7. Summary

The most important influences on the width of the metastable zone are the kind and concentration of the impurities existing in the solution. The presence of impurities in solution leads to different disturbances on the yield of a product. Only an experimental determination for the effects of impurities exists in the relevant literature without any interpretation of the existing results. Most explanations of crystal growth under additive effects start at the solid phase but do not take into account the change in the structure of the solution when additives are added to a solution.

Here it was investigated if the properties of intermolecular interactions cations and anions each for additive, solvent and salt in solution are the key to an interpretation of influences of additives on the metastable zone width of inorganic compounds.

The polythermal method was used to measure the effect of the additives, e.g. Al\(^{3+}\), Fe\(^{2+}\), Ba\(^{2+}\), Li\(^+\) and K\(^+\) on the MSZ width of ZnSO\(_4\), Al\(^{3+}\), Fe\(^{2+}\), Mg\(^{2+}\) and Ba\(^{2+}\) on the MSZ width of LiCl and Cu\(^{2+}\), Ba\(^{2+}\), Li\(^+\) on the MSZ width of K\(_2\)SO\(_4\). These additive ions were selected according to a suggested rule, which takes the amount of hydration enthalpy values into account. The results show that the additives affect the MSZ width not always as expected. Also it is explained that the effect of some additives on the MSZ width can be given in terms of hydration enthalpy values and ion-ion interaction forces. This approach is, however, still not sufficient to interpret the effect of all additives.

Also this study shows the possibility to reduce scale formation e.g. in seawater desalination. The principal idea of the concept is a reduction of the amount of calcium ions, which are causing the main scaling problem in seawater desalination such as CaCO\(_3\) and CaSO\(_4\) scales. This reduction of calcium ions can be carried out before the feed of the seawater enters the desalination unit. It can be defined as precipitation and separation unit. In this unit, it is suggested to use the power of ultrasound to accelerate the precipitation of calcium carbonate after modifying the degree of supersaturation in seawater. By adding a stoichiometric amount of an inorganic compound that is the source of carbonates ions. Normally the CO\(_3^{2-}\) ions are the limiting reactant in seawater, which is not enough to reach the required degree of supersaturation for a precipitation. Thus NaHCO\(_3\) was added to increase the degree of CaCO\(_3\) supersaturation in artificial seawater. The induction time of CaCO\(_3\) precipitation was investigated after modifying the degree of supersaturation. As a result the interfacial tension of CaCO\(_3\) in artificial seawater was determined at different level of temperature and salinity without applying the power of ultrasound.
On the other hand, the power of ultrasound was used to accelerate the CaCO$_3$ precipitation as essential to accelerate the process of calcium ion reduction in seawater.

The experimental work is focused on several operational variables studying the calcium ion reduction as a function of:

1. Optimum amount of $HCO_3^-$ ions addition
2. Operational temperature
3. Operational time of ultrasound
4. Power of ultrasound and seawater salinity

The maximum necessary addition of $HCO_3^-$ ions in seawater was determined to reach a maximum decrease in calcium ions. As a result of this reduction the conditions to control the scale formation will be achieved. Additionally, it was found that the closer the process to optimal operation conditions of temperature and time is the more increased is the efficiency of reduction. In addition, there has been no change recorded in calcium ion reduction due to the change of power input of power of ultrasound. This work can be considered a first step to evaluate the combined chemical-mechanical methods as anti-scaling operations in seawater desalination. Environment and economic aspects would benefit if the present results could be transferred to industry.