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Performance n-Pentane in Geothermal Medium Enthalpy Binary Cycle for Electric Power Small Scale

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Abstract- Hot fluids from unproductive wells can be used as geothermal energy for small-scale power plant utilization. Low temperature and small flow rate are the reason of wells being suspended. Electrical energy can be calculated on a small scale, as case of Well DLSM-2. This well was chosen since it has 150°C temperature with pressure of 10.5 bar which can use a medium enthalpy turbine. The heating fluid from wellhead flowed inside heat exchanger to heat up the n-pentane as working fluid. After the working fluid turns into a vapor phase, it flows into a gas turbine to generate electricity. For this situation, the n-pentane working liquid is chosen by considering the tension circumstances in the intensity exchanger, n-pentane still passes its basic temperature until it becomes superheated condition. The thermodynamic pattern of the n-Pentane working liquid beginning from the power source of the feed siphon, and utilizing a tension of 10 bar and a temperature of 30oC with a mass stream pace of 1.5 kg/sec, is siphoned into the intensity exchanger. Resulting to being warmed by the warming fluid, the working fluid changes into superheated gas and enters the gas turbine with a temperature of 71.85oC, and a kind of 1.1 bar, which will have an enthalpy of 645 kJ/kg. If it is set at the gas turbine outlet, the enthalpy condition is 560 kJ/kg, then, at that point, using the n-Pentane working fluid will make 127.5 kW or 0.1275 MW of electrical energy. This assessment can be used as a model for the usage of hot fluid from suspension wells that are not commonly used for power plants with steam turbines, it just so happens, using a twofold cycle can convey sufficient and productive electrical power.

Keywords Binary Cycle, Electric Power, Heating Fluid, Medium Temperature, N-pentane

1. Introduction

Dieng geothermal field had several abandoned wells that are considered as unproductive wells due to the temperature decreased with the fluid phase is liquid and unable to be used as flash steam or dry steam. Utilization of brine from abandoned wells is designed using a binary cycle power plant in order to produce small-scale electrical energy. The binary cycle offers several advantages for utilizing brine, particularly for low to medium temperature wells [1]. The advantage of the binary cycle is that it can utilize heat energy from brine separator exhaust or from geothermal wells that are no longer usable, flowing into a heat exchanger to heat a working fluid such as light hydrocarbons so that the phase turns into gas and flows into a gas turbine to produce electrical energy.

To overcome the energy crisis around the world requires where one of the demands is aimed at increasing the share of renewable energy sources as a whole, this has resulted in a trend of a significant increase in interest in managing geothermal energy for electrical energy. A few cases in eastern Europe, for example, in Poland and the Czech Republic just have geothermal potential with low and medium temperatures, which are generally just utilized for warming and sporting offices. As of now, research has been completed to examine the utilization of electrical energy with a paired cycle. The actions for the region of a geothermal power plant with a twofold system using working fluids like hydrocarbons or others in Poland, with an assessment of a couple of essential factors that sort out where the region of a geothermal power plant is proposed. The part of temperature and hold source limit, the significance of open resources are the limits of this audit [2]

Geothermal energy is an alternative energy that potentially developed in the future, especially for electricity generation. Indonesia has geothermal resources reaching 40% of the world's potential and including renewable energy sources and environmentally friendly energy in the production stage. According to the Ministry of Energy and Mineral Resources report, Dieng Geothermal Field has been developed in 1990 and continues until now [3].

To convert geothermal energy into electrical energy is not an easy thing to do, so an efficient way is needed to utilize the available energy. Comparison of several types of utilization of geothermal power plants, namely flash steam, dual steam, and binary ORC (Organic Rankine Cycle) using the settings and requirements of the CERN LHC in Geneva, Switzerland uses the System Advisor Model software to analyze the power plant Then, given operating conditions and the ratio of the resulting energy is the same between binary and conventional cycles. As a result, binary cycles require 30-40% less brine than conventional generators. [4].

Switzerland uses the System Advisor Model software to analyze the power plant of the three cycles. From the results, it was found that the binary power plant has the lowest performance and cost compared to other power plants [3]. In addition, an analysis of the heating fluid was carried out with the inlet heat exchanger temperature between 110 – 160 oC, with an injection temperature of 70-100oC, and a mass flow rate between 20-120 kg/s.

