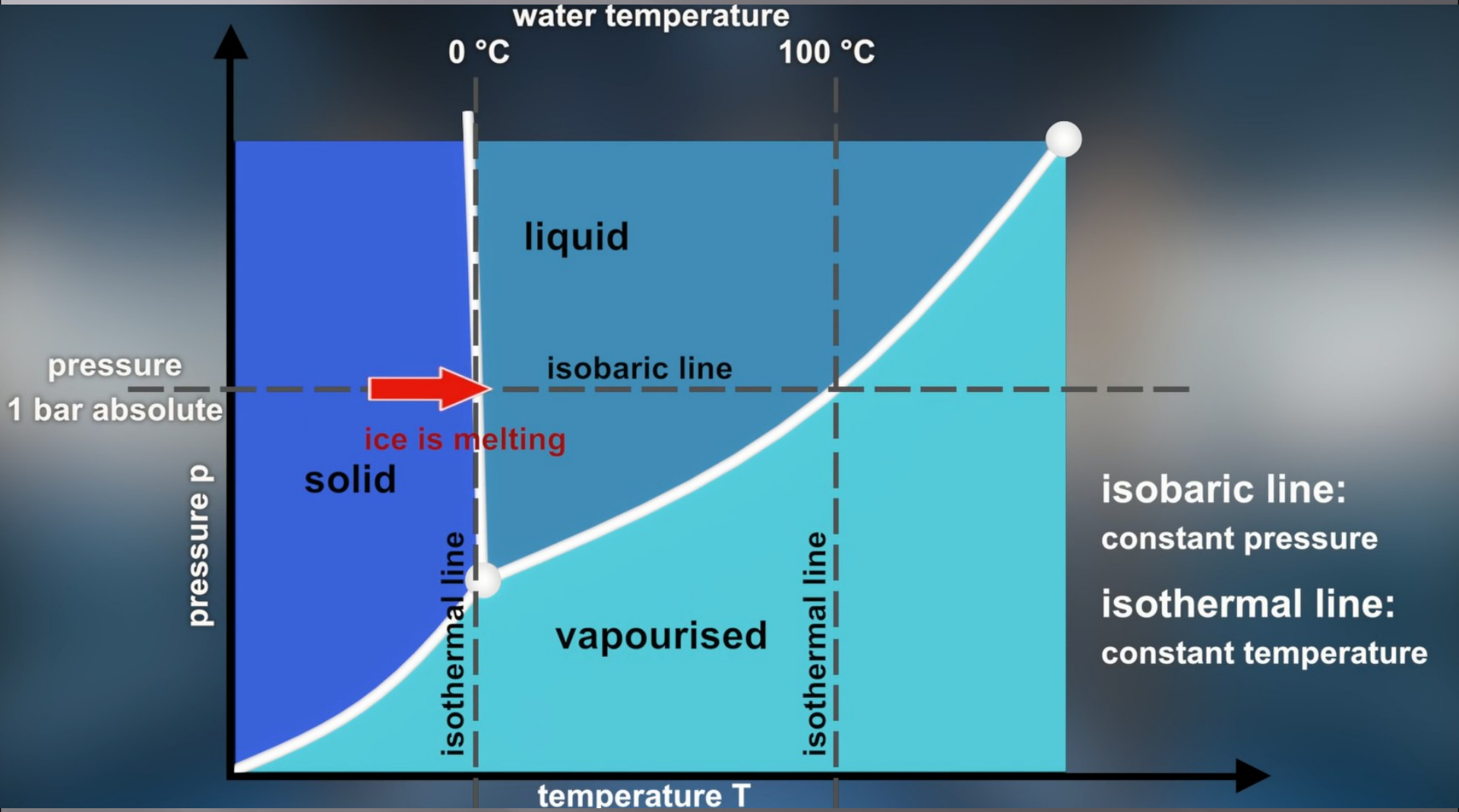


TUBE WITH
ANTI FOULING SYSTEM

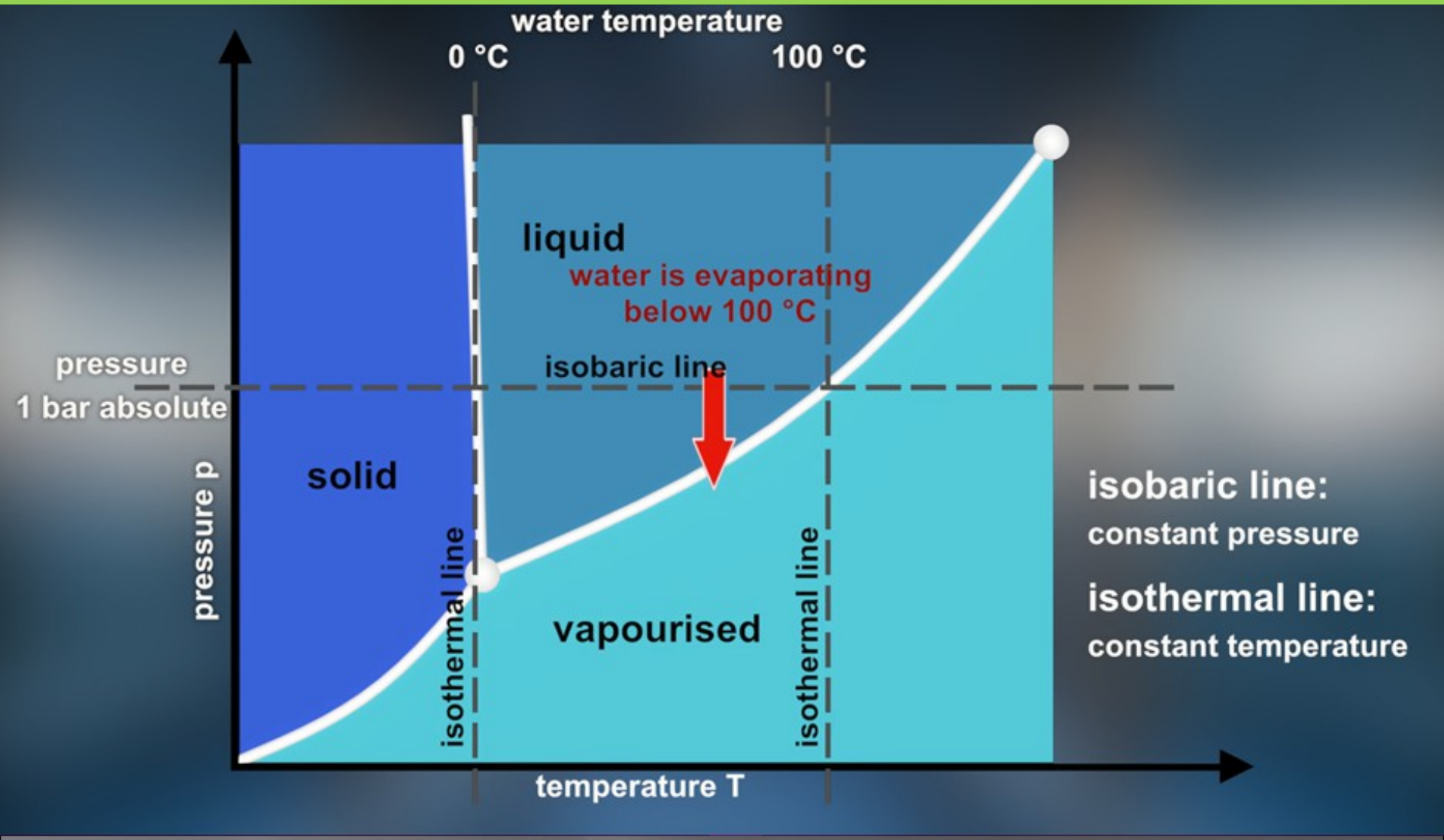
CAVITATION

Explained

Water Phase Diagram



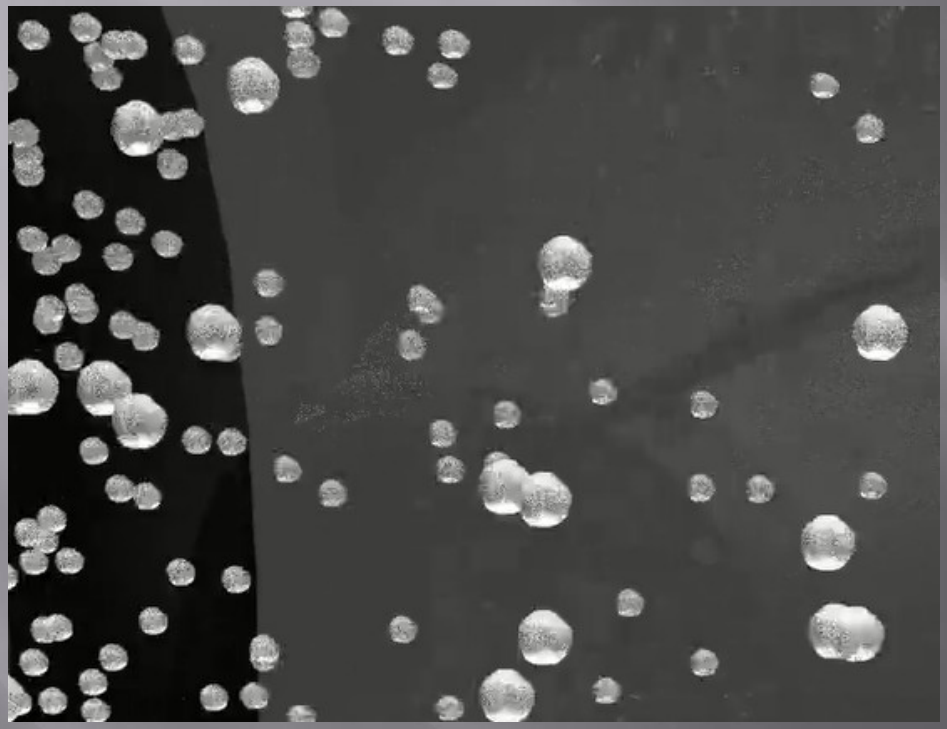
Water Phase Diagram



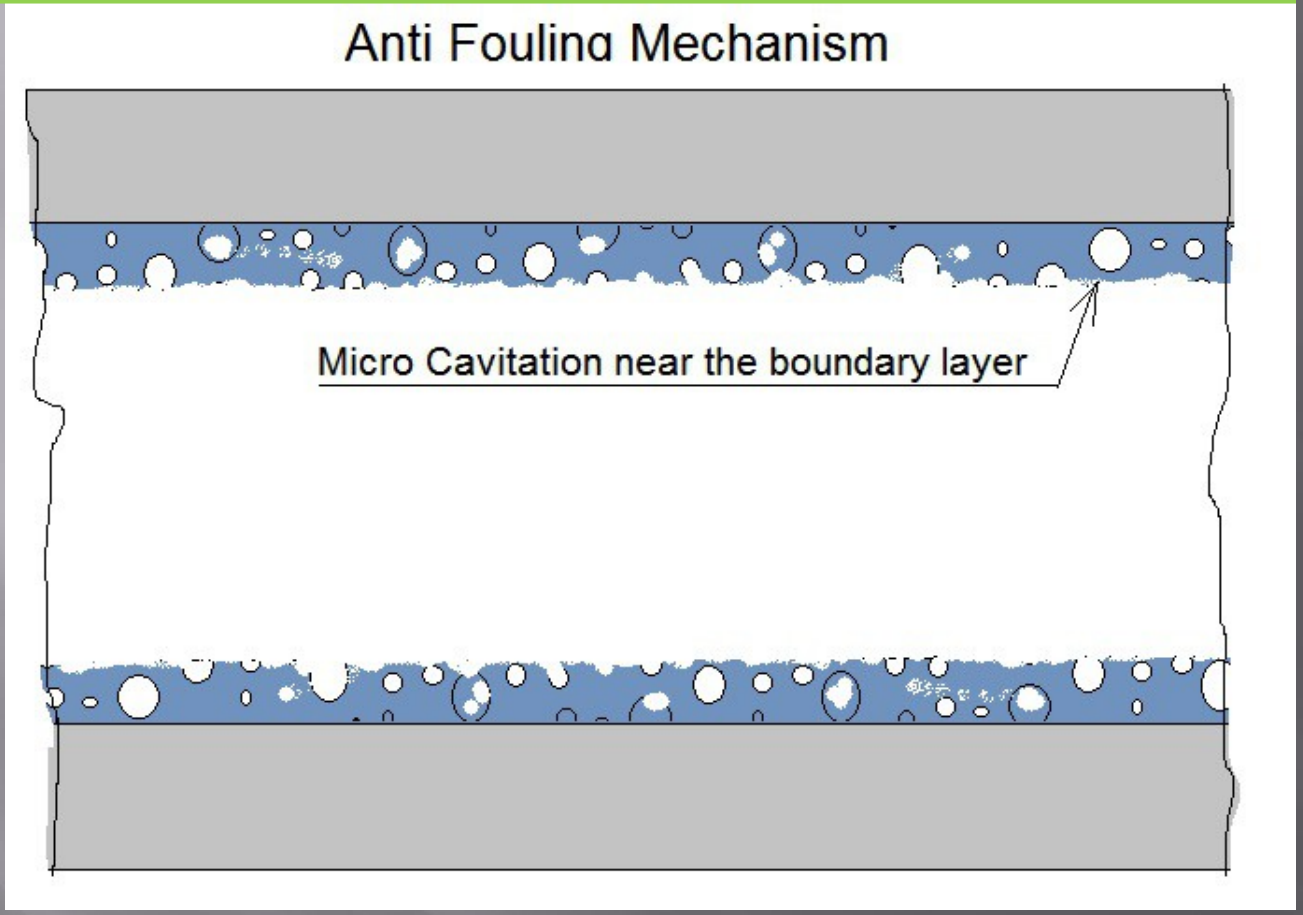
Why Cavitation Occurs

- When the static pressure at a location decreases below the vapour pressure water Boils And vapour bubbles are formed
- When the vapour bubble reaches a location where the static pressure is higher than the vapour pressure then the vapour condenses and the bubble collapses
- When the vapour bubbles collapse a shock wave is created which breaks the foulant layer on the metal surface as the vapour occupies 50000 times more volume than the liquid

