A REPORT

ON

DEVELOPMENT OF A THERMO PHYSICAL PROPERTY MODULE FOR THE CONTAINMENT CODE

BY

OINDRILA GHOSH 2018A1PS0080G

AT

ATOMIC ENERGY REGULATORY BOARD, MUMBAI

A PRACTICE SCHOOL 1 STATION OF

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

JUNE, 2020

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OINDRILA GHOSH 2018A1PS0080G CHEMICAL ENGINEERING

Prepared in partial fulfilment of

Practice School-I Course Nos.

BITS C221/ BITS C231/ BITS C241

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ACKNOWLEDGEMENTS

The success of the work done for Atomic Energy Regulatory Board, Mumbai as a part of the Practice School 1 programme, required a lot of guidance and assistance from multiple people.

I would like to express my special thanks of gratitude to my project mentor, Mr. Aniket Gupta of Atomic Energy Regulatory Board, Mumbai. His continuous guidance and support helped me acquire the skills that were necessary for the execution of this project and smoothly execute the various steps in the coding and documenting process.

I heartily thank my PS Faculty, Prof. Prashant Wali and the entire Practice School Division for giving me this golden opportunity to work on this project for Atomic Energy Regulatory Board, Mumbai and for providing us with all the necessary information even before Practice School 1 began. Prof. Wali's guidance at every step was crucial in smoothly sailing through the process.

I am also very thankful for the unending encouragement, support and guidance from Prof. P. Srinivasan. His lectures have been the most helpful in understanding the basics of the power sector in India.

I am grateful to Prof. Manoj Soni for taking the time to conduct a gap lecture on the solar power sector and other renewable sources of energy in India. It helped me understand the different mechanisms and infrastructure that is available in our country today to harness the power of renewable resources.

Last but certainly not the least; I owe my deep gratitude to Mr. Subrat Kaushik of BARC for delivering a much needed and very informational talk on the nuclear power sector of India. This helped me gain a perspective on the nuclear power generation scene in the country and better appreciate the project assigned to me.

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

(RAJASTHAN)

PRACTICE SCHOOL DIVISION

STATION: Atomic Energy Regulatory Board **CENTRE:** Mumbai

DURATION: 6 weeks

DATE OF START: May 18, 2020

DATE OF SUBMISSION: June 22, 2020

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KEYWORDS: Nuclear power plant, containment chamber, containment code, thermo physical properties, Fortran 95, Doxygen, radiation safety, power generation, nuclear fission, thermal hydraulics, simulation

PROJECT AREA: Nuclear safety analysis and research (Title: Development of a thermo physical property module for the containment code)

ABSTRACT

Atomic Energy Regulatory Board carries out safety and regulatory functions for the nuclear power sector in India. It was set up in 1983 by the President of India in accordance with the Section 27 of the Atomic Energy Act of 1962. Currently the scientists, engineers and researchers at AERB are working on the containment code. It is a package that allows the simulation of the containment chamber, the structure that houses the nuclear reactor core.

The containment code is divided into multiple modules, each of which evaluates and simulates the different aspects of the containment chamber. The project described in this report pertains to one such module- the thermo physical property module. It comprises of the various subroutines required for the evaluation of the different properties like specific heat capacity, dynamic viscosity and heat conductivity of the gases that are found inside the containment chamber as well as the average values to account for their mixtures. The code is written using Fortran 95 and documented using Doxygen.

Contents

List of Figures

1. Introduction

Atomic Energy Regulatory Board was set up on November 15, 1983 by the President of India. Its headquarters is located in Mumbai, Maharashtra. AERB was set up with the aim of carrying out safety and regulatory functions in the nuclear power sector of the country. Its regulatory authority is derived from the Atomic Energy Act of 1962 and the Environmental (Protection) Act of 1986. Currently, Nageswara Rao Guntur is serving as the chairman of the organisation.

Figure 1.1: The AERB logo.

Atomic Energy Regulatory Board is responsible for conducting nuclear projects. They are either nuclear power projects or nuclear fuel cycle facility projects, which include fuel mining and mining facilities, fuel processing facilities and fuel fabrication facilities in India. Due to the wide negative perception of nuclear power, AERB also conducts awareness programmes to enable the set up of more nuclear power plants in the country. Apart from this, the organisation is actively involved with diverse international bodies for the exchange of information as well as cooperation in the vast field of simulation and regulation of the use of nuclear power for peaceful purposes.

AERB has several divisions that take care of the different aspects or functions of the organisation. One of the most important divisions among them is the NSAD (Nuclear Safety Analysis Division). The project described in this report comes under the domain of this particular division.

