SS Consulting

- 25+ Years experience in chemical industry

- Specialize in designing chemical treatment programs for frac, production, and water treatment

- Products are specialized, unique blends that incorporate proven “non traditional oilfield” chemistries to achieve results

OILFIELD SCALE

- Why it forms
- How it forms
- How to control it

OILFIELD SCALE – Primary Types

Calcium Carbonate – pH & temperature

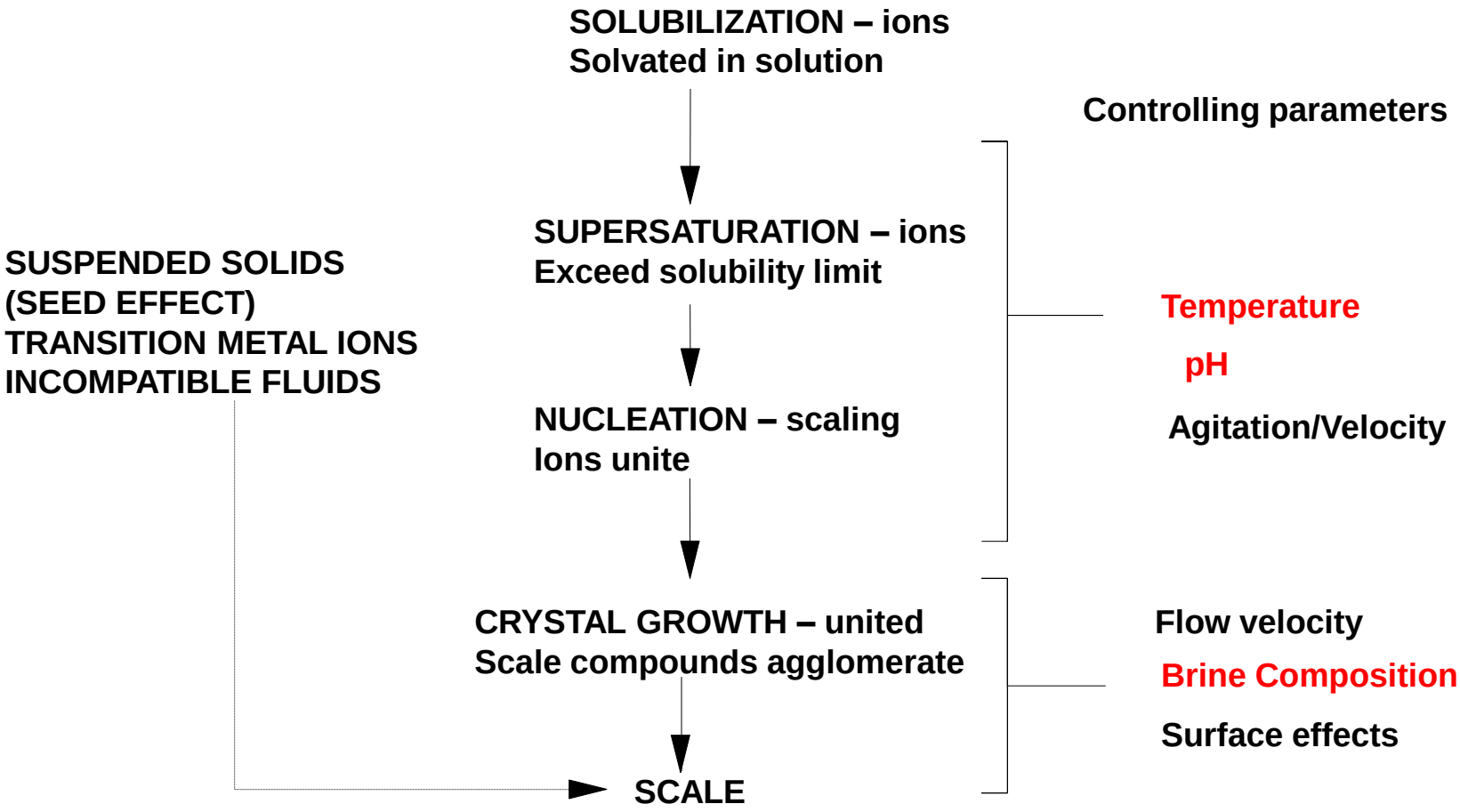
Strontium Sulphate – incompatible ions

Barium Sulphate – incompatible ions

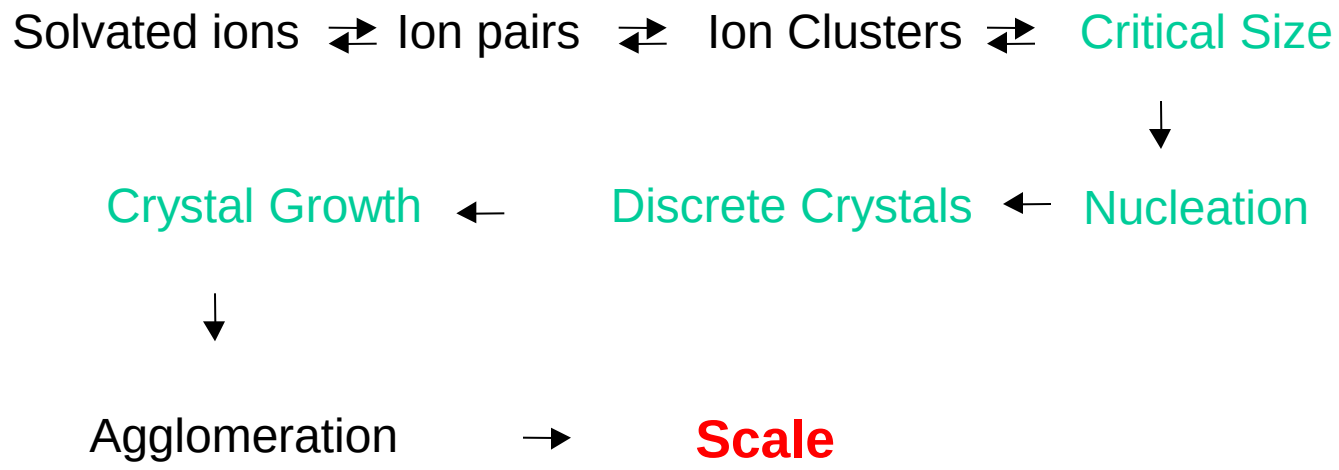
Iron Oxide – corrosion product

Iron Sulphide – sour wells

OILFIELD SCALE – Why it forms

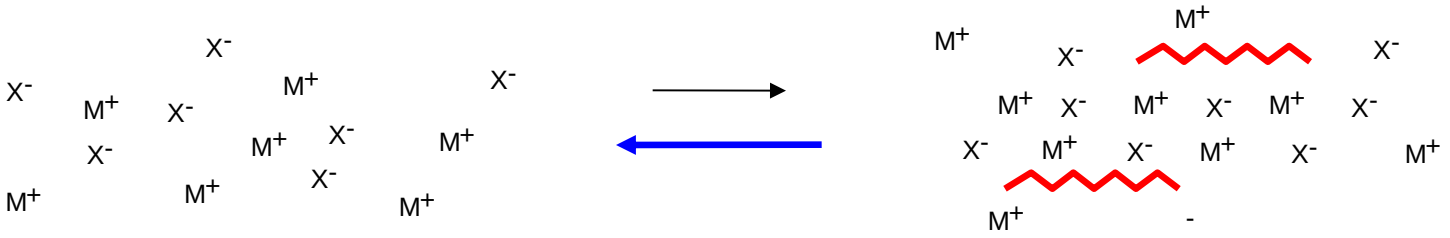


OILFIELD SCALE – How it forms

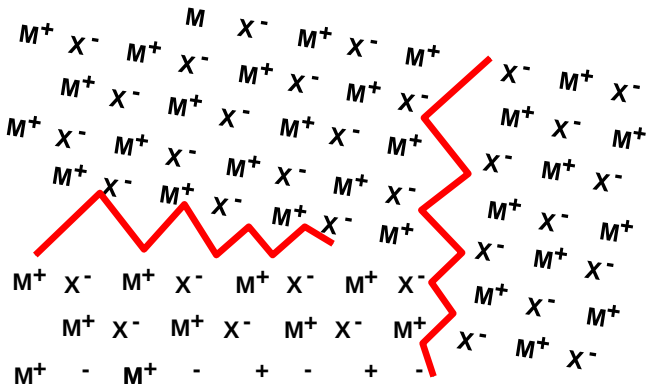


SCALE INHIBITION MECHANISMS

1) Threshold effect – Inhibitor disrupts the connection between anions and cations, and thus "increases" the solubility by keeping these in their dissolved state



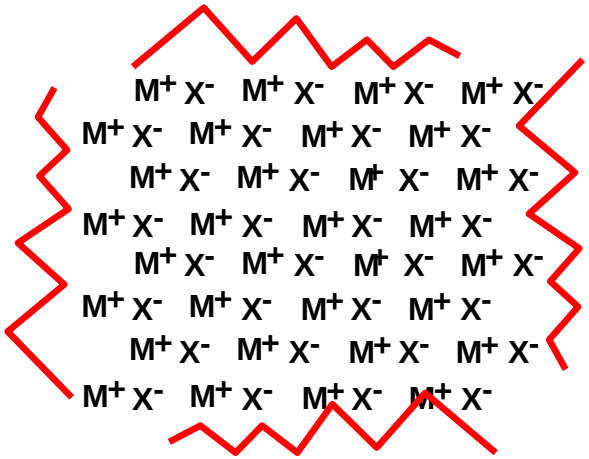
2) Crystal distortion / modification – absorption of inhibitor onto the growing crystal leads to deformation and a less stable structure that "falls apart" due to weakened bonding.

