filtration (microfiltration, ultrafiltration, etc.), membrane distillation; ion exchange; and electrochemical methods to precipitate scale. Non-limiting examples of chemical treatment include chelation using at least one chelant such as ethylenediamine tetraacetic acid ("EDTA") or a salt thereof, or precipitation using one or more caustic and/or phosphate compound.

[0005] Various analytical methods can be employed to measure hardness in water entering, re-entering, or being used in an industrial process (hereinafter "industrial water"). Hardness concentrations can be measured by inductively coupled plasma ("ICP"), ion selective electrode ("ISE"), light absorbance, titration, atomic absorption ("AA"), or other methods known in the art. While all can produce accurate hardness concentration measurements, each has limitations.

SUMMARY

[0006] In a first ~~exemplary embodiment~~aspect, the present disclosure is directed toward an automated method for monitoring soluble magnesium concentration in industrial water where that industrial water contains soluble magnesium. The automated method comprises combining an aliquot of the water and a quantity of (1) a pH-buffered liquid and (2) a magnesium coordinating fluorescing reagent to produce a buffered water sample. The (2) magnesium coordinating fluorescing reagent coordinates with the soluble magnesium present in the buffered water sample and produces a coordinated magnesium compound. The soluble magnesium concentration in the aliquot of water (and, hence, in the industrial water) can be quantified by using fluorescence measurement to measure the fluorescence produced by the coordinated magnesium compound in the buffered water sample. In this process, the (1) pH-buffered liquid comprises a water soluble, non-coordinating base capable of buffering the (1) pH-buffered liquid to a pH from 8 to 12; and the (2) magnesium coordinating fluorescing reagent is selected from the group consisting of a water soluble, aromatic, ortho hydroxyl substituted azo dye; a water soluble, fused-ring heterocycle; and combinations thereof.

[0007] In a second ~~exemplary embodiment~~aspect, the present disclosure is directed toward an automated method for monitoring and optionally controlling total hardness concentration in industrial water where that industrial water contains

soluble calcium and soluble magnesium. The automated method comprises combining an aliquot of water with (4) a magnesium-containing reagent. The (4) magnesium-containing reagent displaces the soluble calcium within the aliquot of water with soluble magnesium, thereby creating a modified water sample having an increased soluble magnesium content. The modified water sample is combined with a quantity of (1) pH-buffered liquid and (2) a magnesium coordinating fluorescing reagent to produce a buffered water sample containing soluble magnesium. The (2) magnesium coordinating fluorescing reagent coordinates with the soluble magnesium present in the buffered water sample to produce a coordinated magnesium compound. The increased soluble magnesium content in the buffered water sample is quantified via fluorescence measurement of the coordinated magnesium compound, which allows for the determination of the total hardness concentration of the aliquot, and hence the industrial water. In this process, the (1) pH-buffered liquid comprises a water soluble, non-coordinating base capable of buffering the (1) pH-buffered liquid and the buffered water sample to a pH from 8 to 12; and the (2) magnesium coordinating fluorescing reagent is selected from the group consisting of a water soluble, aromatic, ortho hydroxyl substituted azo dye; a water soluble, fused-ring heterocycle; and combinations thereof.

[0008] In a third ~~exemplary embodiment~~aspect, the present disclosure is directed toward an automated method for monitoring and optionally controlling total hardness concentration of industrial water containing soluble calcium and soluble magnesium. The automated method comprises two sets of steps, Group A and Group B, and the sets of steps can be repeated as necessary.

[0009] As related to Group A, a first aliquot of water and quantities of (1a) a first pH-buffered liquid, (2a) a first magnesium coordinating fluorescing reagent, and (3a) a first inert fluorescing agent are combined to produce a buffered water sample. The (2a) first magnesium coordinating fluorescing reagent coordinates with the soluble magnesium present in the first aliquot of water creating a coordinated magnesium compound within the buffered water sample. The concentration of any uncoordinated (2a) first magnesium coordinating fluorescing reagent in the buffered water sample is determined by light absorbance. The concentration of the (3a) first inert fluorescing agent in the buffered water sample is determined by fluorescence.