HIGHLIGHTS

AWF News I / The efforts of the countries for CWCS and MGS
AWF News II / Update on Asian Welding Federation (AWF) Member Countries
First Report 1 Indonesian Welding Society / First Report 2 Singapore Welding Society

Area Spot-1 / Beijing  The 19th Beijing Essen Welding & Cutting Fair 2014
Focus Shifts from Scale Expansion to Quality Improvement

Area Spot-2 / Malaysia  CIS Program at Chiyoda Malaysia Sdn Bhd

Feature / Welding Arcs Made Simple for Welding Engineers

Statistics / Continued increase of robot sales in 2014
Editor’s Choice / Product Reviews

A Window Into the World: The Newsletter of the AWS
Guide to International Events

Sanpo Publications, Inc.
The efforts of the countries for CWCS and MOS

The 21st Asian Welding Federation (AWF) Governing Council and Task Force Meeting was held on April 24, at Tokyo Big Sight (as previously reported). The Governing Council featured detailed reports from the countries regarding their implementation plans for the Common Welder Certification Scheme (CWCS) and Manpower Optimization System (MOS), which the countries have been examining and preparing for since the establishment of the AWF. In this paper, we report the efforts of the countries.

The Philippine Welding Society (PWS) reported that the Technical Education and Skills Development Authority (TESDA), a government agency, is implementing training and evaluation of welders. PWS became able to receive support, related to training, from TESDA. Metaphil, a leading company in the country's manufacturing industry that utilizes large numbers of welders, became a member of the PWS's governing council two years ago, and after obtaining a copy of the authorized certification body (ACB) quality manual from the Singapore Welding Society (SWS), it began creating an ACB quality manual for the PWS. An application for ACB authorization is expected to be made in October 2014. Currently, the ACB auditors and examiners have not been authorized, but they are planning to take the AWF auditor examination at the next AWF meeting. The Philippines is now looking into introducing their system in three main islands separately, and plans to translate the CWCS documentation from English into local languages.

The plan is to implement authorized training center (ATC) auditing in early 2015 and to register for TESDA’s MOS in July 2015. The PWS hopes that the CWCS and MOS will finally be operating some time in 2016.

The MOS-linked AWF CWCS was adopted because it is a management system, as opposed to the American Society of Mechanical Engineers (ASME) and American Petroleum Institute (API) systems, which are standards. TESDA wishes to build a national welding skills management system with regard to economic integration with the Association of Southeast Asian Nations (ASEAN), which enables skilled workers to move freely within the region. The MOS will not be publishing registration data of welders employed by companies, but it will publish registration data of people who are unemployed or looking for work in the future. It reports that it will also be useful in employment negotiations.

The Mongolian Material Science and Welding Society (MMSWS) already has two auditors confirmed and another is going to take the auditor examination at the current meeting. The society is just starting to prepare for the establishment of an ACB. It wishes to utilize the implementation plan of the PWS CWCS as a reference.

The Indonesian Welding Society (IWS) has started preparing to create a quality assurance (QA) manual for the establishment of an ACB. To begin with, it will set up model ATCs in Jakarta and Surabaya, but it plans to expand these, to training centers affiliated with the country's Ministry for Labour. The Heavy Equipment Manufacturer Association of
Indonesia (HINABI) is collaborating in the introduction of the AWF CWCS and MOS systems. IWS also wishes to extend the schemes to the automobile and shipbuilding sectors. However, it reports that the petroleum gas industries will not be targeted, since they are already committed to ASME/API welder qualification tests (WQT). The China Welding Association (CWA) reports that there are approximately 2,050,000 welders in China and that the ASME and French standards are used for the WQT, in accordance with contract requirements. Moves to establish an ACB have begun, with members planned to be included from the petroleum and automobile industries. After the ACB is established, ATCs will be set up in Beijing and Shanghai. In the future, there will be a need to translate the CWCS documentation into Chinese.

National WQT standards are based on International Organization for Standardization (ISO) standards and do not vary significantly. China is already implementing WQTs based on ISO 9606-1 and European (EN) 287-1.

Furthermore, after an explanatory meeting for a welding personnel certification system was held for relevant parties from Indonesian industry and academia, in 2007 the JWES and IWS concluded a cooperation agreement on the introduction of a certification system for welding coordination personnel. These certification activities were implemented within the framework of a Japan-Indonesia economic partnership agreement.

At the same time, in 2007, the Indonesian government signed an economic partnership agreement with the Japanese government, known as the Japan-Indonesia Economic Partnership Agreement (JI-EPA). Incorporated into this agreement was a project “to help improve the level of welding technology in Indonesia.” The project was one of the technical cooperation initiatives and was seen as a means to foster supporting industries in Indonesia and to make the country more competitive internationally. As a preliminary step towards providing full-scale technical support in the form of overseas development aid (ODA), Japan’s Ministry of Economy, Trade and Industry (METI) set out to implement a basic survey project of the current state of fostering welding personnel in Indonesia.

Initially, the JWES pursued its own activities for Indonesia, based on its MOU with the IWS, and these ran parallel with the Japanese government’s activities, which were based on
The IWS has approximately 2,000 individual members and 50 member companies. Principal members are people associated with one of Indonesia’s universities called the big four—University of Indonesia, Bandung Institute of Technology, University of Surabaya, and Gadjah Mada University—and also companies connected to the state, or to foreign-owned or affiliated companies. IWS Executive Director Edi Diarman points out, “The society also enjoys the support of Indonesia’s Ministry of Industry. Just two years ago we only had 1,400 members, but this year we passed the 2,000 mark.” Behind this rapid growth is the economic boom enjoyed by Indonesia’s domestic automobile industry, as well as the surging demand for new infrastructure development. Mr. Diarman explains, “Previously the IWS itself was not well known, but as interest in welding technology has grown, many people have come to learn about IWS. Along with this, we are also seeing increasing numbers coming to take examinations to get qualifications as welding coordination personnel.”

