FLOWNEX®
SIMULATION ENVIRONMENT

BOILER HEADER CRACKING

As part of the repowering of a power station Steinmüller is tasked with the optimization of the boiler sub-system. This included a study to determine the reasons for regular Platen Evaporator header cracking. Platen Evaporator Header cracking in the boiler can cause unnecessary and costly down time due to maintenance of the power plant. Steinmüller used Flownex to dynamically simulate the flow and heat transfer over the platen evaporator and determine the possible reasons for header cracking.

POWER INDUSTRY

CUSTOMER PROFILE:

Steinmüller is an innovative engineering services provider operating in Southern Africa for over 45 years. With the global backing of the Bilfinger-Berger Group they excel at developing, implementing, optimising and maintaining industrial plants using state-of-the-art technologies.

CHALLENGE:

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SOLUTION:

Flownex proved that with its two-phase capabilities, momentum conservation, and ability to simulate dynamically the seemingly complex model of the platen evaporator was handled quickly and efficiently providing engineers with dynamic graphs of the flow within the evaporator tubes and the effects brought on by phase change.

From this study the source of oscillations were isolated along with other factors that could have caused the headers to crack i.e. mal temperature distribution that will lead to buckling of the platen evaporator.

This allowed the company to make decisions on how optimize this sub-system and reduce header cracking.

"Extremely valuable during commissioning phase, average of 2 hours turnaround time"

Philip Oosthuizen,
Senior Process Engineer,
Steinmuller Engineering Services

BOILER PLANT PLATEN EVAPORATOR HEADER CRACKING

INTRODUCTION

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CHALLENGES

A thermal-hydraulic simulation model should be created that incorporates all the geometrical data of the evaporative platen flow circuit. This model should be capable of calculating gas/water coupled heat transfer along with the pressure drop encountered during the various stages of heating and boiling of the fluid. A schematic representation of this model is shown in Figure 1.

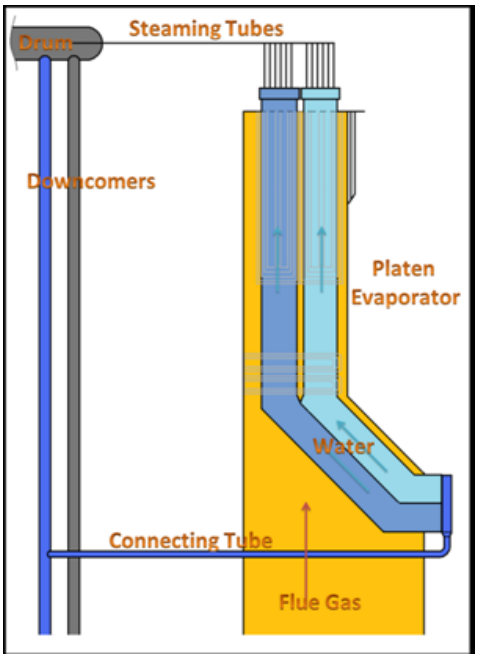

Figure 1: Schematic representation of the simulation model.

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SOLUTION

By modelling the coupled heat transfer, an accurate prediction of the heat distribution over the length of the platen evaporator is made. The heat absorption is then used to calculate the density difference on the water side that drives the natural circulation. Other fluid and metal properties are also calculated in order to predict the mode of boiling heat transfer and two-phase flow pattern.

The heat transfer modes of interest in this model are:

- Sub-cooled boiling,
- Saturated nucleate boiling,
- Critical heat flux point (Dryout point),
- Transition boiling,
- Film boiling.

A dynamic simulation of the system was performed in order to capture the instability that might be present in the platen evaporators. Instabilities that might influence the system are:

- Flow reversal / stagnation (which might lead to dryout or waterhammer),
- Flow pattern instability (slug flow, slug to annular transition),
- Heat transfer instability (post dryout heat transfer i.e. transition boiling)

A dynamic simulation of the system was performed in order to capture the instability that might be present in the platen evaporators.

Figure 2 shows the mass flow rate of various tubes in the platen evaporator. It is seen that none of the tubes shows a negative or low mass flow rate, thus it can be assumed that no flow reversal or stagnation takes place.