In binary cycle ORC, geothermal fluid energy from well is transferred to change working fluid phase into steam in the heat exchanger. Working liquid hot steam is utilized to drive the turbine, then dense in the condenser, and streamed to take care of siphon. From feedpump, the functioning liquid is streamed into the intensity exchanger and warmed until it becomes steam once more [5].

From geothermal wells that produce two-phase fluid, it flows into the separator. The hot steam generated in separator is flowed to turbine for primary power generation. Then, the brine from separator is flowed to heat exchanger for binary cycle process. From separator, steam separated to drive turbine, while liquid waste from the separator is used as a heating fluid. The research was conducted on 2 Liquid dominated production wells which have an average wellhead temperature of 193ºC, by utilizing brine from the separator effluent which is used as a heating fluid. Some of the working fluids used are based on light hydrocarbon fluids, such as iso-butane, n-pentane, and iso-pentane because their critical temperatures can be stable. The results obtained that the most optimum working fluid is the use of iso butane working fluid can produce electric power up to 4 MWh [6].

The relationship between heating fluid and working fluid to optimize binary cycle by simulating 39 different working fluids using a Gradient Based Optimization Algorithm simulation. With the inlet heat exchanger temperature of 120°C, the outlet limit is 75°C and the best working fluid used is propylene and R1234yf [7]. Binary ORC analysis of working fluids R717, R11, R12, benzene, and R113 was also carried out with boiling points between 33.35°C - 79.85°C. The working fluid was analyzed using laws of thermodynamics first and second, resulting in a thermodynamic cycle for each working fluid. The results show that R11 and R113 are the most efficient working fluids because they have the highest boiling point [8].

Heat transfer from brine as a heating fluid will boil the working fluid so that it changes its phase into superheated steam so that it can rotate the gas turbine and the gas turbine drives an electric generator, thus generating electricity. Binary

of the three cycles. From the results, it was found that the binary power plant has the lowest performance and cost compared to other power plants [3]. In addition, an analysis of the heating fluid was carried out with the inlet heat exchanger temperature between 110 – 160 oC, with an injection temperature of 70-100oC, and a mass flow rate between 20-120 kg/s.

cycle power plant can increase power generation capacity in wet steam field because it can use the liquid phase of wet steam. Meanwhile, in the exploitation of low to moderate temperature reservoirs, it is possible to plan small-scale geothermal plants ranging from 50 kW - 5000 kW [7]. which is estimated to produce a turbine power of 141 kW with an electric power of 100 kW. The working fluid used is flammable, so it is necessary to conduct an analytical study to prevent leakage. Based on the design of the turbine having a small size and high rotational speed, further studies need to be carried out for the selection of turbine manufacturing materials [10]. ORC simulation was carried out using n-pentane fluid separator output in the form of a liquid with a temperature of around 165°C and a pressure of 8,001 bar which is usually directly re-injected without further utilization. The n-pentane working liquid has a stream pace of 15.51 kg/s by using the result liquid. separator and produces an electric force of 1173 kW [11]. In reality, binary cycle planning is not always carried out the same as its design, because it is necessary to consider the characteristics and design behavior of the factory equipment [12]. Some manuscripts on geothermal have not yet utilized brine fluid in suspend wells, instead it utilizes brine fluid from the separator exhaust.

In this review, we attempted to plan a suspension well that had diminished its strain and temperature so it was not generally created in light of the fact that it just delivered 100 percent brackish water. The utilization of these suspended wells should be finished to build the creation of power in the old geothermal field without completing penetrating exercises so it will be all the more monetarily.

2. Material

Use of geothermal energy as environmentally friendly power, can be utilized as the need might arise all through the world. By changing over geothermal energy moved in an intensity exchanger, it can warm the functioning liquid so that with the thermodynamic productivity of the paired power cycle, the use of medium to low enthalpy geothermal sources turns into an option for the improvement of limited scope electrical energy improvement. The aftereffects of the financial and specialized investigation did by a few scientists and their application to the pilot project make sense of that this parallel cycle is practical to be applied to a few geothermal fields, particularly those with two-stage fluid overwhelmed frameworks [13].

