

제 10 회 학술 발표회 초록

<제 1 부>

(1)

Neutralization of Boric Acid Solution (12wt%) with Sodium Hydroxide Solution (50%)

Sng Hoon Lee
Kwan Sik Chun
Sang Hoon Park*

Korean Atomic Energy Research Institute

With the goal of eliminating the constraints associated with bituminization of boron-containing effluents from the primary loops in P.W.R., a neutralization of boric acid solution with hydroxide has been studied.

The compounds formed after neutralization were identified by powder X-ray diffraction and atomic absorption spectrophotometric technique, and these thermal analysis curves were compared with those of boric acid, sodium tetraborate and sodium metaborate.

The products at various pH ranges should be formed by the following reactions:

- 1) $H_3BO_3 + NaOH \rightarrow NaB_5O_8 + 8H_2O$
- 2) $H_3BO_3 + 2NaOH \rightarrow Na_2B_4O_7 + 7H_2O$
- 3) $H_3BO_3 + 2NaOH \rightarrow Na_2B_2O_4 + 4H_2O$

For the incorporation of the boric acid solution into asphalt, the optimum condition would be in the range of pH 7 to 8 in which sodium pentaborate (NaB_5O_8) could be formed.

(2)

D₂O Scattering Cross Section

Soo Hyun Suh*
Seong Yun Kim
Dong Hoon Kim

*Equipment Development Project Division
Korea Atomic Energy Research Institute*

In solving the Boltzmann equation of neutron transport, a closed form of the neutron scattering kernel is required to delineate thermal neutron behavior in moderators such as light and heavy water. Particularly thermal neutrons in bound moderator substances agitate in quite complicated way incorporated with thermal motion of molecule and chemical binding energy.

Calculations are carried out for the scattering law, the scattering kernel and the total scattering cross section of heavy water based on the model proposed by Butler. The total scattering cross section computed by use of the code DEUKER is compared with the experimental values.

(3)

Study of Strain Aging in Zircaloy-4

임갑순(핵연료개발공단*)
박원구(핵연료개발공단)
육종철(한양대학교)

The strain aging behavior of Zircaloy-4 has been studied as a function of aging temperature, time, oxygen contents or degree of pre-strain for annealed, cold-worked or quenched specimens in the temperature range of 175°C to 575°C for 1 to 1000 seconds of aging time. The strain aging in annealed specimen occurs in the temperature range of 175°C to 530°C. At around 300°C, the strain aging stress in annealed Zircaloy-4 has been found to be proportionat to the square root of atomic concentration of oxygen atoms interacting rigidly with dislocations. In cold-worked specimen the strain aging stress decreases rapidly with degree of cold work and prestrain. This suppression is considered to be resulted from the trapping of oxygen atoms by the defects produced by cold work. The quenched Zircaloy-4 under stress shows two stages of strain aging: i.e., the initial stage of strainaging proportional to (aging time)^{2/3} having

an activation energy of 0.43 to 0.49 eV which is considered to be associated with Snoek type ordering of oxygen around dislocation, and the second stage of strain aging proportional to (aging time)^{1/2} which is presumed to be due mainly to long-range diffusion of oxygen atoms.

(4)

Effect of Electron-Collective Plasmons Coupling on Multiphoton Resonant Absorption in Laser-Produced Plasma.

Kwang-Youl Kim

*Dept. of Nuclear Engineering,**SNU, Seoul, Korea*

The effect of electron-collective plasmon coupling on multiphoton resonant absorption of laser-produced plasma is investigated by using the collective description of quantum-mechanical many body system consisting of collective plasmon fields and an electron coupled to an electro-magnetic wave in the dipole approximation, by utilizing the time-dependent unitary transformation to an accelerated frame of reference. It is shown that, in the presence of an intense e-m wave, the coupling between the plasmons and the individual electrons can be remarkably enhanced due to the electron quivering energy. In addition to the above coupling mechanism, the role of plasmon-photon coupling in laser-plasma interaction is also considered. The coupled kinetic equations for the electron and plasmon (or electron and phonon) distribution functions show that both effects may be of principal importance in laser driven fusion feasibility studies, and must be taken into account over and above classical collisional heating (inverse bremsstrahlung).

(5)

The Laser as a Tool for Rotating Plasma Diagnostics

S. H. Kim

*Department of Nuclear Engineering
Hanyang University*

Theoretical investigation for the determination of plasma parameter and turbulence by laser light scattering is sketched for a rotating plasma in an annular space between two coaxial electrodes by both axial magnetic field and radial electric field. The essential application of laser light scattering is the determination of the isotope separation ratio by the measurement of velocities of each isotope species.