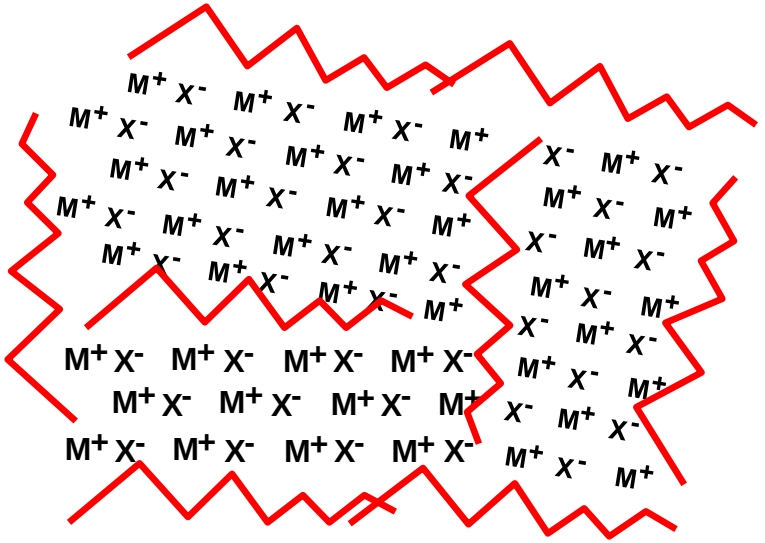


SCALE INHIBITION MECHANISMS

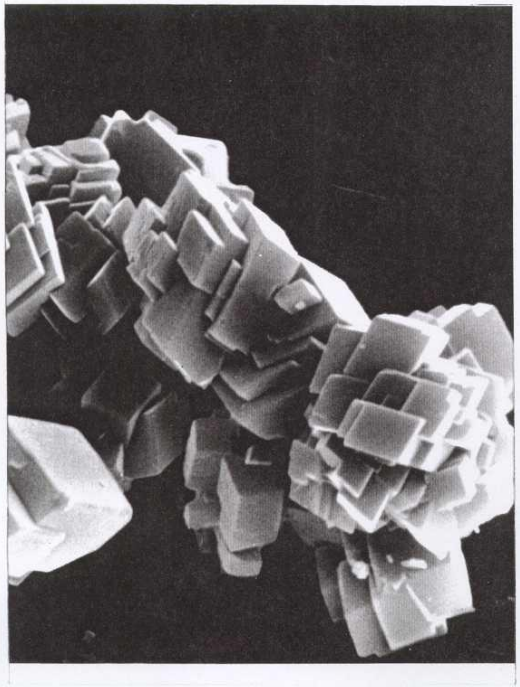
3) Crystal Growth inhibition – similar to Crystal Modification – inhibitor adsorbs onto crystal and blocks new scale particles from connecting at “growth sites”.

4) Dispersancy – prevents scale particles from agglomerating and forming larger defined, growing crystals

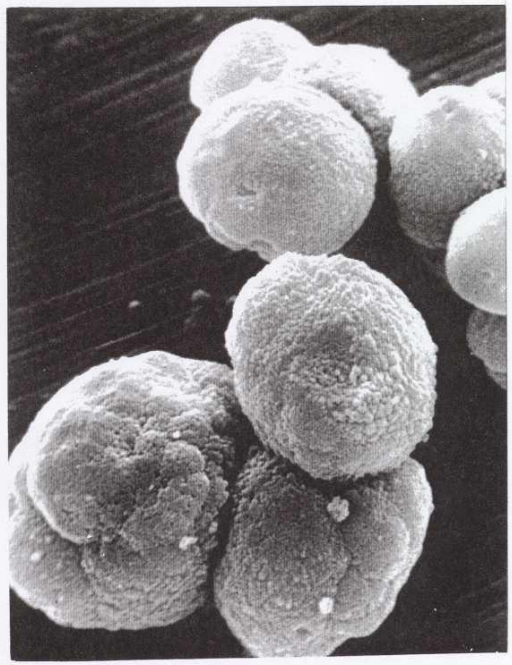




EXAMPLE SCALE INHIBITOR CRYSTAL MODIFICATION EFFECT



No additive (magnification x 7500)



10 mg/l polymaleic acid (magnification x 7500)

SCALE INHIBITOR CHEMISTRIES

Threshold inhibitors:
1)Phosphate Esters – eg. TEA Phosphate Ester
2)Phosphonates – eg. ATMP, DTPMP, PBTC