The thermodynamic process of working fluid to produce electrical energy in a binary cycle system that uses heat transfer from the heating fluid in a heat exchanger [14]. By and large, high temperature fields are taken advantage of to create power, utilizing dry steam and glimmer steam innovations. For medium to low temperature fields, twofold cycle power plants produce great execution. At present, parallel cycles are regularly used to create power in low-temperature geothermal fields. The process of evaporation of the working fluid of this system is usually called a closed cycle in a separate system and there is no direct contact between the heating fluid and the working fluid. Geothermal fluids also do not come into direct contact with moving parts such as turbines and other rotating equipment in the generator. So that it can reduce the negative effects of scale deposits and erosion that generally occur in conventional geothermal plants [15]. Brine from well or separator flows through pipes into heat exchanger. Then, this heating fluid will vaporize hydrocarbon working fluids such as i-pentane, n-pentane, and I-butane which have a lower boiling point than heating fluid temperature [16].

The nuts and bolts estimations of double cycle arranging are deciding the functioning liquid, investigating the thermodynamic pattern of working liquid, deciding the mass stream rate and how much energy produced. Information expected to examine the use of the twofold cycle in the geothermal field are:

1. Wellhead output brine pressure
2. Wellhead output brine temperature
3. Mass flow of wellhead brine output

The binary cycle assumes that the pressure from the feed pump outlet to the turbine inlet has the same value (P_{1B} = P_{2B} = P_{3B} = P_{4B}) and the pressure from the turbine outlet to the feed pump inlet has the same value (P_{5B} = P_{6B} = P_{7B} = P_{8B}). While the temperature from heat exchanger outlet to turbine inlet has the same value (T_{3B} = T_{4B}), turbine outlet temperature to the condenser inlet has the same value (T_{5B} = T_{6B}), and the temperature from the condenser outlet = to the heat exchanger inlet has the same value (T_{7B} = T_{8B}= T_{1B}= T_{2B}). For more details, a schematic model that utilizes heating fluid from a well in a binary cycle system is described in Fig 1. below:

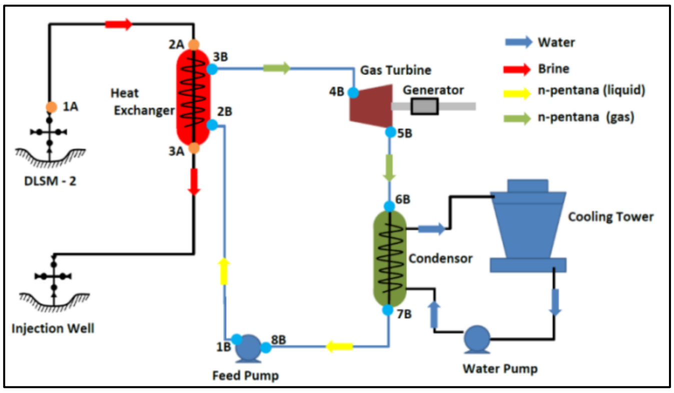

Fig. 1 Binary Cycle Power Plant Schematic

Fig 1. shown the brine flow as heating fluid from well is flowed into heat exchanger and after heating working fluid, fluid is removed to be used as injection fluid. While working fluid flows into heat exchanger through feed pump to be evaporated in heat exchanger. Then the working fluid which becomes steam (gas) flowed to turbine and generator electric power. After driving the turbine, the working fluid flows into condenser to be cooled. And after being condensed, the working fluid flows to feed pump to be recirculated. One sort of parallel cycle that is frequently applied is Organic Rankine Cycle (ORC).