The project is titled: development of a thermo physical property module for the containment code. The containment code is an in-house package that is being developed by AERB to simulate the thermal hydraulics of the containment chamber. Each module of the package is dedicated to a specific aspect of the containment chamber and all that is inside it. Once all the modules have been developed, they will be integrated into a package that will be available for use by any nuclear power plant in India. There are currently 22 nuclear reactors in operation in 7 nuclear power plants in the country.

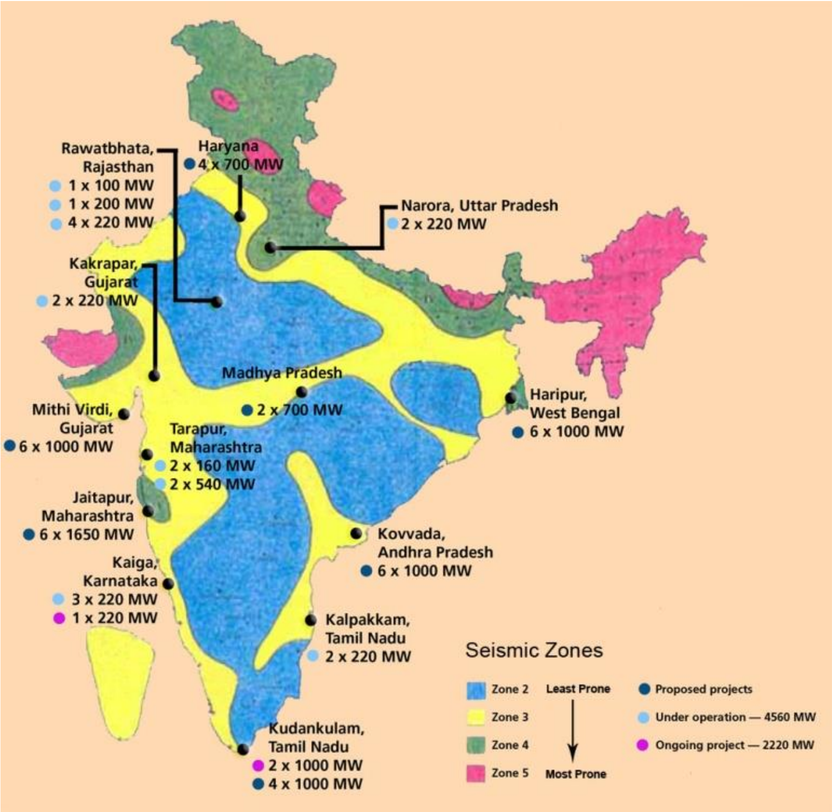

Figure 1.2: The various nuclear power plants in India and their capacities.

2. Gap lectures and Expert Talks

Over the six weeks, several gap lectures were organised by Prof. P. Srinivasan and Prof. Manoj Soni. These helped us get an in depth understanding of the working of a nuclear power plant as well as the other sources of power generation in India. These were crucial in understanding the aim of the project, its use and importance.

2.1. The Power Sector in India

A comprehensive lecture on the power sector of India was organised on May 18, 2020 by Prof. P. Srinivasan. We gained some knowledge about the various aspects of a power sector like the current installed capacity and the power generation capacity. Prof. Srinivasan also talked extensively about the adverse environmental impacts of the continued used of conventional fuels like coal. It is clear that investment in alternative sources of power is the need of the hour.

Some examples of these alternative sources of energy generation are solar power, nuclear power, hydel power, tidal power, geo thermal power and wind power. All of these sources are non-polluting unlike fossil fuels like coal. Although it is clear that these avenues of power generation possess immense potential, the set up of the power plants poses certain problems, especially due to the fact that these sources of energy are very unreliable and are heavily affected by factors like environmental conditions. Thus, energy storage is necessary to ensure continuous flow of electricity. Currently, a lot of research work is going to make a future out of renewable sources of energy possible very soon.

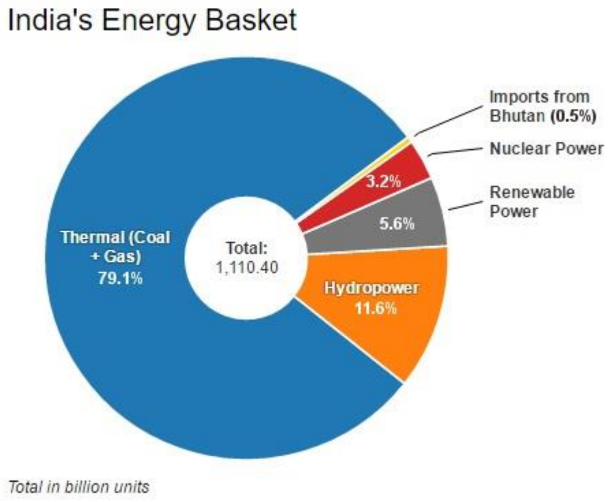

Figure 2.1: The contribution of the different power sectors in India.

