Chemical Treatment of Barometric Condenser Cooling Water Systems

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ABSTRACT

The application of cationic polymers to barometric condenser cooling water systems is described. Reduction of fats, oils, and greases from 900 ppm to 10 ppm in cooling water can be attained economically.

INTRODUCTION

Cooling water systems associated with the deodorization process for fats and oils are sometimes descriptively called Greasy Systems since the cooling water is heavily loaded with Fats, Oils and Greases, F.O.G. The F.O.G. loading is normally in the 500 to 2,000 mg/l range, although the loading may go much higher or lower.

The F.O.G. content of the cooling water is a source of constant problems. The F.O.G. clogs the distribution system and may totally pack the fill area of any "greasy" tower. This necessitates heavy maintenance loads. Steam cleaning and, at times, the total dismantling of the tower fill are common procedures utilized to clean the system. Since F.O.G.-loaded waters do not evaporate well and because of the tendency to promote pluggage, "greasy" cooling systems must be over-designed to handle the decrease in efficiencies. With the advent of strict EPA regulations, disposal has also become a problem. Since F.O.G. has a market value, any unrecovered F.O.G. can represent a considerable loss in revenues as well as penalties.

Obviously, a simple solution to the aforementioned is to separate and remove the F.O.G. from the cooling water system. Industry has consequently spent millions of dollars trying to develop such a program. Unfortunately, the chemical programs developed has been limited by the very narrowly defined parameters which have to be adhered to, and/or the extremely marginal results. The recent practice of physically separating the condenser and cooling tower water via heat exchangers keeps the F.O.G. out of the cooling tower. However, this approach does not alleviate and, in fact, may aggravate the disposal problem for plants that are hydraulically limited. The portion of condenser water that was once evaporated in the cooling tower must now be treated in the waste treatment plant. This approach can add an additional 25,000 gallons of water to the waste stream for each 1,000,000 pounds of oil processed. Other limiting considerations for this type of program include the 120% increase reported in energy consumption, as well as the capital investment required. Obviously, a F.O.G. removal program for cooling systems is needed that is economical and practical, effective with a wide latitude of operating parameters, and easily adapted to the needs of individual plants.

The following is a description of a F.O.G. removal program that fulfils all these requirements.

F.O.G. REMOVAL METHOD

The method utilized for F.O.G. removal with this program is simple. The F.O.G. is chemically demulsified, coagulated and flocculated in one simple step without requiring or resulting in a pH change. The resultant floc may be separated from the water via flotation, settling, filtration or centrifugation.

What is unique about this program is its adaptability and cost effectiveness. The F.O.G. content of the water may be reduced to as low as 1 mg/l as measured by Soxhlet Extraction with Freon or can be controlled at almost any level desired. The program may be fed continuously or on a slug basis. Elaborate dosage procedures or rigid pH controls are unnecessary. Economic considerations are equally attractive with the program costing less than the value of the F.O.G. recovered.

Drew Chemical Corporation developed this program in response to a need by industry. This program is based on the addition of a single componenet, AMERFLOC® 10, to the barometric condenser water cooling system. The initial "cleanup" slug is based on jar testing but will usually fall between 500 to 1000 mg/l, the lower dosage being more prevalent. The addition point is optional. Adding AMERFLOC 10 at the suction side of the circulation pump, however, will enhance the floc formation. The resultant floc will contain almost all of the original F.O.G. Subsequent additions may be fed continuously or intermittently to maintain the desired cooling water quality. The daily additions usually fall in the range of 50 to 200 mg/l. The variables in dosages are dependent upon the F.O.G. loading of the system as well as the method of floc removal.

