

## SCALING PLUG PROBLEMS OBSERVED IN SOME CERRO PRIETO GEOTHERMAL PRODUCTION WELLS.

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### ABSTRACT.

Accelerate scaling problems in some Latina-Calpine wells in Cerro Prieto geothermal field have been causing high steam decline productions in short time. Well 614 began to show high steam production decreasing, only seven months after was connected to the power plant system, therefore were done many operations on this well, like orifices plate diameter changes to try to remove the scaling plug formed inside of it. However, it was not possible, because was necessary to repair it, cleaning production casing and open hole production interval, the production recovered after the workover was around 90 % of the original production conditions. During second well 614 production period, was observed accelerate scaling plug, due to was necessary to repair it again, the production recovered after this second workover was around 90 % of the original production conditions.

Other fast scaling obstruction events were found in well 629, it started the production period in September 97, five months later began to show a high decline steam production, losing around 50 % its capacity, some action conducted to close and open the well, finally the well could remove the scaling plug, reaching similar production level of the original production.

This paper shows five examples about scaling plug problems in wells drilled on the Cerro Prieto reservoir, usually the scaling plug problems are associated to zones where produce more steam flow rates than water flow rate.

### INTRODUCTION.

Cerro Prieto is one of the highest geothermal reservoir in the world, there are around 130 production wells, distributed over approximate area

of 15 Km<sup>2</sup>, Figure 1. The flow fluids in the reservoir is controlling mainly by a structural system trend NE-SW. The major steam production amount is supply by wells drilled in Cerro Prieto II, III and IV areas. Many of these wells were producing initially from beta upper aquifer zone, whose depth are between 1500 to 3000 m. The geothermal fluid quantity required for generate the 620 MWe of the capacity installed is about 11,000 t/h mixture flow, composed by 4500 t/h steam flow and 6500 t/h water flow, approximately.

Several processes have been identified in reservoir zones, the production of high steam-water flow amounts had been long, then it is causing reservoir pressure drawdown, resulting that the high temperatures in the reservoir began to boil (A. H. Truesdell, M. J. Lippmann, et al.). A direct reflex of the drawdown pressure and boiling process in beta upper reservoir it is the steam excess that several wells complexed in this reservoir zone producing (Truesdell, et al., 1992).

Reservoir boiling is accompanied by deposition of minerals (calcite and quartz) in the reservoir. If this mineralization is dispersed it is harmless, but if it is localized around wells it can cause formation plugging (Truesdell et al., 1984; Johnson, 1989).

Excess steam therefore represents flashing in the subsurface within the formation (J. Beall, et al., 1997).

Gutiérrez Puente and Mendoza (1995), have noted that silica scaling in the formation and wellbore is consequence of subsurface boiling, it is the primary cause at Cerro Prieto of accelerate production and wellhead pressure decline.

J. Beall; et al., (1997), explain that Most of Latina-Calpine wells participate in a reservoir process

whereby boiling eventually results in dry steam feed zones in the upper part of the well's productive intervals. this is accompanied by increasing enthalpy.

Similar explanation was point out by J. Ocampo; et al 1997, because several Latina-Calpine wells repaired found clean the production casing without significant scaling, since the main scaling problem was in the reservoir zone near to the well bottom .

**SCALING PROBLEMS OBSERVED ON WELLS**

The Cerro Prieto brine has around 30,000-ppm solid solved. These solids when the fluid loses pressure, are usually deposited, sometime inside of production casing, and many others in the production zones near to the reservoir-well bore interfaces.

There are several cases on Cerro Prieto wells, where are simply to see scaling plug problems that cause declining production characteristics; however is not possible to show all these cases in this paper, therefore were selected five wells with different loose steam production as consequence of scaling formation plugging.

