

Dear Stian

Please see the responses below

Lance

-----Original Message-----

From: Stian Traedal <stiantr@stud.ntnu.no>

To: Lance <biphase1@aol.com>

Sent: Tue, Jan 21, 2014 5:35 am

Subject: Re: Variable Phase Cycle

Dear Lance,

Thank you very much for your email and the information regarding the Variable Phase Cycle. Good luck with the well reparations!

I have some questions regarding the expander efficiency relationship you suggested:

- Is it the total expander efficiency (nozzle and rotor), or is it only for the rotor?

[It's the total efficiency](#)

- Is it based on a constant expander inlet pressure or why is only the outlet pressure important?

[The vapor density \(which is a function of the pressure\) is important for the momentum transfer](#)

[from the driving vapor to the driven liquid droplets in the nozzle. Attached is the original JPL report which details the physics and equations of the two-phase nozzle code we have developed.](#)

- What about fluid properties? We are planning to do simulations for different working fluids and based on Welch's paper "New Turbines to Enable Efficient Geothermal Power Plants" (GRC Transactions 2009) I assumed that the fluid properties (mainly surface tension and vapor density) would play a more important role... Any information on this would be greatly appreciated!

[See the referenced report. In the absence of developing your own nozzle code I would suggest that you use the thermodynamic properties of the different fluids, not the transport properties.](#)

I was also wondering if I may include our communication as reference in future publications on this topic?

[Certainly](#)

Thanks again and best regards,

Stian Traedal

On 2014-01-16 12:35, Lance wrote:

> Dear Stian

>

> I'm sorry to say the two-phase nozzle code and turbine codes are

> proprietary information. For purposes of your thesis I suggest you do
> your analysis using parametric expander efficiencies. For refrigerants
> and similar working fluids an efficiency range of 75-85% is
> appropriate with the condensing pressure as the main influence. The
> above range is typical of condensing pressures from 2 bar to 15 bar.
> You can assume a linear relationship.
>
> The Coso unit has been operated to 800 kW so far. The power generated
> agrees well with predictions. The brine supply (heat input) has
> decreased to less than half of the design value so we are waiting for
> the wells to be repaired.
>
> Regards
>
> Lance Hays
>
> On Jan 16, 2014, at 6:56 AM, Stian Traedal <stiantr@stud.ntnu.no>
> wrote:
>
>> Dear Lance Hays,
>>
>> I am writing a Master's thesis in Mechanical Engineering on the
>> subject of power production from surplus heat using the Trilateral
>> Flash Cycle/Variable Phase Cycle.
>> I am making a simulation of the cycle, and am modeling the two-phase
>> expander as a Variable Phase Turbine. In that regard I am very
>> interested in the analytical model of the nozzle and turbine in the
>> VPT, mentioned in "New Turbines to Enable Efficient Geothermal Power
>> Plants" by Welch and Boyle.
>> Is it possible to get information on how the nozzle and turbine
>> efficiency in the VPT varies with different parameters like surface
>> tension, vapor density and vapor quality of the working fluid?
>> I am also very interested in the Variable Phase Cycle project at Coso
>> Geothermal. Is there any experience from the project so far?
>>
>> Sincerely,
>>
>> Stian Traedal
>>
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