Mr. Diarman also spelled out some of the aims of the IWS over the coming years: “We would like to sign MOUs with many countries to build cooperative relationships and expand our activities. While pursuing a variety of projects, we also want to continue holding seminars and examinations and creating welding-related rules for Indonesia together with government agencies. This will define rules for international businesses, and we will pursue an active relationship with the Ministry of Industry, too.”

Indonesia has become one of the major countries that leads the Association of Southeast Asian Nations (ASEAN) nations, and as an emerging market achieving rapid economic development, it is now attracting the attention of the world for its remarkable potential. The role of the IWS is to ensure the progress and advancement of the welding technology that serves as a fundamental technology of nations, and as an emerging market achieving rapid new infrastructure development. Mr. Diarman explains, “Previously the IWS itself was not well known, but as interest in welding technology has grown, many people have come to learn about IWS. Along with this, we are also seeing increasing numbers coming to take examinations to get qualifications as welding coordination personnel.”

Mr. Diarman also spelled out some of the aims of the IWS over the coming years: “We would like to sign MOUs with many countries to build cooperative relationships and expand our activities. While pursuing a variety of projects, we also want to continue holding seminars and examinations and creating welding-related rules for Indonesia together with government agencies. This will define rules for international businesses, and we will pursue an active relationship with the Ministry of Industry, too.”

Indonesia has become one of the major countries that leads the Association of Southeast Asian Nations (ASEAN) nations, and as an emerging market achieving rapid economic development, it is now attracting the attention of the world for its remarkable potential. The role of the IWS is to ensure the progress and advancement of the welding technology that serves as a fundamental technology of manufacturing in Indonesia. There is hope for further advancement in the future.
Meanwhile, in India, China, and Southeast Asia, the manufacture of parts and structures involving welding continues to expand rapidly. At the same time, the demands of quality control for welded structures is becoming more stringent by the year, and in many cases the AWS-CWI qualification system is being adopted as a means of applying a common Asia-wide quality control scheme. Qualified AWS-CWIs are given the authority to verify welding procedures, certify techniques of welders, etc., and Qualified AWS-CWIs have proved indispensable for quality control based on actual operations.

In this article, we recount a visit to Setsco Services Pte Ltd. (Setsco) in Singapore, an early adopter of AWS-CWI certification in Asia, and the discussion about the company's operation of AWS-CWI with General Manager Sze Thiam Siong (Singapore Welding Society, SWS, president) (Photo 1). We also asked about some of the SWS's future business developments.

The taxi ride from Singapore’s Changi Airport was approximately 20 minutes. Heading from Jurong Town Hall Road to Teban Gardens Crescent, we reached the premises of Setsco at the corner of an industrial estate. A new office building faces the road (Photo 2), while further within is the company’s training center (Photo 3).

Setsco has a broad range of experience spanning 30 years, and it is now one of Singapore's largest testing and inspection companies, with accreditation under a host of schemes, including ISO/IEC 17025 and ISO/IEC 17020, as well as the Singapore Laboratory Accreditation Scheme (SINGLAS) for ISO/IEC Guide 65, certified by the Singapore Accreditation Council (SAC).

Setsco offers comprehensive testing, measurement, inspection, certification, consulting, and training services to major markets including aerospace, petrochemistry, petroleum refining, offshore structures, food and beverages, electronics, environment, medical technology, pharmaceuticals and biotechnology, construction, and equipment.

The company's main business activities include the following:

- Environmental measurement and consulting
- Chemical analysis
- Food hygiene consulting and training
- Clinical laboratory services
- Structural integrity testing
- Inspection of structural steel frame materials and products
- Mechanical inspection
- Metallurgical analysis
- Maintenance testing
- Calibration and measurement
- Electrical and electronic testing

•Nondestructive testing (NDT)
•NDT and welding consulting
•Aerospace inspection
•Advanced NDT
•Third-party inspection and engineering inspection
•Product and personnel certification
•Technical training

In the company’s 4th floor conference room hang a large number of authentication certificates.

The AWS-CWI certification program was introduced to Singapore by the SWS in 1985. Since then, this certification program has been organized periodically, gradually becoming accepted by the country’s industry. While Singapore was the first country in Asia to adopt this program, many other countries have since introduced it too, including India, China, Japan, Korea, Malaysia, and Taiwan. Setsco reports, “This certification program has achieved widespread recognition within the welding industry, both within Singapore and internationally, and the requirement for personnel who are qualified under this certification scheme tends to be designated in employment contracts and project specifications.”

Last year, Setsco trained more than 3,000 welding inspectors, and thereby 1,000 or more welding inspectors earned AWS-CWI certification. As a company rule, all of the company’s welding inspectors must obtain AWS-CWI certifications as one of their occupational qualifications. The reason for such a rule is that “as a service provider, Setsco must guarantee that its own welding inspectors have the experience and qualifications necessary to perform the work assigned to the company.” According to Setsco, this certification program gives the company’s clients the confidence that they can depend on the certified welding inspectors to effectively handle their work.

In addition to Singaporeans, many of the people who attend AWS-CWI training or take AWS-CWI examinations in Singapore come from Malaysia and various other neighboring countries. The Singaporean government actually cooperates quite closely with the SWS, and due in part to its policy of promoting improved public education, it even provides support with training expenses for welding.

As expressed in the phrase “Asia’s domestic demand”, a common Asia-wide market is currently taking shape. The AWS-CWI scheme helps in this by offering a common yardstick for weld quality—something that is essential to the manufacturing industry—and by making it easier to assess the quality and durability of welded structures and products.

Since Mr. Sze Thiam Siong is also the president of the SWS, he spoke to us about the future business developments of the SWS. He pointed out, “The SWS is one of the few organizations having a long history in Singapore. It has been operating steadily now for 36 years, since its establishment in 1978. It started out with only a handful
of welding specialists, but the SWS has grown now, from a small local organization to an organization engaged in various international initiatives."