2.2. Renewable Sources of Energy in India

A lecture on solar power generation and other renewable sources of energy was conducted on May 19, 2020 by Prof. Manoj Soni. The aim of this gap lecture was to give us an insight into the problems faced by the solar power sector among various other things. We had a healthy discussion on the different mechanisms of conversion of solar energy into electrical energy.

Diverse technologies are available today to allow the generation of electricity from solar power on a large scale. This includes Parabolic Trough Technology, Tresnel Lens Collectors, Entech Concentrating PV, Linear Fresnel Reflector, Schefflor Collector and Towers.

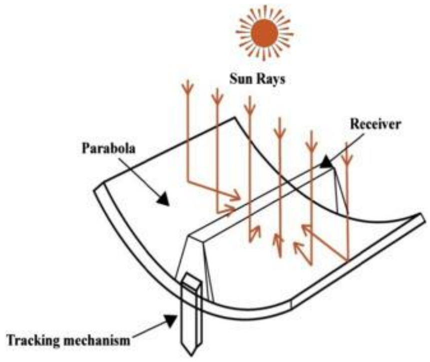

Figure 2.2: Parabolic Trough technology.

The per capita consumption of power has been on the rise since forever. In India, this is primarily due to the fact that electricity is getting cheaper by the year and more and more regions, especially rural areas, are getting electrified. With increase in demand, more and more coal is being consumed. Besides the fact that the process of generating electricity in a fossil fuel based power plant is highly polluting, coal is a non-renewable resource. This implies that once we run out of it, coal based power plants and other products will simply become obsolete and we will be left with no choice but to opt for alternative sources of power.

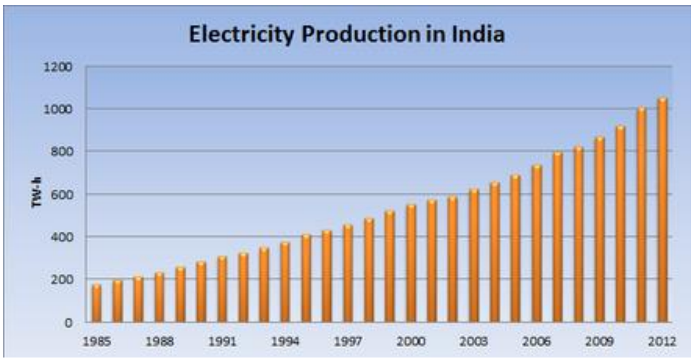

Figure 2.3: The increasing energy production in India.

The Government of India provides various incentives including rebates on the installation of power plants based on renewable sources of energy to encourage less use of coal. On comparing the grid interactive installed power capacity of these renewable energy sectors, we find wind energy in the leading position, closely followed by solar energy in India. There are various factors that make wind a very good source for energy generation:

1. It involves much lower land usage.

2. They can be installed off shore, on hilltops or along the coasts where winds are almost always present and are pretty strong.
3. Wind power plants can generate energy in all seasons.

Nuclear energy on the other hand, although very highly efficient, has not seen a striking rise in its use over the last couple of decades. This is primarily due to the public opposition to the installation of nuclear power plants in India. Research work is currently going on to ensure increased nuclear safety to overcome this hurdle in the near future.

2.3. Power Plant Economics

A very enlightening talk on power plant economics was conducted on May 20, 2020 by Prof. Srinivasan. It gave us an insight into the various economic factors that need to be taken into consideration when one is making critical decisions for a power plant.

The operation of a power plant involves various kinds of expenses like the capital cost, variable fuel cost, operations and maintenance cost, interest, insurance and taxes. Salvage value, often referred to as the scrap or the residual value, is the estimated or expected value of a particular industrial asset at the end of its useful life. In the evaluation of this value, depreciation plays a major role. Calculation of the salvage value is necessary to understand the value of an investment.

The levelised cost of energy (LCOE) is the cost of generating a single unit of electricity. Evaluation of this value is necessary to understand the competition and profitability. The plant load factor (PLF) is yet another value that is evaluated to get an understanding of the performance of a power plant. By definition, it is the degree of plant capacity utilization for a period of time.

Various other values are also calculated to understand the benefits of a particular investment and the regular expenditures of a power plant throughout its life.

2.4. Nuclear Power Generation

A lecture on nuclear power generation was delivered on May 21, 2020 by Prof. P. Srinivasan. The aim of this talk to was to introduce us to the vast world of nuclear power generation in India. We started off with a discussion on the differences between coal based power plants and those based on nuclear fuels like uranium. We also learnt about the various components of a nuclear power plant.