Dispersants:
1)Polyacrylates – eg. PAA, AA/AMPS copolymers & terpolymers

Crystal growth modifiers:
1)Polymers – eg. PMA, PCA, Maleic co & terpolymers

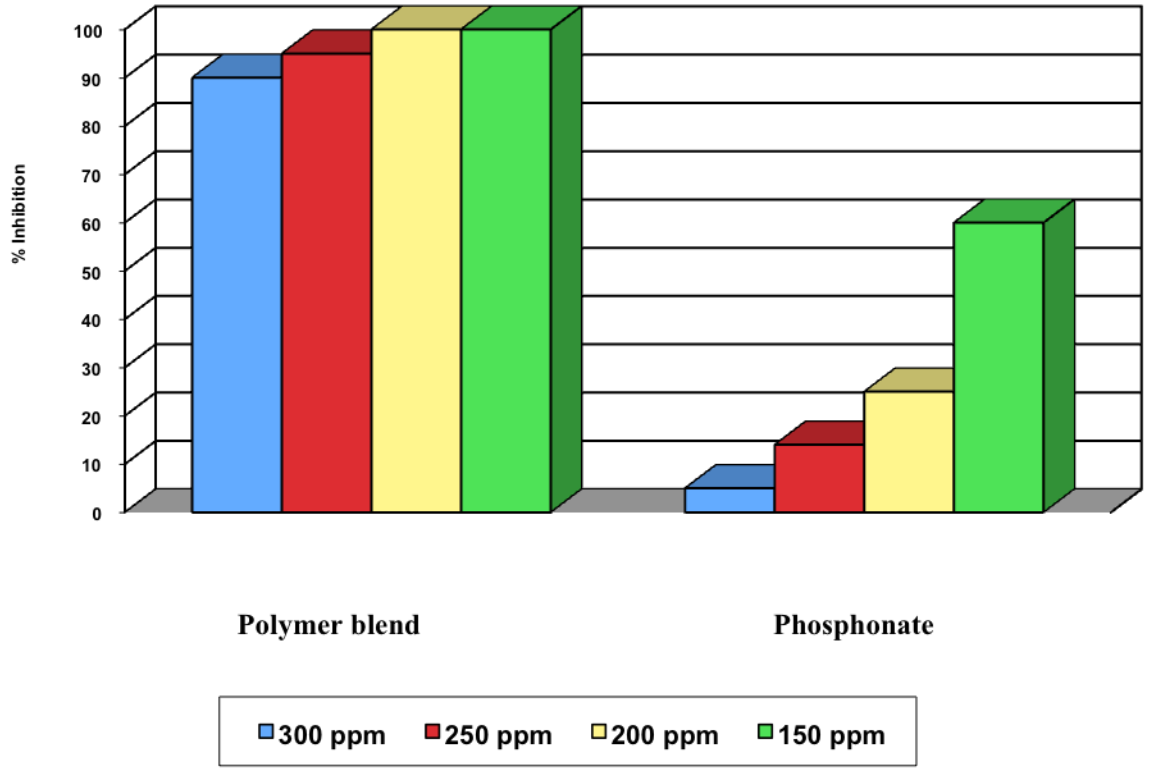
SCALE INHIBITOR SELECTION

Key Factors to consider:

- What are the scale forming tendencies in my application – Calcium Carbonate, Barium Sulphate, both? Scale prediction software will help!
- Temperature stability required
- Chemical compatibility required – FR, biocide, corrosion inhibitor?
- Calcium tolerance required
- Presence of transition metals – eg. Iron, Aluminum
- Presence of suspended solids
- pH
- Mixing ratio of waters – eg. Fresh water with formation ions

Scale Inhibition Tests – Barium Sulphate & Calcium Carbonate

Ca	Ba	Sr	Fe	HCO_3	SO_4	Cl	TDS	Temperature F	pH	CaCO3 Saturation	BaSO4 Saturation
5319	3331	2561	0	253	As shown	59423	99,543	122	7.5	1	2.87



Addition of 25 ppm of Ferric Iron reduced the amount of "Sulphate tolerance" by 50%

Scale inhibition test – Barium Sulphate & Calcium Carbonate

s.u.	*mg/L CaCO3*	mg/L		*Element Concentration (mg/L)*												
pH	**HCO3**	**TSS**	**TDS**	**Al**	**Ca**	**Fe**	**Mg**	**Mn**	**K**	**Na**	**P**	**Si**	**SO4**	**Cl**	**Ba**	**Sr**
7.606	339.8	867	10936	0.704	958	58.3	97.2	1.5	37.6	3458.7	1.1	8.2	1118	5800	620	107

Inhibitors were tested in the above brine mixture that has severe scaling tendency for Barium Sulphate as well as Calcium Carbonate. Iron and TSS levels were filtered to < 10 ppm each.

Only one specialized inhibitor blend was able to achieve inhibition of scale at > 250 ppm Barium.

Summary & Conclusions

• A variety of Scale species are prone to form in Oilfield applications – and some – eg. Barium Sulphate - can be problematic to remediate

• Numerous factors must be considered prior to selecting an appropriate scale inhibitor, but ideally a product that functions via multiple mechanisms is most desirable

• Scale inhibition tests that closely mimic actual field conditions – eg. Temperature, presence of other chemistries and inhibitor “foulants”, etc. - should be conducted to ensure desired results will be achieved