Mr. Sze also said, "The SWS was one of the founding members of the Asian Welding Federation (AWF), which evolved later from the Association of Southeast Asian Nations (ASEAN) Welding Federation, and it is also a member of the International Institute of Welding (IIW). However, the SWS is currently faced with a challenge. As well as pursuing its welding-related projects, it is trying to attract more young people to welding as a career. This challenge has become more difficult as Singapore has developed and its society has become richer. The number of people choosing to work as welders is decreasing, and as a small organization in a small country with a small population, the SWS’s task of attracting more people to welding is more difficult than in most other ASEAN nations."

Mr. Sze stated, "My personal view is that the SWS will have to keep monitoring the global trends of the welding industry and continually review its role to ensure that it remains relevant and effective in the future. Some of the tasks in progress that the SWS is focused on are

- Promoting productivity and innovation in the welding industry
  The SWS can promote greater automation by upgrading the technological capabilities of the welding industry and also by giving priority to support that helps to maintain a high level of competitiveness. This means encouraging manufacturing companies, through forging partnerships with the SMS, to efficiently adopt more welding processes in their various production processes, as well as sharing experience and knowledge in the application of automated welding systems.

- Changing the image of welding as a profession in the industrial world
  The SWS also aims to counter the old but widespread perception that welders are merely blue collar workers within society and to help transform the image of welding techniques and welding specialists as individuals who possess the highly developed knowledge and expertise to perform high-quality joining. This effort can help to elevate the status and reputation of welders and vitalize welding as an occupation within the industrial world.

- Recruiting young people needed for the SWS to become its members
  The SWS is reviewing its recruiting and membership processes and working to make itself more appealing to the young people who can help to energize its business activities by becoming members. To this end, the SWS is both enhancing its existing methods and embracing new approaches.

- Promoting greater member participation and increasing membership
  The SWS can provide a platform for members to facilitate the sharing of knowledge and experience through better communication and networking. In this way, it can also help members to increase their individual expertise and offer them opportunities to obtain qualifications.

To conclude, we think that regardless of membership, these efforts help the SWS to develop a greater sense of purpose and to ensure that it becomes a more effective and relevant organization."
The 19th Beijing Essen Welding & Cutting Fair 2014 Focus Shifts from Scale Expansion to Quality Improvement

The 19th Beijing Essen Welding & Cutting Fair 2014 was held over four days, from June 10 to 13, at the China International Exhibition Center in Beijing. This year was the 19th time the event has been held since the inaugural fair in 1987. Thus far, the Beijing Essen Fair has grown almost continuously, in the context of the rapid growth of China’s economy. The period of high growth of the Beijing Essen Fair seems to have come to an end, however. At the recent fair, there were 800 exhibiting companies and an exhibition space of 38,000 m². Compared to the previous fair held in Shanghai in 2013 where there were 1,019 exhibiting companies and an exhibition space of 48,303 m², this represents a decline of 219 companies (21.5%) exhibiting and 10,000 m² (20.9%) in exhibition space. Compared to the previous fair in Beijing in 2012, exhibiting companies were down about 15% and exhibition space was down about 20%.
Furthermore, although there was a huge rush of visitors on the second day, the fair started fairly slowly on the first day, when the number of visitors is highest in usual years. On the third and fourth days, the number of visitors was quite subdued. Attendance was far from the usual large crowds of the Beijing Essence Fair.

In terms of content, on the other hand, the event was very interesting. The character of the fair was shifting from scale expansion to quality improvement. The current shortage of skilled labor is clearly driving a strong demand for robot systems, and efforts to ensure stable and high levels of quality are evident.

In addition, the world’s leading robot manufacturers were present, and there was a striking rise in the number of laser processing-related exhibits.

---

Daihen exhibits a cordless teaching system, the first time this technology has appeared in China.

ShenZhen Huayilong Industrial Co., Ltd., which expanded into the field of laser technology, exhibits a 1 kW fiber laser cutting machine.

Jasic is expanding into arc welding robots in partnership with Kawasaki Heavy Industries, Ltd.

Panasonic Corporation was quick to bring in the direct semiconductor laser processing robot that it exhibited at the International Welding Show held in Tokyo in April.

Jasic is expanding into arc welding robots in partnership with Kawasaki Heavy Industries, Ltd.

Panasonic Corporation was quick to bring in the direct semiconductor laser processing robot that it exhibited at the International Welding Show held in Tokyo in April.

Daihen exhibits a cordless teaching system, the first time this technology has appeared in China.

Kaierda actively promotes its joint venture with Yaskawa Electric Corporation.
Osaka University is home to the Joining and Welding Research Institute (JWRI), which is the only Joint Usage / Research Center in Japan related to welding science, as well as to the Graduate School of Language and Culture, School of Foreign Studies, which is the only institute in the country with the educational and research resources to cover 27 of the world’s languages. Through an organic fusion and the collaboration of humanities and sciences, these two have linked up to launch the “Project to Create Research and Educational Hubs for Innovative Manufacturing in Asia”, a Special Budget Project of the Ministry of Education, Culture, Sports, Science and Technology scheduled to run for five years starting in 2013 and aimed at developing solutions to a variety of problems arising from the accelerating pace of globalization.

One of the specific activities of the plan is “an initiative to cultivate globalized students who develop a specialization, understand multiple languages and cultures, and are equipped with high-level communication and self-development skills (professional training project), through an interactive training program at Japanese-owned or affiliated manufacturing businesses in the greater Asian region.” This is a key issue of the whole initiative. This training project aims at fostering students with diverse outlooks and knowledge of different cultures and languages, by implementing Japan’s first hands-on manufacturing training for global professionals, which is based on the new concept of coupling internship (CIS), where a pair of students (one from humanities and the other from sciences, or one from Japan and the other from the greater Asian region) study and work together at a Japanese-affiliated company.