The nuclear power plant has two circuits, one inside the containment chamber and one outside. The nuclear reactor core is present inside the containment chamber and the main fission reaction takes place here. The isotope of uranium with a mass number of 235 is highly radioactive and easily undergoes nuclear fission. Thus, the most commonly used nuclear fuel is U-235 and it is used for this purpose as a fuel bundle of 19 pins or 37 pins. This reaction takes place when a neutron is made to strike a U-235 nucleus. The fission products are much more stable than the fuel nuclei. Three neutrons are also released in the process. These neutrons strike three other radioactive nuclei and the reaction continues.

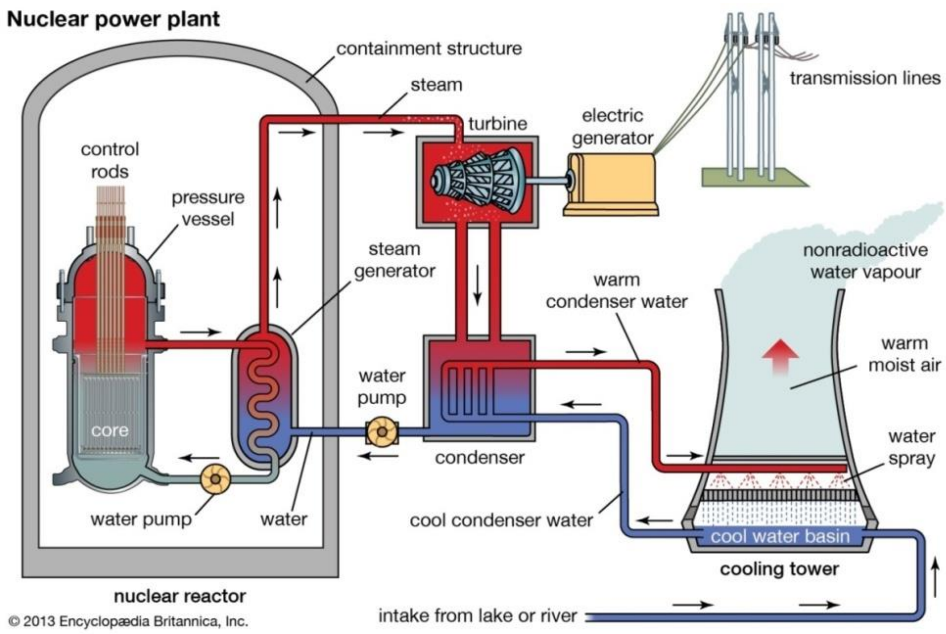

Figure 2.4: Working of a nuclear power plant.

When uncontrolled, this reaction produces a huge amount of energy. This is very dangerous and is the primary principle used in a nuclear bomb. For the purpose of nuclear power generation, the reaction is controlled. Control rods capture excess neutrons, thereby, bringing the reaction under control. In addition to this, moderators slow down the neutrons to make it possible for U-235 nuclei to capture them and undergo fission. Scattered neutrons are still, more often than not, too fast to keep up the reaction. In order to ensure that the reaction does not fizzle out and continuous generation of power is possible, the concentration of uranium nuclei is enriched to about seven times its natural abundance. During the reaction, a large amount of heat energy is produced and this is captured using a coolant.

The heat obtained from the reaction is used to produce steam from purified water. This steam turns an electric turbine present outside the containment chamber and makes energy generation possible. A condenser then condenses the steam to water, which is sent back to the containment structure for reuse.

The most common nuclear fuels are uranium and thorium. The corresponding reactions are fission reactions. Till date, it has not been possible to carry out a fusion reaction and harness the energy produced for electricity generation purposes. However, research is going on in this field to make it possible very soon.

2.5 The Future Opportunities and the Challenges Faced By the Nuclear Power Sector

A lecture titled "Nuclear Power Generation in India: Opportunities and Challenges" was delivered by Mr. Subrat Kaushik on May 23, 2020. Mr. Kaushik is a scientist at BARC (Bhabha Atomic Research Centre). The lecture was primarily about the challenges faced and the future opportunities of nuclear power generation sector in India.

The primary reason behind the fact that the nuclear power sector is still a largely unexploited avenue of power generation in the country is the public perception of what it entails. It is undeniable that nuclear power had a very rough start. One of the most famous first uses of this source of energy was the nuclear bomb. The infamous Hiroshima-Nagasaki twin disasters during the Second World War left the cities destroyed, many dead and the future generations genetically affected after two nuclear bombs were dropped by USA onto the two densely populated cities. This has left a scar in nuclear power's reputation. In addition to this, nuclear reactor meltdowns including the nightmarish disaster at Chernobyl Plant in Ukraine in the year 1986 has left people sceptical of how safe harnessing nuclear power actually is.

Figure 2.5: The nuclear power plant at Chernobyl, which faced a nuclear accident in 1986.

