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Influence Of Copper And Zinc On The Power Furring Of Encrusting Water

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Abstract

In calcareous soils, the underground water of Hamma carry significant concentrations of calcium hydrogencarbonate. For a content of 59 ° F waters were very hard and out have to be in a treated softening way or decarbonation before the use, because lead to phenomenes of scaling. The precipitation of an insulating layer of calcium carbonate on the walls of the water distribution have serious consequences technique and economic. In this work we studied the effect of copper and zinc on the precipitation of calcium carbonate by using the test of rapid controlled precipitation (RCP) and scaling tests on polyethylene. The test of rapid precipitation controlled in the presence of metal cations (Cu, Zn) at low concentrations (0.5mg/L of Cu^{2+}, 0.15mg/L of Zn^{2+}), retarted the precipitation of calcium carbonate.The test of scaling on polyethylene in the presence of Cu and Zn reached an efficiency of 100%. This reflects the pronounced inhibitory effect of these ions.

Keywords: $CaCO_3$; Inhibition; Zn; Cu; RCP; Polyethylene.

I. Introduction

Water natural, industrial or of consumption contains ions calcium and carbonate, likely to cause phenomena of scaling in the installations, which conducted [1, 2] with serious failures obstruction of the drains with weakening of the flows, filling of the membranes, loss of effectiveness of the exchangers of heat, limit the efficiency of these devices (valves and taps) by decreasing the flow rate in the pipes. Various methods were used to prevent or limit the capacity furring of water [3] the chemical methods which implement of the inhibitor which to block the germination of the crystals of calcium carbonate [4-5], and electrochemical techniques like : chronoamperometry [6-8], impedancemetry [9,10] and electrogravemetry [11].

In this work, we wish to present a study performed to quantify the scaling power of a

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drinking water Hamma (locality situated near the city of Constantine) in the presence of metallic cations (Cu, Zn) by rapid controlled precipitation (RCP) tests and scaling tests on polyethylene.

2. Material and methods

2.1. Rapid controlled precipitation (RCP) tests

According to Ledion et al. (1985) [12]. In order to precisely characterize the scaling power of water, the principle of the test is to bring the degree of supersaturation between 20 and 30.To do this, promoting the agitation by degassing of CO_2 dissolved in water, there is an increase of pH due to the increase of OH^- ions formed by accordingly. There is production of ions CO_3^{2-} which react with Ca^{2+} to form of $CaCO_3$.
These tests are used to follow the kinetics of nucleation-growth process of calcium carbonate in water determined. It compares the power of waters of different furring origins. A supersaturation of 20 to 30 Ks, we can put into action the phenomenon of nucleation-growth of calcium carbonate.
The measured efficiency must incorporate both the nucleation and growth phases. The test time is therefore fixed end the area between the resistivity curves for treated and non treated water is compared to the area beneath the resistivity curve for non treated water the efficiency E is then defined by :

$$E(\%) = \frac{\int_0^t (\rho_{NT} - \rho_0)dt - \int_0^t (\rho_T - \rho_0)dt}{\int_0^t (\rho_{NT} - \rho_0)dt} 100$$

ρ_0 : initial resistivity, ρ_{NT} : resistivity of the untreated water, ρ_T : resistivity of the treated water at time t.

2.1.1. Procedure

The experimental device is represented in Fig. 1.
The two containers are cleaned before use in a hydrochloric bath of acid diluted to 50 % then rinsed with water of Hamma. are employed with magnetic stirrer rods. The rods can be rotated at a speed up to 800 rpm. The pH and electrical conductivity are measured using pH-meters and conductimeter respectively.
The electrodes of the pH-meter and the conductimeter are rinsed with the water distilled before each measurement. The electrodes of the pH-meter and the conductimeter are rinsed with the water distilled before each measurement.To test a antiscaling treatment with Cu (0.5, 1, 2) mg/L, Zn (0.15, 0.175, 1.5) mg/L, we proceed by comparing treated water and non-treated water. One treated water and non-treated water which are then taken to the same temperature 30°C in a thermostatic bath.

