



A.N.T. International Academy

ONLINE EDUCATION

BWR Chemistry Introduction

COURSE DESCRIPTION

This course gives an overview of topics relevant to BWR plant chemists with little experience, but also engineers working on fuel and structural material as well as high level chemistry managers. The course involves watching recorded lectures and participating in an online assessment (test). The lectures can be accessed at times convenient for practicing engineers and managers.



Assessment are done online, with an understanding of the current material (i.e., 70% required correct answers). After passing the test, a certificate will be issued to the student.

The content is described more in the [Appendix](#).

COURSE MATERIAL

The course material was developed by A.N.T. International and consists of modified/edited earlier recorded A.N.T. International Seminar.

AUTHORS/LECTURERS

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

Sam Hettiarachchi and **Wilfried Rühle**.

[Read more about the Experts](#)

COURSE DURATION

- Lectures: 20 h
- 1 Test: 1 h

The listed time for the lectures is the actual running time. More time may be needed to digest the information provided in this course.

CERTIFICATE

You will automatically receive an email with your certificate that you can print or share on social media. If you need a printed certificate, please don't hesitate to contact us and we can send it to you via regular mail. You reach us at support@antinternational.com.

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Appendix: Course outline and topics covered

1) BWR DESIGNS AND MATERIALS SELECTION

- 1.1 NWC, chemical background
- 1.2 Materials concepts
- 1.3 Basic knowledge about the materials used (carbon steel, low alloyed steel, stainless steel, nickel alloys, special alloys)
- 1.4 Water radiolysis
- 1.5 Radiochemistry

2) BWR WATER CHEMISTRY, ELECTROCHEMISTRY AND CORROSION FUNDAMENTALS

- 2.1 Properties of water at high temperature, density, dielectric constant, viscosity, dissociation const. of water
- 2.2 High temperature pH as opposed to low temperature pH, high temperature Pourbaix diagrams, why are they important, where to find them, how to generate them
- 2.3 Different types of corrosion, general, pitting, crevice, galvanic, erosion, FAC, IGSCC, TGSCC and IASCC
- 2.4 Basic electrochemistry, Nernst equation, mixed potential theory, electrode potential, standard electrode potential, redox potential, electrochemical corrosion potential definitions, reference electrodes used in BWRs, ECP monitoring

3) AUXILIARY SYSTEM

- 3.1 Recirculation system
- 3.2 Residual heat removal system
- 3.3 Water purification (clean-up) system
- 3.4 Control rod drive system
- 3.5 Off gas system
- 3.6 Emergency core cooling system
- 3.7 Standby liquid control system

4) DOSE RATE MITIGATION

- 4.1 Shutdown dose rate basics, impacts and control
- 4.2 Impact of HWC on dose rates
- 4.3 Why Zn addition for dose rate mitigation, thermodynamic basis
- 4.4 Other approaches for dose rate mitigation

5) IGSCC MITIGATION TECHNOLOGIES

- 5.1 Impact of impurities and ECP on IGSCC
- 5.2 Hydrogen Water Chemistry (HWC)
- 5.3 Noble Metal Chemical Application (NMCA)
- 5.4 On-Line NMCA (OLNC)
- 5.5 Methanol injection
- 5.6 Titanium dioxide addition
- 5.7 Plant operating experiences

6) WATER CHEMISTRY SPECIFICATION, GUIDELINES AND ACTION LEVELS

- 5.1 Impact of impurities and ECP on IGSCC
- 5.2 Hydrogen Water Chemistry (HWC)
- 5.3 Noble Metal Chemical Application (NMCA)
- 5.4 On-Line NMCA (OLNC)
- 5.5 Methanol injection
- 5.6 Titanium dioxide addition
- 5.7 Plant operating experiences

7) PLANT OPERATIONAL CHEMISTRY AND CONTROLS

- 7.1 Start up and shut down procedures
- 7.2 Operational chemicals
- 7.3 Iodine control during shut down
- 7.4 Chemical surveillance program for BWRs
- 7.5 Procedures for chemical surveillance
- 7.6 Emergency sampling and procedures

8) WATER CHEMISTRY IMPACTS ON FUEL

- 8.1 Guarding against chemistry upsets
- 8.2 Impact of water chemistry on fuel performance
- 8.3 Minimising the effect of water chemistry on fuel performance
- 8.4 Fuel performance experiences

9) ACTIVATION PRODUCTS AND FISSION PRODUCTS

- 9.1 Activated corrosion product generation
- 9.2 Activity transport pathways
- 9.3 Water chemistry effects on activity transport
- 9.4 Activity release during plant shutdown
- 9.5 Fission product generation
- 9.6 Fission product release patterns
- 9.7 Iodine carryover



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