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REVIEW ON THE HISTORY OF THE RESEARCH REACTOR

Introduction

A Nuclear Research Reactor is a device that generates neutrons. These tiny particles are used to check the composition of materials and to produce radioactive substances for medical and scientific uses. Research Reactor are smaller power reactors operated at low temperatures and need far less fuel. They are usually found in universities and research centers including countries that non nuclear power are operated [1].

Overview Research Reactors

There are about 220 such reactors operating, in 53 countries. Some operate with high enriched uranium fuel, and international efforts have substituted high assay low enriched fuel in most of these. Some radioisotope production also uses high enriched uranium as target material for neutrons, and this is being phased out in favour of low enriched uranium.

Research reactors comprise a wide range of civil and commercial nuclear reactors which are generally not used for power generation. The term is used here to include test reactors, which are more powerful than most. The primary purpose of research reactors is to provide a neutron source for research and other purposes [2].

History of Research Reactor Development

The first self-sustaining research reactor, Chicago Pile 1 (CP 1), was assembled in 1942, producing a maximum power of 200 W. Within 20 years, the design of research reactors had progressed to the point that the average neutron flux (number of neutrons per unit area, per second) had increased by nearly nine orders of magnitude. (Fig.1.0 History of research reactors and countries) [3, 4].

ANSTO's First Research Reactor: HIFAR

HIFAR was Australia's first national research reactor. It was central to the research that occurred at ANSTO and it operated safely and reliably for almost 50 years. The reactor was in operation between 1958 and 2007, when it was superseded by OPAL the Open Pool Australian light water reactor.

Figure 1.1 First HIFAR research reactor- ANSTO (Source:nucleus.iaea.org/RRDB/, May 2019)

Moata Research Reactor

Moata was one of ANSTO's first reactors and operated successfully for 34 years until 1995. It was a small 100 kW research reactor and was initially used for research and training and later included activation analysis and neutron radiography. Moata also played an important role in aircraft safety [4].

Figure 1.2 Moata research reactor- ANSTO (Source:nucleus.iaea.org/RRDB/, May 2019)

Types of Research Reactors

There is a much wider array of designs in use for research reactors than for power reactors, where 80% of the world's plants are of just two similar types. They also have different operating modes, producing energy which may be steady or pulsed.

a. Nuclear reactors
b. Power reactors
c. Power plants, Heat generating plants, cogeneration units
d. Ship/submarine reactors
e. Nuclear research facilities
f. (Sub) Critical assemblies

Simplest facilities, 'zero' power without active cooling, limited multiplication coefficient, simplified control system, limited experimental possibilities [5].

Classification of Research Reactors

- Single purpose for power reactors design
- Power in tens of MW, built for a specific experiment and decommissioned afterwards. Nowadays, none exists anymore, nor is planned
- E.g. LOFT in Idaho for safety assessment of loss-of-coolant-accidents or PBF pulse reactor for thermal fuel damage research
- Research and development in reactor physics

- Mostly critical assemblies and zero power reactors for various fuel lattices research. Nor these reactors are being built, to research properties of new reactors, the older facilities are often used.
- The Czech reactor LVR 15 belongs to this group
- Radionuclides are used in industry and healthcare, e.g. 99Mo, 60Co, 14C, 192Ir, 3H, 131I, 35S, 198Au, 65Zn, 85Kr. To deliver short lived nuclides effectively (mostly for health radiodiagnostics), the producing reactor should be as close to the customer as possible [5, 6].

Uses of a Research Reactor

a. Research and test Reactors
b. Training and Education
c. Irradiation Applications
d. Research Reactors for Transmutation Applications
e. Research Reactors for Materials Testing
f. Extracted Beam Applications

Future of Research Reactors

- Future of research reactors
- All mentioned areas (reactor physics, material research, chemical regimes, …) are applicable
- For current fleet of reactors (generation II/III) long term operation, technical upgrades, increasing safety
- For future generations research (GIV, fussion)
- Some of them eventually for non-nuclear technology (e.g. fossil fuel power plants with supercritical water)
- New research infrastructure in Rez (commissioned 2015 - 2018):
- Test loops with supercritical water, high temperature Helium, supercritical CO2
- Laboratory of fine measurements (electron microscopy TEM, SEM) [7, 8]

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DIGITALIZATION, DIGITIZATION AND AUTOMATION AND THEIR IMPLICATIONS FOR MANUFACTURING PROCESSES

Abstract

Recent developments in manufacturing have increased the importance of digital elements as well as fully automated processes at the planning, strategy and shop floor level. In this article, we provide analyzes regarding the differences and communities of these terms "digitalization", "digitization" and "automation" as well as their implications at the workshop level. We have found that the term digitalization thus finds its use mainly in the field of social sciences describing the social and cultural effects of digital elements. On the other hand, the terms digitization and automation are very applicable in the field of manufacturing research. Although these two concepts influence manufacturing processes differently, we conclude that they must be analyzed in an integrated way, because one requires the other.

keywords: digitalization, digitization, automation, manufacturing.

Introduction