➤ **Well 609**

Well 609 started its productive period on November 91 (Figure 2), it has been showing local boiling process into reservoir around it during all production time (about 9 years), it boiling process has been caused scale deposition and plugging of reservoir zone and production down hole, therefore was necessary to repair it, making a deepening production zone, in May, 1996. After was workovered, 609 was hook up again to the power plant system with 56.66 t/h steam flow rate initial and orifice plate diameter of 2 1/2 "Ø, immediately it began to shows by itself increase on steam production, until to reach values of 70 t/h , after it began to shows high tendency to decrease of steam flow rate, therefore the well was choked using a orifice plate diameter of 2 5/8 "Ø, due to it showed a steam production recovery, however from May 98 the decreasing tendency was clear, changing seriously from May 99, it stop to flowing on January 2000, the last steam production measured on this well before to stop to flowing was 20 t/h.

**Well 609 Orifice Plate Diameter Changes Statistical**

| Productive Period | ΔØ (inches) | # Production Months |
|-------------------|-------------|---------------------|
| Nov 91 to May 93  | 2 1/2       | 18                  |
| Jun 93 to Apr 95  | 2 3/4       | 22                  |
| May 95 to Jun 97  | 2 1/2       | 25                  |
| Jul 97 to Feb 98  | 2 5/8       | 8                   |
| Mar 98 to Apr 99  | 2 3/4       | 13                  |
| May 99 to Dic 99  | 3           | 8                   |
| Total             |             | <b>94</b>           |

➤ **Well 614**

Well 614 originally was connected to power plant system on March, 1994, however after was producing for 7 months began to shows an abnormal behavior decreasing from 70 t/h initial steam flow rate to 13.10 t/h steam flow rate, along 12 production months. As consequence of lost steam production, it was repaired , one year after be drilled, during workover activities was found scaling into 9 5/8 Ø production casing and partially inside of 7 "Ø casing. The scaling founded was analyzed and it was composed by silica and sulfides mainly. The workover done in it well included the deepening of the original production zone.

After was hook up to the power plant system, it has been supplying steam for 18 months, the well begins to shows again a clear steam flow rate decreasing tendency from September 97, therefore was necessary to do some orifice changes diameter for try to remove the scaling plug inside the casing around the flashpoint. However lower steam production was reached on January 98, around 14 t/h, therefore was necessary a second workover (Figure 3) .

**Well 614 Orifice Plate Diameter Changes Statistical**

| Productive Period | ΔØ (inches) | # Production Months |
|-------------------|-------------|---------------------|
| Mar 94 to Sep 94  | 3           | 7                   |
| Oct 94 to Jan 95  | 2 1/2       | 4                   |
| Feb 95            | 2 1/8       | 1                   |
| Nov 95 to Apr 97  | 3           | 18                  |
| May 97to Sep 97   | 3 1/8       | 5                   |
| Oct 97            | 2 1/2       | 1                   |
| Nov 97 to Dec 97  | 1 3/4       | 2                   |

|                  |       |           |
|------------------|-------|-----------|
| Feb 98 to Apr 99 | 3 1/2 | 15        |
| May 99 to Oct 99 | 3 3/4 | 4         |
| Sep 99 to Dic 99 | 4     | 2         |
| Total            |       | <b>59</b> |

➤ **Well 618**

The well 618 started the productive period on July 94, the initial steam flow rate was 67 t/h, it has been showed a clear productive decreasing tendency, and 21 month later the steam production reached values about 33.57 t/h, therefore it well was deepened, on April 96, it was hook up to the steam supply system, after was producing steam for 36 months it began to shows scaling plug problems, Figure 4.

