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**Research Article**

# Computer Technology Simulation towards Power Generation Potential from Coproduced Fluids in South Lokichar Oil Fields

**PUTRA A.B.W.**
Universidad Nacional Pedro Ruiz Gallo, Lambayeque, Peru
E-mail: Putra A@gmail.com
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**ABSTRACT**
The concept of coproduction reflects an opportunity through which geothermal electricity could be produced from the exploitation of oilfield infrastructure. This concept has evolved due to scholarly affirmations that coproduction tends to counter the costs associated with the drilling of new wells, having abandoned previously mature wells. Also, the costs of drilling new wells are seen to arise from coproduced fluids' existence as a nuisance to oilfield operations. The proposed project seeks to evaluate the feasibility and profitability of coproduction practice implementation in South Lokichar oil fields, with a case study approach on the focus.
**Keywords:** Exploitation of oilfield infrastructure and affirmations that geothermal electricity production.

## INTRODUCTION

The concept of coproduction continues to evolve due to the affirmations that geothermal electricity production is possible via a profitable utilization of abandoned or mature oil field infrastructure. It is also notable that most of the oil reservoirs exhibit moderate temperature ranges, but when abandoned or mature oil infrastructure is utilized, the intensive capital with which initial investments that seek to ensure that new wells are drilled tends to be countered (Augustine and Falkenstern, 2012). According to Crowell and Gosnold (2014), coproduction also aids in eliminating the associated risk of and need for induced fracturing. With the use of binary-cycle power plants also gaining growing interest and attention among investigators, some of the key areas where the use of coproduced fluids could aid in generating power is being examined include Arkansas, Florida, Louisiana, and Wyoming's Rocky Mountain Oilfield Testing Center (Crowell, Ochsner and Gosnold, 2013).

In South Lokichar, a combination of favorable conditions in terms of a large volume of coproduced fluids and geothermal gradient remain promising relative to the generation of electricity (Augustine and Falkenstern, 2012). In the proposed research project, the central purpose will be to screen possible candidates for coproduction in South Lokichar oil fields, gaining insights from a case study perspective. Regarding the incorporation of data about parameters of production and temperature information, the proposed study seeks to implement a simple STARS framework. The role of this framework will be to aid in forecasting or projecting the performance of reservoirs in the South Lokichar basin over a given period. Also, the STARS framework will be employed for the purpose of forecasting the power plants' potential power output. In turn, an economic model will be applied to the findings in a quest to establish the proposed project's net present value, upon which informed conclusions and inferences regarding the feasibility of generating power using coproduced fluids in these oil fields will be made. From the literature, some of the main parameters that are worth considering and evaluating towards informed decision-making regarding the potentiality, economic viability, and feasibility of a basin or oil field potentiality for coproduction include the rate of the production of the total fluid and the temperature of the reservoirs (Crowell and Gosnold, 2014).

### *Project Aim and Objectives*

Some of the issues into which the proposed project seeks to give critical insights include resource assessment, business planning, long-term project operation and maintenance, and equipment analysis and design. Indeed, the main aim of the project will be to demonstrate the

extent to which the generation of power from South Lokichar oil fields' non-conventional and low-temperature geothermal resources (coproduced fields) could be economically and technically feasible. In relation to this central purpose, one of the objectives will be to promote contractual relationships among investors that include oilfield operators, geothermal owners, and investors in South Lokichar oil fields. Also, the objective of the study will be to establish an economic framework aimed at guiding an optimal production of geothermal power from South Lokichar oil fields' coproduced fluids on a long-term basis. Furthermore, the objective of the proposed study lies in the evaluation of the potential of South Lokichar oil fields' power generation from coproduced fluids using selected mechanisms of commercial power conversion. Under this objective, an example of a mechanism of commercial power conversion that will be evaluated is a thermal hydraulic engine, especially relative to its technical feasibility and economic viability. Another objective of the proposed project will be to demonstrate how geothermal energy technology could be replicated (based on different physical parameters) via the use of coproduced fluids in gas and oil wells – towards power generation. With low-temperature geothermal resources in terms of coproduced fluids and varying climatic conditions, South Lokichar oil fields form an ideal site, and it is projected that the results will be insightful and sensitize relevant stakeholders regarding geothermal technology practicability and applicability in these operating conditions.