The goal of the CIS Program is to foster professionals capable of demonstrating true leadership on a world stage. It is a global professional training system that aims at improving problem-solving and communication skills through a hands-on training course, implemented as an internship at a global company. The program is the fruit of the combined efforts of Osaka University sciences (Graduate School of Engineering) and humanities (School of Foreign Studies) schools and local universities in the greater Asian region (sciences and humanities). This overseas internship scheme is different from conventional overseas programs, which place emphasis on language learning. The idea is that students of different academic disciplines, in a setting where they face a different language and culture, undergo training together at a global company in order to develop the problem-solving and communication skills necessary to work as leaders in global manufacturing. At the same time, they not only become familiar with an actual manufacturing plant, they also get to experience an international standard production facility, and thereby broaden their minds.

In the first year of the project, 2013, internships were held in Indonesia (PT. Komatsu Indonesia/University of Indonesia), Vietnam (Fujikin Vietnam Co., Ltd./Hanoi University of Science), and Thailand (Thai-Kobe Welding Co., Ltd./Kaetsart University).

In this article we report on the CIS Program held from August 21 to 29, 2014 at Chiyoda Malaysia Sdn Bhd (Chiyoda Malaysia) in Kuala Lumpur, Malaysia.

A total of eight students from two universities, Osaka University and the University of Malaya, participated in this CIS Program. Two engineering students and two foreign languages students were selected from each university. The program leaders were Tetsuo Suga, a visiting professor at Osaka University’s JWRI, along with Nobuko Yoneda and Kuniko Fujiwara. Dean Yoneda is a professor at the Osaka
University Graduate School of Language and Culture (and vice dean of the School of Foreign Studies), while Professor Fujiwara is a Project Assistant at the same school. On the day before visiting Chiyoda Malaysia, the students went to the University of Malaya to attend a lecture by Professor Suga on the fundamentals of welding, and to participate in a training session with Dean Yoneda and Assistant Professor Fujiwara on cross-cultural communication and interview techniques.

The company hosting the internship, Chiyoda Malaysia, is one of the global engineering companies of Chiyoda Corporation of Japan, which was established on June 12, 1974 to work in the petroleum and petrochemical industries. The company has made a substantial contribution to the growth and prosperity of Malaysia’s petroleum and gas industries. Chiyoda Malaysia also provides high-level services for multi-disciplinary engineering, procurement, construction, and commissioning for turnkey projects, as well as feasibility studies, front-end engineering design, detailed engineering, project management, and construction management in oil and gas, petrochemical, chemical, and related industries.

Chiyoda Malaysia’s main business activities are project feasibility studies; basic engineering/front-end engineering design (FEED); detailed engineering design; engineering, procurement and construction (EPC); engineering, procurement, construction and commissioning (EPCC); engineering, procurement and construction management (EPCM); and project cost estimation for projects such as petroleum refineries/plants, chemical plants, bulk storage terminals, LPG terminals, and industrial facilities, along with plant modifications and revamping.

On August 21, the first day of the internship, the students were met on their arrival at Chiyoda Malaysia by Yukihiro Shibahara, the company’s Commercial Manager, who promptly led them to a meeting room at the training site. To begin, Mr. Shibahara welcomed the group warmly.

Assistant Professor Fujiwara then reported the goals of the CIS Program. “The C in CIS stands for ‘coupling’ with a different discipline and culture. This program is an education system that is designed to cultivate the professionals needed for the global era. By coupling, we aim to develop collaboration skills and professionals that inspire others.” She went on to say, “I hope that through this experience, the students will improve their communication skills, their problem identification and solving skills, and develop the willpower to be the best that they can be.”

Next, Mr. Shibahara announced the schedule and Ms. Diana (Project Development Department) gave a presentation about Chiyoda Malaysia and the company’s structure, explaining the workflow of an engineering company. In addition, the students were given a tour of the various company departments. In the afternoon, Mr. Gan (Project Department) explained the project management process, and Technical Advisor Azumao Kurosawa and Mr. Murali (Engineering Department) explained engineering functions. The students were then divided into two teams of four to play “The Engineering Simulation Game”, which was created by the company. In this role play-style game, two teams compete in performing the engineering tasks needed to implement a hypothetical project, which was the installation of a storage tank. With the funds given, they have to carry out design, procurement, consultant hiring, process management, and client negotiations. Success is measured by the size of the success triangle formed by the intersection of quality, profit, and cost. The objective is to make the triangle as large as possible.
After the game, one student commented that performing realistic engineering tasks made them feel like actual Chiyoda Malaysia employees. Another highlighted the great importance of assembling knowledge from team members in order to solve problems, and the need for having good communication skills during negotiations with consultants and clients (both played by Chiyoda Malaysia employees). Finally, the students created a report reviewing their first day of the program.

On the second day of the program, August 22, the students were presented with explanations on procurement functions by Mr. Varatharajan (Project Service Department), on construction management by Mr. Gerard (a senior project manager), and on project quality management by Mr. Fauzi (a quality assurance / quality control manager). Next, they were given an outline of an actual Petron Corporation project by Mr. Ghazali (a project manager) and an explanation of Chiyoda Malaysia’s health and safety management by Mr. Khairoi (a safety officer).

After this, a student-led discussion was held on the topic of “ways of working in a multinational, multiethnic environment,” together with a group of Pakistani, Indonesian, and Iranian Chiyoda Malaysia employees, as well as Malaysian nationality employees of various ethnicities, including Chinese, Malay, Indian, and others. There was a lively question-and-answer session about the ways to engage in communication with people of different cultural backgrounds.

On Sunday morning, the students had a meeting to discuss the simulation game task and were asked to create a report on their experiences. Even on the weekend, they worked and studied enthusiastically at the assigned task.

On the third day, August 25, the students visited ESE Engineering Sdn Bhd, where they took a safety course and learned about welding and assembly work processes. They were then given a factory tour, which included welding practice using a shielded metal arc welder. After receiving an explanation about work execution, they went to conduct interviews with the company’s management employees and foreign workers.