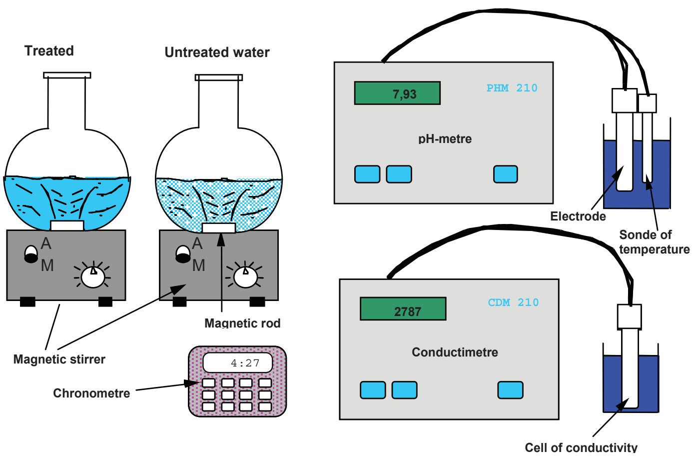

Fig. 1. Experimental device used in the process of rapid controlled precipitation

2.2. Scaling tests on polyethylene

2. 2. 1. Material used

The experimental set-up is described in Fig. 2. The simple is a polyethylene tube (diameter = 75 mm, height = 50 mm, thickness = 1 mm, weight = 12 g)) [13]. It is immersed in 700 cm^3 of water test that is contained in a beaker of austenitic stainless steel. The volume is mixed by a magnetic bar rotating at 600 rpm.

The samples were cleaned before use with dilute hydrochloric acid at 50%. They are then rinsed with tap water and demineralized water. They are dried in an oven at 50 ° C for 20 min in a ventilated oven. They are stable at least 40 min before being weighed. The weighing is performed on a balance accurate to a tenth of milligram. The tests on the water of Hamma are accomplished on batteries from 4 to 5 samples per type of water where in each test, one compares the water of reference (rough) by type of water treated with copper or zinc with ambient temperature 20°C during 15hour or at 50°C during 2,5hour. The number of samples can be increased to have a good precision.

The process of scaling based on a few steps such as:

• The first which consists in filling to 700 ml the stainless steel of raw waters and treated with copper or zinc and to place them on magnetic stirrers at 600 tr/min.

• The second which consists in placing the samples that one weighed on their lids, are introduced into water and the test is put thus on the way.

• the third stage one stops agitation and one removes the lids.Using a grip, one recovers the samples, one makes them dry with the drying oven at 50°C during 20 min. The setting at rest during 40 min. One carries out the weighing of the samples then.

Evaluation of the efficiency

The mass deposited for each sample. We calculate the averages for treated water and untreated water.
Efficiency is defined by the relation:

$$E\% = \frac{m_b - m_t}{m_b} \cdot 100$$

with mb is deposited mass for raw water;
mt deposited mass for treated water.
The treatment has an antiscaling effect for a positive efficiency, if not the effect is accelerating.

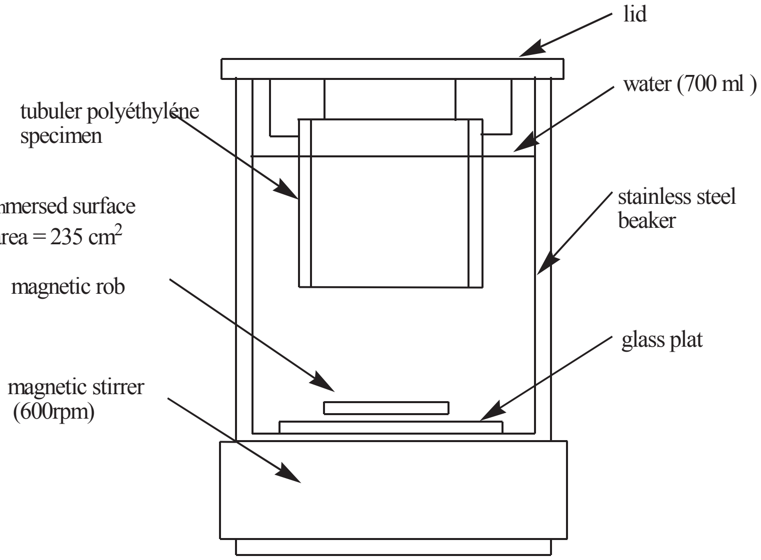

Fig. 2. Experimental device for the tests of scaling on polyethylene.

