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Geothermal Resources Council, TRANSACTIONS, Vol. 13, October 1989

STEAM-PURGING CRITERIA IN GEOTHERMAL POWER PLANT

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ABSTRACT

In order to prevent damage in power station turbines, steam-purging is used before start-up operations to clean the steam pipelines of deposits, iron oxide, welding slag, and any other foreign material.

This paper includes guidelines and acceptance criteria to performance steam-purging on geothermal steam pipelines optimizing the purging-time and reducing the likelihood of turbine damage.

INTRODUCTION

Geothermal power plants need a clean steam pipeline system before commercial generation. The basic purpose of steam-purging is the internal cleaning of the steam piping, flowing from the wells to the turbine (Figure 1) removing welding slag, iron oxide, salts and other foreign materials to eliminate the chance of turbine wear.

Since the steam purging time has a direct impact on start-up schedule, the objective of this paper is to present guidelines and acceptance criteria to minimize the purging-time and the posibility of geothermal turbine damage by means of particles carried by steam during normal operation.

GENERAL CONSIDERATIONS

Required temporary piping and discharge valve during blowing must be designed by means of same standards for permanents ones, taking special care in the way of anchorage of the discharge steam point given the high draft present in making the blowing.

The blowing principle considers the application of a stronger draft force than the present in nominal conditions, over the cleaning particles. The above is obtained by having a blowing factor (BF) greater than 1, which is the rate between the supplied momentum while blowing is carried out and the one in nominal conditions, it means:

$$BF = \frac{Ms^2 \; Vs}{Mn^2 \; Vn}$$

Where:

BF = Blowing factor

M = Mass flow of steam (Kg/h)

V = Specific volume of steam (m3/kg)

s = Blowing conditions

n = Nominal conditions

Higher draft during blowing guarantees that all the dismissed impurities from the inner piping face are discharged to atmosphere through the temporary piping vent.

Prior to blowing the design construction and startup groups must develop a blowing procedure manual.

Some ot the aspects to be considered in the procedure are:

1. Define if blowing will be intermittent or continuous.
2. Have the temporary rig design including the necessary safety measurements during blowing. Verifications must be considered for all of the participants.
3. Set the sequence of blowing
4. Include the calculated operation pressure range in order to get a more efficient blowing.

5. Indicate the number of the blowing cycles

6. Acceptance criteria

For geothermal fields a continuous blowing method is recommended, since at different power plants there doesn't exist an important limitation of vapor reliability.

In respect of temporary piping design as already mentioned, the same standards must be applied for permanent design.

Among the aspects to verify before and during blowing are that the piping system is completely erected according to design indications, verify that all the control fittings and instrumentation are isolated in order to avoid damages and observe the permanent piping thermal expansion.

All branch lines should be blown first, from the wells to the collector holding closed the connection valve to it and beginning with the farthest well.

Later, the collector will be blown through to the entrance of the dryer and finally all the steam piping system to the turbine main valve and the isolation valves of auxiliary equipment, such as the ejectors.

Once the blowing sequence is established, operating conditions must be calculated in the separator or in the wells discharge point depending on what case it is. To get the above, calculating the allowed boundary conditions is recommended at first using the following relations:

$$Ps1 = Pn - 1.5$$

Where:

Ps1 = Maximun separator steam pressure during blowing (kg/cm2 a.)

Pn = Nominal operation separator pressure (kg/cm2 a.)

Minimum operation pressure in the steam separator will correspond to saturation whose specific volume agrees with:

$$Vs2 = 1.29\ Vn$$

Where:

Vs2 = Specific volume of steam during blowing at minimum allowed pressure in the separator. (m3/kg)

Vn = Specific volume of steam at nominal operation conditions in the separator. (m3/kg)

Ps2, will be determined by using the steam tables. Entering with the Vs2 value the corresponding pressure will be the soughtone. This value is the minimum allowed in the separator during blowing.

Considering the arithmetic mean between the Ps1 and Ps2 values, the blowing pressure value is derived.With this value of pressure and the respective nominal mass flow from the well, blowing factors greater than 1 can be obtained. If the operation is developed at a pressure greater than Ps1, blowing factors less than 1 will be obtained since the steam mass flow in the separator decrease and results with less specific volume, while in operating in smaller pressure than Ps2 brine draft could be present. Both of above situations imply an inefficient blowing.

In the case of steam wells the blowing pressure Ps to advice must be smaller than the nominal one for having more steam flow with greater specific volume in order to get a blowing factor greater than 1 also.

For each run, a minimum of five cycles before mounting the first target is suggested.

A blowing cycle is considered the following process:

- Heating until to get the calcultated thermal expansion in the pipe.
- Blowing until to observe cleaned steam in the discharge point during ten minutes.
- Shut down
- Cooling

After repeating the above steps five times the first target will be mounted. Then carry out the blowing process at the same conditions of the last cycle. Once with this conditions count five minutes of exhibition of the target. When time is over, blowing should be interrupted for

analyzing of it.

According to the following aceptance criteria the evaluation of the impacts shown for the target, will be decided if the blowing process goes on or is considered finished.