Natural rankine cycle is a double cycle framework where the functioning liquid utilized is a hydrocarbon compound. The main equipment for the binary cycle is the feed pump, heat exchanger, turbine and condenser. This hydrocarbon compound will be pumped using a feed pump and assumes on the thermodynamic diagram for the feed pump outlet pressure (1B) = heat exchanger inlet pressure (2B) = heat exchanger outlet pressure (3B) = turbine inlet pressure (4B) = 10 bar. Then assume the pressure inside the turbine = turbine outlet pressure (5B) = condenser inlet pressure (6B) = condenser outlet pressure (7B) = feed pump inlet pressure (8B) = 1.1 bar. Meanwhile, the assumed temperature from feed pump to the inlet heat exchanger is assumed different (T1B ≠ T2B), although in reality they are the same. To determine the thermodynamic cycle, a thermodynamic graph of the working fluid is needed as shown in Fig 2.

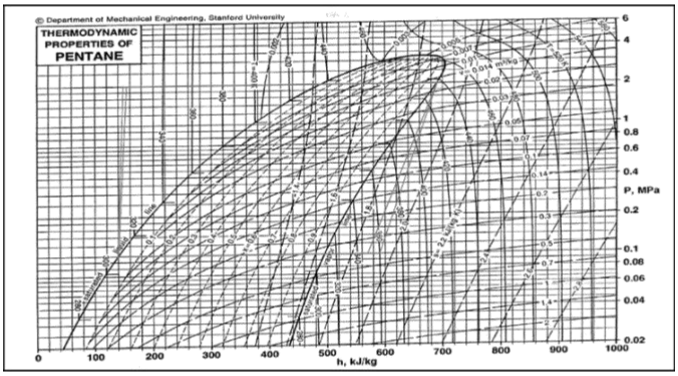

Fig. 2 Thermodynamics Working Fluid Diagram [17]

Thermodynamic diagram used in order to determine the pressure (P), temperature (T), flow rate (m), enthalpy (h), and entropy (s) at the feed pump outlet point, heat exchanger inlet, heat exchanger outlet, turbine inlet, outlet turbine, condenser inlet, condenser outlet, and feed pump inlet. In this study, the state on the thermodynamic diagram and the binary cycle cycle starts from the feed pump outlet.

3. Method

There are 4 completion stages of the methodology in this work, there are: (1) Calculation of P and T of heating fluid, (2) Selection of the type of working fluid, (3) Working cycle and working fluid thermodynamics, (4) Calculation of electrical energy.

3.1 Calculation P and T of Heating Fluid

Calculation of P and T of Heating Fluid used to calculate P and T at the inlet of the heat exchanger, it is necessary to know P and T in the pipe from the wellhead to the heat exchanger by equation [7]:

$$P_{IBHE} = P_{Bwellhead} - \Delta P_{Bwellhead-HE} \quad (1)$$

$$T_{IBHE} = T_{Bwellhead} - \Delta T_{Bwellhead-HE} \quad (2)$$

When :

P_{IBHE} = Pressure Brine in Heat exchanger, bar

$P_{B\ wh}$ = Pressure Brine in Wellhead, bar

ΔP_{Bwh}=Pressure loss Brine , WH-HE. bar

T_{IBHE}= Temperature Brine in Heat exchanger, oC

T_{Bwh} = Temperature Brine in Wellhead, ºC

Δ_{TBwh}= Temperature loss Brine , WH-HE, ºC

After knowing the magnitude of P and T at the inlet heat exchanger, then look for P and T heating fluid at the inlet heat exchanger with the outlet heat exchanger with equation [7]:

$$\Delta P_{BHE} = P_{inlet\,BHE} - P_{outet\,BHE} \quad (3)$$

$$\Delta T_{BHE} = T_{inlet\,BHE} - T_{outet\,BHE} \quad (4)$$

When :

ΔP_{BHE} =Pressure Loss Brine in HE, bar
$P_{inlet\ BHE}$ =Pressure inlet Brine in HE, bar
$P_{outerBHE}$ =Pressure outlet Brine in HE, bar
ΔT_{BHE} =Temperatur Loss Brine in HE, ºC
$T_{inlet\ BHE}$ =Temperatur inlet Brine in HE, ºC
$T_{outerBHE}$ =Temperatur outlet Brine in HE,ºC

After knowing the amount of temperature entering the heat exchanger, the working fluid can be determined which has a temperature below the temperature of the heating fluid.