There are various other factors that make it difficult to set up a nuclear power plant. The transportation of the materials involves various strict protocols. Regular testing and simulation are also very important. The personnel need to be rigorously trained before they start working in such a plant. These and several other measures are taken to ensure the safety of the personnel, the environment and the equipment. It is clear that setting up a nuclear power plant is an enormous investment and considering the fact that these plants have a very small lifetime, many believe it to be an investment that is certainly not worth making.

In spite of all this, there is no denying that nuclear power generation has come a long way. The safety measures taken today are very advanced. In addition, the power generation capacity of a nuclear power plant is much higher than any of the other known sources of power. It also does not actively pollute the environment and in a world crippled by the effects of green house gases, this is a huge bonus. The Government of India actively encourages the switch from coal based power plants to those based on cleaner sources of energy. This has been making it easier to set up nuclear power plants in the recent times. Currently there are around 22 nuclear reactors in operation in 7 nuclear power plants in India, with a total installed capacity of 6780 MW.

3. The Containment Chamber

The containment chamber is an essential part of any nuclear power plant. It is the tall domed structure that one can see inside the compound of such a plant. This structure houses the nuclear reactor core and holds in the fission products. Apart from the various equipments, fission products and the nuclear fuel required for the power generation process, various other gases can be found inside. The main function of the containment chamber is to prevent a leakage and release of any of these substances. As most of the contents of the containment chamber are highly radioactive in nature, their release into the atmosphere or the environment can prove to be extremely hazardous. This makes the job of the containment chamber all the more essential.

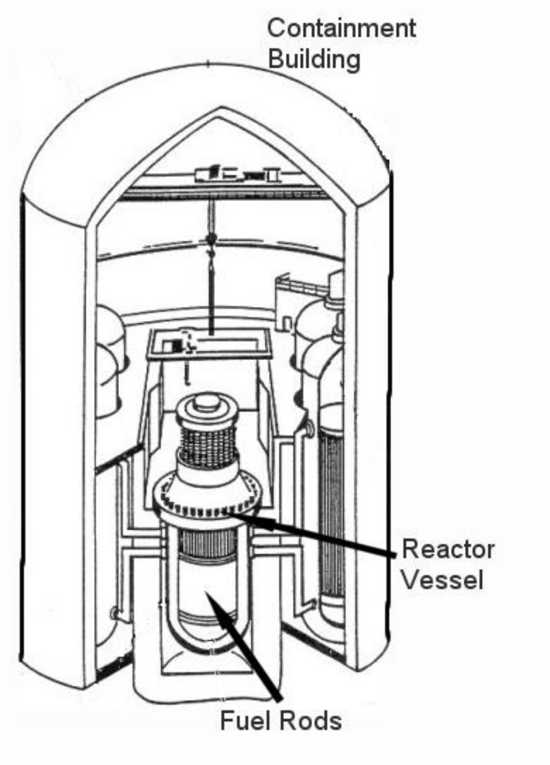

Figure 3.1: The components of a containment chamber.

The conditions and the properties of the various gases present inside the containment chamber greatly affect the overall condition of the structure. Steam and liquid air is almost always present. Apart from that, gases like helium, nitrogen, carbon dioxide, carbon monoxide, hydrogen and oxygen can also be found.

4. Aim of the Project

The overall project that Atomic Energy Regulatory Board, Mumbai has been working on is a package that, when completed, can be used by any nuclear plant in India to simulate the containment chamber.

The containment chamber, as previously mentioned, is the primary line of defence against a release of the radiation from the nuclear fuel and the nuclear reaction into the atmosphere.

The effects of a nuclear failure are very clear in the previous instances of the same- the Chernobyl disaster of 1986 and the Fukushima Daiichi disaster of 2011.

There are various ways in which a meltdown of the nuclear reactor core may occur. Loss of coolant accident or LOCA is one of the most common among them. Besides that, the states of the different substances and the components inside the containment chamber, that is, either inside or outside the nuclear reactor core but near it, heavily affect the conditions of the core. Unfavourable conditions can lead to disasters involving the meltdown of the core.

It is because of the highly critical nature of the containment chamber’s function that its simulation and regulation from time to time is absolutely necessary to ensure safety. The containment code, which is a simulation package, is being developed for this very purpose. As mentioned before, the containment structure holds in various gases and their states affect the overall conditions of the containment chamber. Thus, the thermo physical property module is a part of the containment code to account for the different properties and states of the gases and their mixtures.

5. Pre- Requisites for the Project

There are three main resources that are required for the execution of this project. For the formulae that are to be used to evaluate the different properties, related research work and literature in the field are required. For the purpose of the development of the thermo physical property module, all the required formulae and data were provided by AERB itself and the documents are proprietary.

