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ENHANCING A LOW ENTHALPY WELL FOR PRODUCTION: THE TONGONAN EXPERIENCE

Marie Hazel B. Colo, Romeo P. Andrino and Edwin H. Alcober

Energy Development Corporation
One Corporate Center, 38F Julia Vargas cor. Meralco Ave., Ortigas Center
Pasig City, 1605, Philippines
e-mail: colo.mhb@energy.com.ph

ABSTRACT

The paper presents a recent experience in Tongonan, Leyte in the application of production technology to enhance a low enthalpy well for production.

The procedure was applied to a deep well drilled at the outflow of the Upper Mahiao sector in the Leyte Geothermal Production Field. Deep well drilling is one of the resource management strategies implemented in Tongonan, Leyte to sustain steam requirement to power plants. This approach aims to produce from the deeper, liquid region of the reservoir, in order to better distribute extraction between the shallow two-phase region and deep resource allowing liquid recharge to Tongonan reservoir.

However, commercial production of the new well was a challenge during its discharge testing. Evaluation of the discharge data showed that the well is mainly producing fluids with low enthalpy which hinders it from attaining the target high commercial well head pressure (WHP), unlike the neighboring wells producing from the two-phase region. Thus casing perforation and acid injection were conducted to avail of the hotter zone behind the cased-off part and to initiate some contribution from the two-phase region leading to its successful production and commissioning to the system.

INTRODUCTION

The Tongonan geothermal area is one of the two hydrothermal systems that encompassed the Leyte Geothermal Production Field (LGPF) in the north central of the Leyte province. It is composed of four sectors, namely – Tongonan, Upper Mahiao and the Malitbog – South Sambaloran each supplying to their respective power plants.

Commercial production in the Tongonan area commenced in 1983 and full scale development took off in 1996. After about 15 years of commercial extraction in the area, pressure drawndown and reservoir boiling were among the challenges encountered affecting the steam supply from the Tongonan area. And in order to augment steam supply requirements to the Tongonan power plants, one of the management strategies implemented is drilling of new make-up and replace wells to target the deeper liquid resource of the area.

WELL UM-A DRILLING

The first deep well drilled to the north of the Tongonan reservoir is well UM-A located at the Upper Mahiao sector (Figure 1). Deep well refers to the latest drilling strategy being implemented in the Leyte Geothermal Production Field (LGPF) that intends to utilize the deeper, liquid zone of the resource for production (at least 500m deeper than most existing wells). In contrast to the older wells that generally has low water fractions having tapped the highly two-phase zone as a result of drawndown after several years of extraction. Other benefits expected from this strategy are minimized production sharing from the upper region of the reservoir, deep heated liquid recharge to the central portion of the field and additional information gathered on the deep reservoir of the Tongonan geothermal field.

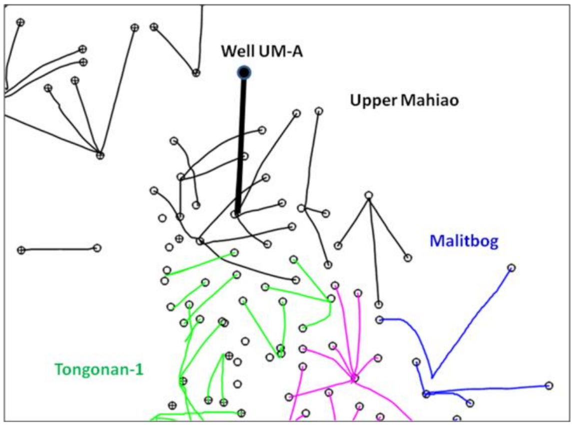

Figure 1: Well UM-A Location Map

Drilling Background

Well UM-A was the fifth well drilled from the pad situated at the central portion of the Upper Mahiao sector. The well was drilled during the second to third quarter of 2010 with the surface and anchor casings depths completed as programmed, while the production casing and the slotted liner were set shallower by 100m than target attributed to total loss circulation of drilling fluids.

The well targeted the deep section of the northern portion of the area intersecting five geologic structures, two within the 12-1/4" hole section and three in the 8-1/2" open hole section. Of the three structures in the open hole section, two were proven to be productive in nearby wells and the last one near bottom was evaluated to be exploratory, not yet intersected by previous wells. In effect, the completion test result of the well suggests relatively high permeability in terms of injectivity index and transmissivity values than the other wells in the area.