## METHODOLOGY

### *Collecting and Analyzing the Production and Temperature Data*

The initial step will involve collecting and analyzing the production and temperature data from South Lokichar oil fields. In particular, the data will be collected from the databases of the geothermal resource and oil and gas divisions. At this point, the project will discern the number of South Lokichar producing reservoirs that will exhibit the initial temperature, based on the data obtained from the databases. In turn, there will be an illustration of the interaction of the parameters of reservoir temperature versus depth. The motivation will be to establish oil fields with the hottest independent reservoirs. The next step will be to determine the geothermal gradient. Indeed, it is expected that the database might exhibit some degree of inaccuracy because the real reservoir temperatures tend to be underestimated in temperature records, as the recording of the well temperatures occurs in the course of logging runs and that due to mud circulation, the temperature may not have recovered from the effect of cooling. The objective of focusing on the production and temperature data will be to determine the number of reservoirs whose temperatures might be suitable for the utilization or exploitation of geothermal energy technology towards coproduction in South Lokichar oil fields or basin; especially after gaining insight into the injection and production rates. Similarly, the collection and analysis of this data will aim to determine South Lokichar's overall average temperature for the oil fields in the entirety and in turn, discern whether the values (temperature and depth) would be within the limits through which electricity generation using coproduced fluids could be deemed feasible.

### *Implementing the STARS Numerical Framework*

Programmed in STARS, the role of this framework will be to forecast how South Lokichar's reservoirs might perform 20 to 30 years that will follow. Hence, the aim of utilizing this model will be to determine declines in the temperature of reservoirs relative to heat mining, upon which the potential for electricity production (in the place of thermal energy reinjection) would be predicted. Indeed, the model simulation will be in the form of a closed system with a producer pair and single injector and that several experimental assumptions will be made. These assumptions will include two fluid phases (constituting oil and water), no sink or heat source, and no aquifer. For the respective simulations, there will be a customization of injection rates, production, temperature, and reservoir size. Also, a real typical sandstone reservoir will be used to simulate geologic properties such as thermal conductivity, relative permeability, viscosity, permeability, and porosity. The next stage will involve the scaling of the findings to represent the entire South Lokichar basin.

Still, on STARS simulation, the evaluation of field inputs will base on the available data, as well as the sensitivity analysis. In some situations, common variables will be under examination in

all the model simulations. In other situations, certain parameters will be examined in some field simulations but not in others. This variation will arise from the need to customize the variables relative to the prevailing conditions of the oil field or reservoir under examination. Some of the variables that will appear in all field simulations will include the parameters of the wellbore (such as the radius of the hole, the outer radius of the casing, the outer radius of the tubing, and the inner radius of the tubing) and the type of the rock. Under the latter parameter, specific input factors that will be evaluated under the STARS model simulation exercise in all fields will include the thermal conductivity of the gas, the thermal conductivity of the oil, the thermal conductivity of water, the thermal conductivity of the rock, the heat capacity, and compressibility. It is also notable that in all the simulation fields, oil properties will be evaluated and this parameter's specific variables that will aid in gaining specific insights will include molar density, the liquid phase heat capacity's coefficient, the thermal expansion's coefficient, the aspect of liquid compressibility, and molecular weight. Also, the grid parameter of permeability will be evaluated for all field simulations while implementing the STARS model. However, in some situations and as mentioned earlier, some inputs will be customized relative to the prevailing conditions of the specific oil field or reservoir under examination. Some of these variables will include the geothermal gradient, the depth of the reservoir, the rate of fluid production or injection, the initial saturation level of the water, the pressure of the reservoir, the temperature of the reservoir, and field porosity.

Apart from the different parameters or STARS inputs that will be examined, the proposed project's determination of the economic viability and technical feasibility of coproduction in South Lokichar oil fields (if any) will be achieved by focusing on model outputs. At this point, more emphasis will be on the rate at which the production of oil might change due to electricity generation from coproduced fluids. Additional focus will be on the rate of heat loss in the wellbore and how the resultant fluid's temperature might change. To achieve these objectives, some of the specific variables or inputs that the STARS model will consider will include the rate of change in the production well's surface temperature with time, the production well's temperature of the bottom hole, and the behavior of the temperature of the injection well's bottom hole. Additional outputs that the STARS framework will consider while seeking to achieve the proposed study's aim and objectives will include the injection ell's surface temperature, the rate of water cut, the rate of production of oil, and the rate of production of the total fluid.

| **Grid Parameters** | |
|---|---|
| DI | 20 ft |
| DJ | 20 ft |
| DK | 20 ft |
| Permeabiliy | 300 md |
| **Oil Properties** | |
| Molecular Weight | 300 lb/blmole |
| Liquid Compressibility | 0.000005 (1/psi) |
| Coefficiet of Thermal Expansion | 0.00016 (1/°F) |
| Coefficient of Liquid Phase Heat Capacity | 300 Btu/lbmol°F |
| Molar Density | 0.10113 lbmol/ft3 |
| **Rock Type** | |
| Compressibility | 3e-6 (1/psi) |
| Heat Capacity | 39.51 Btu/ft3°F |
| Rock Thermal Conductivity | 44 Btu/ft-day-°F |
| Water Thermal Conductivity | 8.6 Btu/ft-day-°F |
| Oil Thermal Conductivity | 1.8 Btu/ft-day-°F |
| Gas Thermal Conductivity | 1 Btu/ft-day-°F |
| **Wellbore Parameters** | |
| Tubing inner radius | 0.167 ft |
| Tubing outer radius | 0.208 ft |
| Casing outer radius | 0.33 ft |
| Hole radius | 0.5 ft |