3.2 Working Fluid Selection

That the temperature of the warming liquid influences the choice of the kind of working liquid which will decide the thermodynamic cycle and will decide how much enthalpy that enters the turbine. The more prominent the enthalpy that enters the turbine, the more noteworthy the electrical power delivered with a similar liquid stream rate. Moreover, the greatness of the functioning liquid rate is exceptionally subject to the warming liquid rate. Expanding the functioning liquid rate at a similar enthalpy will deliver a more prominent electric power. In this way, the higher the temperature and pace of the warming liquid, the higher the electric power. There are a couple newcomers that ought to be noticeable in **Table 1.**

Table 1. Physical Properties of Hydrocarbon Working Fluid Rankine Cycle [17]

Fluida	Molekular Weight	Critical Temp. (ºC)	Critical Pressure (bar abs)	Condensing Pressure (bar abs)	I-Factor	Heat Transfer Coefficient (W/m²K)
Propane	44	96.7	42.36	12.76	0.89	3821
n-Butane	58	152.2	37.18	3.59	0.75	3441
n-Pentane	72	196.7	32.4	1.1	0.78	3452
Isobutane	58	135	36.85	5.03	0.83	3350
Isopentane	72	187.2	34.09	1.45	0.71	3214

From the table above, we can choose the working fluid to be used with those that meet several requirements, such as:

a. The basic temperature of the functioning liquid in the intensity exchanger doesn't surpass the temperature of the warming liquid at the channel of the intensity exchanger.

b. T of the warming liquid in the intensity exchanger doesn't surpass T of the warming liquid in the intensity exchanger

c. The working liquid stream rate doesn't surpass the warming liquid stream.

Next, choose a working fluid that meets the existing requirements for use in the binary cycle.

3.3 Working Cycle and Working Fluid Thermodynamics

For the heating fluid cycle, it is necessary to pay attention to the magnitude of the pressure and temperature losses along flow pipe from wellhead to heat exchanger. Information of tension, temperature, and mass stream pace of wellhead for this situation study are 10.5 bar, 150oC, and 3 kg/s. The feed pump (1B) flows the working fluid to inlet heat exchanger (2B). From the heat exchanger inlet (2B) to heat exchanger outlet (3B). From the heat exchanger outlet (3B) to turbine inlet (4B). From the turbine inlet (4B) to turbine outlet (5B). From the turbine outlet (5B) to condenser inlet (6B). From the condenser inlet (6B) to condenser outlet (7B). And from the condenser outlet to feed pump inlet (8B). To ascertain how much intensity that can be moved from the warming liquid to the functioning liquid, first compute T between the intensity exchanger channel and the intensity exchanger outlet with condition [16]:

$$\Delta T_{BHE} = T_{Inlet\,BHE} - T_{outlet\,BHE} \quad (5)$$

Furthermore, it is necessary to know the efficiency of the heat exchanger in heat transferring [15]:

$$T_{transfer} = \Delta T_{BHE} \times \eta_{HE} \quad (6)$$

Then, ascertain the functioning liquid temperature at the power source of the intensity exchanger with condition [15]:

$$T_{outlet\,HE\,Wf} = T_{inlet\,HE\,Wf} + T_{transfer} \quad (7)$$

When :

ΔT_{BHE} = Temperature Loss Brine in HE, ºC

$T_{transfer}$ = Temperatur Transfer in HE, ºC

T_{outlet} HE WF = Temperatur outlet HE Working Fluids, ºC

After that, find the enthalpy value at the turbine inlet using the n-pentane thermodynamic diagram in Fig 2. So that the pressure (P), temperature (T), entropy (s), and the working fluid phase can be determined.

3.4 Calculation of Electric Power Generated Amount

Then calculate the electric power generated by using equation [14]:

$$W_t = m_{wf} \times (h_{4B} - h_{5B}) \tag{8}$$

When :

Wt = electric power generated, kW

m_{wf} = Mass flow rate gas, kg/s

h_{4B} = Enthalpy in inlet Turbine, kJ/kg

h_{5B}= Enthalpy in outlet Turbine. kJ/kg

4. Result

The outcomes acquired from this study are the attributes and execution of the warming liquid, the determination of the functioning liquid, the functioning cycle and thermodynamics of the functioning liquid and the estimation of the energy created for this parallel cycle.