(6)

Theoretical Studies on Weakly-Ionized, Rotating Plasma

S. H. Kim and

Sung Sil Ko*

*Department of Nuclear Engineering
Hanyang University*

Theoretical studies are made on a steady, weakly ionized, weakly turbulent rotating plasma in a plasma centrifuge. Especially, the dependence of the isotope separation ratio on the relaxation mechanism by plasma instabilities is both qualitatively and quantitatively investigated.

(7)

Plant Safety-The Inspector's Role

W. A. Ruhlman and Nam Ho
IAEA Expert*Nuclear Reactor Division 1* Atomic Energy Bureau
Ministry of Science and Technology Seoul 110 Korea*

From around 2200 at night until 0400 in the morning, about 20% of electricity used in the Republic of Korea is produced by nuclear power. This paper deals with accomplished fact not with hypothetical possibilities; Korea is in the nuclear age.

Within the lifetimes of almost everyone in this room, the nuclear age burst upon the world with shattering fury. Since that time, since its power was adequately demonstrated, people throughout the world have been concerned with the safety of this awesome energy source. Many factors are involved in making nuclear power a safe source of energy, among them are design features, automatic safety systems, trained operators, redundant systems and of course, the regulatory inspector. Any of these factors would make a subject for several presentations, but I would like to cover the role of the inspector in plant safety.

I have met regulatory inspectors from the US, the UK, Canada, Japan and Korea. I have found various perspectives within these individuals of the inspector's role. Some see themselves in a role like General Lee out to make world safe for nuclear power as he fought to make Korea free for peaceful development. Others see themselves in a passive role more like the Greek philosopher Socrates calmly reviewing plans submitted by others to assure that the prospective nuclear facility is built safely. The real role lies somewhere between these two extremes.

Most of you are familiar with the technique of defining something by defining what is not part of the item or problem. This is really a easier approach than defining the role of the inspector since the role varies over a fairly wide range based on the conditions incurred. It is not the inspectors role to dictate HOW something is to be accomplished. The HOW is left to the individual power plant operator subject to the restrictions placed on WHAT must be accomplished. The HOW is also restricted by the requirements of safe operations and conservatism which were assumed in the Safety Analyses. The inspector also determines, in general, whether actions are in compliance with previously established standards. He does not attempt to perform an instant exegesis of a specific requirement to see if what is being done is adequate. Rather he reviews what is being done against the requirements previously established for what is to be done to see if they are in compliance. The

inspector plays the Socratic role of determining acceptability of a proposed action during the review of the licensee's Safety Analysis Report when time and working conditions permit the thoughtful, reflective atmosphere necessary for making such decisions. The inspector is also not concerned with efficiency or cost or schedule; he is concerned with safety.

Having stated that he is concerned with safety, we find the inspector immediately faced with two questions 1) what concerns safety; and 2) how safe is safe? To answer the first, the inspector must have some clear-cut ground rules. He must at some point rely on the system design. I think everyone here can easily see that nothing can be protected from everything. As an example, one of the states in the USA had a proposition placed on the ballot that would require that nuclear power plants be protected against every known act of God. Well, since most world religions and legends include a story of a great flood that covered the entire world, passage of that proposition would have required that all nuclear power plants in the state be able to operate or safely shutdown completely submerged! The Christian and Jewish Bibles both contain passages that declare that God parted water on 3 different occasions. Again passage of the proposition would have required power plants in that state to be able to operate with the waters in the intake parted, that is, with a complete lack of all cooling water. While plants could be designed to operate under the above conditions, most people would agree that such conditions are not probable enough to require such protection. On the other hand, plants in the US that use the waters held back by dams for cooling water, do have separate storage facilities for cooling water so that if the dam were to break, they would have sufficient water to cool down the plant. Similarly, plants which are located where flooding is possible are required to be able to protect plant equipment against the worst known flood conditions when combined with the worst known rain/storm conditions in the area. The answer to the first question, what concerns safety, is those items of the plant

which are needed to operate, function or remain intact in order for the plant to cope with the most severe analysed accidents. The answer to the second question, how safe, is still being debated in the US. As you can see from the above examples with flooding and lack of water, someone basically has to make a decision where protection must stop. The answer to the second question is as safe as required by the regulatory body in each country involved, That is some what modified by the agreements between nuclear powers. The International Atomic Energy Agency (IAEA) imposes some minimum requirements on all countries. In addition, countries like Korea and Brazil have additional requirements imposed upon them by the countries which provide them with fuel and/or technology.

