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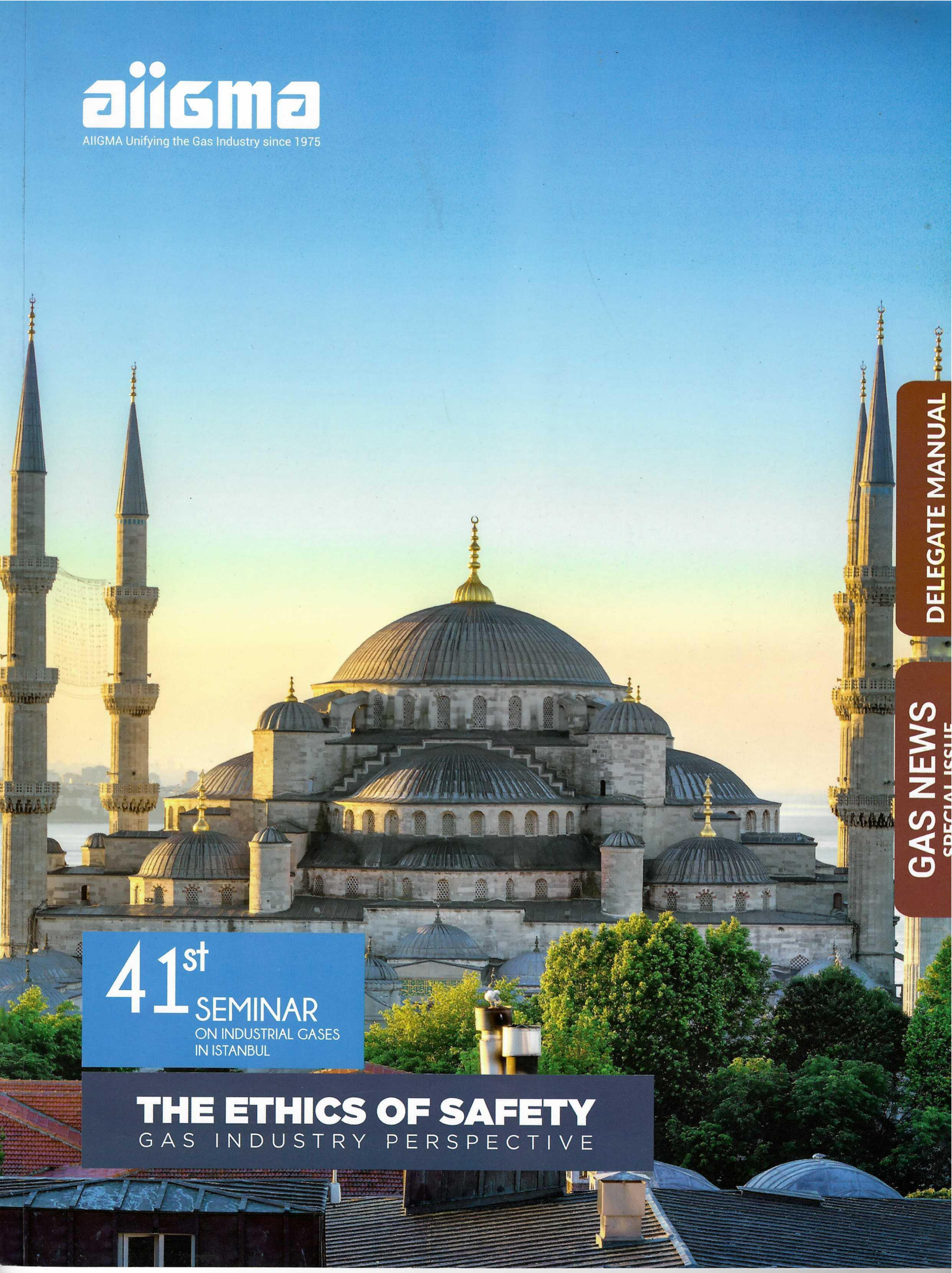

