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COMPARATIVE ANALYSIS OF COOLANT MASS FLOW RATE FOR PELUIT-40 REACTOR IN ENERGY CONVERSION SYSTEM: A STUDY OF CONCEPTUAL DESIGN WITH AND WITHOUT A SPLITTER

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Abstract *PeLUIt-40 is a nuclear reactor being designed in Indonesia for heat utilizing and generating electricity, with a thermal power of 40 MW. To improve energy efficiency, a system of electricity power and heat generation for hydrogen production called a cogeneration system was developed. The purpose of this study is to determine the best design for the cogeneration system. In this study, two conceptual designs of the cogeneration system were simulated, i.e., with and without a splitter system, respectively. The effect of coolant mass flow rate from (5, 6, 7, 8, 9, 10, 11, 12, 13, and 14 kg/s) to the energy utilization factor were analyzed. Calculations were performed using the ChemCAD 6.4.1 program and Python programming. The result shows that an increase of the coolant mass flow rate will increase the exit temperature of the coolant secondary side as a result of the heat transfer in the Intermediate Heat Exchanger (IHX). This temperature impacts an increase in the thermal power used for power generation and heat production. An increase in the mass flow rate in both designs also causes the value of the energy utilization factor (Energy Utilization Factor-EUF) and the value of the thermal efficiency to increase. Using the splitter has an EUF value of 34.51%, while the without splitter design is 33.92%. Likewise, the efficiency value of both with a splitter and without a splitter are 71.02% and 69.92%.*

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Hasil dan Pembahasan

RESULTS AND DISCUSSION

The energy conversion system of Peluit-40 has been represented through modelling in ChemCAD, as shown in Figures 3 to 4.

The simulation was conducted by varying the coolant mass flow rate in the primary cycle from 5 kg/s to 14 kg/s, increasing by one unit in each simulation. The mass flow rate in the secondary cycle remained constant at 12 kg/s. The range of coolant mass flow rates in the primary cycle was determined because a pitch zone occurred in the IHX in both designs (with and without a splitter) when the flow rate was set to 4 kg/s. A pitch zone is a condition where the temperature difference between the hot and cold fluids at that location is minimized. This can occur when one or more fluids between the ends of the heat exchanger are undergoing a phase change.

Conversely, when the mass flow rate of the coolant in the reactor is set to 15 kg/s, the first design (without a splitter) of the pump to

Pertama paparkan bagaimana cara memvalidasi data yang sudah di dapatkan. Jika penelitian berupa simulasi sofware maka jelaskan batasannya.

Therefore, in a cogeneration system, using a splitter with the appropriate mass flow rate ratio it can increase the electrical power output. This is because the thermal energy in the mass flow rate is conserved to enter the turbine and is utilized as needed for hydrogen production. With a higher amount of thermal energy entering the turbine, the electrical energy output is also increased.

To calculate the total EUF shown in Figure 7, we use equation (1). In Figure 6, to calculate the value of each EUF power, we divide each thermal energy utilization by the thermal power of the PeLUIt-40 reactor. However, there is a slight difference when calculating EUF electricity generation. The thermal energy for electricity is reduced by circulators, such as blowers and pumps, and then the result is divided by the thermal power of the PeLUIt-40.

Lalu bagaimana cara pengolahan data dari penelitian.

Hasil dan Pembahasan

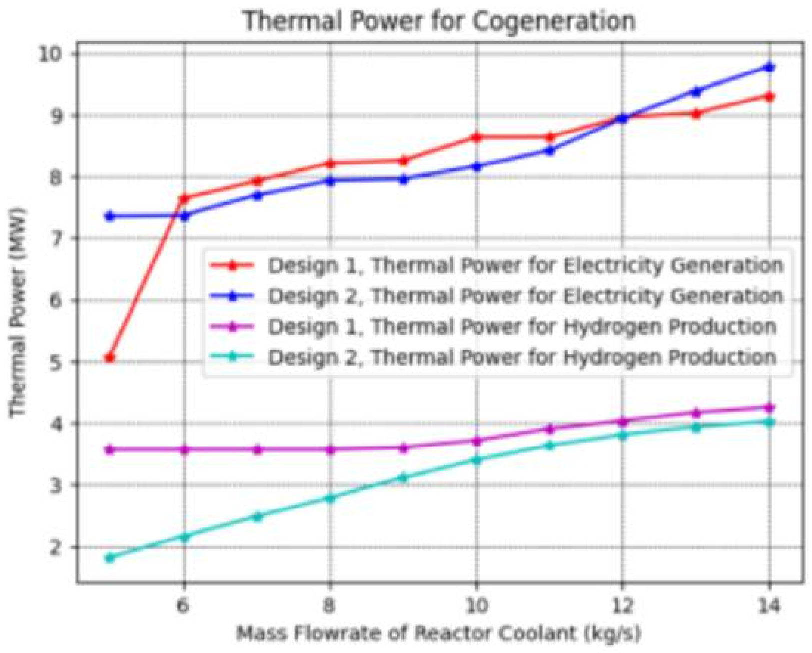

Figure 5. Power of each thermal energy utilization.

