# Erosion Investigation of Liquid-Solid Two Phase in Wide-channel Welded Plate Heat Exchanger

**Libo Ren[1], Manli Zhang[2], Hailan He[3], Xinyan Wang[4] and Limei Zhang[5]**
1. Phd, R&D Engineer,
2. Chief Executive
3. Chief Engineer
4. Sales Manager
5. Export Manager
Shanghai Heat Transfer Equipment Co., Ltd, Shanghai, China
Corresponding author: renlibo@shphe.com



**Abstract**

In the wide-channel welded plate heat exchanger, the two-phase flow characteristics and the wall erosion in the channel with existence of cylindrical objects was studied. The finding shows that the liquid velocity around the cylindrical objects increases sharply and consequently the erosion on the plate surface surrounding the cylindrical object is accelerated, and the erosion rate increases with the increase of inlet velocity and wall roughness. Compared with the smooth wall, the particles impact the rough wall with higher energy and higher frequency, leading to faster erosion. Therefore, it is important for equipment user to keep appropriate inlet flow velocity, monitoring function of strainer, setting up effective CIP (cleaning in place, CIP) mechanism and observing heat exchanger performance regularly, so as to prolong service life of the equipment.

**Keywords:** Erosion, Foreign objects, Wide-channel welded plate heat exchanger.

## 1. Introduction

In the alumina production, the stability of sodium aluminate solution greatly restricts its precipitation yield. Because of the controllability, cooling system has become the most effective means to regulate the precipitation process and improve the precipitation yield while maintaining the alumina quality at the desired levels. The wide-channel welded plate heat exchangers are widely applied in alumina precipitation process thanks to its advantages of high heat transfer efficiency, compact structure and small footprint. The wide-channel welded plate heat exchangers are often used in process industry where medium contains solid particles or fiber suspensions due to its smoother channel structure than conventional heat exchanger. Nevertheless, when there are foreign objects in the channels, such as precipitation of aluminum hydroxide or bottle caps (Figure 1(a)), solid particles would accelerate erosion of heat transfer surfaces (Figure 1(b)). According to the statistics, equipment life could be shortened by about 1 / 3 to 1 / 2 when foreign objects exist. Therefore, it is of great significance to study the erosion in the liquid-solid two-phase flow field in the channels with unexpected foreign objects, so as to guide the design and the operation of the wide-channel welded plate heat exchanger.

The erosion rate caused by the slurry in the wide-channel welded plate heat exchanger is slow, and the experimental measurement has disadvantages like long period and difficulty in obtaining accurate erosion information, therefore, in this article, the Euler-Lagrangian model is applied to study the influence of erosion rate in the area surrounding foreign objects caused by flow velocity and surface roughness, and then to provide information for the design and operation of the wide-channel welded plate heat exchanger for equipment manufacturer and user respectively.

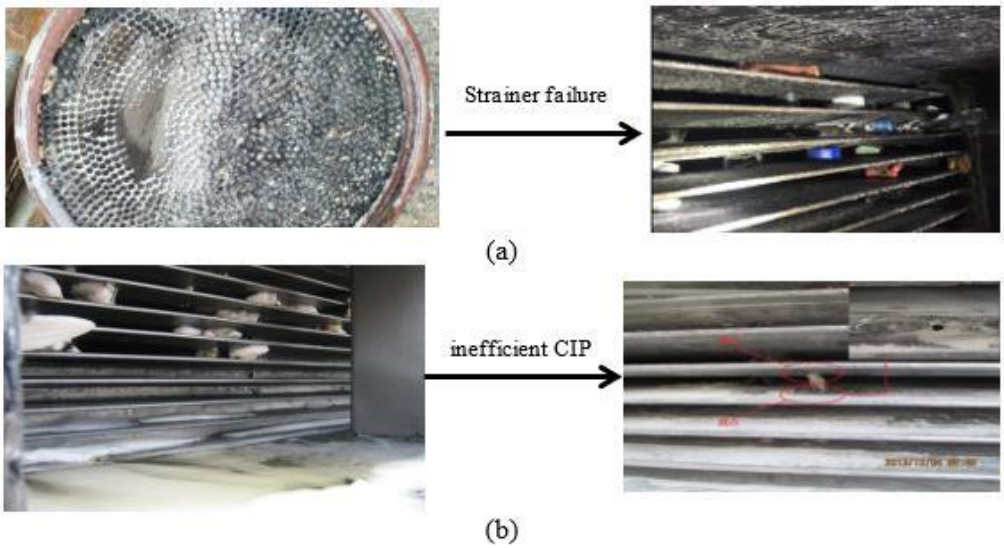


**Figure 1. Foreign objects.**

**Figure 2. Eroded plate by foreign objects.**

## 2. Governing Equation

Euler method was applied to describe liquid phase flow while Lagrange method is applied to describe particle movement. For single solid particle, Oka erosion model [1,2] was used to compute the wall erosion rate by sparse particles in liquid-solid two phase stream by volume removal rate of the target plate wall caused by solid particles per unit mass ($mm^3/kg$).

## 3. Simulation Method

The size of the computation domain was 1200 mm (length) × 30 mm (width) × 12 mm (height), and the foreign object was the bottle cap with a size of ϕ 27.9 mm × 12 mm. The density and the viscosity of liquid was 1200 $kg/m^3$ and 4.0 cP respectively and the density of solid particle was 2400 $kg/m^3$. The finite volume method was used to solve the liquid governing equation and the coupled algorithm was used for iterative computation.

## 7. References

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