Simple Simulation Using Coupling between Flownex and LabVIEW Simultaneously in Case of Indonesian Experimental Power Reactor

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Abstract
Experimental power reactor known as Reaktor daya eksperimental (RDE) is a National Nuclear Energy Agency of Indonesia (BATAN)-designed nuclear power reactor that will be built with 10 megawatts of power. RDE will serve as a pilot for next power reactors that will be built in Indonesia. In its design, RDE can be scale-up for larger power sizes. RDE development make detail design need to do some experiments for various facilities that will be built. One method can be done by simulating the RDE design. This study simulated the components using Flownex software and used LabVIEW as a software to display simulation results. The use of these two different software can optimize the simulation results.

Keywords: Experimental Power Reactor, Simulation, Flownex, LabVIEW

1. Introduction
Experimental power reactor or Reaktor daya eksperimental (RDE) targeted that all of detail engineering design has to be done in 2108. Development of the RDE itself was appropriate with national research agenda on energy sector [1]. Test facility would build in the same year, in this phase many detail should be test before build a real reactor. RDE model is modified from high temperature gas cooled reactor (HTGR), so RDE will have a pebble bed as nuclear fuel. RDE design to produce 10 MWth and it will generate 3MW electrical power. This case shown that the thermal energy have bigger than electrical power. In reactor pressure vessel the temperature when fission reaction take place will rise until many hundred Celsius degree. So that the temperature produce from the ongoing process is not excessive then used the cooling system by using helium gas to keep the reactor temperature relatively stable.

One step before the construction there are many things to be prepare first such as the complete design, safety analysis, material selection and simulation of RDE process. The simulation can be uses as simple proof of design that will be applied on construction. Simulations become important because its ability to change parameter without loose in any cost. Not only in cost view, simulations become more important because it can manipulate the parameter but also the parameter change in simulation not giving risk at all in safety factor otherwise build and modify the real one. Usage of difference parameter in many case also need less time when using simulation. Because of these various things it is necessary to create a simulation that can describe the state of the RDE itself simultaneously and is easy to use and manipulated.
The process of making the desired simulation required several stages that must be met. The stages needed are the simplification of the RDE design, test of design that it can be operate, the determination of variable parameters, data form type to be stored and how the data calling process is needed. As addition then visualization of the data obtained and data transfer process which can be done continuously. Overall simulation become one of many aspect that RDE must have licenses from Nuclear energy regulatory agency of Indonesia (BAPETEN) to make sure that engineering design was ready for construction [2].

2. Methodology
RDE would be built by design of fourth generation reactors, High temperature Reactor model. It was modified the design of HTR10. In the proposed design of RDE it would using gas as cooling system. So basically RDE was High Temperature Gas cooled Reactor (HTGR). Helium was selected as coolant of cooling system. Helium gas will entering the reactor core to keep the temperature at 250°C in its inlet and at temperature 750°C in its outlet. RDE operate in pressure of the reactor core which set to approximately 30 bar. The use of pressure greater than the environmental stresses presents its own risk of leakage of the gas contained in the reactor. It can also be used as a reason for the importance of using the simulator as a reference tool before development on an actual scale.

This research was develop using Flownex as software to simulate the process that took place in RDE. Flownex is generally uses to calculate temperature, pressure, flow rate and heat transfer. In addition Flownex also can show the amount of energy rate, entropy and efficiency of a system when needed both in single phase or two phase fluids. Furthermore, Flownex contains a simplified model of pebble bed nuclear fuel which integrated its core neutron calculation [3]. This can be done by Flownex because it is a system level simulation tool that common to use in thermodynamic modelling of thermal-fluid system. The simulation in Flownex can be set to simulate in steady state or transient state. Flownex contain part electrical and other part that actually can be modify by the user. Basically Flownex has been developed to generate fast results even for network with minimum user effort in large scale [4].