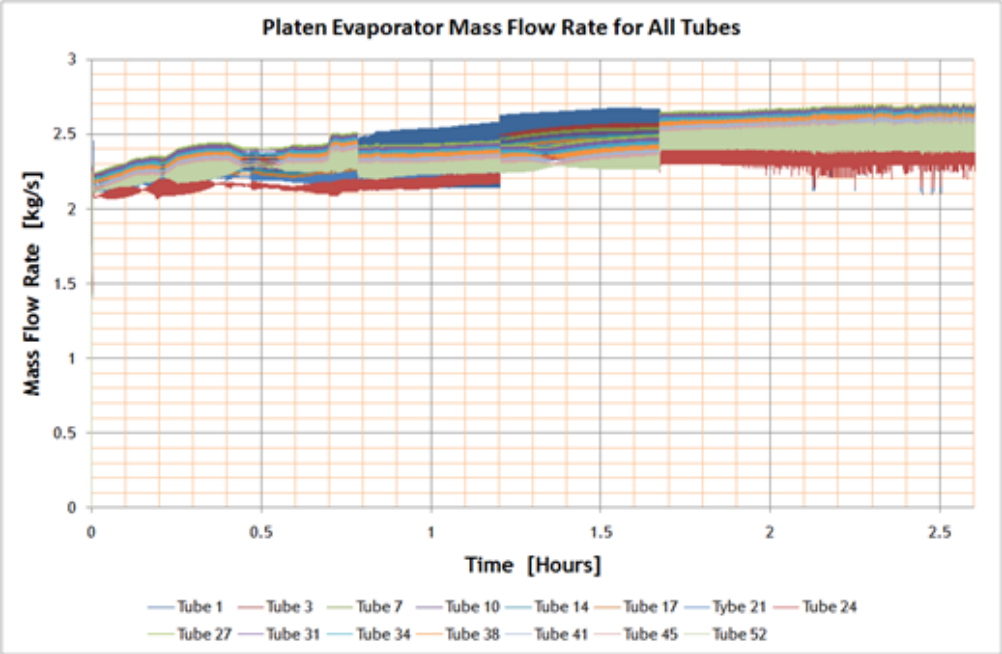

Figure 2: Mass flow rate of various tubes for the "As Build" design case.

Figure 3 shows the mass flow rate of a single tube for various case studies. The different case studies refer to various feed piping and extraction piping diameters. It is seen that oscillations are present for all the case studies, with the exception of case 8. Case 8 is only a theoretical case that was investigated to quantify a "no-oscillating" system.

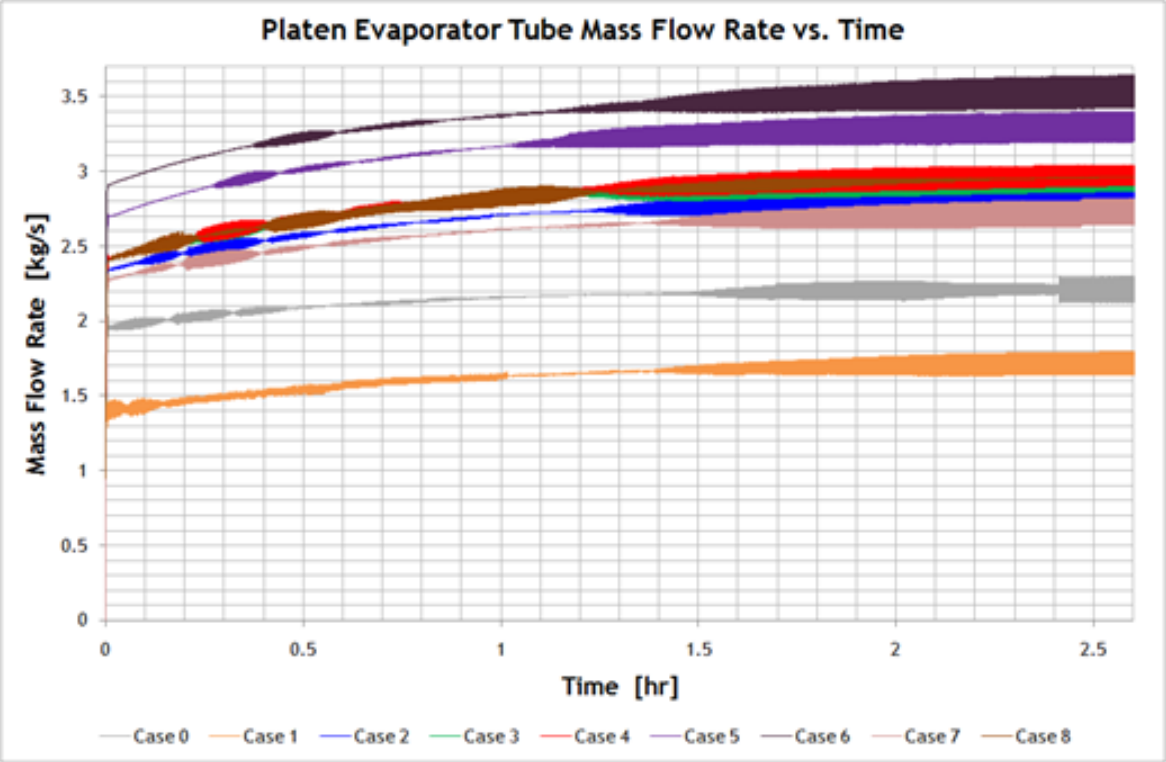

Figure 3: Tube Mass Flow distribution for Case 0 - 8.

RESULTS

Flownex proved that with its two-phase capabilities, momentum conservation, and ability to simulate dynamically the seemingly complex model of the platen evaporator was handled quickly and efficiently providing engineers with dynamic graphs of the flow within the evaporator tubes and the effects brought on by phase change.

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