Seal Training Center (STC) – Interactive Training for Sealing Operation

1. Introduction

In recent years, technology succession issues in plant maintenance skills have gained attention in Japan due to the retirement of the baby-boomer generation and the deterioration of plant equipment. Therefore, maintenance management is becoming more important. However, as extension of continuous running periods, there are fewer opportunities for younger operators to experience on-site periodical repair, and making it difficult to maintain and improve plant-maintenance skills. Especially, it is said that plant managers who are educated with only basic knowledge of flange operation including specifications and procedures without enough on-site experience have increased. In spite of that, they need to face on-site troubles and field operators tend to follow their experience and intuition for troubleshooting. In general, finding root causes of troubles by knowledge only from education is not easy. It is considered that some serious seal-related accidents have occurred by luck of on-sight experience. According to the Fire and Disaster Management Agency, the number of accidents including fires and leakage (except for those caused by earthquakes) occurring at major petrochemical complexes around Japan has been increasing rapidly since 2006.

Also, in developing nations, where many projects for the new construction and expansion of facilities and equipment are planned, manpower shortages cause leakage troubles due to inappropriate selection of seal product and unstable operation. To address such problems, these countries are urgently demanded to develop and secure operators.

To meet those needs and to provide training opportunities regarding various on-site sealing operations, Valqua started to produce skill-training curriculums. The first Seal Training Center (STC) was established in our R&D center in Nara, Japan in 2014 to train specialized trainers. It offers interactive training of sealing operation curriculum with organizing hardware-side educational accommodation.

2. Market Development

As Figure1 shows, starting from STC in our Nara R&D center, we opened other STCs including in Machida, Tokyo, Japan and also in China, Taiwan, Vietnam, Thailand, and South Korea to provide training on sealing operations for Japanese and oversea customers. This training program has become widely known and been rated high.

Especially, in Vietnam, Petrovietnam Manpower Training College (PVMTC), a technical-education school under the control of Petrovietnam, the largest nation energy company, adopted our training system for their technical training on handling industrial-use seal products. PVMTC is Vietnam's only vocational training school for processing plants, where over 15,000 field workers from various industries study.

We dispatched several Vietnamese specialists as a trainer to PVMTC, and lent main equipment of STC and transferred it to PVMTC. We also provide our technologies through essential training-associated knowledge, textbooks and other materials, thus offering practical training on sealing skills to contribute the heavy chemical industry of Vietnam. We also expect to promote the Valqua brand through

those activites.

Furthermore, in China, we have co-held "Valqua Training Session" with China Petroleum and Chemical Industry Federation which have been sponsored by the China Friction & Sealing Material Association for seals and fluororesin products since 2003. At "Valqua Training Session" in 2016, our new on-site service of conducting STC training at users' sites was introduced with user's great interest.

Figure1 Locations of STC

3. Concept

STC, which has attracted great interest from the market, was developed through our accumulated sealing skills, especially engineering skills obtained by analyzing and solving troubles.

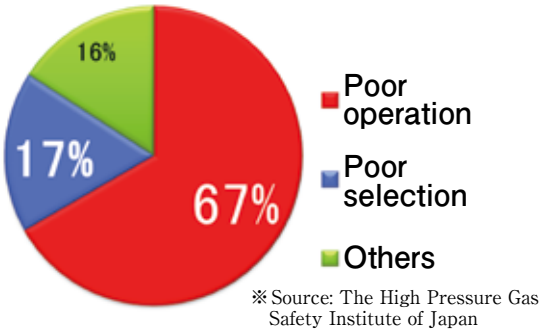
The High Pressure Gas Safety Institute of Japan has analyzed the causes of high-pressure-gas accidents and disclosed the results as shown in Table 1. The colored cells in the table show the number of accidents caused by seals, which account for 20 to 25% of all accidents.

