Customize operator training for your thermal oxidizers

This case history shows the benefits of site-specific programs in new equipment installations

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Shintech began construction of its new Plaquemine, Louisiana, manufacturing facility (see Fig. 1) in October 2005. The facility is located on a 1,725-ac site, and it manufactures chlorine, caustic soda and vinyl chloride monomer (VCM). Historically, Shintech has manufactured only polyvinyl chloride (PVC). This new plant is Shintech’s first integrated complex. This new manufacturing facility uses state-of-the-art environmental technologies and is subject to the most stringent environmental controls in the country.

Thermal oxidizers (TOs) are commonly used to treat volatile organic compounds (VOCs) and carbon monoxide (CO) emissions because TOs have very high destruction and removal efficiencies.1,2 Thermal oxidation can be defined as “the process of oxidizing combustible materials by raising their temperature above the auto-ignition point in the presence of oxygen and maintaining it at high temperature for sufficient time to complete combustion to carbon dioxide and water.”3

Shintech partnered with the manufacturer of the TOs to offer customized training to 37 of its plant operators for the start-up of its new facility.4 Fig. 2 shows part of the thermal oxidation system installed at the Shintech facility. The TO training course was offered with optional Continuing Education Unit (CEUs) credits that were available to any students meeting the following criteria: take (not pass) a pre-test, attend at least 80% of the course contact time, pass (at least 80%) a post-test and complete an anonymous course evaluation. The manufacturer also operates a training organization that is accredited; the JZI is authorized to offer CEUs through its accreditation by the International Association for Continuing Education and Training (IACET).

Course design. While the plant is responsible for all safety practices and training, JZI provided training designed to give operators at the new facility a good idea of both the what and why of operating the TO system and associated equipment. All too often, operators are trained, sometimes hurriedly and haphazardly, by existing experienced operators. The new operators may learn what to do, but not the why behind it. It is also fairly common for long-time operators not to understand some of the basics because they were never taught to them.
The *why* is important because it helps operators better understand the cause and effect that can impact safety, thermal efficiency (and, therefore, operating costs), productivity and pollutant emissions.

For example, Fig. 3 illustrates the potential problem of blow-off if a burner is over-fired. Moving from left to right shows what happens as the air/fuel mixture velocity is increased. The last furnace, on the far right, depicts the danger of going beyond the design firing limit for the burner. The *why* also better prepares operators to react to new situations that may not have been covered in formal training sessions.

The course content included basics that apply to any equipment of this type, along with very detailed and specific information on the equipment in their particular installation. Materials presented include:

1. Combustion and thermal oxidizer basics
2. Safety overview and warnings
3. Overall equipment familiarization
4. Detailed walkthrough of equipment
5. Detailed blower, boiler, absorber, scrubber and demister details
6. Detailed walkthrough of P&IDs
7. Drawings review
8. Pre-startup and refractory cure out
9. Normal startup and shutdown
10. Logic demonstration and DCS screens
11. Normal maintenance
12. Troubleshooting

Each student received a three-ring binder containing the color PowerPoint slides of the course. Adequate room was provided for them to make notes in the manual as desired. Some students received their manuals prior to the start of the class and came prepared with questions to ask. Statistics for all types of training show that retention of the material diminishes fairly quickly after the training has been completed. The student manual can be quickly and easily referenced as often as needed to refresh previously learned information. Although operators do not generally receive their own copy of the operation and maintenance manual, the student manual contains much of the same information, including many of the written operating procedures.

**Training.** The training was conducted over three consecutive days, followed by a fourth day about six weeks later on a couple of specific pieces of the equipment. Although most of the time was spent in the classroom, there were many short sessions spent outside at the equipment to review and emphasize specifics after reviewing the basics in the classroom. The plant had not been started up yet, so the equipment was installed but not operational. While this did not allow the operators to do live training, it did permit operators from all shifts to attend classes together during normal working hours. This produced significant interaction and feedback between participants and with the instructors. Another important aspect of the training...
was that supervisors were present during most of the sessions, which sent a strong message about the importance of the class.

The format of the training was designed to be very interactive. While colorful PowerPoint slides (for example, see Fig. 4) were used to guide the discussion, operators were encouraged to ask questions and make comments at any time. This was encouraged in part through subject-oriented fun games such as poker and bingo. Every time a participant asked or answered a question, they were given a random card from a poker deck. For the poker game, the student with the best poker hand at the end of the day received a prize. For the bingo game, cards were drawn from a deck until someone had enough matching cards to win. The more cards a student had, the more chances of winning, so this encouraged continuous and frequent participation. Other token gifts were also given out during the training as deemed appropriate by the instructors, for example, to a student asking a particularly good question.

