

# Book Review

**Handbook of Generation-IV Nuclear Reactors**, by Igor Pioro, ed., Woodhead Publishing, Elsevier, Duxford, UK, 2016. ISBN: 978-0-08-100149-3. eISBN: 978-0-08-100162-2.

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At the beginning of 2016, there were 441 nuclear power reactors operable in 31 countries with a total generation capacity of 383 GW<sub>el</sub>. This represents an increase of about 6.5 GW<sub>el</sub> in total capacity compared to previous year. The increase in the number of reactors and capacity came despite the number of premature reactor retirements mostly in Europe and North America. According to the International Energy Agency (IEA), the existing nuclear fleet contributes with about 10.8% to the global electricity supply. However, the rate of bringing new reactors to grid is far from sufficient if the world is to meet the target of reducing the impact of global warming as agreed at the 21st Conference of Parties (COP 21) to the United Nations Framework Convention on Climate Change in December 2015 in Paris, France. Same figures from the IEA show that in addition to nuclear, there are barely 20% of other low-carbon and renewable global electricity supply, with remaining 70% of world electricity supply still coming from fossil fuels (coal, gas, and oil). At the COP 21, it was recognized, albeit rather silently than in explicit proclamation by signing parties, that nuclear should be an integral part of future global low-carbon electricity supply in order to ensure sustainable, affordable, and reliable clean energy supply across the globe. The World Nuclear Association (WNA) is very optimistic in their vision that the COP 21 target could be met with addition of 1000 GW<sub>el</sub> of new nuclear capacity by 2050. The number of nuclear reactors currently under construction is at the peak for the past 20 or so years, however, it should be recognized that the prospect facing the nuclear industry today is challenging. Continued safe and reliable operation of the current generation of nuclear power plants (NPP) along with their life extension is essential for global sustainability of both, social development and the protection of the natural environment. The current fleet of nuclear power reactors, largely water-cooled, have and will continue to serve the world well, however, we should notice that substantial progress has already been achieved toward the commercialization of small-modular and advanced reactor designs. The future lies in full commercialization of advanced, so-called, Generation-IV, nuclear power reactors, which offer advances in thermal efficiency, economic competitiveness, radioactive waste management including managing rare-event safety, as well as public acceptance and political participation.

The Elsevier just released a brand new book titled *Handbook of Generation-IV Nuclear Reactors*, which actually offers important insight into a global progress of development and

commercialization of new generation of advanced nuclear power reactors. The handbook has been written by a number of world-known practitioners and academics in the field. This timely handbook was prompted by a wave of significant advances over the last 15 years since the initiation of the Generation-IV International Forum (GIF). The *Handbook of Generation-IV Nuclear Reactors* does a profound service in framing the technical and technological issues involved in the development of, in many cases, revolutionary technological solutions. It also conveys just how complex the field of nuclear technologies for clean electricity generation is. Internationalization and globalization of nuclear technologies opens up new horizons for many, even as it potentially threatens notions of dominance of national technical standards and points to the need of their harmonization and collaboration in development of internationally accepted regulatory requirements and oversight practices.

Introductory chapter to the *handbook* discusses current technologies for commercial electricity generation with the focus on nuclear technologies and its role in future global electricity supply. The bulk of the book is organized in three parts and a rich block of appendices.

- (A) Part 1 titled *Generation-IV nuclear-reactor concepts* is organized along the GIF's strategic focus on the six advanced systems selected in 2002 and than reaffirmed in 2012: (1) Gas-cooled fast reactor (GFR) or simply high-temperature reactor (HTR), (2) very high-temperature reactor (VHTR); (3) sodium-cooled fast reactor (SFR), (4) lead-cooled fast reactor (LFR), (5) molten salt reactor (MSR), and (6) supercritical water-cooled reactor (SCWR). This part of the book starts with an historic overview of the Generation-IV International Forum's activities and summarizes the collective progress made under the GIF umbrella.
- (B) Part II—*Current status of Generation-IV activities in selected countries* goes into detailed discussion of the status of development in countries with substantial advanced nuclear-reactor and fuel-cycle research and development programs. Seven chapters cover the advances in the development of Generation-IV technologies in the U.S., the European Union, Japan, Russia, South Korea, China, and India.
- (C) Part III—*Related topics to Generation-IV nuclear-reactor concepts*. Five chapters in the third part of the handbook cover additional topics of importance to full commercialization of advanced reactors, from safety of advanced reactors, political and social aspects of nonproliferation, thermal aspects of conventional and alternative fuels, hydrogen cogeneration, to advanced small-modular reactors (SMRs).
- (D) *Appendices*—The handbook accommodates eight appendices, which provide reader with additional reference material and data on current nuclear power reactors and nuclear power plants, thermophysical properties of reactor coolants, thermophysical properties of fluids at subcritical and critical/supercritical pressures, heat transfer and pressure drop in

forced convection to fluids at supercritical pressures, world experience in nuclear steam reheat, etc.

In summary, the *Handbook of Generation-IV Nuclear Reactors* provides broad international perspective of next generation of nuclear power reactors, combining historical overview of development, research, industrial operating experience, safety assessment,

and applications of nuclear energy for sustainable, reliable, and environmentally friendly electricity supply for distant global future. The handbook delivers in one place a comprehensive, up-to-date information of interest to wide range of practitioners in nuclear and power engineering, mechanical and environmental engineering, as well as in academia, research organizations, and social and technology policies and development planning.