Governing Parameters of Magnetic Fluid Treatment Theory

Scale Control Factor (SCF)

The design of Scale-X™ MFC's is based on scientific principles. For MFC Technology to function properly, all the MFC governing parameters must be taken into consideration.

The MFC will only operate if it is designed to function within the operating range of those parameters. Otherwise, like all other technologies, if the governing parameters are not met the MFC will not stop scale build-up occurring or will only partially reduce the scale problem.

The following limited information on some of the governing parameters of MFT is presented.

The Scale Control Factor (SCF) of a Scale-X™ MFC's is a function of a combination of the following governing parameters within the particular fluid process system:

Em = MFT energy generation factor

$= [\ \mathbf{J}\ .\ \mathbf{V}_m^{\ kp}\ .\ \mathbf{B}_{sg}^{\ pg}\ .\ \sin\theta\ ]\ .\ [\ \phi\ .\ \mathbf{l}\ ]\ .\ [\mathbf{Ø}_{pH}]\ .\ [\mathbf{RT}_m^{\ \infty}]$ - where

J is a constant,

V is the fluid velocity in the effective operating range of "m" to "kp",

B is the magnetic flux density in the effective operating range of "sg" to "pg",

θ is the angle of intersection of the fluid velocity vector and magnetic field gradient

ϕ is a variable ap

l is the length of MFC treatment

$\mathbf{Ø}_{pH}$ is a variable dependent on pH of the fluid

RT is the residence time variable within the operating range "m" to " ∞ ".

(Note: 1. The effect of the magnetic field on the diamagnetic scale crystal in the fluid as it passes through the magnetic field is proportional to the rate at which the magnetic flux is intersected.
2. The MFT energy is the increase in the electric charge on the growing scale crystals produced by the interaction of the magnetic field on the crystals).

Ed = MFT energy dissipation factor

= Function of fluid turbulence, heat transfer, elapsed time and distance travelled after treatment by the MFC.

Cs = Scaling Category

= Function of $[\ \Phi\ .\ Tp_{pp}^{\ sp}\ ]$, Ms and $[\ \lambda\ .\ \mathbf{X}m_s^{\ -\infty}\ ]$ - where

Φ is a variable

Tp is the fluid process operating temperature within the range "pp" to "sp",

("Tp" is a major factor for some organic scales and their treatment has definite operating ranges, however, it usually has little influence in inorganic scale treatment within the operating temperature ranges of most fluid process).

Ms is the mixed scale factor where more than one type of scale is being deposited,

λ is a variable and

Xm is the magnetic susceptibility of each type of scale within the effective operating range of "s" to "- ∞ ".

Rg = Rate of scale generation factor

= Rate at which scale builds up per unit thickness

Gs = Type of scale generator factor

= Function of one or more of the following – heat transfer, evaporation, gas release, fluid shear and/or chemical reaction

Qs = Severity of scale generator factor

= Function of the severity of the type of scale generator and $[\ \beta\ .\ \mathbf{t}_d\ ]$

= Function of $[\ \Gamma.\ \Delta T\ ]$, $[\ \Psi\ .\ \Delta P\ ]$ and $[\ \beta\ .\ \mathbf{t}_d\ ]$ - where

Γ is a variable

ΔT is the temperature differential between the fluid and the vessel or pipe wall

Ψ is a variable ap

ΔP is the pressure drop of the fluid

β is a variable and

$\mathbf{t}_d$ is the duration of the time the fluid is subject to the scale generator

SCF = Function { Em, Ed, Cs, Rg, Gs, Qs }

There is no simple empirical formula, as can be seen from above, as there are many variables involved in the correct design and application of a MFC Unit to treat a particular fluid process scale problem. The values of the various constants and variables have been derived by MTA through laboratory experiments and simulated trials and through extensive industrial applications.

In many applications it is necessary to modify the fluid dynamics at the point of application of the MFC Unit to bring the variables within the operating range of magnetic fluid treatment technology.

Where there are a number of scale forming points in a fluid process it is often necessary to apply multiple Scale-X™ MFC Units in various strategic locations in the fluid system to totally eliminate/control all scale generating points. These should be organized into a number of overlapping zones of treatment.