Short video clips and brief plant visits were used to break up the lecture periods to help keep students engaged in the materials. Videos are particularly powerful when demonstrating potential problems, such as flashback from a burner, that may not have been previously experienced at a particular plant, but which could happen under certain circumstances. This is analogous to airline pilots who train in simulators to react to situations they hope they never encounter, but for which they are prepared to handle just in case.

The actual equipment drawings for this plant were used during the training to help familiarize the operators with the equipment and with the operating procedures. To make it even more realistic, photos were taken of individual components that would pop up on the drawings when clicked. For example, clicking on the symbol of a valve would pop up a picture of the actual valve in the plant as shown in Fig. 5. This personalized the training and made it easier for the operators to connect the drawings to the actual equipment.

Results. Identical 15-question pre-tests and post-tests were given to the students to measure learning. The pre-test assessed students’ knowledge prior to taking the class. The average pre-test and post-test scores were 52% and 99%, respectively. The difference between the scores is an indicator of what was learned in the training.

Students were also given a questionnaire at the end of the course to assess their level of satisfaction with the course. Students did not put their names on the forms, although their names were checked off a list to show they completed the evaluation, which is one of the requirements for receiving credits for the course. A five-point Likert scale was used, where 1 = none, 2 = little, 3 = average, 4 = above average, and 5 = great. Students rated each section of the course according to their interest in the topic and its benefit to them. There was also a space to write in any comments they may have had on the topic. Fig. 6 shows the averaged results by interest and benefit for each topic. The results show that, on average, students found all topics to be of above-average interest and benefit.

Another part of the questionnaire asked students for written comments on the instructors and material. Some of the instructor comments included “Very Knowledgeable,” “Excellent” and “Very Thorough.” Some students felt more time should have been spent on startup, shutdown and troubleshooting, and less time on the drawings. Content and coverage are always the challenge with a group of students having a wide range of backgrounds and experiences. Note: All students met the necessary requirements and received CEUs for the class.

Outcome. Properly training plant operators is critical to ensure that process equipment is operating safely, while maximizing efficiency and productivity and minimizing pollution emissions. Operators need to understand some basic information about the equipment, as well as the details on their specific installation. Although not always possible, it is particularly beneficial to have all operators together in the same class to enhance discussion and mutual learning. Training should be customized to the needs of the plant and should incorporate techniques such as fun games to promote interaction among the participants and instructors. Ideally, there should be a “hands-on” portion of the training where instructors use the actual equipment during demonstrations. Pre-testing and post-
testing are effective tools to show that operators have learned the key points in the training.

NOTES

a John Zink Company, LLC (JZC) manufactures thermal oxidation systems used to destroy unwanted wastes.1

b The John Zink Institute (JZI) is the training group for JZC and delivers training both at its US headquarters in Tulsa, Oklahoma, and at customer plant sites. JZI works with the plant to determine a suitable course agenda.

LITERATURE CITED


Tim H. Gilder joined Shintech Louisiana, LLC, in 2006 as vinyl chloride monomer production superintendent. Prior to joining Shintech, Mr. Gilder served in engineering and supervisory positions at flexible polyurethane foam, furfural, polyvinyl chloride and ethylene dichloride/vinyl chloride monomer production facilities. He earned a bachelor’s degree in chemical engineering from the University of Mississippi.

Dale Campbell, P.E., is a senior design engineer at John Zink Company, LLC, where he serves as the primary resource for incinerator troubleshooting and design in the thermal oxidizer aftermarket group. Since 1973, his primary responsibility has been the detailed design, equipment application, startup, and project management of waste incinerator systems. Mr. Campbell earned a bachelor of science in chemical engineering from the University of Tulsa.

Todd Robertson is a combustion service leader at John Zink Company, LLC. He is responsible for thermal oxidizer installation supervision, startup, maintenance, service and training. He retired from the United States Air Force after 23 years of service. Mr. Robertson earned a bachelor's degree from Embry Riddle Aeronautical University.

Chuck Baukal is the director of the John Zink Institute at John Zink Company, LLC in Tulsa, Oklahoma. He has nearly 30 years experience in industrial combustion in a wide range of industries. Dr. Baukal has a PhD in mechanical engineering from the University of Pennsylvania and is a registered professional engineer in the state of Pennsylvania. He has authored/edited eight books on industrial combustion and has 11 US patents.

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