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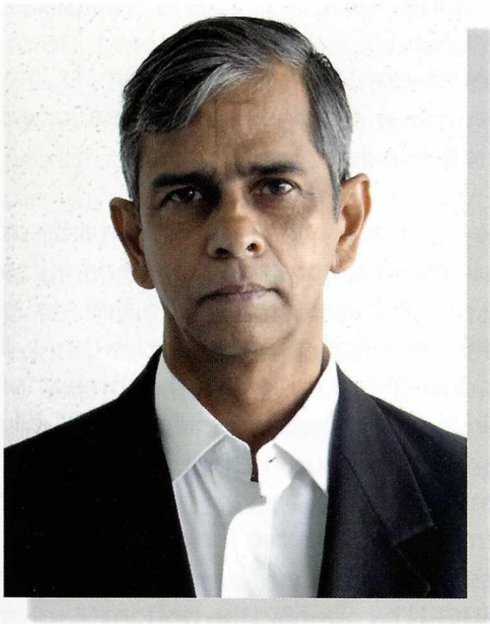
GAS NEWS

41st SEMINAR ON INDUSTRIAL GASES IN ISTANBUL

# THE ETHICS OF SAFETY

## GAS INDUSTRY PERSPECTIVE



# ADVANTAGES AND SAFE OPERATION OF CRYOGENIC THERMOSYPHON TANKS

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A thermosyphon (or thermosiphon) is a device that transfers heat via natural convection in a fluid. The natural convection is driven by gravity with the colder, denser fluid flowing downhill and the warmer, less dense fluid flowing back up. Thus, thermosyphons connect an object to be cooled with a reservoir or device providing the cooling. There are a variety of designs in thermosyphons; they may use a single phase fluid or, more commonly in cryogenic applications, a two-phase system in which liquid flows down to the item being cooled and vapor flows back up to the cold sink. Depending on the application, thermosyphons may consist of a single pipe or separate pipes for the cold and the warm fluids. Thermosyphons in cryogenics use a variety of working fluids, including helium, nitrogen, argon or even neon. Increasingly, thermosyphon systems have incorporated small cryocoolers to provide cooling at the cold reservoir end.

Thermosyphons have a number of advantages. They are passive devices requiring no external pumping to provide fluid flow and heat transfer. This leads to simpler, more reliable systems. Since the thermal conductivity of most materials at cryogenic temperatures is quite low, thermosyphons can in many cases transfer heat more efficiently than solid conduction.

There are potential disadvantages to thermosyphons as well. As they are gravity driven, they are best oriented in vertical or near vertical geometries. The distance between the top and bottom of the thermosyphon must be sufficiently large to set up the natural convection flow needed. The design of the thermosyphon loops must be carefully done to avoid pockets that can trap the returning warm vapor, thus stopping the convective flow. The passive nature of the thermosyphon can limit the amount of adjustability that the cooling system has for dealing with unexpected heat loads.

**Product Advantages**

- Simple and reliable pump start-up in five minutes with 100% product utilization.
- Thermal-siphon design manages heat from pump cool-down, keeping storage tank pressure down.
- Pump priming at tank pressure of 15psi (1 bar) or less without the necessity for pressure building.
- Vacuum insulated pod provides colder liquid to pump reducing cavitation.
- Extended legs add head pressure to pump without increasing liquid inventory for improved pump performance.
- Reduce liquid cylinder & MicroBulk Delivery System filling losses.
- Longer life of high-wear pumps parts.
- Capability to operate two pumps at once (liquid and HP pump).

## SPECIAL DESIGN FEATURES

The tanks are optimized during manufacture for pumping applications with the following specific enhancements:

- Extended one-piece legs.
- Liquid line traps are located below the sump of the pumps being attached.
- Baffles within the inner vessel separate liquid flow in and out of the siphon system.
- Automatic recirculation of the liquid to provide cold liquid to the pump at all times.
- Highly efficient multi-layer super insulation for low loss.
- A set of tank to pump transition piping kits, designed for specific pump models, to provide minimum product loss and repeatable pump start.