Discharge Evaluation

Clearing discharge and output testing of well UM-A commenced in the third quarter of 2010. The well has sustained horizontal discharge for six months with high massflow, >50 kg/s, but unable to attain the target wellhead pressure (WHP) for commercial utilization. Maximum wellhead pressure (WHP) observed at already highly throttled condition was even short of 0.2MPa than the target value, considering the high WHP's of nearby online wells in the pad. The low discharge enthalpy of well UM-A, ~1200 kJ/kg, compared to the medium discharge enthalpy of the other wells validated that the well is producing mostly from the deeper liquid zone of the reservoir.

Though the discharge is neither erosive nor corrosive as indicated by low total suspended solid (TSS) level and neutral pH; other chemical parameters showed relatively lower reservoir chloride and quartz temperature levels as compared to the other wells in the pad (Figure 2). This further confirms that well UM-A major zone is drawing fluids from the lower temperature lower chloride reservoir. Further review of the data shows affinity of discharge fluids source with that of a well (UM-B) drilled from the most northern pad of the Upper Mahiao, already in the outflow of the Tongonan reservoir.

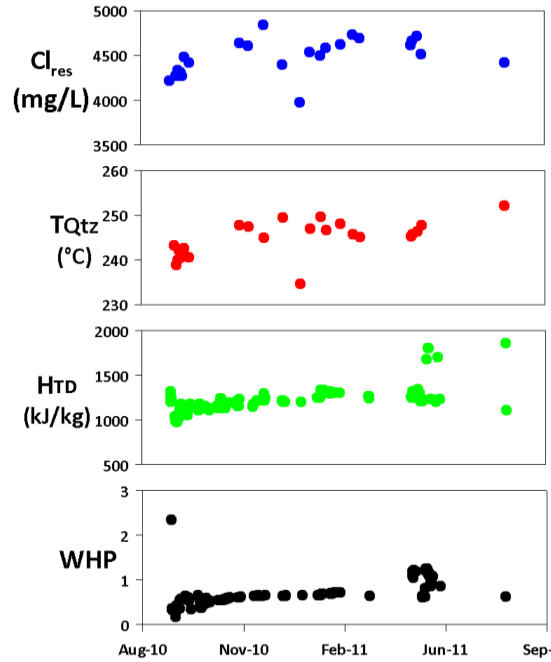

Figure 2: Well UM-A Discharge Chemistry Plot

Temperature contour in the area (Figure 3) showed that both wells are discharging fluids from the 240-250°C liquid region, but the other well is able to achieve high commercial discharging pressure since it has contribution from the upper two-phase region attributed to the shallower production casing shoe (PCS). On the other hand, well UM-A casing shoe was set deeper in the liquid region with nil contribution from the upper two phase region to assist build-up in wellhead pressure to attain the commercial value.

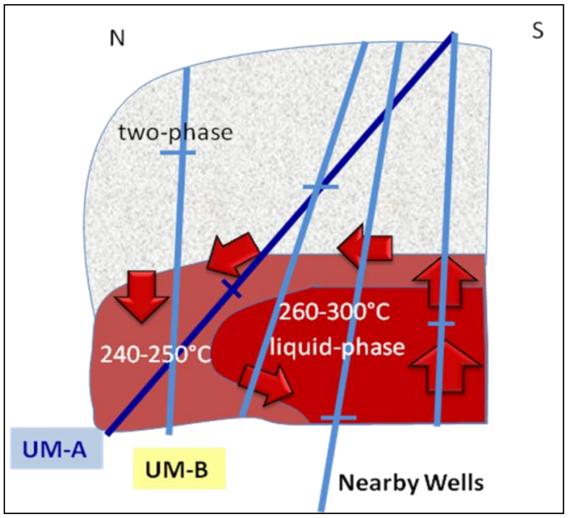

Figure 3: Temperature Isotherms in the Vicinity of Well UM-A

WELL INTERVENTIONS

The pad is offering promising output as reflected in the performance of nearby wells and even in the massflow performance of well UM-A. Relevant procedures were thus reviewed to commercialize well UM-A.

Casing Perforation

The downhole temperature surveys of well UM-A (Figure 4) showed a hotter zone behind the cased-off section associated with a fault with proven permeability in nearby wells in the Upper Mahiao sector. In order to avail of the hotter fluids from this zone, casing perforation using perforating gun was implemented. Perforation is the process of creating holes in production casing to establish communication between the well and formation. Perforation holes are used to recover formation fluid and increase discharge potential of production wells.