Table 1 Cause-specific analysis of high-pressure-gas accidents

Year \ Classification	Poor design and manufacturing of equipment				Poor maintenance and administration of equipment						Poor organization				Human factors			Total
	Poor design	Poor manufacturing	Poor operational management	Total	Poor corrosion management	Poor testing management	Poor inspection	Poor fastening management	Poor sealing management	Poor vessel management	Total	Poor organizational management	Insufficient operational standard and others	Insufficient communication	Total	Errors in operation and judgment	Malpractice	Total	
2015	54	9	24	87	85	30	13	28	26	21	203	2	6	1	9	40	6	46	345
2014	53	14	19	86	72	19	11	29	26	17	174	0	15	6	21	33	6	39	320
2013	38	14	23	75	77	28	18	23	33	19	198	0	15	1	16	50	4	54	343
2012	35	11	10	56	65	65	8	28	31	11	208	0	13	1	14	69	13	82	360
2011	22	17	11	50	67	66	8	38	28	20	227	0	8	1	9	45	4	49	335

The High Pressure Gas Safety Institute of Japan, *Summary Report of Accidents Associated with High-Pressure Gas* (as of December 2015)

Among accidents caused by seals, over 80% were due to inappropriate selection of seal product and unstable operation, as shown in Figure2.



※Source: The High Pressure Gas Safety Institute of Japan

Figure2 Causes of leakage

Therefore, as Figure3 shows, we extracted on-site problems, analyzed seal-related troubles, introduced countermeasures against the problems and applied the knowledge into our STC training curriculums. In short, the STC training covers the processes from the basics of seal product selection to the management of sealing-associated components. Based on "Know-Why"; to know the causes of leakage and why selection and operation are important, we have developed training which integrates classroom-lecture theories and operational training to teach our Know-How including what operations are required and how to solve problems.

4. Training Program

We analyzed mistakes in seal-product selection and operation which are the major causes of accidents stemming from sealing and then devised countermeasures. STC offers training focusing on such countermeasures. In selection training of seal product, trainees study the basic selection guidelines to learn how to select optimal gaskets based on fluid type, pressure, and temperature specified by the customer. Then, they learn about the dynamic behavior of

