NTEC N12 –ASSIGNMENT

INITIAL REACTOR THERMAL HYDRAULIC DESIGN

Using information from the course notes and references produce the first iteration of a Thermal Hydraulic design for a reactor plant required to supply 1000 MW electrical power. The following aspects should be examined: Choice of reactor type, power conversion efficiency, thermal limits on reactor core power, coolant circulation, heat transfer from the primary circuit. Qualitative description of accident challenges and design features to ensure safety.

Suggested activities and time scales are given below. Relative timings are framed with water cooled reactors in mind and may need to be adjusted for other types.

Activity	Time hrs	Outputs	Cumulative hrs
1. Reactor choice	1	Type and number of reactors.	1
2. Power conversion	9	Core thermal power, Secondary temperatures	10
3. Nominal and Hot channel description	5	Number of fuel elements, flow area, PPFs, Hot Chan Factors	15
4. Thermal limits	2	Define limiting quantities, T, q'' etc.	17
5. Limiting powers	20	Max power as function of flow rate, temp and pressure	37
6. Coolant conditions, m,Tin,p	5	Core flow rate, Coolant T, p, Loop flow rates.	42
7. Coolant circulation	10	Circuit pressure drop, pump power	52
8. Heat removal	10	Heat exchanger (SG or other) configuration, heat transfer area.	62
9. Safety strategy	8	Description of reactor accident response.	70

Notes on the above activities:

1. **Decide on reactor type** to be designed: Balance information available from existing types with potential benefits from new types (including what interests you).

2. **Power conversion efficiency and core power:** Estimate secondary temperature, sketch T-s diagram of cycle (think about practicality), calculate efficiency, allow for turbine efficiency and find core power.

3. **Nominal and Hot channel assumptions:** Look up notes and comment, choose hot channel factors, choose initial mass flow rate from assumed average DT

across core, choose primary pressure. Choose a simple axial power profile e.g. chopped cosine shape.

4. **Thermal Limits:** Decide on key limits for the reactor type. Fuel Temperatures, clad temperatures, heat fluxes?

5. **Limiting power at different flow rates and coolant temperature:** State limiting conditions, calculate key temperatures and/or heat fluxes at several flow rates and inlet temperatures. Determine limiting powers for these conditions

6. **Required flow rates and coolant temperature:** From limiting powers choose mdot and Tin, justify choice.

7. **Pumping power:** Calculate pumping power from mdot and circuit Dp. Choose values for circuit Dp coefficients etc., iterate with SG design, explain choices.

8. **Heat removal:** Using primary to secondary temperature difference from the previous stages of design calculate corresponding heat transfer coeff. and area for the steam generator or the equivalent heat exchanger for the reactor type. Finalise number and size of tubes.

9. **Safety strategy:** Identify the dominant accident threat to the plant and the plant features that will be needed to mitigate the effects of such an accident. Are these active or passive systems.

Assessment Strategy

Final mark - maximum of 60

You will be marked against the following criteria:

Achievement (/40): This assesses the level of achievement, measured against the set objectives. Particular emphasis is placed on the student's demonstrable understanding of the problem, the overall conclusions and the extent to which these are supported by detailed investigation, and the level of accuracy in quantitative work. Evidence of originality will be rewarded.

Demonstration of understanding	(/10)
Conclusions - support by detailed investigation	(/10)
Conclusions - support by quantitative work	(/10)
Originality	(/10)

Report Writing (/20): This assesses the quality of the written report. The report should be clear, coherent, objective and succinct. It should be logically structured with appropriate use of sentences, paragraphs and

chapters. The report should use correct units, meaningful captions of figures and tables and appropriate labeling of axes. Padding with unnecessary and irrelevant material should be avoided.

Quality of writing	(/10)
Use of figures, tables and references	(/10)

Deadline

28th November 2022

Submission

All work should be presented in the form of a written report which must present your methodologies, results and analysis in a clear and concise manner. Do not submit large spreadsheets containing all your calculations (or similar).

Contact

Please contact me if you have any questions or problems with the assignment.

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