# Experimental verification of LPB and SCP systems in University of Limoges

## 1. Background

Elgressy Engineering Services Company specializes in development, production and marketing of water and wastewater treatment equipment. Two systems, SCP and LPB, were last developed by Elgressy Engineering Services engineers. SCP system is based on a controlled release of trace concentrations of metal ions, which are capable of inducing a scale suppression effect. SCP system aids primarily to prevent $CaCO_3$ scale deposition in a large number of applications such as cooling towers, reverse osmosis systems, heat exchangers, mini bars, washing machine and so on. In addition, SCP system enables to reduce chlorine concentration in water and to prevent corrosion.

The LPB system is an electrochemical system intended for destroying Legionella *Pneumophila* bacteria in hot water systems. This process is free of chemicals, environmentally friendly and does not cause corrosion in the water systems.

Electrochemical verification of LPB and SCP systems was performed in University of Limoges by Dr. Alex Drak and Eng. Gaby Elgressy in collaboration with Prof. Guy Matejka, Director Patrick Leprat and water & environment engineer David Chaisemartin.


**Fig. 1**: University of Limoges

## 2. Objective

The aim of the experiments performed in University of Limoges was to show the ability of SCP system to prevent scale deposition and the ability of LPB system to reduce the concentration of different types of microorganisms that could be often found in water.

## 3. Experimental techniques

### *3.1. SCP scale prevention test*

Scale prevention test was performed using SCP experimental system (Fig. 2). This system consists of feed tank, SCP unit, two kettles, centrifugal pump, two flow meters, temperature probes and control panel that includes power supply and temperature controllers. This system simulates scaling the heated flow of hard water in the tank and enables to compare between two streams treated with and without SCP system at the same hydrodynamic and fouling conditions.

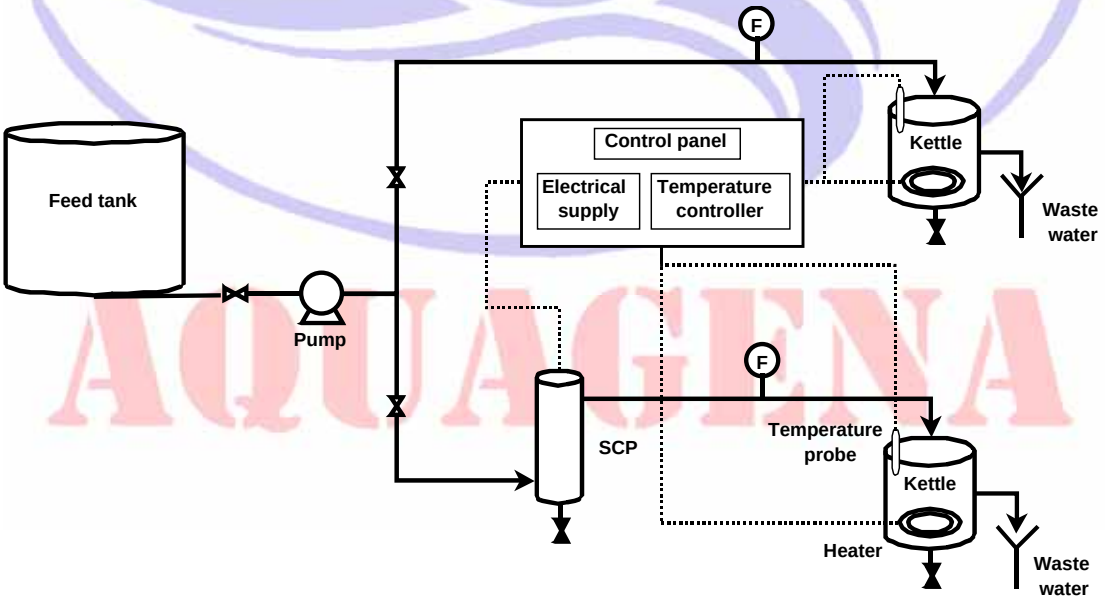


**Fig. 2:** SCP experimental system for scale prevention test

Feed water was prepared in 300 liter feed tank. Approximately 27g of $CaCl_2 \cdot 2H_2O$ was mixed with tap water of University of Limoges. The final chemical composition of the feed water is shown in Table 1.

**Table 1**: Chemical composition of feed water for SCP test

| Parameter | Value |
|---|---|
| Temperature, $^oC$ | 55 |
| PH | 8.2 |
| Total Alkalinity, mg/L as $CaCO_3$ | 85 |
| Calcium, mg/L | 57.6 |
| Sodium, mg/L | 9.1 |
| Potassium, mg/L | 1.0 |
| Magnesium, mg/L | 0.9 |
| Chloride, mg/L | 8.5 |
| Nitrate, mg/L | 1.5 |
| Sulfate, mg/L | 3.5 |
| LSI | 1.0 |

Test was performed as follows. Feed water was continuously pumped through the two kettles simultaneously at flow rate of 40 L/hr for a period of about 4 hours. One of the streams, before entering the kettle was treated by SCP unit. The temperature inside the kettles was kept constant at 55$^o$C. The inhibitory effect of SCP system was evaluated by visual comparison between kettles treated and non-treated with SCP system. SCP unit was operated at electric current of 80 mA. The major parameter that characterizes scaling tendency of hard water is Langelier Saturation Index (LSI). This test was performed at LSI of 1.0.