On the fourth day, August 26, the group went to Petron’s Port Dickson Refinery, where they were given a presentation on a Petron project and a tour of the construction site. The students had the opportunity to inspect the work of a Chiyoda Malaysia supervisor and even accompanied the supervisor inside a tank under construction.

On August 27, the fifth day, the students divided themselves into Teams A and B to continue their work on the “The Engineering Simulation Game”, with each of the teams making a presentation. In the afternoon, the students interviewed Chiyoda Malaysia management employees, and learned the importance of creativity, fairness, and flexibility as leadership skills.

On the final day of the program, August 29, in the presence of faculty and staff of from Chiyoda Malaysia, the University of Malaya, and Osaka University, the students made presentations about what they had learned over the course of this CIS Program.

The CIS Program aims at developing a program that gives consideration to all kinds of diversity: the diversity of Asian cultures, the diversity of regional cultures, individual diversity, and the diversity of companies. Reflecting on this CIS Program, Professor Yoneda said, “The four students from Osaka University were Japanese, while the four students from the University of Malaya, included a Malay, Chinese, and an Indonesian. In this program, we divided the students into two teams, each with two humanities and two science students, and two Osaka University and two University of Malaya students. In this way, there was not only coupling between students of different cultures, Japan and the greater Asian region, but also a coupling between different academic disciplines, sciences and humanities.

“On top of this, the training at the company represented an industry-academia partnership, which gives this program a third dimension of coupling. We feel that giving students a simulated experience of working in a multiethnic company, by allowing them to work alongside people of different cultures—whether they cooperate or argue, they gain experience of resolving problems—makes a significant contribution towards fostering global human resources.”

In the future, the CIS Program is expected to be extended to Vietnam, India, Thailand, the Philippines, and Qatar, and the number of host countries is expected to increase next year.
1. Introduction
In the preceding part of this series, we focused on consumable electrodes, or welding wire, as electrodes that generate arcs, and we described the influence of wire type and polarity on the melting characteristics. In this article, we consider the parent metal, which serves as the electrode of opposite polarity, and discuss how it melts and forms beads. Melting and forming beads is the most important factor in arc welding. Because melting of the parent metal is directly tied to the quality of welding, it is important to understand and accurately control the phenomenon; so we are going to look at both theoretical models and the actual phenomenon and compare the two.

2. Melting and Bead Formation in Theory
2.1 Formation of Weld Pools According to Heat Conduction Theory
Heat generated by an arc flows to the parent metal by means of droplets, electron current, and plasma current. When the temperature of the parent metal reaches its melting point, weld pools are formed. As the arc moves, so do the weld pools, and after the arc has passed, the weld pools solidify as they release their heat to the surroundings. Up until now, this kind of heat transfer has been widely discussed in terms of heat conduction theory, which has been able to explain the phenomenon of weld pools.

There are three modes of heat transmission—conduction, convection, and radiation—but the formation and solidification of weld pools are governed by the heat conduction in the parent metal. If we assume a heat source at a point in a parent metal corresponding to the welding arc, the question of how the heat is conducted in the parent metal can be understood by solving heat conduction equations. However, to express the welding phenomenon, it is necessary to consider the diffusion of heat in three dimensions as the heat source is moved. (If the parent metal is a thin sheet, it is sometimes possible to solve the heat conduction equation in two dimensions.)

Figure 1 shows an example of the temperature distribution of a parent metal surface, based on the solution of a heat conduction equation. Under the assumption of bead-on-plate welding, the welding heat input is constant at approximately 1.9 kJ/cm and the welding speeds are 80 cm/min and 160 cm/min. It is clear that, as the welding speed increases, the weld pool becomes longer and narrower.

2.2 Melting of Stationary Weld Pools
The use of heat conduction theory makes it possible to estimate not only the spread and temperature distribution of weld pools but also the extent of melting. It has been reported that comparisons of the melting cross-section obtained by the theory closely match the observed melting cross-section for bead-on-plate welding using various arc welding techniques. Thus, modeling methods based on heat conduction theory are effective for qualitatively understanding melting phenomena. However, if we consider the shape of melting, we find that the melting observed in actual welding occurs with various shapes, whereas the shape predicted by theory is semicircular. It is therefore difficult to express the phenomenon by using heat conduction theory alone. One reason is that convection of molten metal occurs within the weld pool and affects the shape of melting, though it is not taken into account by the heat conduction theory. In view of this, let us consider the convection of a stationary weld pool with tungsten inert gas (TIG) welding, which is relatively easy to analyze.

As shown in Fig. 2, the shape of melting of a stationary weld pool can be categorized into three types: simple melting (heat conduction type), which yields semicircular melting; central melting; and peripheral melting. The
differences between these kinds of shapes of melting are due to the convection of molten metal. Also, the force applied on the weld pool by this convection is thought to vary, as shown in Fig. 3.

In addition to applying arc pressure to the weld pool and depressing the central part of the pool, the arc plasma current produces a force on the surface of the weld pool, from the center part outwards to the peripheral part (Fig. 3a). The electron current flowing into the weld pool generates a downward electromagnetic force (Fig. 3b) through interaction with the magnetic field generated by the current itself. In addition, buoyancy is generated within the molten metal due to density differences caused by temperature differences (Fig. 3c). Furthermore, temperature differences at the surface of the molten metal generate differences in surface tension, such that the molten metal is pulled by the parts where the surface tension is high (Fig. 3d). The convection due to this surface tension can be influenced by trace elements contained in the parent metal or shielding gas, and the quantity of such constituents can cause a reversal in the direction of flow.