For coding purposes, a programming language is required. It is necessary that the chosen programming language has the following characteristics or properties:

1. It should be easy to code in. It is very difficult to develop a simulation package using a language that is not very easy to understand or code in.
2. It should be a language that is commonly used by the professionals in the same domain of work. Besides, the language should be preferably easy to learn. This will ensure that interns or new comers can easily learn the language and start contributing to the project.
3. The language should be such that it can be used by anyone, anywhere. This is necessary because, although the different modules of the package are developed at

different times and by different people, they need to be in the same language so that they are compatible with each other and can be eventually, successfully integrated into the required package.

Fortran, although an old High Level Language (HLL), is used extensively in scientific and mathematical applications even today. The term FORTRAN itself stands for FORmula TRANslator. Various versions of this programming language have been introduced over the years. Due to the obvious benefits of using this language, Fortran 95 was chosen as the programming language for this project.

Figure 5.1: The Fortran logo.

The entire package has been subdivided into a number of modules. This is in keeping with the Divide and Conquer mechanism. It has several benefits:

1. Dividing the entire package into modules makes it easier to develop it. This is because the developer can focus on one particular aspect of the containment chamber at any point of time.
2. It also enables higher efficiency in its use. Once ready, one can implement any specific module at any point of time as per requirement.
3. The division of the code into modules also makes the code more readable.

As the modules are being developed by different people and the modules themselves are very long and sometimes unreadable, documentation is a very important aspect of the project. The presence of reliable documentation helps in keeping track of all the aspects of an application or package, and it is especially beneficial for a future programmer looking to improve on the code or add new functionalities later.

Figure 5.2: The Doxygen logo.

Doxygen is a software that is popularly used as a documentation generator. It makes the documentation process very easy and user-friendly; and thus, was chosen for the documentation purpose for this project.

6. The Basic Layout of the Project

The overall project is primarily a package written in Fortran 95 and referred to as the containment code. The package consists of different modules. These modules simulate a specific aspect of the containment chamber. The wall heat transfer module simulates the heat that is being transferred through the walls of the containment structure. The conduction module simulates all the heat that is being transferred by the mechanism of conduction. Similarly, the thermo physical property module, which is the module that this particular report is about, simulates the thermal hydraulics of the containment chamber, by accounting for the different thermo physical properties of the gases found inside the structure.

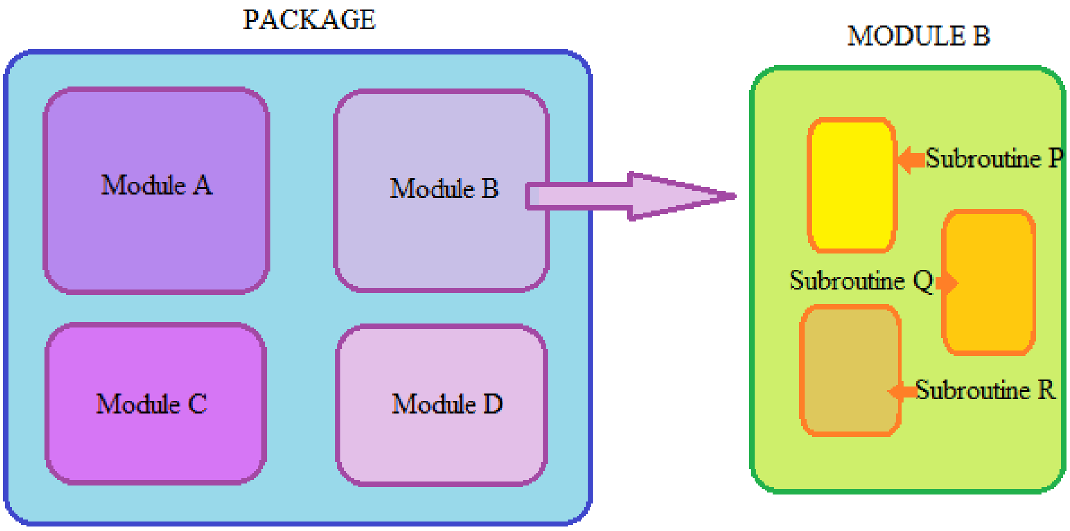

Figure 6.1: The basic layout of a simulation package.

As, various properties need to be evaluated in order to simulate the containment chamber, every module is divided into subroutines. Each subroutine is dedicated to the evaluation of a specific property for one of the components of the containment chamber or the substances that it holds in.

7. Execution of the Project

The containment chamber contains a lot of different gases like carbon dioxide, hydrogen, oxygen, nitrogen, steam, carbon monoxide and helium. While steam and liquid water are always present, the same cannot be said for the other gases. Thermo physical properties refer to a group of properties like specific heat capacity, heat conductivity, dynamic viscosity, diffusion coefficient, specific volume, partial pressure and specific enthalpy. These properties are closely dependent on the temperature and affect the state of a gas at any point of time. Using various mechanisms and formulae, these properties can be evaluated for each of the individual gases as well as the average values to account for their mixtures.