In both the US and Korea, the inspector's role started as one primarily of design and analysis review with minimal onsite inspection. In both countries, the onsite inspection role continuously increased and more areas are being inspected. The US has now placed resident inspectors at selected US facilities and it appears that AEB will have the first resident inspectors at Kori 1 within the near future. The progression can best be described as a deepening involvement.

The inspector have also "evolved". In the beginning, the inspector were more scientists steeped in knowledge of the theoretical problems and applications of nuclear theory. Today, the inspectors are more engineers familiar with the operational problems of equipment and systems. The shift has been caused by the shift in problems. The nuclear phenomena are now well defined and the body of expertise and experience has shown that the technology is theoretically safe for peaceful applications. The problems that have been found are those dealing with pumps, valves, switchgear, motors and similar devices which have a wide range of application outside of the nuclear industry.

The direct evolution from scientist to engineering did not produce the individual best designed to meet the required role of inspector. The basic engineering function is to improve components or

processes and to increase efficiency and/or output. These aspects of the normal engineer must be somewhat suppressed if he is to fulfill the role of inspecting to improve plant safety. Plant safety is assured primarily by continuation of processes and operations in accordance with tried and proven formula. The inspector will have a tendency to recommend better ways to perform operations, and these are quite proper as suggestions, but the role requires that compliance with accepted standards be enforced. Although not yet as prevalent in Korea as in the US' the engineer/inspector must also be to write' speak and deal with the public and media. Most engineers are woefully unprepared for these tasks. As a result, some engineers are "trapped" by media personnel. For an example, when asked if a plant is completely safe, the engineer part of the inspector knows that nothing is completely safe; therefore he answers "No." The media then can truthfully print that they asked an inspector if the plant was safe and he said "No." Failure to deal with the media is just as damaging. The press will then report that, when questioned about the nuclear safety of the facility, the inspector refused to discuss the issue.

As you can see, the inspector that is required has several talents. He must be part engineer, part scientist, part public relations man, part writer (since all of his findings must be documented) and last but certainly not least, he must be basically curious and/or suspicious.

The curiosity requirement stems from the need for follow-up. To assure safety, the obvious items are seldom overlooked by the plant operating staff. Oh to be sure there are exceptions to this rule, but most plant operators are really concerned with safe operation. The inspector must detect those subtle deviations from the normal reading or indication. He must then have the curiosity to followup that abnormality to see if it means that a safety issue exists. This leads us to the next phase of the inspectors role, determination of what to look at and how much to review.

As with any job, experience is the best teacher. It is sort of like looking for rocks. Now any of

you that do any gardening know that finding rocks isn't very difficult. When you first plant your garden, rocks are everywhere. Similarly, many problems are obvious when either the first plant of a particular design or the first plant by a particular country or the first plant by a particular utility is being placed into operations. This is normal. As the utility, country or design gains experience, and use the more obvious safety issues are resolved. As with the old garden spot, fewer and fewer rocks are found each year, so to with nuclear plants; fewer and fewer problems are found by the inspectors. In any garden, if you dig a deep enough hole, you will find a rock; in a power plant if you inspect any given area in enough depth, you will find something improper. It may be insignificant, but you will find something. A missing signiture on a form, a missing from; something. As any good gardener can tell you, those deep down rocks aren't the problem, it is those near the surface. Therefore, the effective inspector digs a large number of shallow holes. If he finds no rocks (problems), he can then assume that the plant is being operated safely. But you can't dig all those holes in one spot and make such a judgement; the sample has to be representatives.

I am sure that this audience contains several mathematicians who can lecture for hours on the theory of random sampling. I can't. I can tell you from experience that it works. The inspector's samples are not, strictly speaking, completely random, but that is the basic concept. Again, experience will tell the inspector where problems are more likely to occur. He will then take a random sample from the more likely problem areas. To do this effectively, the inspector must keep abreast of current problems. We have information on problems at all of the plants in the free world available on a fairly routine basis. Symposiums like this one, international meetings, IAEA reports, abstracts published by various governments, and exchanges of inspectors among cooperating countries and agencies within a country all tend to highlight known problem areas. In addition, certain areas influence many other areas. These

"precursors" are always fertile ground for digging. As previously mentioned, the inspector's own curiosity is vital. While no single inspector qualifies as an omniscient expert, each usually has some particular field of interest and expertise. With the vast numbers of inspectors inspecting nuclear plants today throughout the world, each with his own little area of special interest and expertise essentially all areas are covered with very critical inspections. Since all reactors use the same basic technology and the resulting problems are widely disseminated, the role of the inspector is enhanced by the finding and expertise of other inspectors.