The kinds of forces that generate convection in molten metal vary in intensity according to the welding conditions and the parent metal composition. For example, when the direction of convection is from the periphery to the center part of the weld pool, or when there is a predominantly downward force in the weld pool, a central melting-type shape results; conversely, when there is strong convection outwards to the periphery, a peripheral melting-type shape results. In the case of melting of gas metal arc (GMA) welding with a consumable electrode, the shape of melting is determined by the various forces that are applied. Welding with a relatively low current results in a simple melting-type shape, but high-current welding, particularly spray transfer metal active gas (MAG) welding, causes heavy melting at the central part of the weld pool due to convection driven by a strong arc force and electromagnetic force, and results in a finger-shaped weld pool.

Some research has drawn attention to the influence of active elements such as sulfur on the shape of melting of the parent metal composition. In TIG welding of stainless steel, parent metals of low sulfur content tend to melt in a shallow shape, whereas those of high sulfur content melt deeply. This phenomenon can be explained in terms of the impact of the active element on surface tension convection. In molten metal with a low active element content, surface tension decreases as temperature increases. For this reason, surface tension at the part of the weld pool with the highest temperature, which is the center part of the pool directly under the arc, becomes lower than the peripheral parts of the weld pool, and results in convection towards the higher peripheral part (Fig. 4a). Conversely, when the active element content is high, the surface tension increases with rising temperature, such that convection is generated at the surface of the weld pool from the peripheral part towards the center part, where the temperature is high. Since the convection at the center part turns downward, melting becomes deep (Fig. 4b).

In TIG welding with helium as the shielding gas, the presence of the active element causes contraction of the arc and results in a concentration of melting at the center part of the weld pool. This results in a predominantly downward electromagnetic force in the weld pool, making the melting deep, as expected. Thus, it is clear that the active element influences the surface tension or electromagnetic force.

The above explanation is only a qualitative description of the impact of convection in molten metal and the arc shape on the shape of melting. To accurately...
ascertain the shape of melting, it is necessary to know in quantitative detail how much heat is transferred from which parts and to what extent. Unfortunately, not enough research has yet been done to investigate the quantitative detail, so this remains a challenge for the future.

2.3 Modeling of Bead Shape

Bead shape is an important criterion in the assessment of the quality of welding. Research has been done to investigate the relationships between bead shape and a variety of welding parameters, with the objective of achieving the appropriate bead shape. Studies involving the modeling of bead shape have also been carried out. Computations have been conducted to qualitatively analyze the bead shape by approximating the cross-sectional shape of weld beads (in two dimensions) for bead-on-plate weld beads on flat plate, horizontal position weld beads, and one-sided butt weld beads, but here we focus on the modeling of horizontal fillet weld beads, where the bead shape is of particular importance.

To achieve a large leg length with horizontal fillet welding, it is necessary to increase the quantity of deposited metal. But, if there is too much deposited metal, the shape becomes defective due to overlap on the underside of the plate or by undercut on the top side of the plate. The well-known computation illustrated in Fig. 5, which relates to the question of determining the extent of leg length at which welding is possible, assumes that the bead shape is determined solely by the equilibrium between the surface tension of the molten metal and the force of gravity acting on the molten metal (refer to the Beginner Class Q&A in last month’s edition of this journal).

The results of this computation show that the range of conditions for obtaining a fillet weld bead of equal leg length is relatively narrow and the maximum leg length is limited to approximately 1.8 times the capillary constant. The capillary constant, considered to depend on the surface tension and density of the molten metal and the gravitational acceleration, has a value of approximately 5 to 5.5 mm. Therefore, the maximum leg length for which welding is possible is calculated to be 9 to 10 mm. In actual welding, the limit of leg length is about 8 mm with straight line welding (welding with no weaving). Thus, although the calculation is slightly different, this model well expresses the bead formation for horizontal fillet welding.

However, the above model determines the leg length only in terms of the equilibrium of forces acting on the molten metal; it does not take into account factors such as the effect of slag when using flux-cored wire (FCW), which is widely used in shipbuilding, or weaving of the torch. Compared to solid wire, horizontal fillet weld beads made using FCW are superior in terms of isosceles symmetry and external appearance, but bead formation is strongly influenced by slag fluidity (viscosity) and torch holding conditions. Accordingly, FCW is thought to be indispensable when considering bead shape that takes into account longer leg length and greater fatigue strength. In the future, further studies on the modeling of bead formation in fillet welding need to incorporate more advanced concepts.

〈To be continued in the next issue〉
According to a survey of the International Federation of Robotics, in 2013, about 179,000 industrial robots were sold worldwide, again an all-time high and 12 percent more than in 2012. Incoming orders in the first four months of 2014 increased remarkably and requests from all customer industries are on the rise. Therefore, we expect that in 2014, growth of unit sales will continue with the same pace as in 2013.

Robot sales reached record levels in Asia/Australia, in the Americas, and in Africa. Almost 100,000 new robots were installed in 2013 in Asia/Australia, 18% more than in 2012.

The European market increased by 5% to more than 43,000 units, almost reaching the all-time-high of 2011. Robot supplies to the Americas continued to increase by 8% to more than 30,000 units. More than 700 industrial robots were sold in Africa, 87% more than in 2012.
Product Reviews

MIG-MAG machines "The MX 350"

Welding unit for mobile applications in combination with the separate MIG-MAG wire feeder case. Innovative and patented MICORR technology delivers maximum power and exceptional welding characteristics. Outstanding MIG-MAG welding characteristics for mixed gas and CO2. MIG-MAG synergic mode can be activated separately. Synergic characteristic curves for steel / stainless steel (0.8 mm:1.0 mm:1.2 mm wire). Aluminium by adjusting the wire feed correction accordingly. Crater filling for a perfect weld seam finish. DC-TIG feature with ContaCTIG ignition (no HF). Electrode welding with Hotstart, Anti-Stick and Arc-Force regulation technology for electrodes with diameters of up to 8 mm and absolutely reliable vertical down-welding of cellulose electrodes (CEL). "3 steps to weld" operating concept. Stable arc also in case of voltage fluctuation and when using cables of up to 200 m in length.