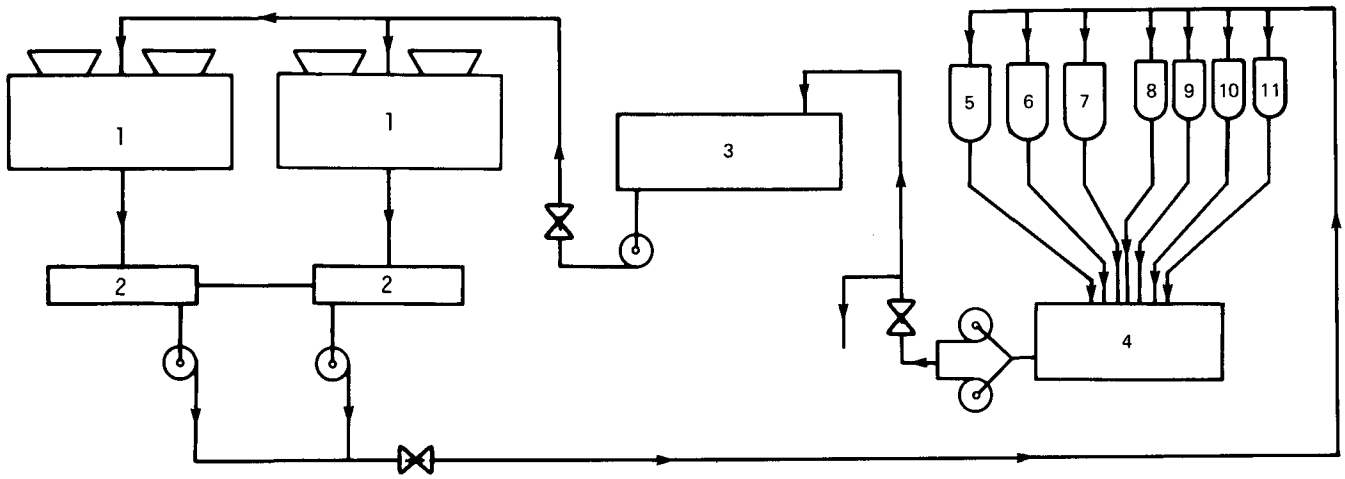
This program has been found to be extremely effective and forgiving. The resultant floc passes through the whole system (pumps, piping, spray nozzles, tower, etc.) without any detrimental effects. The reason for this is the floc's ability to form a microparticulate under shear agitation and rebuild in a more quiescent area. With proper separation of the floc from the water, a turbidity of 0.01 to 0.30 JTU can be obtained with this program.

Developing the F.O.G. removal program from the laboratory bench to field use was greatly enhanced through the efforts of Archer, Daniels, Midland in Decatur, Illinois. ADM supplied Drew with technical assistance and made available a barometric condenser water cooling system. Although several trials were conducted only one will be discussed.

The purpose of this trial was to investigate the feasibility of utilizing the F.O.G. removal program on a continuous feed basis. Previous trials has proven the program was operationally and economically feasible with intermittent slug feeding.

The plant trial was conducted on the barometric condenser water cooling system at ADM's West Refinery (Fig. 1). Untreated, the recirculating water in this system has an average F.O.G. loading of 900 to 1200 mg/l. The cooling tower was heavily fouled with two to three inches of F.O.G. on the splash fill and drift eliminators. The rest of the system was also fouled, the degree of fouling being related to location within the system and water velocities.

Enough AMERFLOC 10 was slug fed to the hot well to react with all of the F.O.G. in the recirculating water. The initial dosage was based on jar test results. AMERFLOC 10 was then fed continuously to the hot well via a small chemical metering pump. The continuous feed rate was determined by visually inspecting the recirculating water



1. Induced Draft Tower ΔT 30°F
   Temp. in 110°F, Temp. out 80-88°F
2. Tower Basin with skimmer capability (external)
3. Skimmer Basin
4. Hot Well
5. Four-stage steam ejector deodorizer (3 mm. pressure)
6. Four-stage steam ejector deodorizer (3 mm. pressure)
7. Four-stage steam ejector deodorizer (3 mm. pressure)
8. Two-stage steam ejector refinery dryer
9. Two-stage steam ejector bleach dryer
10. Two-stage steam ejector degumming dryer
11. Two-stage steam ejector acidulation

X. Level controlled throttle valves.

FIG. 1. Barometric condenser water cooling system (all pumps 5000 gpm capacity).

quality and varying the feed rate accordingly. The trial period covered, approximately, eighteen days.

RESULTS

The trial results were dramatic. The F.O.G. and C.O.D. loading of the recirculating water was reduced by over 99% and 75%, respectively. The appearance of the water changed from an opaque cream white to clear. The recovered F.O.G. handled easily and contained less water than usual, prior to the trial. The floc performed as predicted, passing easily through the system, and none of the floc appeared to adhere to any system surfaces. An unpredicted result of the trial was that the program cleaned up on-line approximately 60T of the F.O.G. fouling the tower splash fill and drift eliminators. The results of on-line cleaning were evident in other areas of the system as well, although not quite as dramatic. The trial also proved that the economics of a continuously fed program were very favorable with the program cost being less than the value of the increased F.O.G. recovered.

Several conclusions can be drawn from the results of the work done to date. The F.O.G. removal program can enconomcally and effectively provide a plant with *clean* barometric condenser cooling water. Utilization of the F.O.G. removal program may also provide a plant with better cooling efficiencies, reduced equipment maintenance, improved F.O.G.-handling characteristics and reduced sewer loading.

The F.O.G. removal program may also provide a means to reduce capital expenditures for new plant systems, since the cooling system will be much cleaner, thereby eliminating the need for gross over-design.

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