**Well 618 Orifice Plate Diameter Changes Statistical**

| Productive Period | ΔØ (inches) | # Production time months |
|-------------------|-------------|--------------------------|
| Nov 91 to May 93  | 2 1/2       | 18                       |
| Jun 93 to Apr 95  | 2 3/4       | 22                       |
| May 95 to Jun 97  | 2 1/2       | 25                       |
| Jul 97 to Feb 98  | 2 5/8       | 8                        |
| Mar 98 to Apr 99  | 2 3/4       | 13                       |
| May 99 to Dic 99  | 3           | 8                        |
| Total             |             | <b>94</b>                |

**Well 627**

Well 627 is a typical case like 614 of new well that lost the steam flow rate capacity faster, since it started the productive period in October 97, with 55.46 t/h initial steam flow rate and 2 5/8 "Ø orifice plate diameter, the steam production showed a highest declining, because five months later changed to 33.44 t/h, as consequence it well was take out of the steam supply system, and sidetrack drilling a new productive 8 1/2 "Ø open hole.

Several changes have been observing in it well, because in April 99, the steam production increased by itself from 57.32 t/h to 66.93 t/h (ΔWs = 9.61 t/h), and August, 99, one month later after be done an increase the orifice plate diameter from 3 1/2 to 3 3/4 "Ø it shows again increase steam flow rate from 55.15 t/h to 79.53 t/h (ΔWs= 24.38 t/h), Figure 5.

**Well 627 Orifice Plate Diameter Changes Statistical**

| Production Period | ΔØ (inches) | # Production Months |
|-------------------|-------------|---------------------|
| Oct 97 to Feb 98  | 2 5/8       | 5                   |
| Apr 98 to May 99  | 2 3/4       | 14                  |
| June 99 Dec 99    | 3 3/4       | 7                   |
| Total             |             | <b>26</b>           |

➤ **Well 629**

Well 629 started the production period on September 97, with 68.12 t/h initial steam flow rate, and 3 1/8 "Ø orifice plate diameter, after was producing 4 months with similar steam level production, it began to shows a clear decreasing steam tendency, to reached steam flow rate values about 40 t/h during 8<sup>th</sup> production month, then were done several try to remove the scaling plug formed in the casing (assumption), therefore it well was choked and opening using several orifice plate diameter, this kind of discharge test with different mixture flow rate, caused finally a removeing the scaling -plug formed, and the steam production increased itself suddenly until to reach values of 84.10 t/h, with 3 1/2 "Ø orifice plate diameter, Figure 6 .

**Well 629 Orifice Plate Diameter Changes Statistical**

| Productive Period | ΔØ (inches) | # Production time months |
|-------------------|-------------|--------------------------|
| Sep 97 to Feb 98  | 3 1/8       | 6                        |
| Mar 98 to Apr 98  | 3           | 2                        |
| May 98 to Apr 99  | 3 1/2       | 12                       |
| Jun 99 to Dec 99  | 3 3/4       | 8                        |
| Total             |             | <b>32</b>                |

DISCUSSION AND FINAL REMARKS.

Production behavior of wells 609, 614, and 627 point out faster scaling plugging, these are observed on drastic changes on steam, water flow rates and production enthalpy values. Changes on water production on well 609 can be associates to local boiling reservoir process, the pressure reservoir

drawdown caused due to exploitation, let to cold water inflow to the reservoir exploitation zones.

The production characteristic in well 627 were affected initially because the feeding zone had a restriction by one "big fish", it caused a faster productive declining. It is important to know that this well has a directly productive response increase, associated with almost any seismic event occurred on Cerro Prieto area.

wells 614 and 629 are good examples of typical scaling plug problems in short productive time, wells 608 and 618 show first a standard productive behavior and finally in three productive years the scaling plug problems cause damage on productive flow rates levels.

Acid treatment of geothermal wells has been a reliable technique for recover the production of geothermal wells in Philippines, affected by silica scaling deposition (B.C., Buñing, R.C.M. Malate, et al, 1997), this kind of alternative could be tested on Cerro Prieto wells with scaling plug problems.