The vessel is comprised of a stainless steel inner tank encased in an outer carbon steel vacuum shell. The insulation system between the inner and outer containers consists of multiple layer, composite fiber, and high vacuum to ensure minimum heat leak. The insulation system, designed for long-term vacuum retention, is permanently sealed at the factory to ensure vacuum integrity.

The vessels are protected from over-pressurization with a tank pressure relief device. The normal relief device pressure setting is at the operating pressure of the inner vessel.

## SYSTEM OPERATION

The vessel pumping operation is limited to opening and closing liquid supply to the pump(s). This is done with either an air actuated automatic valve connected to a control panel or manual suction and return valves. The air actuated valve with a timer system is recommended. The following recommendations should be used to optimize tank filling:

1. Keep the transfer lines as short as possible. Long non-insulated transfer lines will result in higher fill losses and longer fill times.

2. Anytime liquid can be entrapped in a line between two valves, the line must be equipped with a safety relief device.

3. Conduct the filling operation in as short a time as possible. Liquid may be transferred into the tank so that venting is not necessary. The top fill valve (HCV-2) on the tank has a spray header that will splash the incoming cold liquid onto the somewhat warmer gas in the tank. The cold liquid will actually collapse the vessel pressure while being sprayed into the warmer gas. The bottom fill valve allows liquid to be transferred into the tank at a fast rate. The tank pressure can be maintained at a constant pressure level (PI-1) by opening the bottom fill valve (HCV-1) completely and throttling open the top fill valve to lower and maintain a constant pressure. All efforts should be made to fill the vessel only through the top fill, in order to lower the vessel pressure as much as possible. The full trycock valve spits liquid when the vessel becomes full. Do not over fill the tank.

## OPERATING SAFETY GUIDELINES

Cryogenic containers, stationary or portable, are from time to time subjected to assorted environmental conditions of an unforeseen nature whenever a cryogenic container is involved in any incident whereby the container or its safety devices are damaged, good safety practices must be followed. The same holds true whenever the integrity or function of a container is suspected of abnormal operation. Good safety practices dictate the contents of a damaged or suspect container be carefully emptied as soon as possible. Under no circumstances should a damaged container be left with product in it for an extended period of time. Further, a damaged or suspect container should not be refilled unless the unit has been repaired and re-certified.

Incidents which require that such practices be followed include: highway accidents, immersion of a container in water, exposure to extreme heat or fire, and exposure to most adverse weather conditions (earthquake, tornadoes, etc.). As a rule of thumb, whenever a container is suspected of abnormal operation, or has sustained actual damage, good safety practices must be followed. In the event of known or suspected container vacuum problems (even if an extraordinary circumstance such as those noted above has not occurred), do not continue to use the unit. Continued use of a cryogenic container that has a vacuum problem can lead to embrittlement and cracking. Further, the carbon steel jacket could possibly rupture if the unit is exposed to inordinate stress conditions caused by an internal liquid leak. Prior to reusing a damaged container, the unit must be tested, evaluated, and repaired as necessary. It is highly recommended that any damaged container be returned to manufacturer.

When the oxygen content of air is reduced to about 15-16%, the flame of ordinary combustible materials, including those commonly used as fuel for heat or light, may be extinguished. Somewhat below this concentration, an individual breathing the air is mentally incapable of diagnosing the situation because the onset of symptoms such as sleepiness, fatigue, lassitude, loss of coordination, errors in judgment and confusion can be masked by a state of "euphoria," leaving the victim with a false sense of security and well-being. Human exposure to atmosphere containing 12% or less oxygen leads to rapid unconsciousness. Unconsciousness can occur so rapidly that the user is rendered essentially helpless. This can occur if the condition is reached by an immediate change of environment, or through the gradual depletion of oxygen Most individuals working in or around oxygen deficient atmospheres rely on the "buddy system" for protection - obviously the "buddy" is equally susceptible to asphyxiation if he or she enters the area to assist the unconscious partner unless equipped with a portable air supply. Best protection is obtainable by equipping all individuals with a portable supply of respirable air. Life lines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constrain.