At a coolant mass flow rate of 12 kg/s in the reactor, the thermal power for electricity in design 2 finally reaches an equivalent value to that of design 1. As seen in Table 4, the value for design 1 at a reactor mass flow rate of 12 kg/s is 8.9584 MW, while for design 2, it is 8.9397 MW. This equivalence occurs because both the reactor coolant and the secondary cycle have a

Untuk mempermudah penampilan data dapat dibuat tabel, gambar, grafik dan bagan. Namun perlu diperhatikan bahwa setiap jurnal memiliki format tersendiri dalam penyajian tabel dan grafik.

In previous research conducted by Djoko Irianto, the EUF value of RDE was achieved at 66% with a reactor power of 10 MW (8). In this study, the EUF value of PeLUIt-40 was achieved at 34.51% for the second design with a reactor power of 40 MW. This occurred because the priority in this study was to generate electricity rather than prioritize hydrogen production. The purpose of this study is to scale up steam production for hydrogen and optimize electricity generation. The hydrogen production is already at 1.2 kg/s in the steam generator with a temperature of 506.36°C, which qualifies it for the use of the SOEC method for hydrogen gas production.

System efficiency is a measure of system performance, as described in equation (2). It can be seen in Figure 8 that system efficiency increases with increasing mass flow rate of coolant in the reactor. In the first design, with a mass flow rate of coolant in the reactor of 14 kg/s,

Jika ada penelitian relevan dapat dituliskan dan jelaskan perbandingan hasil yang didapatkan.

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Kesimpulan

Pada bagian kesimpulan tuliskan jawaban dari masalah yang dibahas.
Penting untuk menyelaraskan antara bagian abstrak, pendahuluan dan kesimpulan.

CO_2 emissions. Another available hydrogen production technology is electrolysis, which uses water or steam as a raw material. There are three types: Proton Exchange Membrane (PEM) Electrolysis, alkaline water electrolysis (AWE), and Solid Oxide Electrolysis Cell (SOEC) (11).

The purpose of this study is to determine the best design for the cogeneration system. In this study, there are two conceptual designs of the cogeneration system were simulated, i.e., with and without a splitter system, respectively. The effect of various coolant mass flow rate for energy utilization factor were analyzed.

Masalah yang dimaksud harus dituliskan pada paragraf terakhir bagian pendahuluan.

CONCLUSION

From this study, it can be concluded that an increase of the coolant mass flow rate will increase the exit temperature of the coolant secondary side as a result of the heat transfer in the Intermediate Heat Exchanger (IHX). This temperature impacts an increase in the thermal power used for power generation and heat production. An increase in the mass flow rate in both designs also causes the value of the EUF and the value of the thermal efficiency to increase.

The first design has a higher value of total EUF is 33.92%, while the second design has a total EUF value of 34.51%. Both are at a mass flow rate of coolant in the reactor of 14 kg/s. The system performance, as measured by the efficiency parameter, shows that the first design outperforms the second design. The efficiency value of the first design is 69.92%, whereas the efficiency value of the second design is 71.02%, both with a mass flow rate of coolant in the reactor of 14 kg/s. Therefore, the second design is preferable for implementation cause by using a splitter, the thermal power in the secondary cycle can perform more effectively.

Maka jawaban dari masalah yang telah dipaparkan harus di tuliskan pada bagian kesimpulan.

Daftar Pustaka

Dhiya Salma Salsabila, Ign. Djoko Irianto, Sukmanto Dibyo, Athiek Sri Redjeki. COMPARATIVE ANALYSIS OF COOLANT MASS FLOW RATE FOR PELUIT-40 REACTOR IN ENERGY CONVERSION SYSTEM: A STUDY OF CONCEPTUAL DESIGN WITH AND WITHOUT A SPLITTER. Jurnal Sains dan Teknologi Nuklir Indonesia (Indonesian Journal of Nuclear Science and Technology) [Internet]. 2023 [cited 2023 Oct 27];24(2):66–74. Available from: https://jurnal.batan.go.id/index.php/jstni/article/view/6903

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