4.1 Heating Fluid Characteristics and Performance

The warming liquid created from the Well DLSM-2 has a P of 10.5 bar, a temperature of 150°C, and a stream pace of 3 kg/s. Salt water liquid is moved from wellhead to warm exchanger a good ways off of 300 ft, then, at that point, saline solution liquid is streamed to infusion well. Boundaries of mass stream rate, tension, and temperature from the wellhead to bay and outlet of intensity exchanger are displayed in **Table 2.**

Table 2. Parameters of Heating Fluid from Well and In Heat Exchanger.

Fluid	P (bar)	P (Mpa)	T (°C)	T (°K)	m (kg/s)	Q (gal/ min)	ΔP (bar)	ΔP (°C)
1A	10.5	1.03	150	423.15	3	47.55	-	-
2A	10	1.02	148	421.15	3	47.55	0.5	5
3A	2	1.02	40	313.15	3	47.55	8	108

From the table, it very well may be seen that the channel heat exchanger has a temperature of 148oC, and the tension is 10 bar, and stream rate is 3 kg/s. In the mean time, at outlet of intensity exchanger temperature is 40oC, pressure is 2 bar and the stream rate is 3 kg/s.

4.2 Working Fluid Used

To drain the working fluid, a process pipe is used by ignoring the pressure and temperature losses along the process pipe. Conditions at inlet heat exchanger of the heating fluid have P of 10 bar, T of 150°C, and m of 3 kg/s. The functioning liquid stream rate is determined from the volumetric limit of the heating fluid in the heat exchanger by 50%. Thus, the working fluid capacity is 1.5 kg/s. If n-pentane is used with, Critical on the heat exchanger is 126.85°C, the temperature conditions in the heat exchanger are appropriate. T of working fluid n-pentane in heat exchanger is 30°C while T of heating fluid is 148°C, so with simulation conditions T heating fluid is greater than T working fluid, it can be concluded that n-pentane can be used in binary cycle design as working fluid. For more details on the characteristics of n-pentane as a working fluid, see **Table 3.**

Table 3. Working Fluid Characteristic n-Pentane [18]

Formula	C_5H_{12}
Molecular Weight	72.15
Boiling Point (°C)	36.1
Basic Temperature (°C)	196.7
Basic Pressure (bar abs)	32.4
Condensing Pressure (bar abs)	1.1
I-Factor	0.83
Heat Transfer Coefficient (W/m^{2}K)	3452
Density (kg/m^3)	626

The choice of n-pentane fluid over other fluids is because it can still turn into a fully vapor phase with a pressure of 10 bar in the heat exchanger, has the highest enthalpy value compared to other working fluids, and is environmentally friendly.

4.3 Working Fluid Thermodynamics Results

Binary Cycle planning needs to be applied based on the duty cycle and the thermodynamic properties of the n-pentane fluid. Initial planning data is also needed, such as **Table 4**, as follows:

Table 4. Parameter Data Design (19)

No	Parameter	Value	Value
1	$P_{condensation}$	1.1 bar	0.11 Mpa
2	$P_{feed\ pump} = P_{evaporator} = P_{turbin}$	10 bar	1 Mpa
3	Effisiensi Termal Heat exchanger	90%	0.9
4	T_{brine}	148°C	421.15°K
5	P_{brine}	10 bar	1 Mpa
6	m_{brine}	3 kg/s	
7	$m_{working\ fluid}$	1.5 kg/s	
8	T_{3B}	127.2°C	400.35°K