3. Results and discussion

3.1. Physico-chemical characterization water of Hamma :

We have the physico-chemical results of analysis obtained on water Hamma, (Table ,1).

Table 1: Analysis of water of Hamma.

parameter	Water of Hamma
T, °C	30-32
pH	6.95-7.40
CE, mS/cm	0.89-1.06
O_2 dissous mg/L	7.55
HCO_3^-, mg/l	340-360
TH, mg/l $CaCO_3$	515-590
Ca^{2+}, mg/l	158-168
Mg^{2+}, mg/l	29-41
Cl^-, mg/l	125
SO_4^{2-} mg/L	278

It should be noted that the water of Hamma is naturally rich in minerals. Moreover, it contains calcium and magnesium. Therefore, it is of high hardness.

3.2. Rapid controlled precipitation (RCP) tests

This method was used to study the variation of scaling potential of water due to zinc and copper additions in the form of zinc and copper sulphate for different concentration, Zn (0.15, 0.175, 1.5) mg/L, Cu (0.5, 1, 2) mg/L.
We note that the pH of the untreated water generally decreases before that of the treated water (delay in precipitation) and decreases faster (difference in precipitation kinetics) when using Zn and Cu as inhibitors of scaling. Fig (3, 4) and Fig (5, 6). It may be noted that this method of pH is most sensitive to delays in the precipitation (weak difference in kinetics). As shown on Fig (7, 8) the effectiveness was equal to 100% when the water contained 1.5 mg/L of Zn and 2mg/L of Cu.
The rate of precipitation of Ca^{2+} and CO_3^{2-}, indicated by the slope of the resistivity curve, is considerably reduced.
The tests carried out at 30°C and in the presence of zinc gives a curve of increasing efficiency as a function of the added quantity. Fig. 9
It is seen that with an addition of 0.150 mg/L of Zn, the effectiveness reaches 50 % and from 1 mg/L the blocking of the process of germination - growth of calcium carbonate is more significant.
The inhibitory effect of copper is produced from 0.5mg/L Fig. 10. The effect of zinc, it is important to not that it is more pronounced because blocking is done for definitely lower contents.

