Case study of high charge polymer used in refinery cooling water system to improve performance in stress condition, to decrease polymer consumption and environmental impact and to decrease total cost of operation (corrosion rate, oxidizing biocide consumption)

Abstract

A European refinery has replaced their traditional high stress polymer in cooling water system by high charge polymer to improve performance under stress conditions and to reduce the active ingredient consumption. The other interest is to minimize the environmental impact as the formerly applied high stress polymer-product contains solvents that are not considered as environmental green.
The new high charge polymer developed by Nalco Champion is resilient to degradation within the bulk recirculating water thus treatment and cost efficiency is improved.
The implementation of the new high charge polymer decreased the active compounds consumption with more than 25%, decreased the oxidizing biocide demand and in this way the corrosive effect on copper alloys and the carbon steel (galvanic) corrosion.
The closely monitored impact on corrosion rate and treatment product demand since the implementation of the high charge polymer is shared.
Based on the promising results, the new high charge polymer is anticipated to have a positive impact on total cost of operation (corrosion cost, treatment cost...).

Introduction

A North European petrochemical plant has decided to replace their traditional high stress polymer used to prevent tri calcium scaling in recirculating cooling system by more environmental friendly high charge polymer.

This petrochemical complex has several recirculating cooling water systems with sulfuric acid injection and pH control to allow high cycle of concentration. Regarding the historical data and the cooling system make up water characteristics this site is considered with stress conditions.

The stress conditions are mainly coming from:

- High level of chlorides
- Hard water (hardness around 150 ppm as $CaCO_3$)
- Make up water high cost
- High cycle (over 6)

Regarding the cost of make up water the operation maintained a high cycle to have water savings and increase risk of tri calcium scaling in heat exchangers with higher skin temperature.

The corrosion and anti-scaling cooling water system treatment should be robust and it is based on anodic corrosion inhibitor (orthophosphates), cathodic corrosion inhibitor (phosphino succinic oligomer PSO),

tagged high stress polymer, copper corrosion inhibitor (azoles), oxidizing biocide (continuous chlorination controlled by chlorometer) and bio-detergent.

The monitoring, the treatment dosage adjustment, the data recorder has been continuously controlled by 3D Trasar technology.

All the high stress polymer and all polymer contain dangerous component in the safety data sheet, the most frequent are :

-Methanol,

-Formaldehyde

-Acrylamide monomer

The motivation of the petrochemical site regarding polymer change (with the use of new high Charge Polymer) was related to environment impact improvement with equivalent dispersion capabilities or more with without dangerous component and minimizing AOX.

High charge polymer has been developed by Nalco to replace the high stress polymer with more dispersion capabilities and without methanol, formaldehyde components. The table below present high stress polymer and high charge polymer difference.

	High stress polymer	High Charge polymer
Methanol in SDS?	YES	NO
Formaldehyde in SDS?	YES	NO
Formulation challenges?	YES	NO
Acrylamide monomer?	YES	NO
Chlorine consumption	YES*	NO
Fe and $CaHPO_4$ dispersion	Average	Excellent (HCP)

A very important change with High Charge polymer is related to chlorine consumption, traditionally the the high stress polymer and all polymer have chlorine consumption that increase free chlorine injection increase AOX, increase copper alloys and carbon steel corrosion. High charge polymer don't have chlorine consumption.

Background and action plan

One recirculating cooling system of the Northern Petrochemical Plant has been selected to implement first the High Charge Polymer instead of the high stress polymer used since many years. We have decided to start with the use of tagged High Charge Polymer with equivalent active polymer and to

monitor the follow up with 3D Trasar. 3D Trasar measures continuously the tagged high charge polymer with fluorometer, adjusts automatically the tagged high charge polymer dosage based on the high charge polymer demand. In the polymer replacement strategy, we have decided that after 6 months of use and validation a second step has been planned to try the use the higher dispersion capabilities to increase cycle of concentration.

Kommentar [BV1]:

The cycle increase strategy should be done with precaution as the cooling water system limiting factor are chlorides or other parameters and not really velocities or skin temperature of heat exchangers that can increase tri calcium scaling stress conditions that can be under control by high charge polymer.

