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A SURVEY OF ALFA LAVAL'S EXPERIENCE OF FOULING PREVENTION IN PLATE HEAT EXCHANGER SYSTEMS

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ABSTRACT

This paper will present some aspects on and experiences of fouled plate heat exchangers in industrial applications as well as the present status on a new tool to monitor heat exchanger performance and to predict future cleaning procedures.

INTRODUCTION

Fouling of heat exchangers in the process industry represents large amount of money in loss of energy and shortened equipment life time. Cleaning in place (CIP) is a normal built in procedure in any food process that is performed every day. In industrial applications, CIP has been scarcely used. Process heat exchangers have often been run until they have been required to be opened and cleaned manually, a both time consuming and dirty work.

An obstacle with CIP is to verify the cleaning result and to estimate optimal cleaning frequency. To tackle this Alfa Laval has developed a tool to measure the performance of a heat exchanger and to predict next cleaning session.

Alfa Laval has since long supplied CIP solutions for industrial applications to e.g. refinery and HPI industries but also in building services applications and central cooling plants. Experiences from this will be presented.

BODY

The different types of fouling that affects plate heat exchangers and how these are dealt with will be presented including examples of the most frequently used cleaning chemicals we use.

The design philosophy of a plate heat exchanger as compared to a shell & tube as to minimize the creation of fouling will be also be covered.

The Alfa Check tool for "fouling management" will be presented. With this tool, the heat exchanger performance is measured and the optimal performance based on actual operation parameters is calculated. A comparison of these two values decides if cleaning is necessary or not. By further measurements the time for next cleaning can be predicted.

Examples of different industrial cleaning problems

Refinery gas cooling. Two all welded plate heat exchangers operating in parallel as gas coolers in a refinery. Water cooling is made by water without any treatment. After 5 years of operation, a very low performance required some action. Units seamed totally blocked on cooling water side and had to be opened and cleaned with high pressure water jet before being cleaned by CIP. After cleaning only one gas cooler did the entire performance.

Air conditioning installation. A gasketed plate heat exchanger installed in an A/C plant in Australia. An Alfa Check measurement indicated that performance was down at 41% against optimum. A CIP was carried out after which a new performance check gave 96% output. A further performance check 40 days later gave 94% output and a predicted new CIP in about 3 month time.

Bitumen production. In a refinery that is specialised in production of bitumen, which is used as asphalt, eight shell and tube heat exchangers were replaced by all welded plate heat exchangers due to severe fouling and cleaning problems. These are installed in:

A) Atmospheric distillation: 3 units for cooling kerosene and gas oil

B) Vacuum distillation: 3 units for gas cooling and condensing

C) Oxidizing tower: 2 units for bitumen heating and interchanging

Previously the shell & tubes had to be opened every year for inspection and cleaning. This took one week per unit and cost almost EUR 10 000 per unit. With the exception of one unit the plate heat exchangers do not have to be opened for cleaning. Cleaning of these units is done by CIP with 3% NaOH every third year. This operation takes less than a day at a cost of less than EUR 1 000 per unit. Only the bitumen interchanger has to be opened every year for manual cleaning by HP water jet. This operation takes two days.

Central cooling. Four large Plate Heat Exchangers working as central coolers, each 561 m2 surface installed in a petrochemical plant. Cooling water is taken from the Baltic Sea. An Alfa Check measurement showed an optimum performance of 19.8 MW per unit but actual was only 12.8 MW, i.e. 65%. The loss of the 7 MW represents an energy value of some 8 000 US$ per day! Although a theoretical figure, the combined loss of energy for all four heat exchangers represents a significant amount of lost money each day.

Refinery naphta condensers. In a refinery four all welded plate heat exchangers are in operation as top condensers since 1997. The exchangers are installed at the atmospheric distillation tower and are used for condensing and cooling the overhead stream of "virgin naphtha" which is composed of C1 to C9 fractions. A total of 16.5 MW is recovered to boiler feed water and crude oil feed. The units are cleaned by CIP on the condensing side only, as follows. Caustic is being circulated at 80C to remove HC related fouling. Then sulfamic acid is used to remove salts, e.g. FeS. Finally sodium carbonate is used for neutralisation and passivation of the CS piping. A final rinse with water is carried out before units are taken back in operation.

CONCLUSION

Our experience is that it is possible to maintain the performance of Plate Heat Exchangers even in heavy fouling applications with CIP only. It requires a properly designed system including high enough channel shear rate. One problem is to be able to predict the appropriate time for CIP to optimize the heat exchanger performance and eventually to avoid open up the heat exchangers due to too heavy fouling, a labour intensive, dirty and time consuming exercise. This problem we have solved with the Alfa Check tool.

Another problem is to find the right cleaning solutions and procedures for demanding applications, without affecting the heat exchanger, especially if it is gasketed plate heat exchangers. A systematic build up of experience based on trails that are controlled by performance measurements is our way to successfully tackle difficult fouling problems in industrial process heat exchangers.

For the future we can see a shift towards more environmentally friendly cleaning methods, an issue that is exemplified in another Alfa Laval paper. We also anticipate further developing and simplifying performance monitoring.