#### CONCLUSIONS.

1. Were revised 32 well production history of CPLatina wells Located On Cerro Prieto geothermal field, drilled between 1990 to 1997, almost all them showed decline steam flow rate as consequence of scaling
2. The scale deposition into the reservoir zone near to the wells down hole zone, is the main problem that usually affect the production capacity of Cerro Prieto wells, severa silica fouling in the production wells is a major impediment to well operation, and extreme maintenance problems results.
3. The workover done on wells that lost totally or decreasing the steam flow rate as consequence of scaling plug problem, have been shown that with a new production zone it is possible to recover good steam production.
4. The only way to prevent boiling (and possible formation plugging) over long periods of production time on the wells could be the injection of liquid into some reservoir zones. Other alternatives could be the exploitation of deeper reservoir zones saturated with more water amount than steam amount, finally some times the wells operation with high wellhead pressure may delay the boiling process into the well down or reservoir zone.

5. The experience acquired in wells operation have been allowed to implement a routinely task on all those well with scaling plug problems doing shorter and faster discharge test, choking the well for some time period, and then open the wells (reducing the choking) using several orifices plate diameter, it has been let to eliminate the soft scaling plug formed, as consequence of the pressure and mixture flow changes, then the normal production condition has been recovery, avoiding a possible workover, well 629 is the more representative case of this situation.

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### WELL 614 STEAM FLOW RATE