LORCH (http://www.lorch.biz/)

Pipe Cutting Machine "ProCutter PC 600"

The PC600 is a highly standardised pipe cutting machine, designed for cutting complex piping constructions up to 610 mm in diameter. An exceptionally all-round machine at a very affordable price, the PC600 provides savings on welding, material, and fitting costs. A basic PC600 contains the following components: Software (programming / work preparation), Three jaw chuck, Pipe support / cutting bed (pipe carriages or roller chute), Machine frame, Y-carriage with cutting head (oxyfuel or plasma), Operator interface. Unique feature: The application of HGG software is but one of the distinguishing technology features of the PC600. Having specialized in the optimization of cutting shapes since 1985, we were able to incorporate all of that unique know-how into the PC600. Parameters such as root, kerf, and divergence can be programmed to provide perfect fitting. The PC600 is also equipped with two patented cuts: the Partial Joint Penetration (PJP) and the Strainer, providing savings of up to 20% in welding volume.

HGG Profiling Equipment B.V. (http://www.hgg-group.com)

Resistance Welding Technology to build
the tomorrow and connect to the future.

Suitable for not only spot welding but also nut and bolt welding. We can supply welding know-how by combining our feeder.

Please ask us for your resistance welding.

- High quality
- Short delivery
- Easy to choose gun

DENGENSHA MFG.CO.,LTD.

- email: dg.sales@dengensha.co.jp
- Tel: +82-44-922-1117
- Fax: +82-44-932-8008
- http://www.dengensha.co.jp.

Stationary Spot Welder
NDZ Series

DGI made Portable Gun
Thoriated Tungsten Electrodes

The AWS Safety and Health Committee recently approved a revised Safety and Health Fact Sheet No. 27 on thoriated tungsten electrodes. The new fact sheet, dated March 2014, follows.

Introduction

Thoriated tungsten electrodes contain thorium, a radioactive material that can pose health and environmental risks at elevated exposure levels. The use of these electrodes is exempt from Nuclear Regulatory Commission (NRC) regulations.

Effective August 27, 2014, electrode manufacturers and importers will need to possess a specific NRC license to distribute these electrodes. The license will impose requirements for labeling, quality control, reporting, and record keeping.

All persons shipping thoriated tungsten electrodes in the United States need to comply with Department of Transportation (DOT) regulations. DOT requires the thoriated tungsten electrodes to be properly packaged and labeled. The surface of the package must be monitored for radioactivity. For example, the U.S. Postal Service requires the following label on the address side of the package:

“This package conforms to the conditions and limitations specified in 49 CFR 173.426 for radioactive material, excepted package articles manufactured from natural uranium (or natural thorium), UN2909 and is within Postal Service activity limits for mailing.”

Nature of the Hazard

Thorium is a low-level radioactive material that primarily emits alpha particles as well as some beta and gamma radiation. These electrodes are normally sharpened by grinding as part of the standard procedure while preparing to perform gas tungsten arc welding (GTAW). Dust particles from this grinding process can cause internal radiation exposure if the dust is accidentally ingested or inhaled, so precaution is necessary. Concern regarding radiation exposure to the external body from these electrodes is minimal.

The risk of internal exposure during welding is negligible in most circumstances since the thoriated electrode is consumed at a very slow rate.

During the grinding of the thoriated tungsten electrodes, radioactive dust is created, posing the potential hazard of internal radiation exposure by inhalation or ingestion unless care is taken to control the dust.

How to Reduce Exposure

- Choose thorium-free tungsten electrodes such as those containing cerium, lanthanum, yttrium, or zirconium.

- Read, understand, and follow all information in the Safety Data Sheet (SDS) for the selected tungsten electrode.
- Use a high-efficiency dust collection system to capture particles created during the grinding of electrodes or disturbed during housekeeping.
- Evaluate the ventilation system before acceptance and periodically thereafter to minimize personnel and environmental contamination.
- Develop and implement standard operating procedures for the use of thoriated tungsten electrodes, including proper procedures for storage, grinding, use, housekeeping, and disposal.
- Provide training in the operation of the welding and grinding equipment, personal hygiene, and safety.

What to Do with the Collected Dust Particles

- Regularly remove the dust generated by grinding.
- Properly dispose of the dust and spent electrodes in accordance with federal, state, and local regulations.

Summary

Several of the information sources listed indicate that the risk of occupational exposure to radiation during storage, handling, and welding with thoriated tungsten electrodes is negligible where simple precautions are taken. Special care should be taken to control and collect dust from grinding these electrodes in order to prevent a potential ingestion and inhalation exposure to radioactive dust particles resulting from this operation.

Information Sources


AWS disclaims liability for any injury to persons or to property, or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this information. AWS also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.
The American Welding Society (AWS) was founded in 1919 as a multifaceted, nonprofit organization with a goal to advance the science, technology, and application of welding and related joining disciplines worldwide.

From factory floor to high-rise construction, from military weaponry to home products, AWS continues to lead the way in supporting welding education and technology development to ensure a strong, competitive and exciting way of life for people worldwide.

AWS MEMBERSHIP BENEFITS

INFORMATION AT YOUR FINGERTIPS
- Monthly digitized subscription of award-winning Welding Journal — on your computer, mobile phone or tablet.
- Quarterly digital edition of Welding Marketplace keeps you current on welding's newest products and services.
- Access to members-only website at www.aws.org and access to country-specific AWS microsites
- This Week in Welding e-Newsletter
- Access to career information and job postings at www.careersinwelding.com

PLUS, NEW AWS INDIVIDUAL MEMBERS CAN GET:
A popular AWS publication/CD-ROM (up to a 50% discount) for only $85 (includes shipping/handling). Choose from more than 20 publications including the Welding Handbook, 9th ed., Vol. 4, Welding Metallurgy, Jefferson's Welding Encyclopedia (CD-ROM only) and many more.