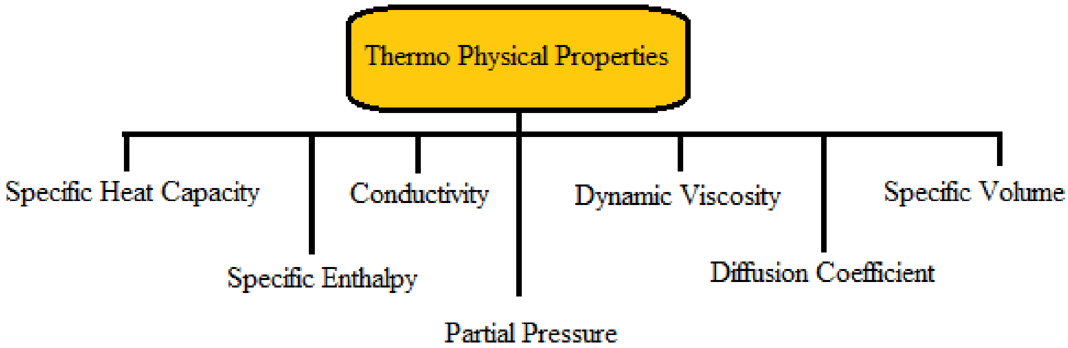

Figure 7.1: List of properties covered by the thermo physical property module.

It is necessary to evaluate the average property for the mixture of gases present in the containment chamber. This is primarily because of the fact that the state of the individual gases does not affect the conditions of the containment chamber. Instead, it is their overall effect that needs to be considered.

The thermo physical property module has different subroutines and functions, as required, each of which is dedicated to one property. As each run may not have all the possible gases, an initializer function is defined. It takes an input of the gases available from the user in an array. Separate arrays also store the mole fraction and the molecular weights of the gases in the order in which the different gases are supplied by the user. For air, the weighted mean value of the component gases are taken to evaluate its molecular weight and this comes out to be approximately 29.

Various other subroutines are defined and each is dedicated to a specific thermo physical property. They return value of the property evaluated for each gas as well as their mixture. The value returned is also an array, which has the values in the same order as the gases that were provided during the initialization process. The number of elements in the returned array is one greater than the number of gases present inside the containment chamber. The last element of the array returned has the average property, evaluated for the mixture of the gases.

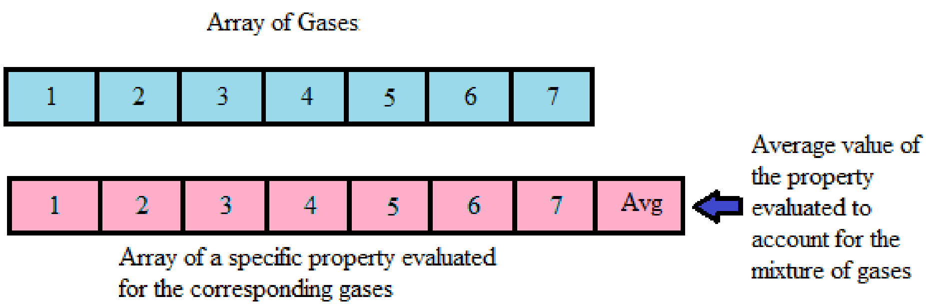

Figure 7.2: Layout of the input and output arrays.

The code is written as per guidelines provided by Atomic Energy Regulatory Board, Mumbai. In addition, in order to prevent any confusion regarding the code, which is pretty long and might be unreadable to some, it is duly documented. This is accomplished using a software called Doxygen.

8. Issued Faced

A couple of issues were faced during the execution of the project. Fortran 95 is a first generation high level language. Although it has undergone several revisions and many versions of the same are available, the core concepts are fundamentally different from the more modern object oriented programming languages like Java or Python. While these languages would have been better suited for the purpose of this project due their object oriented nature, it is important to note that Fortran as a programming language is still very widely used in scientific, mathematical and engineering applications. Although, it does not have the extensive libraries similar to that of C++, Java or Python, Fortran does provide various intrinsic functions to operate on strings and arrays; and allows us to carry out mathematical operations, including but not limited to the evaluation of partial differential equations more efficiently. Various softwares are available to deal with the unreadability of a

Fortran code. These documentation softwares provide fast and efficient documentation of the code. This documentation can be referred to at any point in the future to understand the code and improvise on it as required.