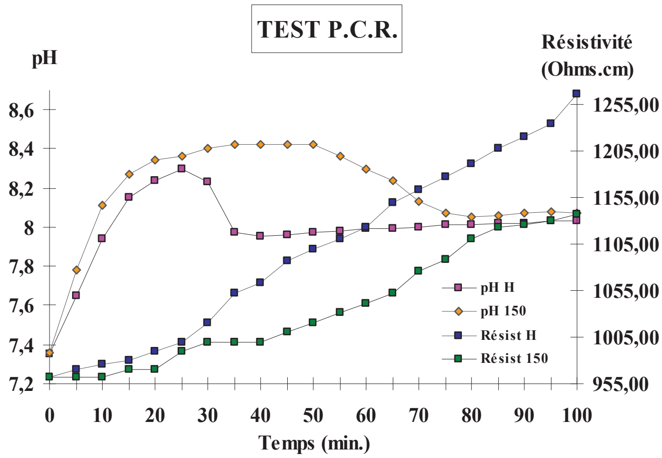

Fig. 3. Curves RCP (pH and resistivity) after addition of 0.150 mg/L of Zn

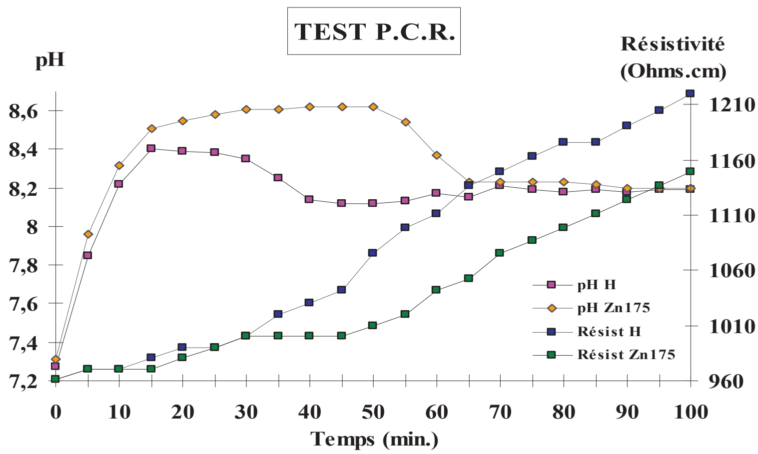

Fig. 4. Curves RCP (pH and resistivity) after addition of 0.175 mg/L of Zn

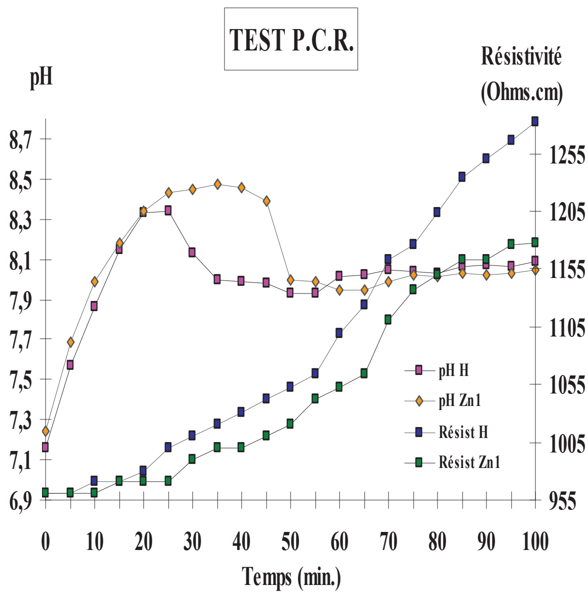

Fig. 5. Curves RCP (pH and resistivity) after addition of 0.5 mg/L of Cu.

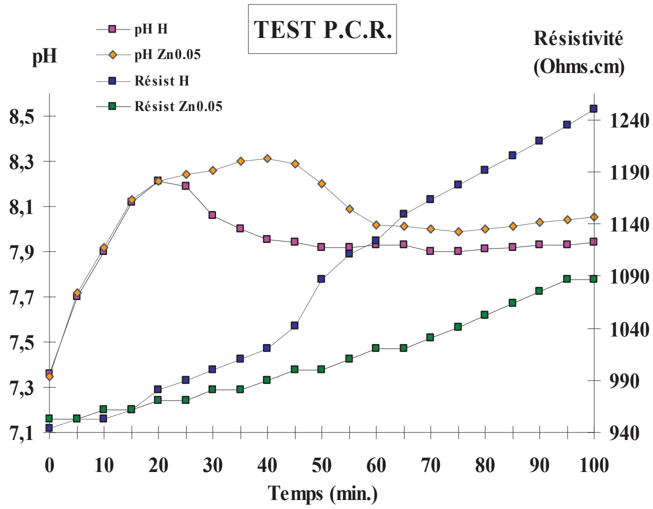

Fig. 6. Curves RCP (pH and resistivity) after addition of 1 mg/L of Cu.

