Familiarize Yourself With Reduced-Bore Immersion Tube Burners

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Reduced-bore immersion tube burners can provide high velocity and high heat transfer rates with shorter immersion tubes. However, proper tube length and diameter is vital to the successful use of this type of burner. What are the advantages and what sizing considerations must be taken into account when considering reduced-bore immersion tube burners for your application?

Reduced-bore immersion tube burners are designed for low temperature (1,300°F [704°C or less) immersion tube applications, including spray washers, coating lines, pickling baths, dyeing applications and salt bath heaters. But, what is a reduced-bore immersion burner?

It is a burner designed to fire into small-diameter tubes. Reduced-bore immersion tube burners fire into tubes with length-to-diameter ratios up to 150:1. Standard immersion tube burners fire into tubes with length-to-diameter ratios up to 80:1.

Because the first few inches of the tube remain cool, there is no need to water-cool the portion of the immersion tube that remains outside of the tank.

One advantage to using a reduced-bore immersion tube burner relates to the small tube diameter. Because the tube occupies less space, smaller tanks can be installed. Due to higher flow rates per cross-sectional area and greater turbulence created inside the smaller tubes, the smaller tubes provide higher heat releases per foot and increased efficiency over a standard tube of the same length.

The reduced-bore design incorporates staged combustion; that is, air and gas are mixed in stages to keep flame temperatures low and reduce NOX levels. The flame initially is established inside the burner housing, but when established, the flame continues on into the immersion tube, where the final stage mixes the last portion of air with the flame. The combustion process comes to completion in the immersion tube. Staged air tends to lengthen the flame while reducing flame temperature and immersion tube hot spots.

One benefit of staged combustion involves a cool burner/tank interface. The first few inches of immersion tube remain cool, so special tanks or water cooling of the portion of the immersion tube that sits outside the tank are not required. Heat loss is minimized and accidental injury to operators that may inadvertently come in contact with the burner or tube is avoided.

Reduced-bore immersion tube burners are designed for use in immersion tube systems. Up to 80% efficient, the burner may provide higher efficiencies if the fluids being heated are above the boiling point of water or where special consideration is given to the removal of condensation. Lower efficiencies also are possible where tank size or other restraints limit tube length.

System Sizing

The risks associated with undersizing an immersion burner using water-based solution include:

- Condensation at a turndown of 1.3:1 if efficiency is 80%.
- Condensation at a turndown of 2:1 if efficiency is initially 70%.
- High flue temperatures and lost efficiency.
- Slow heatups.
- Slow recovery.

An external blower will develop approximately 30% more capacity than a combustion air blower mounted directly on the reduced-bore immersion tube burner.

If turndown is greater than the above numbers, the tube must be sloped down and away from the burner and have a drain at its lowest point to facilitate the removal of condensation.

Sizing the immersion tube system is important. If too long a tube is used, the high efficiency will cause condensation. If too short a tube is used, the user will not be able to take full advantage of the heat generated by the burner. In general, the tube should be sized for 80% efficiency. In applications using water-based solutions with a 3% oxygen level in the flue gas and 80% efficiency, target exhaust temperatures should be less than 400°F (204°C).

The combustion air blower can be mounted directly on the reduced bore immersion tube burner, or an external blower can be used. An external blower will develop approximately 30% more capacity than a direct-mounted blower. For example, a 6" burner operated at 2 million BTU/hr with a direct-mounted blower can be pushed to 3 million BTU/hr with an external blower at 80% efficiency. This tube would be 18% longer than the one used in the 2 million BTU/hr application.

When more than approximately 10" w.c. of air pressure is required at the burner or if the application requires a multiple burner system, it may be more economical to use an external blower. Single gas trains can be used for multiple burners if the burners are fired at the same time.

Tube diameter influences efficiency. The smaller the diameter and the longer the tube that is used, the higher the system's efficiency. The higher velocity and smaller tube diameter of a reduced-bore immersion tube burner result in higher efficiency per foot of tube.

Doubling capacity does not mean doubling tube length. The relative length per BTU will decrease as tube length increases. For example, suppose that a reduced-bore immersion tube burner with a 6" dia. tube is operated at 900,000 BTU/hr. Tube length is sized for 80% efficiency. If the input is doubled to 1.8 million BTU/hr, an 80% longer tube is required for the same 80% efficiency. This is less than double the length with the same 6" dia. pipe. A higher heat load per foot of pipe at the same efficiency is achieved.

If 1 million BTU/hr is put in a 6" tube at 80% efficiency, a 10% longer tube is needed than if the same capacity was placed into a 4" tube with the same efficiency. While the numbers used in these examples are only approximations, they show how these burners could benefit your process.