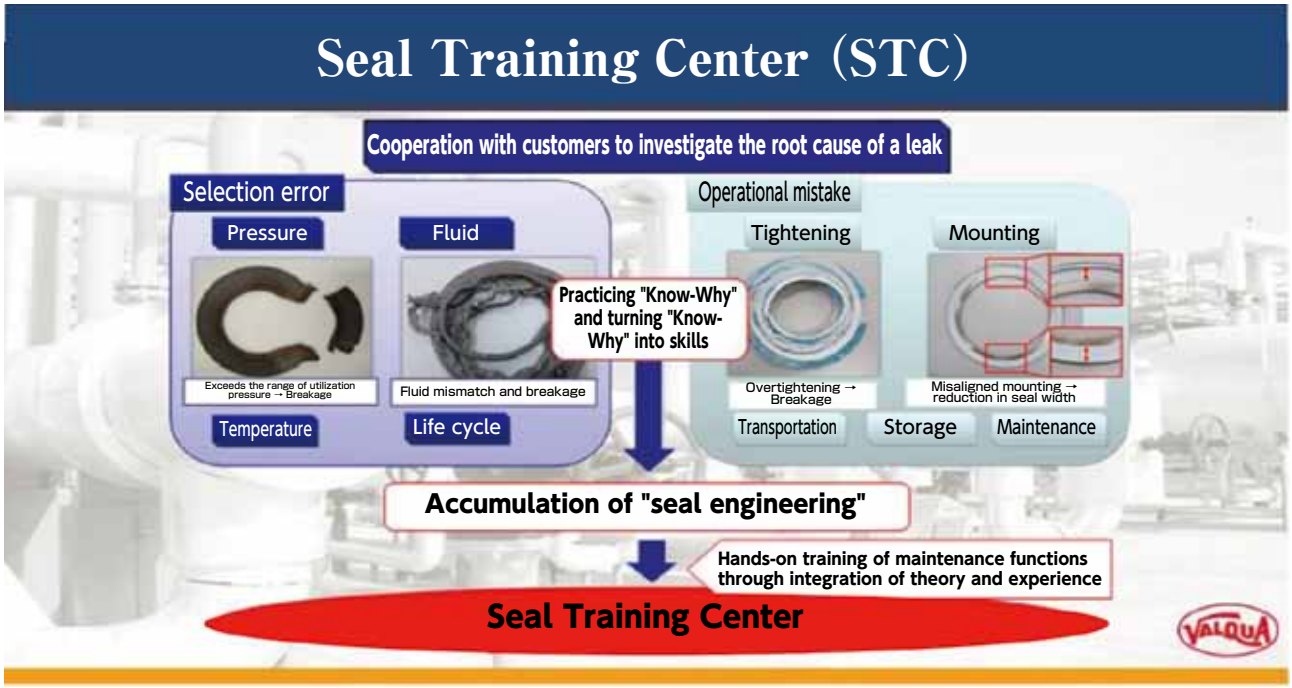


Figure3 Concept of STC

gaskets under special environments to understand the malfunctions and troubles caused by inappropriate selection.

In addition, trainees learn the effects of management conditions regarding not only gaskets but also sealing-associated components including flanges and bolts, which are used in flanged fasteners, to acquire key aspects of on-site management/supervising operations.

In operational training, trainees use the flange training device shown in Figure4 to confirm their own bolt-tightening skills. In the confirmation process, the device uses special sensor bolts to compare the trainee's tightening force with the target force and then shows how a particular trainee can conduct a tightening operation. In the process, the special sensor bolts output the axial bolt force applied during flange tightening as an electronic signal, then the data logger transforms the signal into axial bolt force, which is shown on the PC display. The display can compare the trainee's results with the predetermined target axial bolt force.

Trainees then use the torque-sensor training device, shown in Figure5, to confirm their own tightening characteristics and power-adjustment skills, and

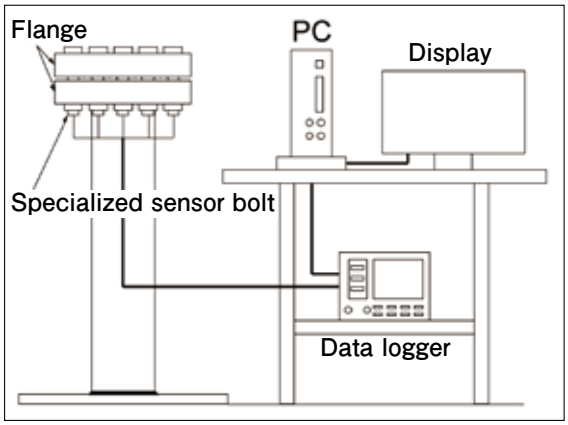


Figure4 Flange-tightening training device

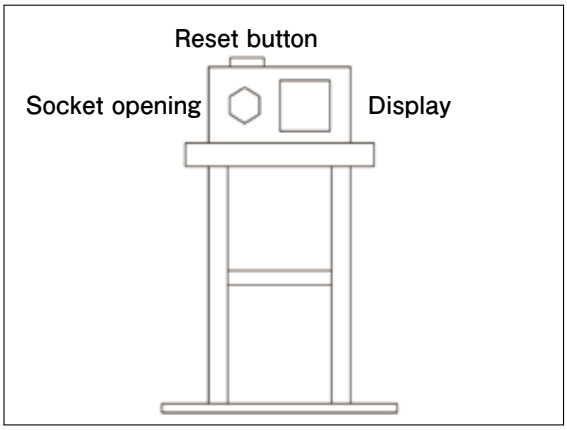


Figure5 Torque-sensor training device

practice repeatedly until there is no deviation in bolt-tightening. The torque-sensor training device inserts a tightening tool in the socket opening and the display shows the tightening torque under the trainee's posture and power adjustment.

In addition, trainees receive training on recognizing malfunctions which occur due to over-tightening and under-tightening. The training proceeds as follows. First, the trainee fastens flanges loaded on the sealing-property training device, as shown in Figure6, to make the contact pressure lower than the contact gasket stress necessary for sealing. Then, the pressure gauge adjusts the pressure to replicate air leaking, so the trainee experiences the leakage to understand the necessity of selecting the optimal fastening conditions. Next, the trainee uses the compression-fracture training device shown in Figure7 to experience and understand problems which occur due to over-tightening.