At the end of a blowing of a run, it should be kept pressured by means of a minimum steam flow that is discharged through its respectives drains.

ACCEPTANCE BLOWING CRITERIA

Besides of having a blowing factor (BF) greater than 1.5, other element to consider that blowing has been developed efficiently and so finished is the target appearance after five minutes of exposition against the steam blowing flow.

The criterion for considering blowing as a concluded process requires three followed targets with a maximun of five impacts each located in the central area equivalent to 0.85 of the target's length and no impacts outside this area.

In the figure 2 these criteria are shown.

CONCLUSIONS

In order to reduce the out of service time of the geothermal plant, the guidelines and acceptance criteria presented here are a first proposal for geothermal power plants.

ACKNOWLEDGES

The author thanks the collaboration and comments of M.I. Miguel Angel Acevedo Ruiz in preparing this document.

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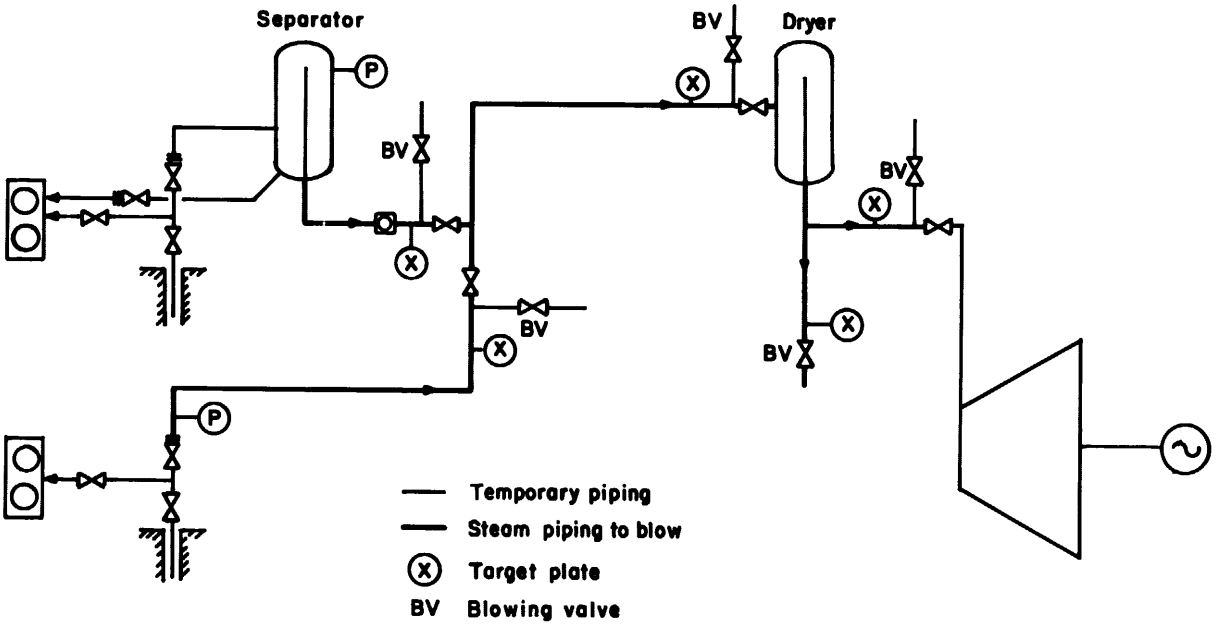
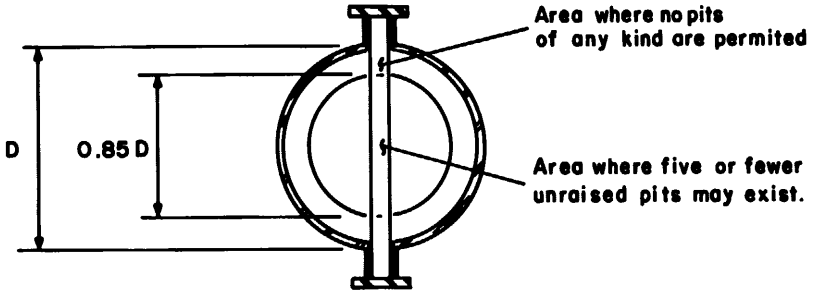


FIGURE 1
Steam piping from wells to turbine



Allowable number and location of pits.

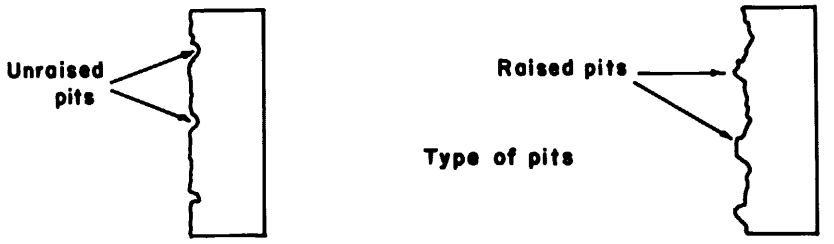


FIGURE 2
Acceptance criteria for target.