Flownex can be communicate with other software in many way. This factor make Flownex can be compare or coupling with other software to increase its performances, for example Flownex can be communicate with Ansys, Matlab or Microsoft Excel. For communication purpose between Flownex and other software, the data transfer can be use Simulink, ‘dll’ file, ‘txt’ file, excel component and other many ways. This research try to communicate between Flownex and LabVIEW to simulate the case process of experimental power reactor (RDE). RDE simulation part for this research take a sample of cooling system. Flownex will do the simulation and LabVIEW will display the data from Flownex. LabVIEW was chosen because its well know and can visualize data in various way. LabVIEW or Laboratory visual instrument engineering workbench was develop to be system platform for virtual programing language by National Instruments. LabVIEW is commonly used for instrument control, data acquisition and industrial automation. In many level of user, LabVIEW often to create virtual circuit and its visualization and easy to use [5]. LabVIEW’s virtual instrument can show the virtual circuit that represent the real condition.

3. Results and Discussion
This research try to coupling between Flownex with LabVIEW using third party software, Microsoft excel. Flownex uses to doing the simulation of condition to be measure its parameter which is selected before. The data gain from Flownex simulation then save in Microsoft excel format. The excel data will be used by LabVIEW as data to create visualisation. In this term the simulation result data from Flownex will be save in specific format of Microsoft excel. The already data then call and transfer using feature in the LabVIEW. In advance stages, the control of this simulation can be modified so the control of simulation in Flownex can be controlled using LabVIEW. However the real simulation basically still run using Flownex. Microsoft excel chose as third party software because it was
common software to use by most of people as data processing tool. Many other software also have feature to coupling with this software.

The case of this research simulation was part of reactor cooling system of RDE, especially describing how the helium gas cooling the nuclear process of RDE. The properties of cooling system of the RDE shown on the Table 1.

Table 1. Characteristics of RDE Cooling system

| Parameters                  | Values |
|-----------------------------|--------|
| Reactor power (MWth)        | 10     |
| Power density (MW/m³)       | 2      |
| Core height (m)             | 2      |
| Core diameter (m)           | 1.8    |
| Number of pebble fuel       | 27000  |
| Coolant pressure (bar)      | 30     |
| Coolant flow rates (kg s⁻¹) | 4.4    |
| Coolant inlet temperature (°C) | 250   |
| Coolant outlet temperature (°C) | 700   |
| Fuel material               | UO₂    |
| Coolant material            | Helium |
| Reflector material          | Carbon |

After the simulation done using Flownex, it will gain various data. The result data can be selected, so it can show the selected data only. The selected data then communicated use of Microsoft excel feature. All data communicated to Microsoft s excel then communicated to LabVIEW. So it would be needs to create virtual instrument which becomes the visualization of data from Flownex.

Figure 1. show that LabVIEW can read data from Microsoft Excel. This is one of many other way to take data from excel. The use of LabVIEW in the visualization of Flownex simulation result in the advanced stage can be used as a control to run the simulation process, data storage and termination of the simulation process.
The main problems of simulation using two difference software is about communication methods in both of them. This problems can be solve in many way. Coupling process on Flownex software with LabVIEW in this research using Microsoft excel as third party software. The use of third parties is basically less efficient because it requires more software involved. The more software involve allows more opportunities for errors. The most effective way that can be used to connect between Flownex and LabVIEW is to use ‘dll’ files with extension, but the use of files with this extensions makes the data transfer become apply to special case only and it make the conversion more difficult when compared with using Microsoft excel. Another possible way is to use a file with ‘txt’ extension. The use this extension type files is more flexible than ‘dll’ file type extensions. The ‘txt’ file is the basic readable file and is generally supported by many other software. However when ‘txt’ file type usually make a simple data structure. So for direct perform processing or interpretation of data in other forms such as graphs need other action. This is different from the use of Microsoft excel which can allows the user to process data in another form if desired action on Microsoft excel itself.

4. Conclusion
This Research shows that using two software to perform a simulation can be done with variations as needed. Third-party software can be used to facilitate communication between software required. Coupling process between Flownex software and LabVIEW software can improve the optimization between both software where Flownex software was used to perform simulation process and LabVIEW software is used as a software to display the simulation result done by Flownex so it is easier to be used by the user. The use of coupling in this process can be applied on a large scale so as to improve the performance of the simulation. In the advanced stage, if third-party software can be eliminated to simply the simulation process and minimizing errors that may occur during the communication process between software took place.

5. Acknowledge
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