**Fig:1**

***Analyzing the Economic and Power Output Data***

At this point, factors that will be considered will include the injected or outlet temperature and the produced or inlet temperature. Economic assumptions that will be investigated will include the capacity factor of the power plant, operation and maintenance parameters, the initial capital cost, and the price of electricity. Notably, it will be assumed further that the generation of power from coproduced fluids will seek to be utilized on-site at South Lokichar and that its role will be to save on the costs previously incurred to purchase electricity, ensuring that the geothermal power operators deviate from relying on the electricity purchased from the grid. Thus, this assumption will imply that the generated electricity will not be meant for selling to the grid at subsidized prices. Regarding the initial capital cost, the economic analysis will focus on factors such as the cost of the power plant, documentation and reporting, regulatory expenses, legal costs, pollution abatement, the cost of transmission lines and on-site substations, the need for pumps, and the cost of more pipelines that will be required. In South Lokichar oil fields, it is worth indicating that the costs of system development and exploration are not anticipated because there is an already established oilfield infrastructure in South Lokichar.

## EXPERIMENTAL RESULTS

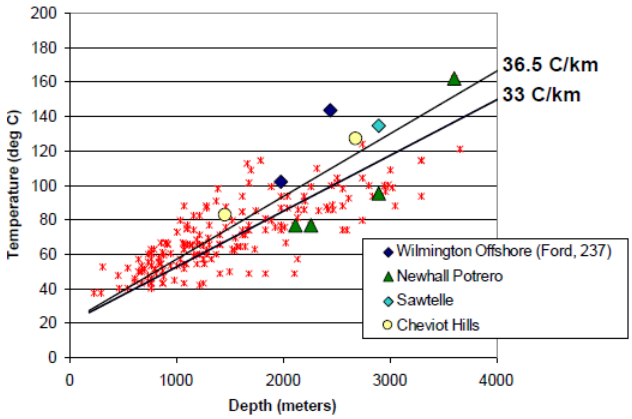


**Fig:2**

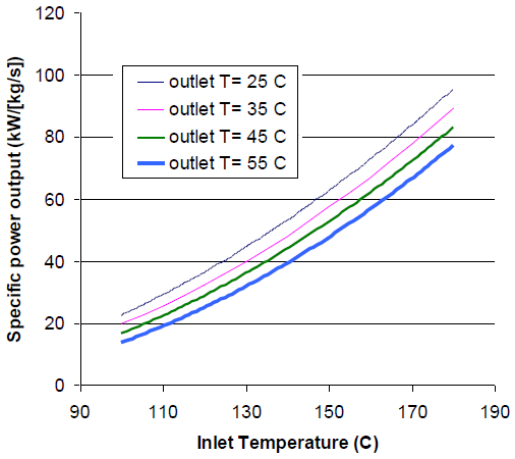


**Fig:3**

Indeed, mixed outcomes arise regarding the sufficiency of reservoir temperature and flow. Particularly, different reservoirs are poised to yield varying results relative to their economic viability and technical feasibility. However, if the overall findings obtained after scaling individual simulation results to the rest of the basin in South Lokichar oil fields confirm that the geothermal energy technology could be replicated and that the region's production and temperature data reflect a region that is feasible and one with a confirmed potential for the generation of power from coproduced fluids, several beneficial aspects are predicted to arise. For instance, the above situation would suggest that with the current infrastructure in place within South Lokichar, the eventual piggy-backing would end up eliminating some of the costly demands linked to hydro-fracturing and drillings that are associated with the previous arrangement of abandoning mature wells. In so doing, there might be profit maximization, having transformed coproduced fluids into opportunities for profitability, rather than perceived them as a nuisance to oil field operations in the region.

## CONCLUSION

In summary, the concept of coproduction reflects an opportunity through which geothermal electricity could be produced from the exploitation of oilfield infrastructure. This concept has evolved due to scholarly affirmations that coproduction tends to counter the costs associated with the drilling of new wells, having abandoned previously mature wells. Also, the costs of drilling new wells are seen to arise from coproduced fluids' existence as a nuisance to oilfield operations. The proposed project seeks to evaluate the feasibility and profitability of coproduction practice implementation in South Lokichar oil fields, with a case study approach on the focus. This region has been selected due to the presence of oil fields. From a methodological viewpoint, the project will rely on the STAR simulation framework to aid in projecting the production and reservoir conditions in the basin. In turn, there will be a conversion of the temperature and rate of flow of the coproduced fluid into electricity outputs. This procedure will pave the way for economic analysis in a quest to establish the basin's net present value arising from the avoidance of certain costs (as outlined in the methodology section). With the power generation potential eventually combined, it is predicted that different reservoirs, due to temperature and production rate variations, would yield different results, with some proving feasible and others remaining uneconomic.

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