Then draw the n-pentane thermodynamic cycle using a nomogram diagram. The condition at point 1 with a tension of 1 MPa and a temperature of 303.15 oK is the state of the feed siphon outlet (1B), the condition at point 2 with a strain of 1 MPa and the temperature is thought to be equivalent to the gulf heat exchanger (2B) of 303.15 oK. for point 3 has a tension of 1 MPa and a temperature of 400.35 °K, h of 645 kJ/kg, s of 1.81 kJ/(kg.K) with the presumption that the intensity exchanger outlet (3B) = turbine bay (4B). Point 4 is inside the turbine with a tension of 0.11 MPa, a temperature of 345 °K, h of 560 kJ/kg, and s of 1.81 kJ/(kg.K) , as expecting the turbine outlet (5B) = condenser bay (6B). At point 6 has a strain of 0.11 MPa and a temperature of 303.15 oK expecting condenser outlet (7B) = gulf feed siphon (8B). For additional subtleties should be visible in **Fig 3.**

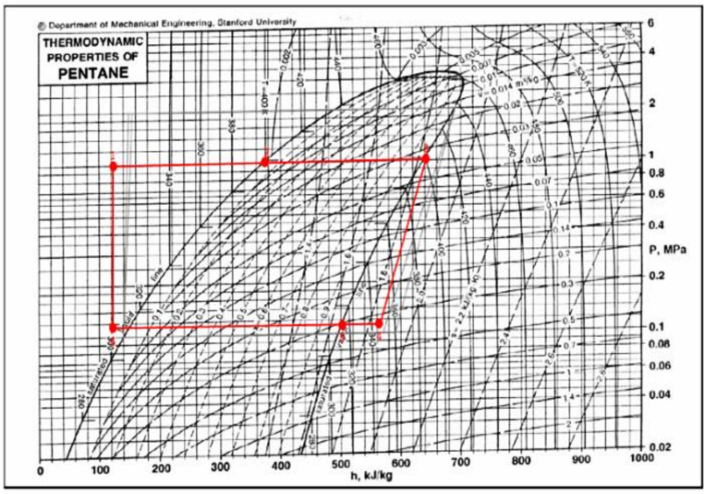

Fig 3. Thermodynamics Cycle Fluid n-Pentane Diagram

From the graph above, it can be seen that the thermodynamic cycle of n-pentane from the feed pump to the turbine inlet (point 1 – point 3) experiences an increase in temperature so that it changes its phase to completely steam. While from point 3-4 there is a decrease in enthalpy which is converted into electrical energy. Then from the turbine outlet to the feed pump inlet there is a decrease in temperature carried out by the condenser and returns to the feed pump for circulation. To see the value of the feed pump outlet, heat exchanger inlet, heat exchanger outlet, turbine inlet, turbine outlet, condenser inlet, condenser outlet, and feed pump inlet, see Table 5.

Table 5. Result Analysis Pressure and Temperature Working Fluid Analysis n-Pentane

Work-ing Fluid	P (bar)	P (Mpa)	T (°C)	T (°K)	m (kg/s)	q (gal/min)	h (kJ/kg)	s (kJ/kg)
1B	10	1	30	303.15	1.5	37.98	-	-
2B	10	1	30	303.15	1.5	37.98	-	-
3B	10	1	127.2	400.35	1.5	37.98	645	1.81
4B	10	1	127.8	400.35	1.5	37.98	645	1.81
5B	1.1	0.11	71.85	345	1.5	37.98	560	1.81
6B	1.1	0.11	71.85	345	1.5	37.98	560	1.81
7B	1.1	0.11	30	303.15	1.5	37.98	-	-
8B	1.1	0.11	30	303.15	1.5	37.98	-	-

From the table above, it very well may be seen that the enthalpy of the functioning liquid acquired at the power source of the intensity exchanger = the turbine channel of 645 kJ/kg and the enthalpy out of the turbine of 560 kJ/kg. This enthalpy change is utilized to compute how much electrical energy that will be produced.

4.4 Electric Power Generated

The following is a calculation of the amount of energy produced by a binary cycle power plant using the n-Pentane working fluid:

$$W_t = m_{wf} \times (h_{4B} - h_{5B})$$

$$= 1{,}5 \times (645 - 560) \ = 127{,}5 \text{ kW}$$

From the above calculation, the electrical energy value is 127.5 kW or equivalent to 0.1275MW in one cycle.