9. Conclusion

The thermo physical property module and the other modules, once completed, will be integrated together into a single package. This package, known as the containment code, can be used to simulate the containment chamber of any nuclear power plant in India. Regular simulation is a necessity in any nuclear power plant because of the highly radioactive nature of the fuel used and the effects of a nuclear reactor core meltdown, leading to a nuclear disaster. Radiation can lead to dizziness, vomiting and in the worst case, death. This makes simulation and regular radiography checks very important. The containment code is a part of this process and thus, the development of the thermo physical property module is an important project.

References

1. Aerb.gov.in. 2020. *Home*. [online] Available at: <https://www.aerb.gov.in> [Accessed 6 June 2020].
2. *Containment Chamber*. [image] Available at: <https://en.wikipedia.org/wiki/Containment_building> [Accessed 5 June 2020].
3. Document on thermo physical properties and their evaluation for different gases(AERB, proprietary)
4. *Increasing Electricity Production In India*. [image] Available at: <https://en.wikipedia.org/wiki/Electricity_sector_in_India> [Accessed 6 June 2020].
5. *India's Energy Basket*. [image] Available at: <http://www.businessworld.in/article/Cheaper-Renewable-Energy-Soars-Past-Nuclear-Power-In-India/18-03-2016-92093/> [Accessed 5 June 2020].
6. *India's Nuclear Power Plants*. [image] Available at: <https://www.downtoearth.org.in/news/how-vulnerable-are-indias-nuclear-power-plants-to-disaster-33202> [Accessed 7 June 2020].
7. *Parabolic Trough Technology*. [image] Available at: <https://www.sciencedirect.com/topics/engineering/parabolic-trough> [Accessed 6 June 2020].
8. Tutorialspoint.com. 2020. *Fortran Tutorial - Tutorialspoint*. [online] Available at: <https://www.tutorialspoint.com/fortran> [Accessed 31 May 2020].
9. *Working Of A Nuclear Power Plant*. [image] Available at: <https://www.britannica.com/technology/nuclear-power> [Accessed 5 June 2020].

Glossary

1. **Array**- It is a collection of data items of the same type that are accessed using a common name.
2. **Condenser**- It is an industrial apparatus used for condensing the vapours of a substance.
3. **Conductivity-** It is the degree to which a specific material can conduct heat or electricity. It is expressed as the amount of heat or electricity that flows per unit time through a unit area with a temperature gradient of one degree per unit distance perpendicular to the area taken.
4. **Containment Chamber-** It is a tall domed structure inside a nuclear power plant that houses the nuclear reactor core and holds the radiation inside.
5. **Containment Code**- It is a package that is used for simulation of the containment chamber.
6. **Control Rod**- It is a part of the nuclear reactor core that is capable of absorbing neutrons without itself fissioning, which helps to keep the nuclear reaction under control.
7. **Coolant**- It is a substance with a high specific heat capacity that is often used to reduce or regulate the temperature of a system that can get heated up due to various factors.
8. **Diffusion Coefficient**- It is the quantity of a substance that diffuses through a unit cross sectional area per unit time, keeping the volume- concentration gradient unity.
9. **Doxygen**- It is a software that used for the documentation of a code.
10. **Dynamic Viscosity**- It is the force needed by a fluid to overcome its own molecular friction so that it can flow.
11. **Fortran 95**- It is a high level language developed in the 1950s by IBM for scientific and engineering applications.
12. **Moderator**- It is a part of the nuclear reactor core that takes up some of the kinetic energy possessed by the neutrons produced as a consequence of a nuclear reaction thereby, reducing their speed without capturing any of the neutrons.
13. **Module**- Packages are made up of units called modules. They have functions that carry out a process or evaluate a value.
14. **Nuclear Power Plant**- It is a power plant that uses a nuclear fission reaction to generate energy.

15. **Package-** It is a group of modules coded in a specific language that provides a particular functionality.
16. **Partial Pressure**- It is the pressure that would have been exerted by one of the gases in a mixture if it was allowed to occupy the entire volume.
17. **Renewable Source-** It is a natural resource that is capable of replenishing to replace the portion depleted by usage or consumption.
18. **Salvage Value**- It is the estimated or expected value of a particular industrial asset at the end of its useful life.
19. **Specific Enthalpy**- Enthalpy of a system is the sum of its internal energy and the product of its pressure and volume. Specific enthalpy is the enthalpy of a system evaluated per unit mass.
20. **Specific Heat Capacity**- It is the heat required to raise the temperature of a unit mass of a substance by a definite amount (usually one degree).
21. **Specific Volume**- It is the volume occupied by a substance per unit mass.
22. **Subroutine-** It is a sequence of instructions written in a programming language to perform a specific task; and packaged as a single unit.
23. **Thermo Physical Properties-** They are the physical properties of a substance that are temperature dependent or affected by temperature.
24. **Turbine**- It is the machinery used in a power plant that has a wheel or rotor, usually fitted with vanes, which are turned by steam, water, air or any other fluid.