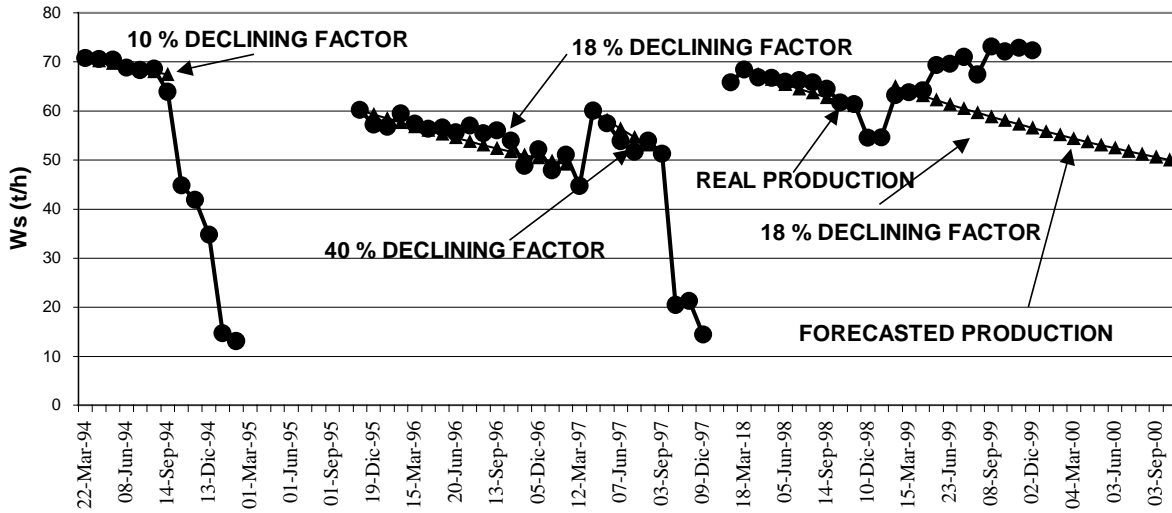


Figure 3 Well 614, Steam Production Behavior

### WELL 618 STEAM FLOW RATE

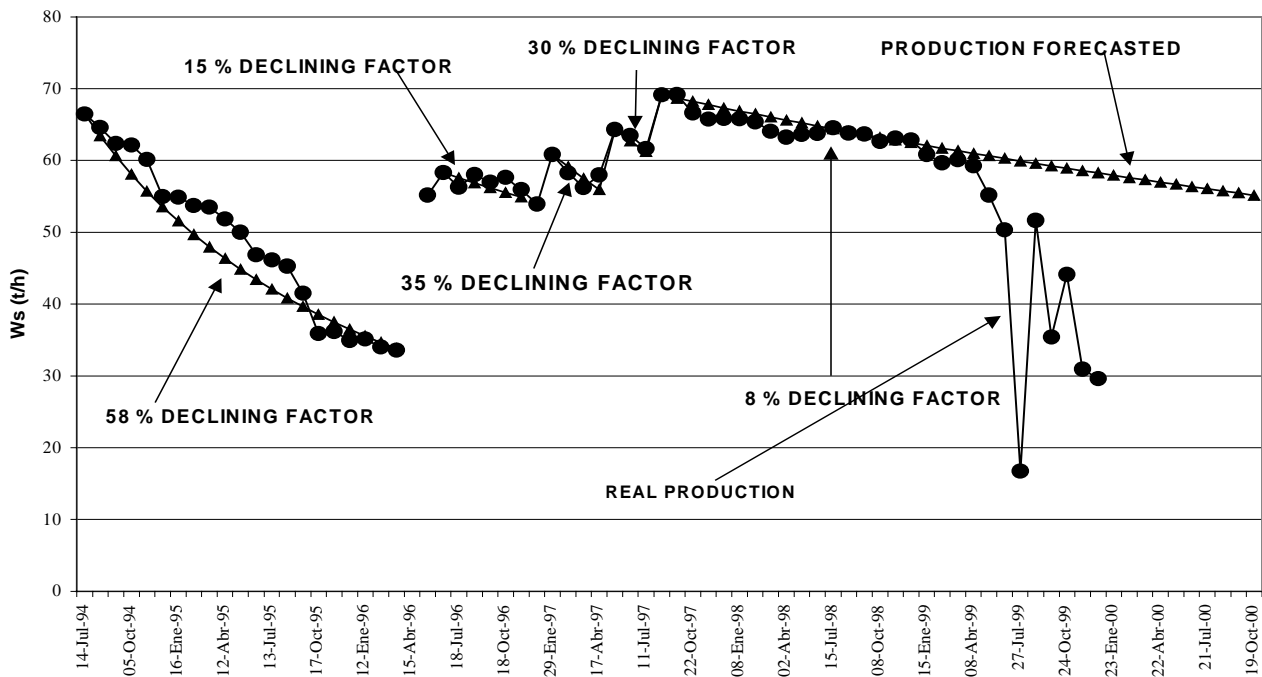


Figure 4 Well 618, Steam Production Behavior