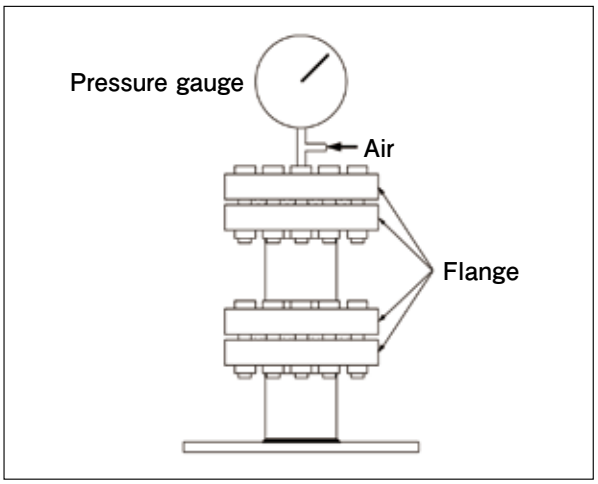


Figure6 Sealing-property training device

In addition, we established a curriculum in which trainees can learn other important points. For example, some devices, which are replicated device and piping alignments, are used to make trainees understand the phenomenon of creep, which is dependent on the gasket's temperature, so they can experience and understand the resulting problems and countermeasures.

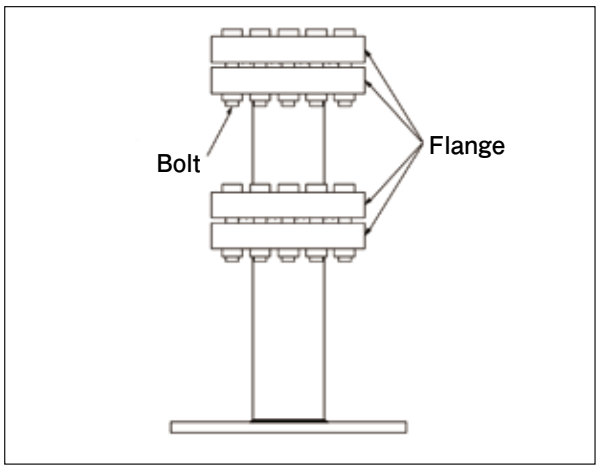


Figure7 Compression-fracture training device

At the end of the training, the on-site tightening-simulation training device shown in Figure8 replicates the following situations to confirm the effectiveness of the training and whether the trainees have acquired tightening skills and whether they can operate properly: a) a work environment with a narrow footing, assuming that the trainee works at a high place; and b) a work environment which replicates a narrow work space due to the presence of piping which is not subject to tightening.

These efforts of ours are highly evaluated by many customers including plant owners and companies associated with plant engineering.

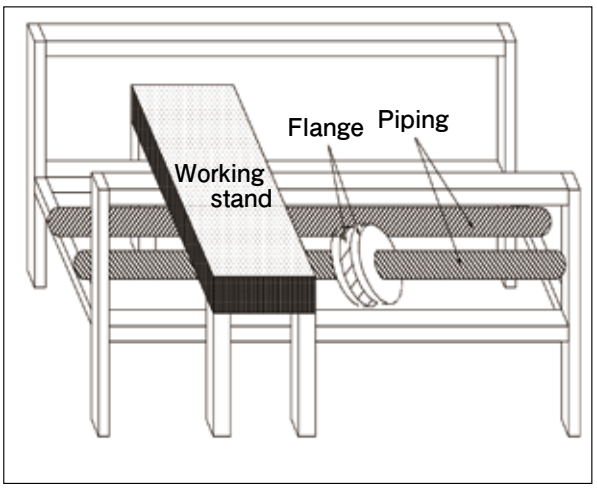


Figure8 On-site tightening-simulation training device

5. Conclusion

To date, STC users have given us feedback that they want to continue with such training programs. They have also requested additional training on trouble-prone devices including heat exchangers, so we will continue to develop new curriculums. We have also received inquiries for training all operators engaging in flange operations at periodical-repair sites, and are now studying ways to improve on-site services.

Overseas, we are planning to expand collaboration with public institutions, such as we have already done in Vietnam and China, in other countries.

Furthermore, we are establishing service package systems which include IT-based maintenance supports and abnormality diagnoses as a "Hardware & Seal-engineering service" business, which integrates products and services to meet needs obtained at skill trainings.

Akira Muramatsu
H&S BUSINESS GROUP