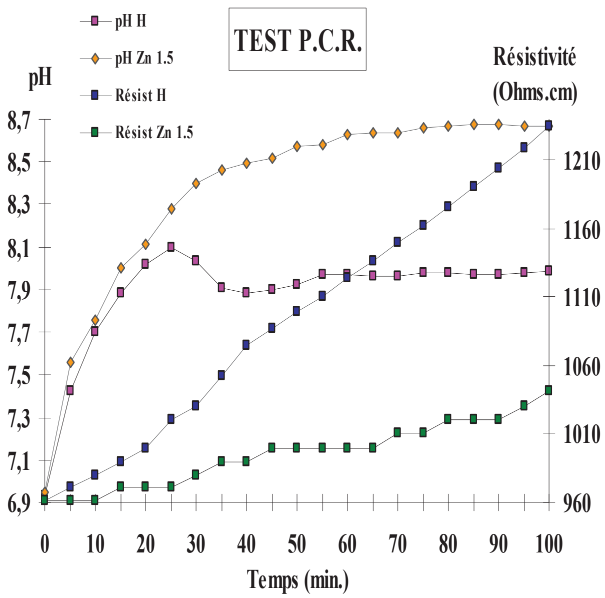

Fig. 7. Curves RCP (pH and resistivity) after addition of 1.5 mg/L of Zn

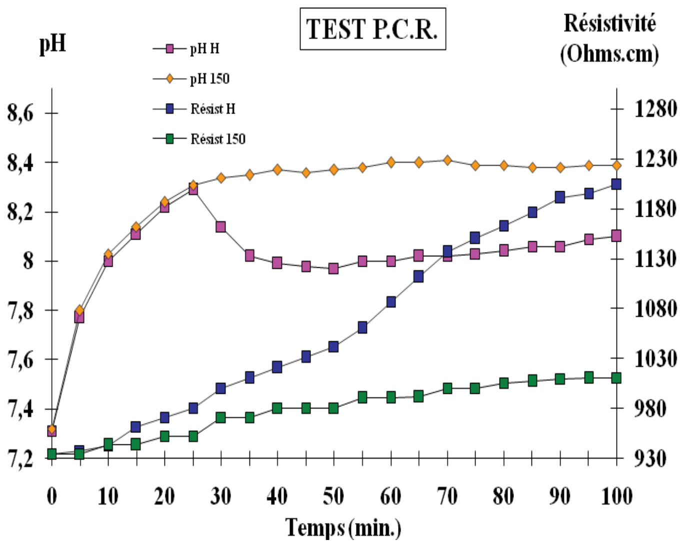

Fig. 8. Curves RCP (pH and resistivity) after addition of 2 mg/L of Cu.

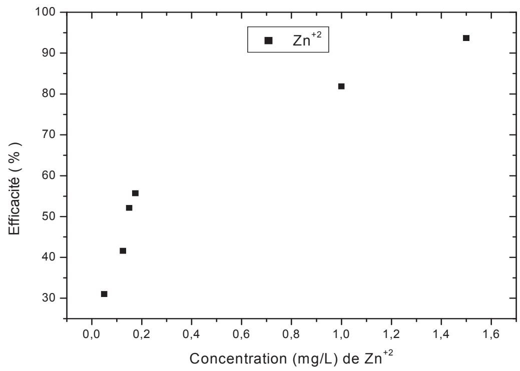

Fig. 9. Evolution of the efficiency according to the concentration of Zn.

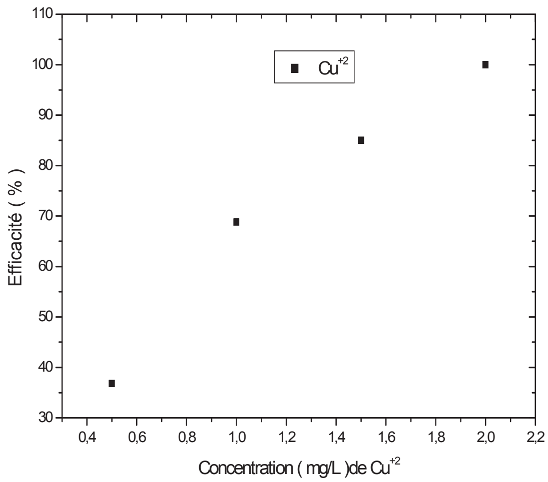

Fig. 10. Evolution of the efficiency according to the concentration of Cu.

3. 3. Scaling tests on polyethylene

Fig (11-12) shows the results of the tests with copper at 20° C and 50° C.
It can be seen that a total efficiency (100 %) from 1 mg/L for the tests carried out at ambient temperature. At 50°C scaling is almost completely inhibited for copper concentrations greater 1.5 mg/L.
The results obtained on zinc Fig (13-14) indicate its greater effectiveness against scaling. At 20° C the addition of 0.8 mg/L of zinc is enough to block the process of germination - growth of $CaCO_3$ and thus to block scaling.
When working at 50° C the total effectiveness is reached to 1 mg/L.