### WELL 627 STEAM FLOW RATE

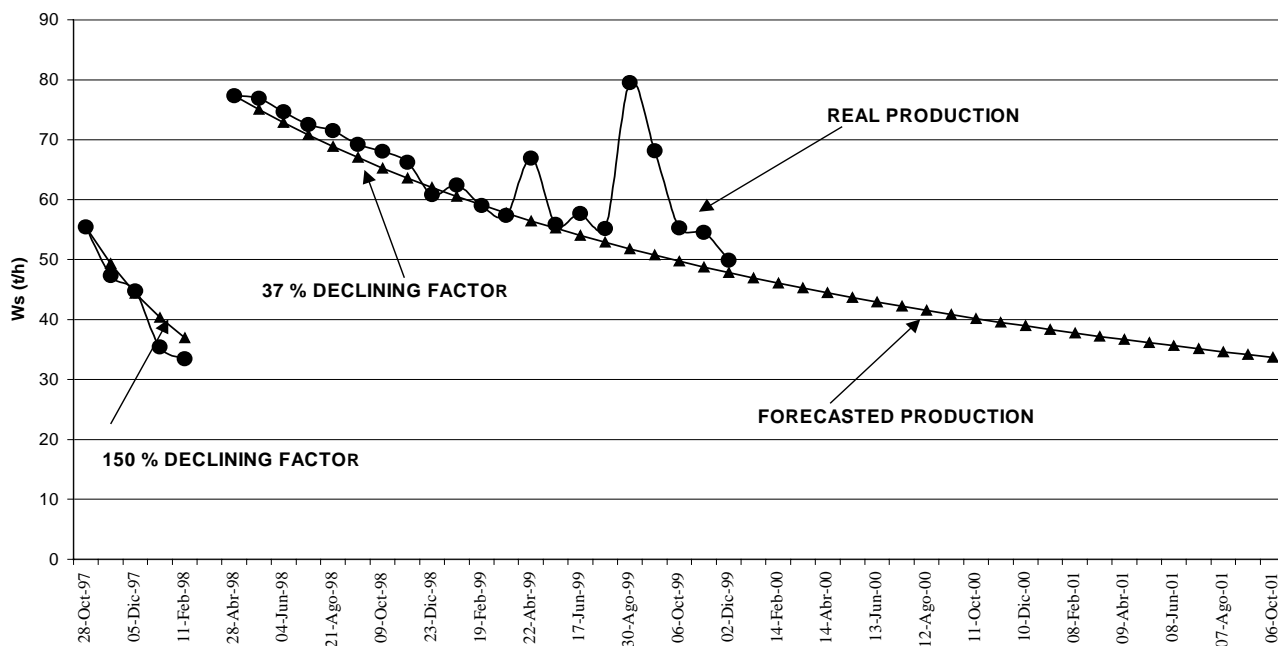


Figure 5, Well 627 Steam Production Behavior

### WELL 629 STEAM FLOW RATE

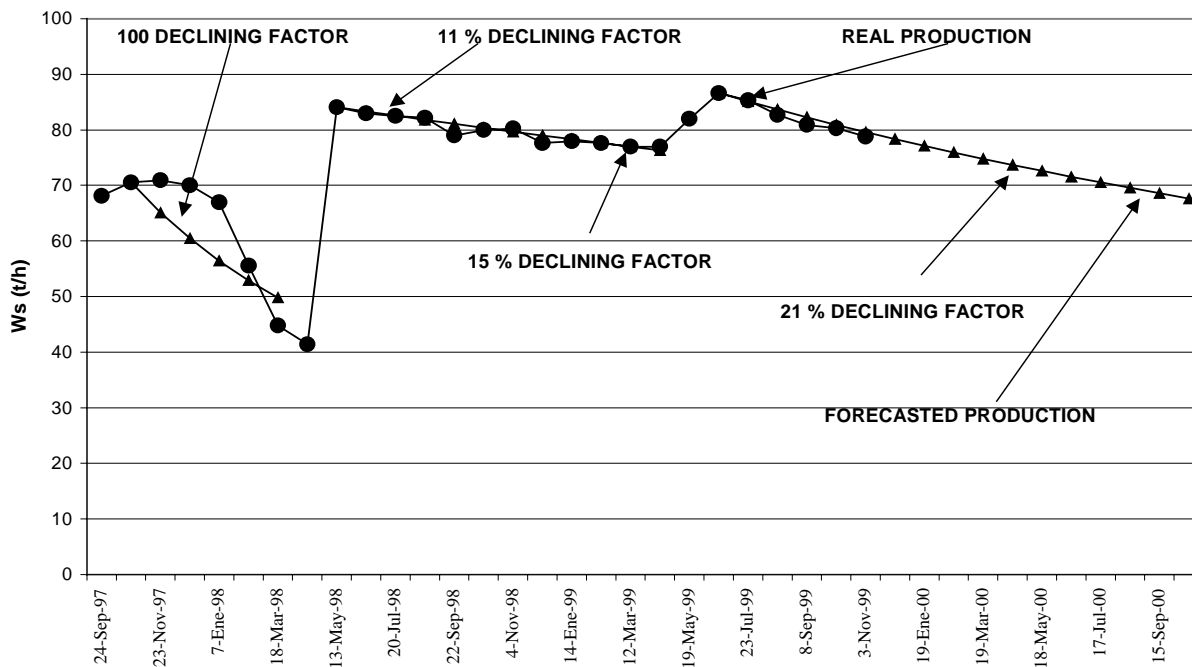


Figure 6, Well 629 Steam Production Behavior