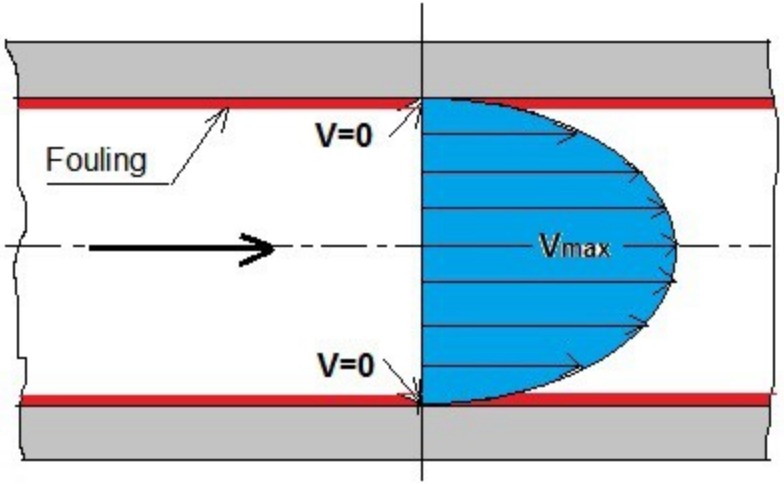
Cavitation Bubbles



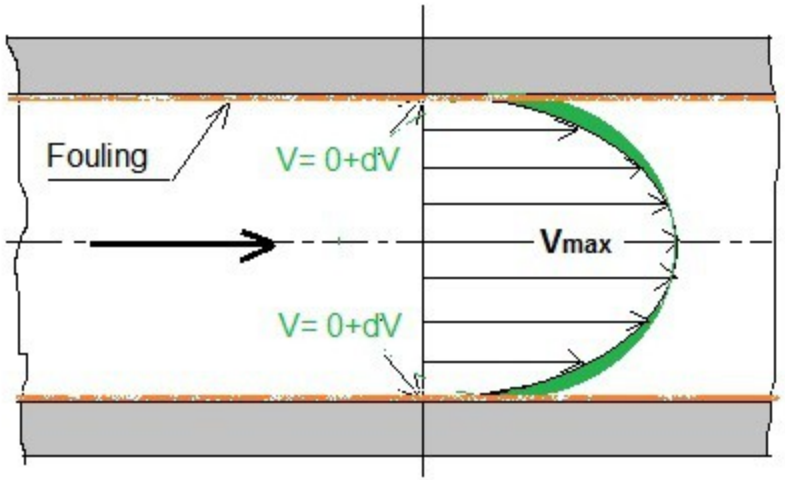
Cavitation in Action



How Anti Fouling System works



With out Anti Fouling System



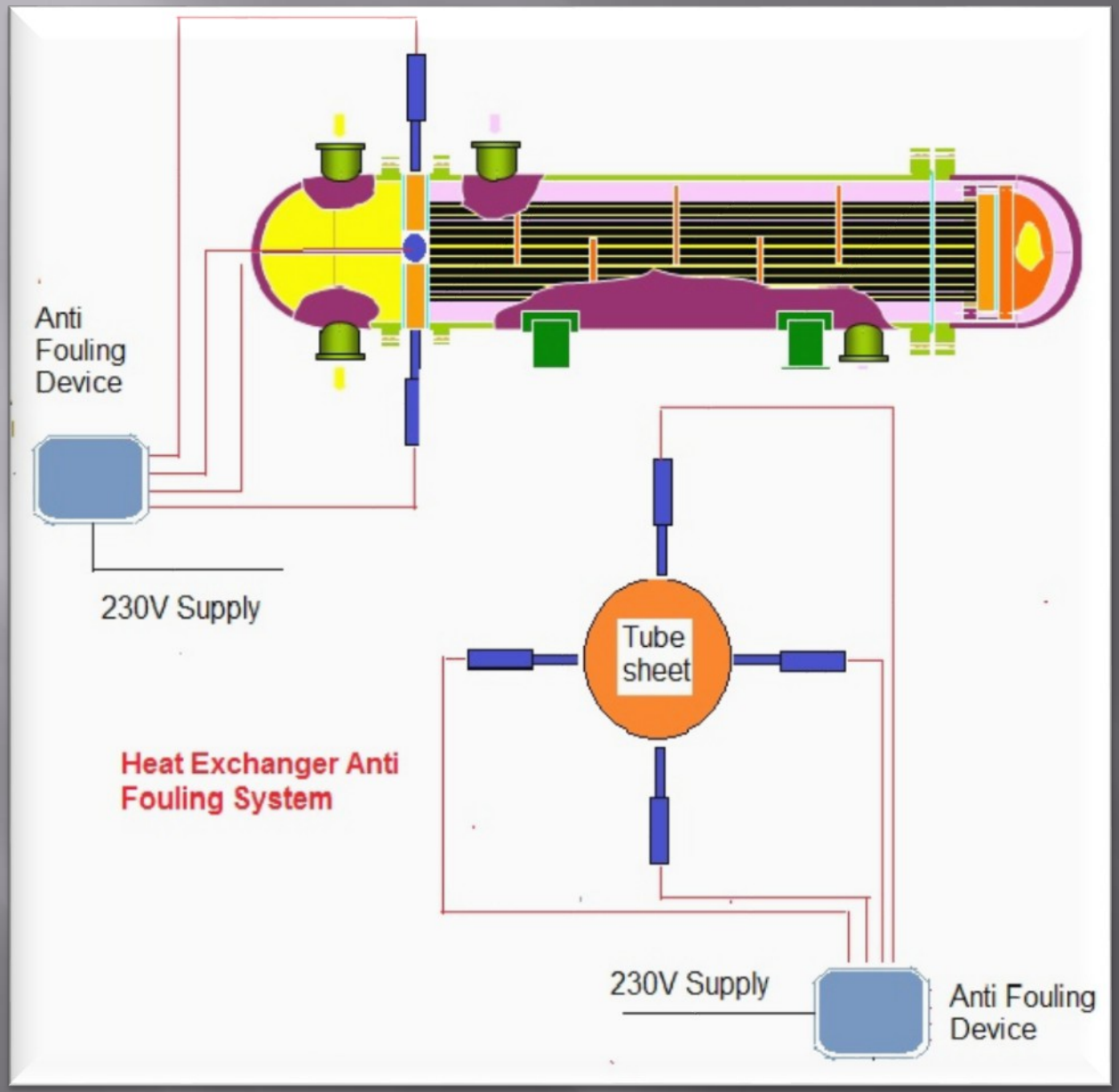
With Anti Fouling System

Heat Exchanger Fouling – With antifouling system

With out anti Fouling System

With Anti fouling system

Heat Exchanger Anti Fouling – TECHNOLOGY



Heat Exchanger Anti Fouling System

- Reduce the fouling tendency
- Remove the scales and fouling
- Increase the heat transfer efficiency
- Reduces the pressure drop in exchangers and condensers
- Reduce down time to clean the Exchangers
- Stop loss of energy due to fouling
- Reduce the Cleaning and Maintenance cost

Applications – Anti Fouling system

- Crude Pre heat trains
- Condensers
- Coolers
- Evaporators
- HVAC equipment
- Pipelines
- Boilers and economizers
- Subsea pipe and structures

OUR SOLUTIONS

- We offer study and evaluation of Heat Exchanger performance and fouling
- We offer Heat Exchanger Anti Fouling systems on turnkey basis
- Online Heat exchanger performance monitoring systems
- Increased mean time before cleaning
- Guaranteed heat transfer efficiency
- Guaranteed Energy savings

PIOLT IMPLEMENTATION / DEMONSTRATION

- Send us details of one of your Pre Preheat exchangers / Cooler / Condenser
- We will evaluate Potential for savings and Anti Fouling system efficacy for the application
- Conduct field study
- Implement the system on Trial basis to demonstrate the efficacy

THANK YOU

Contact us for

FREE Evaluation

Email : info@firstesco.in

Dr Vijayakumar : 09985502589

Who are Using the Anti Fouling system

GS CALTEX
S-Oil
Samsung Fine Chemicals
Hyundai Oil Bank