Results

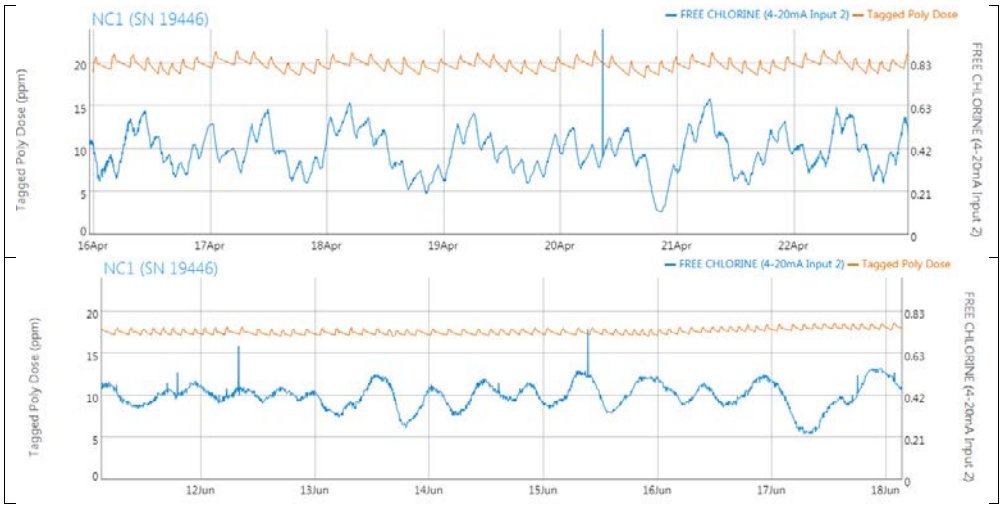
After several months of high charge polymer implementation, the results show that:

-The bleach consumption has dropped also that obliged operation to adjust free chlorine set point to decrease the impact of oxidants on copper alloys and carbon steel galvanic corrosion,

-High Charge Polymer (HCP) has provided the same performance than high stress polymer at lower dosage. For all recirculating cooling system where HCP is used we have noticed a dosage drop of 30% to 40% of consumption,

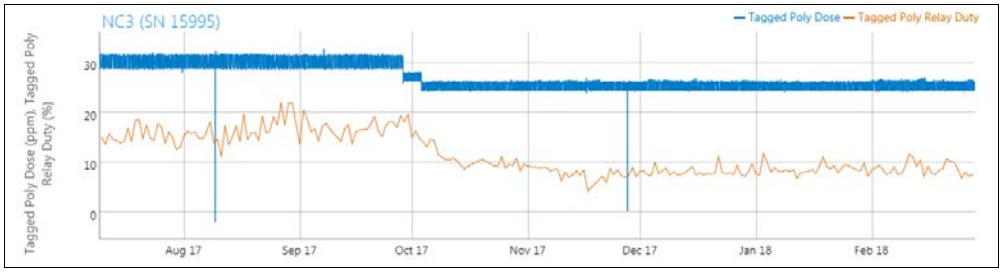
- The environment aspect with les dangerous substances and les AOX (less bleach injection). According to the regulation AOX is part of the cooling system blowdown component analysis.

Bleach consumption improvement



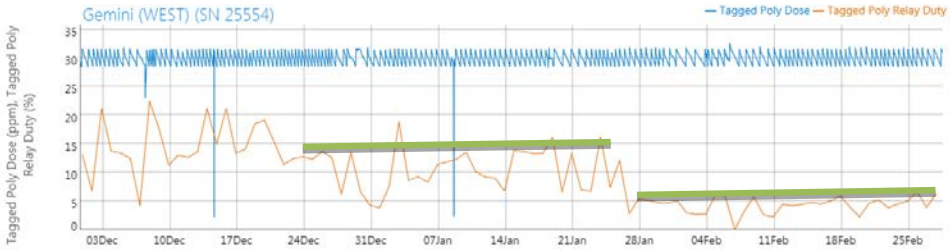
The graph above shows the difference regarding free chlorine variation and tagged polymer dose with tagged High stress polymer (graph above) and new high charge polymer (graph below). High charge polymer tagged dose has been decreased to 18 ppm and the free chlorine level has been also decrease to less than 0,5 ppm. The free chlorine trend show also much more stability.

Impact of implementation of high charge polymer



The graph above is coming from 3D trasar records coming from another recirculating cooling system of this northern petrochemical plant. The implementation of high charge polymer to replace the traditional high stress polymer help locally to lowering setpoint from 30 to 25 ppm with the new high charge polymer. The injection dropped from 40% and the injection dropped to from tagged polymer relay duty 18% to 10% .

VARIATION OF POLYMER INJECTION AFTER IMPLEMENTATION OF HIGH CHARGE POLYMER



The latest graph above is coming from the third recirculating cooling system. They have maintained the same set point for tagged polymer injection at 30 ppm (trend in blue color). The trend showed that the injection dropped from with (50%) or from relay (trend in green color)

Conclusion

The replacement of the high stress polymer by the new High Charge Polymer on the different recirculating cooling system of a Northern petrochemical plant has provided a polymer consumption decrease of more than 20% with a treatment cost reduction associated.

Higher dispersion performance at same active dosage and a lower bleach consumption. Free chlorine residual is more under control and be decreased to be lower than 0,5 ppm. This change has a strong impact on copper alloys corrosion and carbon steel galvanic corrosion.

The new HCP provides also a better Environmental impact with no formaldehyde or methanol presence as well a low AOX level in the cooling system blowdown.

High Charge Performance is a good replacement alternative of traditional high stress polymer to improve dispersion performance, decrease polymer injection, decrease bleach consumption, having better free chlorine residual under control and less corrosion impact on copper alloys and carbon steel (galvanic corrosion) and a strong environment improvement (less AOX in cooling water blowdown and absence of methanol and formaldehyde).

Background and action plan

Results