As to the future role of inspector, I see increased involvement. The more time you spend looking for rocks, the more rocks you will find. Quite honestly, the nuclear industry's inspector have been becoming more experienced. We are finding more problems. That has, in itself, created a problem. The problems that are found must be corrected. That takes time and manpower and money. It sometimes takes more time to correct a small problem than to correct a large problem. Again as seen in the analogy with the garden it takes less time to remove all the rocks larger than a man's toe. There are simply more small problems in any industry that large ones after the technology becomes reasonably developed.

The inspector role for plant safety is summed up, then as one of providing additional assurance of safety. The plants are designed, built, and generally operated safely. The inspector sort of keeps things honest as it were. He will find problems. In many cases while the licences is fixing that problem he will himself find other problems or possible problems. There is no other industry employing as many people or with such a capital outlay as the nuclear industry that has the safety record that has been accumulated. In over 500 reactor years of commercial nuclear power plant operation, there has not been one nuclear related death.

The final polish, although not often appreciated as such, on the inspector role with safety are you sitting in the audience. As you and the countless

millions of others like you around the world ask the regulators of this industry and their inspectors those "difficult" questions, you force the inspectors and the regulatory bodies themselves to become better at their respective jobs. Your questions will inevitably help to mold and fashion tomorrows inspector's role in plant safety.

<제 2 부>
(1)

Studies on the Therapeutic Irradiation
and Chromosome Aberrations

Young Jin Kim*, Jin Yong Kim
and Jong Bong Kim

Korea Atomic Energy Research Institute

Five ml of blood samples were taken from cervix, Lung and other cancer patients treated with therapeutic radiation of 1,000r, 1,200r, 1,400r, 1,600r, 2,000r, 2,800r, 3,000r, 3,800r, 4,000r, 4,600r, 5,000r, 5,400r, 5,800r and 6,000r respectively.

Chromosome Preparations were obtained from in vitro leukocyte culture and air drying method. Types of chromosome aberration and chromosome aberration rates were analyzed according to the radiation dose.

Two types of abnormal chromosomes, dicentric and acentric chromosomes, were observed in the leukocytes. The polyploid cells were also found in the experimental groups.

(2)

방사선 처리에 의한 비의 돌연변이
형질의 유전연구

권신한, 원종락*, 김재리

한국원자력연구소 방사선 육종학연구소

진리방사선을 작물 종자 및 생체에 처리하면 여러가지 종류의 돌연변이체(mutant)를 얻을 수 있고 이것은 육종사업상 귀중한 재료로 이용되는데 이때 돌연변이체의 각 형질의 유전현상을 정확히 알므로서 육종사업을 효율적으로 수행할 수 있다.

본 연구는 벼품종 진홍종자에 X-선 25kR 을 처리한 결과 종자의 영(lemma)에 갈색 반점(brown color spot)을 지니면서 진홍 모품종에 비해 출수기(heading date)가 일주일 정도 빠르고 장간이 돌연 변이체를 얻어 이 변이형질(mutated character)의 우열관계, 관여하는 인자의 수, 그리고 세가지 변이형질의 상호관계를 규명하였다.

영의 갈색반점, 조숙 장간 형질은 각각 열성단인자형(recessive single gene)유전을 하였으며 세 형질을 동시에 고려한 F₂에서도 3:1의 분리를 하였다. 교로, 이 세 변이형질의 유전관계는 다면적 발현현상(pleiotropism), 밀접한 연관(close linkage)에 기인되는 것으로 추측된다.

(3)

방사성 동위원소 표지에 의한 미소곤충의
비산거리 측정연구

권신한, 정규희, 유준

한국원자력연구소 방사선 육종학연구소

식물의 즙액을 빨아먹는 곤충의 표지는 섭식에 의한 방법과 체표에 묻히는 방법이 있다. 솔잎혹파리와 같이 미소한 곤충은 체구가 작아 염색약에 의한 표지는 힘들다. 본인들은 몇가지 핵종을 이용하여 표지법과 비산거리를 조사하였다.