5. Discussion.

The utilization of warming liquid from the suspension very much taken for this situation study is the DLSM-2 all around situated in the Dieng Geothermal Field with a water predominance framework. This well is a well that is not generally delivered, on the grounds that it produces 100 percent salt water with a wellhead temperature of 150°C, a strain of 10.5 bar, and a mass stream pace of 3 kg/second. From the well to the intensity exchanger it has a tension deficiency of 0.5 bar and a temperature deficiency of 2°C to the gulf of the intensity exchanger. At the bay of the intensity exchanger, it has a tension of 10 bar, a temperature of 148°C, and a mass stream pace of 3 kg/s. This condition permits the preparation of paired cycles for limited scope power plants utilizing n-pentane working liquid.

Working fluid n-Pentane is used because it corresponds to the boiling point of pressure and temperature as well as the critical point of pressure and temperature in the heat exchanger. Hydrocarbon n-pentane as a functioning liquid since it has met specific prerequisites, including the temperature of the n-pentane working liquid in the intensity exchanger 30°C while the temperature of the warming liquid is 148°C, then, at that point, the recreation conditions have been met where the temperature of the warming liquid is very huge. can change the working fluid of n-Pentane hydrocarbons from reaching superheated and into the vapor phase or into dry gas to drive a gas turbine. This is in accordance with research conducted by Bliem et al., using a saturated hydrocarbon working fluid (alkane) which operates on a binary cycle has been proven to produce good electrical power. Analysis of several design parameters used, will provide a good efficiency limit at the implementation stage. For a sophisticated factory design, it is considered close to a reasonable performance limit so that the designer must consider all design factors so that he can provide a design with the best parameters (20)

Fundamental parts in a double cycle power plant are the intensity exchanger, turbine, condenser and feed siphon. The utilization of plate-type heat exchangers organized upward will be more productive in their intensity exchanger capacities when contrasted with those organized evenly or organized diagonally, as has been finished by Bliem CJ and Mines GL. Research led utilizing an intensity exchanger tube that uses geothermal assets with moderate temperatures with a paired cycle (21)

Usage of geothermal assets that have high and low enthalpy, with a fluid ruled framework, is typically utilized utilizing a blazing separator that isolates steam and saline solution from the well. Then, at that point, the glimmering steam from the separator which has a high enthalpy is streamed into a steam turbine to deliver essential power in the geothermal field. In the mean time, salt water which has a low enthalpy and has a fluid stage is utilized as a warming liquid to stream into an intensity exchanger to warm the functioning liquid as light hydrocarbons. so it can utilize a gas turbine to produce power on a double cycle (22).

The consequences of this study when contrasted and the consequences of different investigations that utilization 2 creation wells and brackish water from the separator partition which streams into the intensity exchanger as a warming liquid. The functioning liquid utilized is iso-butane light hydrocarbon which can create 4 MWh of power. This is on the grounds that these wells produce with a genuinely enormous mass stream rate, with each well 50 kg/s with a dryness component of 0.2, bringing about 80% brackish water so the creation is a lot bigger. [6]. Be that as it may, the DLSM-2 suspension well can deliver limited scope electrical energy which is very prudent.

From the analysis of benefits and economics, if the average electricity consumption per house is 1 kW, then the DLSM-2 Well can provide electricity for 127 houses. Thus the manufacture of binary cycle monoblocks with mini gas turbines will benefit the surrounding community

6. Conclusion

At a heating fluid flow rate from a suspension well of 3 kg/s, n-Pentane working fluid with a mass flow rate of 1.5 kg/s can be used. The thermodynamic cycle of the working fluid in the heat exchanger will produce Pentane gas. The condition at the gas turbine inlet has a pressure of 10 bar, a temperature of 127.2°C, an entropy of 1.81 kJ/(kg.K), an enthalpy of 645 kJ/kg, and has a superheated gas phase. While the turbine outlet conditions with a pressure of 1.1 bar, temperature 71.85°C, entropy 1.81 kJ/(kg.K), enthalpy 560 kJ/kg, and hydrocarbon gas phase. The electrical power that can be generated in the binary cycle using n-pentane fluid is 127.5 kW or 0.1275MW. In small-scale gas turbines this design is very profitable and this research can illustrate that suspension wells that are no longer suitable for use can produce sufficient and inexpensive electricity.

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