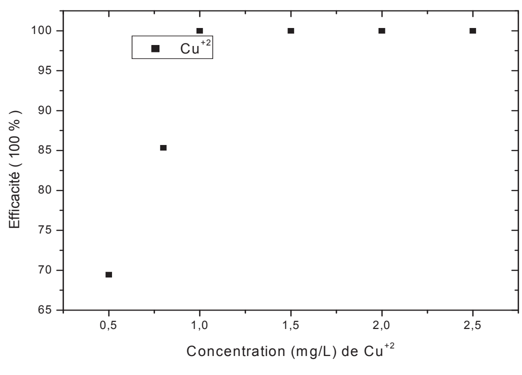

Fig. 11. Influence of Cu^{+2} addition on scaling of polyethylene at 20° C.

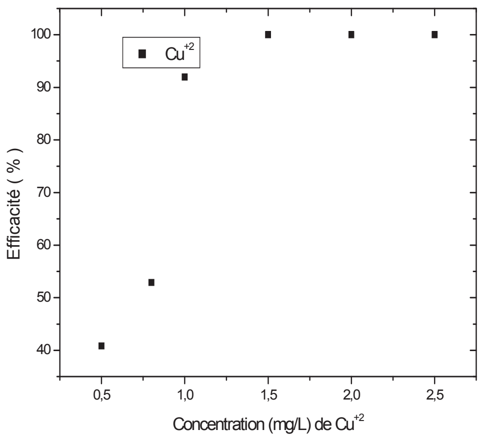

Fig. 12. Influence of Cu^{+2} addition on scaling of polyethylene at 50° C.

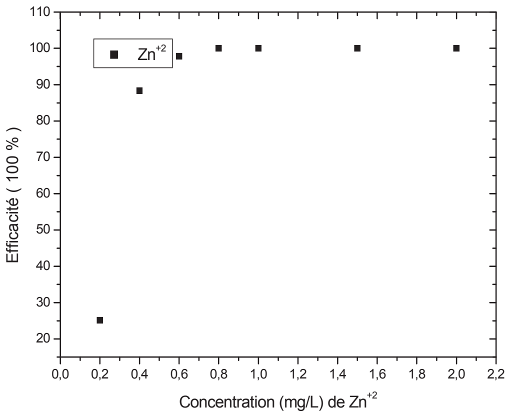

Fig. 13. Influence of Zn^{+2} addition on scaling of polyethylene at 20° C

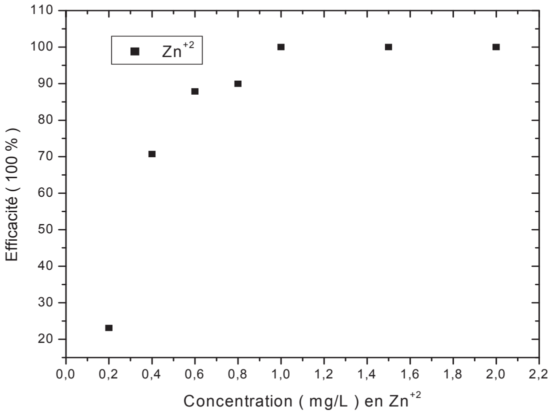

Fig. 14. Influence of Zn^{+2} addition on scaling of polyethylene at 50° C.

4. Conclusions

The test of rapid controlled precipitation made it possible to implement the process of nucleation-growth of calcium carbonate.
The addition of metal ions at low concentrations (0.5mg/L of Cu^{2+}, 0.15mg/L of Zn^{2+}), showed their considerable role for the antiscaling effect.
Inhibition is total for quantities of copper about 2 mg/L or 1.5 mg/L for zinc, while remaining in the standards of potability.
The use of the test of scaling on polyethylene also revealed the inhibiting effect of Cu and Zn.
We improved the test on polyethylene by considering experiments at ambient temperature at 20°C during 15hour and 50°C during 2.5 hour. The total blocking of the scaling of Cu and Zn appears with (1mg/L Zn and 0.8mg/L Cu) at 20°C and (1.5mg/L Cu and 1mg/L Zn) at 50°C. That is confirmed by a calculation of effectiveness which atteind 100%.

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