NETWORKING & RECOGNITION
- AWS Membership Certificate and Card
- Networking opportunities at one of 20 AWS International Section's meetings, and at online forums and communities
- Free admission to North America's largest welding, metal forming, fabricating and finishing exposition... FABTECH.
- AWS Awards and International Scholarship Programs

DISCOUNTS ON PROGRAMS TO ADVANCE YOUR CAREER AND YOUR PAY
- Continuous Learning and Skills Upgrades at a discount
  - Certification Programs (administered by AWS Agents worldwide)
  - Technical Conferences
  - Educational Programs
  - Online distance learning
- 25% discount on 300+ AWS publications and code books

American Welding Society®
6100 NW 20 St., #120, Miami, FL 33184-4672
(305) 443-9353
www.aws.org/membership

Save Money!
on the DI: 1 Structural Welding Code-Steel (Spanish, Portuguese, Chinese)
GUIDE TO INTERNATIONAL EVENTS

INTERMACH MYANMAR 2014 - Myanmar’s International Industrial Manufacturing and Subcontracting Exhibition - 2nd Edition
Date: 29-31 Oct. 2014
Venue: Tatmadaw Exhibition Hall, Yangon, Myanmar

MET+ HTS’2014
Materials Engineering, Technology+11th Heat Treat Show 2014
Date: 4-6 Dec. 2014
Venue: The Exhibition Centre, Mahatma Mandir, Gandhinagar, Gujarat, India

indometal 2014 - international metal & steel trade fair for southeast asia
Date: 11-13 Dec. 2014
Venue: JI Expo, Kemayoran, Jakarta, Indonesia

44th INTERNEPCON JAPAN
Date: 14-16 Jan. 2015
Venue: Tokyo Big Sight, Japan

The 11th SteelFab 2015
Date: 26-29 Jan. 2015
Venue: Expo Centre Sharjah, United Arab Emirates

Preliminary announcement of Vol. 17
Area Spotlight: Malaysia, Thailand, Japan

Notice: “Asia Welding Show in Jakarta 2014” Postponed
Greetings and very best wishes to all our dear readers. We sincerely thank you for your continued support of our company’s efforts. We wish to inform you that due to various circumstances the “Asia Welding Show in Jakarta 2014” organized by the Indonesian Welding Society (IWS) and our company and scheduled for this coming November 26 to 28 at Jakarta International Expo (JIExpo) has had to be postponed. To all the companies that have actively planned and prepared to exhibit or attend the event, and everyone else involved, we extend our deepest apologies for the inconvenience caused. We humbly ask for your understanding in this matter. The new dates for the show will be decided after further evaluating the situation. As soon as the dates are decided, we will contact you again. We look forward to your continued cooperation. Sincerely, with best wishes,

Yutaka Kukita
President
Sanpo Publications Incorporated

Payment
*Invoice
After you place your order online, we will mail you an invoice, which can be paid at any bank or post office. Please allow 5 days for confirmation of your payment.
Subscription form on web site: www.sanpo-pub.co.jp/welpro.html

*IPMOs
Please send payment to the above address by International Postal Money Order (IPMO) in US dollars.

SUBSCRIPTION ORDER FORM
Please send me Welding Promenade for a period of _____ year(s) beginning with issue No. _____, for which I agree to pay the sum of _____ USD in advance.

Name: ____________________________
Address: __________________________
________________________________
E-mail: __________________________

Advertising
Commercial Ad Rates
General Advertising
• Cover 3, 4 col, 1/2 page
  size: 12.5 cm × 18 cm
• Cover 4, 4 col, 1/2 page
  size: 12.5 cm × 18 cm
• Main text, 1 col, 1/3 page
  size: 8.5 cm × 17.4 cm
• Main text, 1 col, 1/6 page
  size: 8.5 cm × 8.5 cm
• Main text, 1 col, 1/12 page
  size: 4 cm × 8.5 cm

Submitting editorial contributions
Address for submission:
Welding Promenade Department
Sanpo Publications, Inc.
E-mail: wp@sanpo-pub.co.jp

For information about subscriptions and advertising:
Welding Promenade Department,
Sanpo Publications, Inc.
E-mail: wp@sanpo-pub.co.jp
Internet: www.sanpo-pub.co.jp/welpro.html
KOBE STEEL GROUP

http://www.kobelco.co.jp/english/welding/weldingtoday/index.html

neis co.,ltd
Head Office
20-1 kidadanmolsa-cho Amagasaki 660-0804
TEL 06-6488-7700 FAX 06-6488-5068
E-mail: sonyu@neis-co.com

Your best partner for
Vacuum brazing and Al brazing solution

Vacuum brazing
neis’s expertise of brazing provides such components exposed to high vacuum as used in the facilities or the institutes of research & development of semi-conductor liquid crystals, medical apparatus, optics, beam accelerator, and synchrotron radiation. neis is one of the leading companies to be able to supply solution for vacuum brazing problems by virtue of neis’s specific filler metal and processing knowhow alike.

Al. brazing
Alloys of Silver, Phosphorus, Copper, Nickel, and for Vacuum filler. Their forms available in rods, wire, strip, paste, sheet (much wider than strip), powder, clad (newly developed), and preforms. Aluminum brazing filler neis Alu 19FCW is now widely used in car-air conditioning apparatus. Automated equipment engineered and manufactured to meet your requirements.

NEIS & TOCALO (Thailand) Co.,Ltd
neis (Thailand) Co.,Ltd
Amanatikom Industrial Estate 70/435 Moo7 Bangna-Trad Highway Km57 Donhuarot, Muang District, Chonthuri 20000 Thailand
TEL 010-66-38-717-035-7 FAX 010-66-38-717-038 E-mail: thai@neis-co.com

NEIS KOREA CO.,LTD.
210, Guyang-ro 17 Beon-gil, Wolpo-riyon Gimpo-si, 415-874, Korea
TEL 010-82-31-983-2120 FAX 010-82-31-983-2125

URL: http://www.neis-co.com