### *3.2. LPB assessment test*

LPB system was tested by examination of the ability of LPB system to generate chlorine. The experimental system, used in the experiment, is shown in Fig. 3.

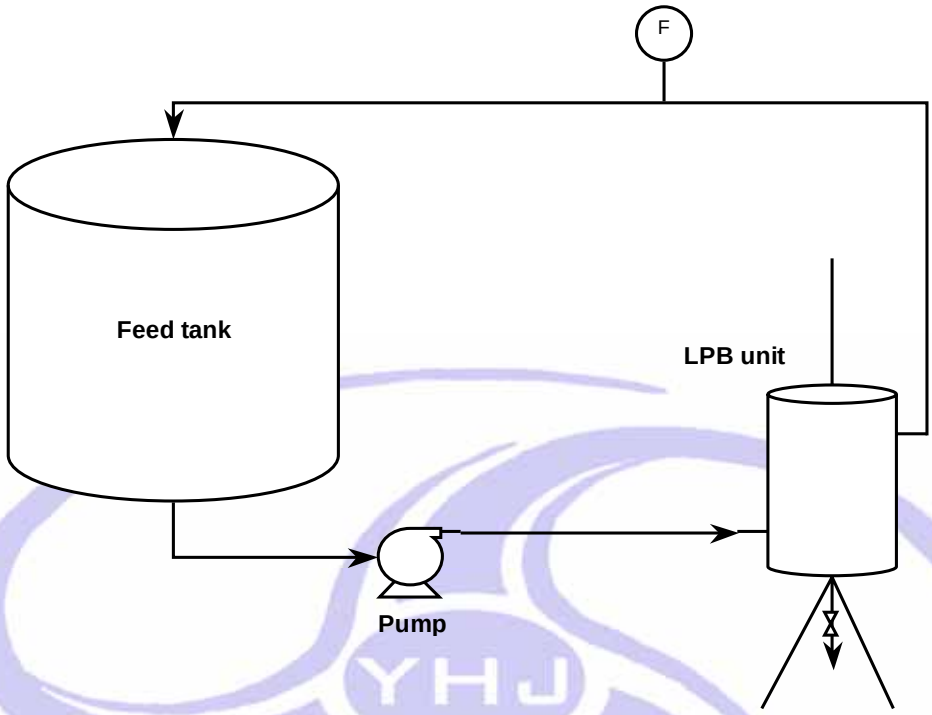


**Fig. 3:** LPB experimental system

The Limoges tap water was used as feed water for LPB test. 1000 liter of tap water was prepared in feed tank. Centrifugal pump was connected to the feed tank and forced the prepared solution to flow through the LPB system. The effluent stream of LPB system was returned to the feed tank. The flow rate through the LPB system was kept constant at 500 L/hr and electric current of LPB system was 8 A.

The concentration of chlorine was measured at the inlet and outlet of LPB system unit HACH DR2400 spectrophotometer.

## 4. Results

### *4.1. SCP verification test results*

SCP scale prevention test was carried out in experimental system shown in Fig. 2. Feed water was pumped through the two electrical kettles. Feed water of one of the kettles was pretreated by SCP unit. Water temperature in the kettles was kept constant at 55$^{o}$C that corresponds to LSI = 1.0. SCP unit was operated at electrical current of 80 mA.

The inhibitory effect of SCP system was evaluated by visual comparison between kettles treated and non-treated with SCP system. Figure 4 and 5 show the state of electrical kettles before and after test.

(a) without SCP treatment (b) with SCP treatment

**Fig. 4:** State of the kettles before test

(a) without SCP treatment (b) with SCP treatment

**Fig. 5:** State of the kettles after test

It can be seen clearly that kettle treated by SCP unit remained clean after test, while kettle not treated by SCP unit was covered by thin layer of $CaCO_3$. This result definitely shows the ability of SCP unit to prevent $CaCO_3$ scaling.

### *4.2. LPB verification test results*

LPB assessment test was carried out in experimental system shown in Fig. 3. Feed water was pumped through the LPB system at flow rate of 500 L/hr.

After 5-minute stabilization time, chlorine concentrations at the inlet and outlet of LPB system were measured. The inlet concentration of chlorine was 0.09 mg/L. The outlet concentration of chlorine was 1.96 mg/L. Thus LPB system produces 1.87 mg/L of free chlorine at flow rate of 500 L/hr and electrical current of 8 A. Chlorine production presents only 10% of oxidants that LPB produces. The rest oxidants produced in LPB system are ozone, hydrogen peroxide, oxygen and a few radicals (Table 2).

**Table 2**: Oxidants produced in LPB system

| **The anodic reactions obtained near the electrodes (anodes)** | |
|---|---|
| Chlorine | $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ |
| Ozone | $O_2 + 2OH^- - 2e^- \rightarrow O_3(g) + H_2O$ |
| Oxygen | $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$ |
| Hydrogen Peroxide | $2H_2O - 2e^- \rightarrow H_2O_2 + 2H^+$ |
| Radical Oxygen | $H_2O - 2e^- \rightarrow O^0 + 2H^+$ |
| Radical $OH^0$ | $OH^- - e^- \rightarrow OH^0$ |
| Radical $Cl_0$ | $Cl^- - e^- \rightarrow Cl_0$ |

This result shows the potential ability of LPB system to destroy most of microorganisms often found in water.

Dr. Alex Drak

October 27, 2006