TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Министерство науки и высшего образования Российской Федерации
федеральное государственное автономное
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«Национальный исследовательский Томский политехнический университет» (ТПУ)

Field of training (specialty): 14.06.01 Nuclear, Thermal and Renewable Energy and Related Technologies, 05.14.03 Nuclear Power Plants: Design, Operation and Decommissioning.
School: Nuclear Science & Engineering
Division: Nuclear Fuel Cycle

Scientific qualification work

Topic
Thermo-hydraulic processes near the surface of vertical pipes and bundles of rods in a coolant flow with supercritical parameters

UDC: 621.039.534.4

PhD student

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Министерство науки и высшего образования Российской Федерации федеральное государственное автономное образовательное учреждение высшего образования

«НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»

Направление подготовки/профиль: 14.06.01 Ядерная, тепловая и возобновляемая энергетика и сопутствующие технологии, 05.14.03 Ядерные энергетические установки, включая проектирование, эксплуатацию и вывод из эксплуатации
Школа: Инженерная школа ядерных технологий
Отделение: Отделение ядерно-топливного цикла

Научно-квалификационная работа

Тема научно-квалификационной работы
Теплогидравлические процессы вблизи поверхности вертикальных труб и пучков стержней при течении теплоносителя со сверхкритическими параметрами

УДК: 621.039.534.4

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Abstract

The supercritical water-cooled reactor (SCWR) is basically a water reactor working over the thermodynamic basic place of water (Pc = 22.064 MPa). It is thought of as one of the most encouraging Age IV reactors due to its simple working almost fifty years of modern experience from nuclear energy plants with a SCW cycle. Developing from the current plans, there are right now two sorts of SCWR ideas: (a) an enormous reactor pressure vessel containing the reactor center (fuelled) heat source, practically equivalent to regular PWRs and BWRs, and (b) conveyed pressure cylinders or channels containing fuel groups. The SCWR center is worked over the basic strain of water (22.1 MPa), where reactor coolant encounters no stage change and the coolant temperature can surpass the temperature, which relates to the bubbling temperature at subcritical pressure. Regarding the developing movement of different progression on the planet, there is another innovation connecting with different atomic fields and it related conditions.

Trial examinations committed to exchange in packs cooled with water at supercritical are extremely restricted. Its noticed huge strain motions at large mass transitions and high intensity transitions. As far as the Heat transfer coefficient (HTC), depended on heat move through the rods without considering inner intensity age revealed a huge data set for water streaming in enormous packs at supercritical tensions. They announced that the exploratory intensity move information can be agreeably depicted by connections acquired for water stream in tubes for the ordinary intensity move system at supercritical tensions, however no Heat transfer deterioration (HTD) in packs were seen inside a similar test boundary range for which intensity move crumbling happened in tubes. The trial on the intensity move of supercritical water in 2 × 2 bar is serious areas of strength for an of network spacer on heat move and non-uniform circumferential wall temperature circulation was noticed. The intensity move tries different things with supercritical tension water streaming vertical in a 2 × 2 bar. The utilization of this investigation assists with setting and viable CFD which can likewise act as prevention. The proposed CFD framework streamlining model assists with validating the choice on the examination of mechanical different progression in SCWR.

The information utilized in the examination are solid since they were accumulated through experienced trial explores in the field of atomic field. The outcomes got from the examination was performed with current logical techniques to

get viable outcomes which can be approved in correlations which satisfactory boundaries. In this current review to examine the three-layered stream, Ansys familiar is utilized as CFD solver. The discretization of thick and warm dissemination terms has been accomplished through the focal differencing plan. Second request upwind plan is utilized to discretize the shift in weather conditions terms. Straightforward (Semi-Verifiable Strategy for Strain Connected Conditions) calculation has been adjusted to accomplish the coupling of tension and speed fields, which certainly deals with the disparity free nature of the incompressible liquid stream. The intensity movement qualities for the upward 2 × 2 rods group while evolving temperature and pressure of supercritical water, driven model of supercritical water stream in an upward channel with 4 fuel bars in the Ansys program. Played out a similar examination of the computation results and distinguish the fundamental examples of intensity move in the channel while changing the boundaries of supercritical water were obtained. CFD recreation was performed to duplicate the outcomes from the trial of intensity move to supercritical water in 2 × 2 bar group directed at Shanghai Jiao Tong College. In our work we mimicked the convective intensity move of water at supercritical tensions. Awareness reads up were performed for three disturbance models, K-epsilon, K-omega and Spalart-Allmaras. Different cross section setup will be chosen for every choppiness model. K-omega disturbance model will require crystal layers nearer to the wall to determine the liquid stream completely.

The test segment comprises of two channels isolated by a square steel get together box with adjusted corners. The examination condition is with variety in mass flux and heat flux and pressure from 23 to 26 MPa. The small portion of intensity move from the second channel to the principal channel is lower than 15% under the test conditions. It decreases with the increment of gulf water temperature and arrives at the most reduced esteem when the delta water temperature is nearby the pseudo-basic point because of the little temperature contrast between the diverts around here. The intensity move decay peculiarity saw in the pole group. Without wire wraps has been performed on different wire twists can smother yet not the HTD in the completely evolved area. The non-consistency of circumferential wall temperature dispersion around the heat rod is noticed. The wall temperatures estimated can be utilized as benchmark information for CFD examinations.