Well UM-A was perforated above the production casing shoe with the penetrated section about 50m length. Target depths were based on drilling parameters and measured downhole data of the well. Post-perforation discharge was then conducted during the second quarter of 2011. Yet, discharge data and chemistry data showed comparable values to pre-perforation data with the wellhead pressure still short of the target value. No indication of steam phase input from the perforated shallow two-phase zone to lessen density and aid ascent of upwelling liquid. The perforated portion is possibly blocked with casing cement considering the volume of drilling losses encountered in this section.

Acid Stimulation

Well UM-A was then programmed for acidizing on the third quarter of 2011 to enhance permeability at the perforated section. This would further allow entry of hotter two-phase fluids and increase the total discharge enthalpy of the well that will translate to higher wellhead pressure and capacity. Initially, cement plug was installed to seal off bottom zones and ensure maximize flow of acid fluids to the perforated zone. Post-acid completion test confirmed permeable zones at the perforated section with increased value in injectivity index.

Discharge testing after the acid injection was very successful in attaining the required cut-in wellhead pressure of well UM-A resulting to the well's successful commissioning to the system as additional production well to augment steam supply requirement to the Upper Mahiao power plant.

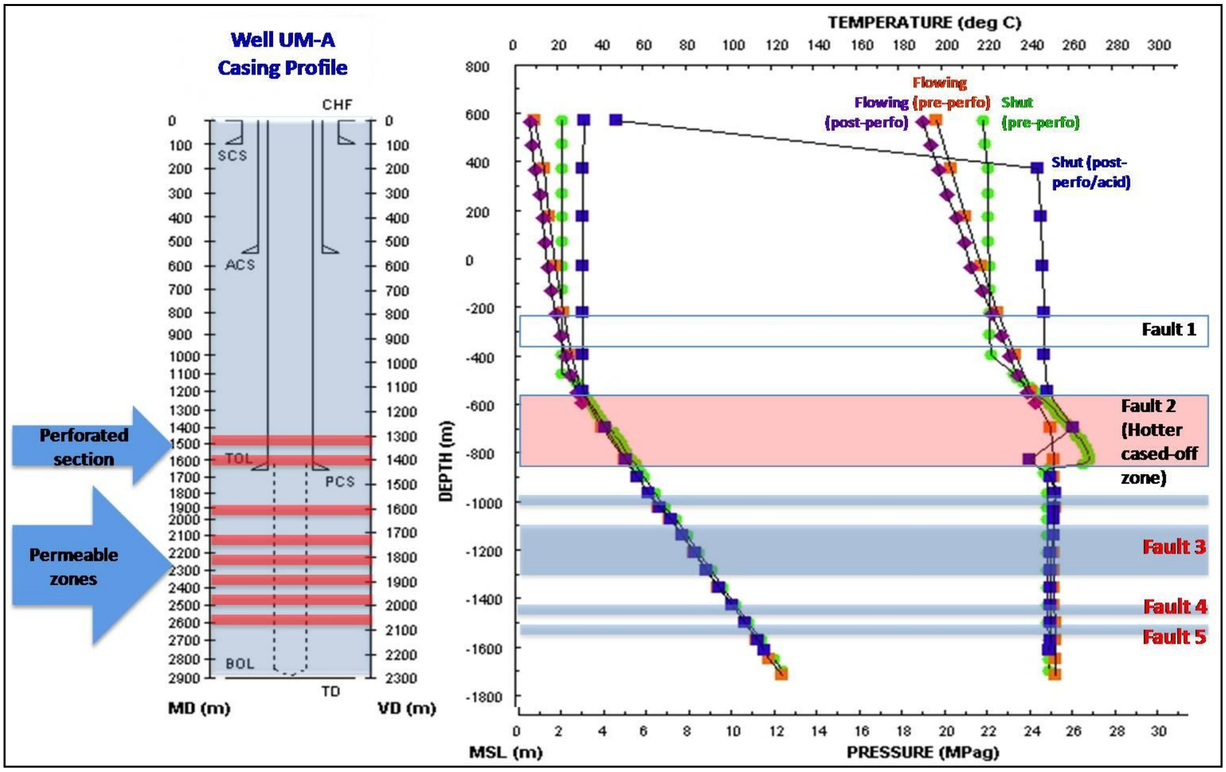

Figure 4: Well UM-A Casing Profile and Downhole Pressure / Temperature Data

CONCLUSION

The experience in commercializing well UM-A have been vital in the assessment of other deep wells drilled in the Leyte Geothermal Production Field. The assessment was specifically applied in evaluating the balance contribution from the deeper liquid resource and from the upper shallow two-phase region of the reservoir in enhancing productivity of the well.

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