1. 유충시기에 섭식을 시켜서 오랫동안 표지시킬 수 있는 핵종을 Ca⁴⁵이며 수간주입에 의한 방법이 좋았다
2. P³²는 수간 주입시 Ca⁴⁵보다 표지는 빨리되나 반감기가 짧아 본 해충에서는 표지효과가 없었다.
3. 노숙유충 및 번데기 시기에 침지하는 방법은 표지율이 낮았으며 우화시기에 체표에 묻게하는 것이 표지율이 높았다.
4. P³²로 표면처리시 농도는 목재처리상(55×65×25cm)에 total activity 3mCi 가 표지율 86%로 가장 높았다.
5. P³²로 표지한 솔잎혹파리 성충을 방산한 후 재포획하여 비산거리를 추정한 결과 약 400m 이었다.
6. 성충의 재포획율은 약 0.001%이었다.

(4)

The Effect of Protent Content and Adsorptivity
of Charcoal on the Validity of Insulin
Radioimmunoassay

Kyong Hee Lee, Ok Doo Awh, and Jae Rok Kim

Korea Atomic Energy Research Institute

As a blank plays a pertinent role in the usual sensitive assay, minimizing and equalizing the unadsorbed radioactivity to charcoal in the antibody blank tubes is quite important in preparing insulin radiomunoassay (IRIA) kit to work its normal assay function.

The effect of protein content in standard insulin tubes on the validity of IRIA, and the adsorptivity of the labelled free insulin to the dextran coated charcoal (DCC) were studied varying protein content from 0.3 to 0.8%. Incubation mixture of different protein content were incubated at 4° for 24 or 48 hrs and subsequently the bound insulin was separated from the unbound (free) insulin by applying the DCC method.

The adsorptivity of the free labelled insulin to DCC was slightly decreased with increasing protein content but generally increased with improving the intactness of the labelled insulin. The results indicated that the equality of protein concentration between the standard insulin tube and the serum samples is a minor factor is so far as the adsorptivity of DCC is efficient. The adsorptivity of the ¹²⁵I labelled insulin was slightly improved by using dextran T-70. Thus, dextran T-70 is preferable to T-80 for IRIA.

(5)

土壤 및 農作物의 우라늄含量
—槐山 德平里 地域—

金台淳, 宋基俊*, 柳長杰, 韓康完
李 澈, 金洛培, 李仁鍾

韓國原子力研究所

槐山 德平里 地域 우라늄鑛床 附近의 環境 放射能
이 地域 住民에게 미치는 影響을 調査하기 위하여 實施한

調査 研究의 一環으로 農耕地 土壤中の 우라늄 含量과 이들 土壤에서 栽培된 農作物中の 우라늄含量을 調査하여 이 地域 住民들의 飲食物 攝取時 體內에 들어가는 우라늄량을 算出해 보았다.

調査된 21個 土壤試料中の 우라늄含量은 30ppm 以上이 2個 圃場, 20—30ppm 가 2個 圃場, 10—20ppm 가 11個 圃場, 10ppm 以下가 3個 圃場이었고 對照 土壤으로 定한 京畿道 楊州郡, 利川郡 內에서 採取한 土壤試料中の 우라늄含量은 각각 5.4ppm 과 4.8ppm 이었으므로 德坪里地域 土壤의 우라늄含量은 對照 地域보다 훨씬 높은 水準이었다.

農作物(德坪里地域)의 우라늄平均 含量은 깨가 0.99 ppm, 감자 0.92ppm. 벼 0.6ppm, 콩 0.52ppm, 보리 0.37ppm, 옥수수 0.26ppm 等이다.

一般的으로 德坪里 地域의 벼, 보리, 쌀, 감자의 우라늄含量은 他地方의 그것들 보다 높은 傾向을 보이고 있다.

德坪里地域 住民은 成人 한사람이 1일 飲食物로 攝取하는 우라늄량은 247.3μg 程度인데 우라늄放射能은 108μCi 이다.

(6)

Radiation-induced graft polymerization of
methacrylic acid and methyl methacrylate
onto polyester

공영건*, 최재호, 이종광, 장훈선

한국원자력연구소 방사선 화학연구소

The radiation-induced graft polymerization of methacrylic acid and methyl methacrylate onto polyester fabric was investigated with γ -ray as radiation source, and the rate of grafting was examined.

When acrylic acid, methacrylic acid and methyl methacrylate were grafted onto polyester fabric, grafting efficiency was depended upon the dielectric constant in solvent of monomer mixture.

The yield of graft polymerization was related to the total dose, concentration of monomer, and concentration of swelling agent.

Melting point and glass transition temperature of graft copolymers were analysed by DTA.

Physical properties, such as moisture regain, antistatic property, wicking time were measured.