THE EFFECTS OF IN SITU BURNING OF OIL ON FIRE BOOM

Richard Lazes
Oil Stop, Inc.
804 First Avenue
Harvey, Louisiana 70058

ABSTRACT: *In situ burning of oil is an efficient way to get rid of spilled oil at sea. Recent tests have proven that the benefits associated with in situ burning of oil far outweigh the potential health hazards of the smoke from the oil fire. Fire-resistant materials are available for use in the construction of fireproof oil booms. The effects of oil fires on these booms were studied: more than a dozen tests were carried out on fire booms to evaluate the effectiveness of the booms for use with in situ burning of oil.*

For more than 10 years scientists have studied the effects of in situ burning of oil on air and water quality and potential related health issues.[1-3] The recent Newfoundland Offshore Burn Experiment (NOBE), conducted by Environment Canada, was the culmination of several years of work. The results of this experiment found that "emissions from the in-situ oil fire were lower than expected, and that all compounds and parameters measured were below health concerns at 150 meters from the fire."[4] Polyaromatic hydrocarbons (PAH) were found to be lower in the soot generated from the fire than in the oil

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prior to the fire. The conclusion reached was that the environmental benefits resulting from the burning of oil spills far outweigh the potential air pollution caused by the smoke. These findings open the door to the use of in situ burning of oil as a major tool to mitigate environmental damage from oil spills.

As a result of these and other test findings, the Region 6 Regional Response Team (made up of the U.S. Coast Guard, the Minerals Management Service, the Louisiana Department of Environmental Quality, the U.S. Environmental Protection Agency, and other state and federal agencies) has preapproved the use of in situ burning of oil spills for offshore Louisiana and Texas. Other parts of the country and other countries are evaluating the use of in situ burning to combat oil spills. Now that the scientific community has weighed the environmental costs and benefits of in situ burning, it is time to address the operational and procedural issues.

The present study evaluated the effects of oil fires on fire booms: more than a dozen oil burn tests were carried out, including studies of the effects of various insulation systems employed to protect oil booms from the intense heat they are exposed to in oil fires. Thermocouples were used to measure the temperatures generated by the oil fires and the heat transfer from the fires to the boom. Automated infrared imaging temperature measurements were also used to obtain transient temperature distributions of oil fires.

Background testing

Only a few government-sanctioned in situ test burns have been conducted in the United States and Canada over the past several years. Several tests have been performed at the U.S. Coast Guard, Mobile, Alabama, test site. These tests were conducted under the supervision of the U.S. Coast Guard, the Minerals Management Service, and the National Institute of Standards & Technology. Temperatures in the fire were monitored and reached 2,000° F (1,102° C).[5]

Another in situ burn experiment was conducted under the supervision of Environment Canada in Newfoundland, Canada, during 1993. Several U.S. government agencies, including the U.S. Coast Guard, the Minerals Management Service, and the U.S. Environmental Protection Agency, participated in witnessing this test, along with the American Petroleum Institute. Thermocouples were attached to the fire boom to monitor temperatures. Temperatures were found to be around 1,750° F (962° C) at the top of the boom and in the 400° F (206° C) range at the lower portion of the boom's flotation near the waterline. "Researchers indicated that the boom did not hold up as well as expected." Researchers inspected the boom after the burn and found that the "middle tension member had lost three of its flotation logs. The boom was in fair condition but could not have been safely used for another burn."[7]

Ongoing testing

Oil Stop, Inc., has conducted more than a dozen tank burns to further evaluate the effects of oil fires on fire booms. These tests have been aimed at monitoring the temperature in the oil fires, as well as the heat transfer to the boom itself. Thermocouples were placed in the fires, on the surfaces of the booms, and inside the booms. Oil Stop's inflatable fire boom was used during these tests to evaluate its ability to withstand the high temperatures of the oil fire. Various reflective and insulating materials were used to test their effectiveness at reducing the internal temperatures of the fire booms.

Fire temperatures were found to reach 2,000° F (1,102° C), while water temperatures reached 212° F (100° C). External boom temperatures reached 1,700° to 1,800° F (952° to 990° C). Infrared thermography was used to measure the radiant characteristics of the crude oil fires.[6] Hot spots in the fires moved randomly as winds shifted. Many of these tank tests were conducted to evaluate insulating materials for protecting the inflatable boom underneath. Refractory materials, which are ceramic based, were found to withstand the high temperatures of the fire, but they lost tensile strength and became brittle after being subjected to the high temperatures. The conclusion was reached that ceramic materials should not be subjected to tension loads during in situ burns, or they would be susceptible to failure. Multiple layers of ceramic material improved the longevity of the inner layers. When waves and salt water were introduced during the burns, it was found that outside layers were susceptible to embrittlement. Temperature measurements on the boom surfaces were found to be highest at the top of the booms' flotation members. Temperature dropped by 20 to 30 percent at 90° F (32° C) from the top of the flotation chamber. This fact led us to conclude that, to be effective, insulation should be increased in the hottest area at the top of the float. The Oil Stop inflatable boom withstood four hours of continuous burning and was then removed from the test tank for evaluation. Each section of boom was dissected for careful inspection.

Underwater tubes were added to the inflatable boom to allow for heat transfer between the inside of the boom and the water below the boom. Air was allowed to circulate through these tubes. The internal temperature of the boom was monitored and was reduced by 20 to 25 percent as a result of the heat transfer with the cool water below. The external boom fabric evidenced significantly less degradation as a result of this reduced heat. These findings indicate that it may be possible to cool the boom using seawater and that doing so would greatly extend the life of fire booms.

Conclusion

In situ burning of oil represents an extremely efficient manner to remove spilled oil at sea. According to studies conducted by Allen & Ferek, an operating fire boom unit that includes 300 to 500 feet of fire boom can eliminate 15,000 barrels of oil per day.[2] Based on their calculations, the estimated costs associated with in situ burning amount to 20 percent of the costs associated with mechanical oil recovery. It is logical therefore to consider the use of in situ burning of spilled oil as an alternative to mechanical recovery under favorable conditions. Now that the concerns over air quality have been resolved, it is appropriate to turn the industry's attention to the operational aspects of in situ burning, to facilitate good technical information related to the operational capabilities of fire booms. It is imperative that offshore tests be conducted in a controlled and scientific environment to gather more data about available technology used to contain spilled oil while burning, and to continue to develop new technology.

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Author

Richard J. Lazes has been involved with the oilfield industry for more than 12 years. Lazes founded Oil Stop, Inc., a company dedicated to developing and manufacturing a patented oil containment boom called the Auto Boom and other new technology employed to mitigate oil and chemical spills from tankers.