CRYOGENIC INDUSTRIES
FROSTBYTE
A NEWSLETTER FROM CRYOGENIC INDUSTRIES FALL 2014

Climate Affects the Selection of Ambient Air Vaporizers

When designing ambient air vaporizers, many factors need to be considered. The environmental effect is one such criterion. When designing and specifying fan-assisted and natural draft ambient air vaporizers, four main climate zones are used: tropical, Mediterranean, humid continental, and marine. Each of these zones, however, may contain micro climate zones with significantly different climate than the surrounding area.

Figure 1

In discussing climatic effects, a basic understanding of the principles of ambient air vaporizers is necessary. Fan-assisted vaporizers utilize forced convective heat transfer whereas natural draft ambient air vaporizers utilize natural convective heat transfer. Natural convective vaporizers are typically manufactured with three different fin spacings, depending on how long the vaporizers are going to be operated before complete defrost is achieved. Standard spaced vaporizers typically operate less than 24 hours before complete defrost and have a fin tip-to-tip air gap roughly 1.5" (38 mm). [*Figure 1*]

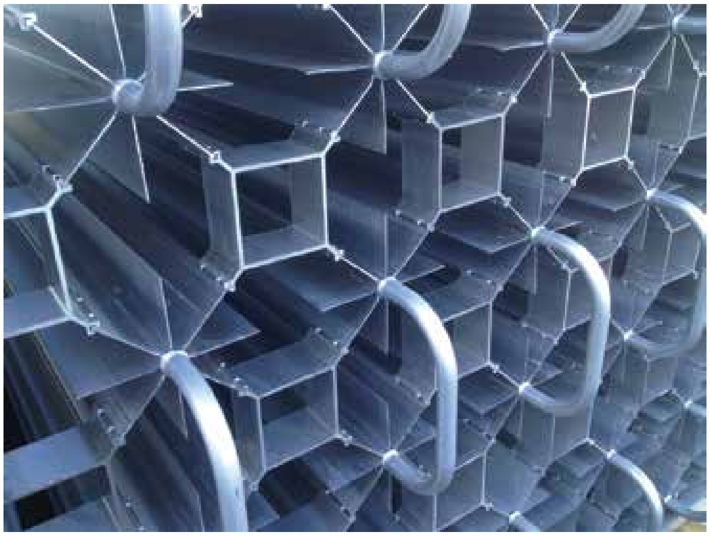

Figure 2

Wide gap natural convection vaporizers are generally designed to operate three to seven days without defrost and typically have a fin tip-to-tip air gap spacing of 3" (75 mm) or more. [*Figure 2*] Super-wide spaced ambient air vaporizers are designed to operate continuously, with the possibility of manual defrost required several times per year. These vaporizers have a typical fin tip-to-tip spacing of 10" (254 mm) or more. [*Figure 3*] Forced convective vaporizers are designed with maximum heat transfer area in a minimum space. They typically have fin tip-to-tip air gap spacing of considerably less than 1.5" (38 mm). [*Figure 4*]

Natural draft ambient air vaporizers operate on the principal of natural convective heat transfer. Air is cooled as gravitational force pulls it past the heat exchanger fins. It therefore becomes more dense and heavier. This density further promotes a downward motion due to gravitational effects. Forced convective heat transfer vaporizers rely on mechanical fan driven forced-stimulation movement of the air, and therefore does not rely on gravity.

Figure 3

The following are basic vaporizer design considerations when dealing with the issues of location and duration of operation of ambient air vaporizers. Other considerations also must be reviewed, such as electrical/fuel requirements, availability of land or real estate, proximity to roads, walkways, driveways and occupied businesses or housing.

Tropical Climate Zones

For the purpose of specifying vaporizers, tropical climate zones include equatorial regions such as Malaysia, Thailand, Indonesia, Panama, Venezuela, and Brazil. Other regions such as Japan and the southern United States replicate this climate zone closely in their summer months or monsoon season, but are generally closer to the humid continental zone. Tropical climate zones are characterized by dew point temperatures greater than 70°F (21°C). Dry bulb temperatures generally range from 80°F (27°C) to 95°F (35°C) year round. The temperature between night and day typically doesn't vary widely here. This is because the high moisture content of the atmosphere tends to trap the infrared radiation emitted by objects at night, not allowing it to escape.

Both natural and fan-assisted draft ambient air vaporizers should be considered in tropical climates due to the available ambient air temperature driving force. Flow rates under 57,000 scfh (1500 Nm3/hr) are likely to perform more economically with natural convection units; flow rates over 152,000 scfh (4000 Nm3/hr) with forced convection units. The main advantages of these systems is maximum vaporization capacity at minimal or no operation cost, coupled with maximum reliability.

In order to maintain maximum vaporizer capacity in this zone, both types of vaporizers should be switched quite often. Typical switching cycles would be about every four to eight hours. This is due to the high moisture content in the atmosphere and therefore rapid ice formation on the fins which rapidly reduces the overall heat transfer coefficient. Switching less than every two hours, to obtain even more vaporization capacity, is both unrealistic and dangerous. Both the natural and forced draft vaporizers will defrost adequately in this climate zone without any external energy source, as long as the off cycles are at least half the duration of the on cycles. The fan driven units will assist in this process.

A system can be designed with a larger approach temperature (approach temperature is defined as the difference between ambient temperature and discharge gas temperature), because of the consistently warm temperature both night and day. This results in greater capacity from a system rated for less in other climate zones.

Mediterranean Climate Zones

Mediterranean climate zones include areas such as the southern and central coast of California, Greece, the Algerian Coast, and other areas like Italy and Israel. These regions are characterized by precipitation periods of about four months per year. This climate zone, like the tropical climate zone, is well-suited to the ambient air temperature driving force available. The same rules generally apply regarding which vaporizers become economical choices.

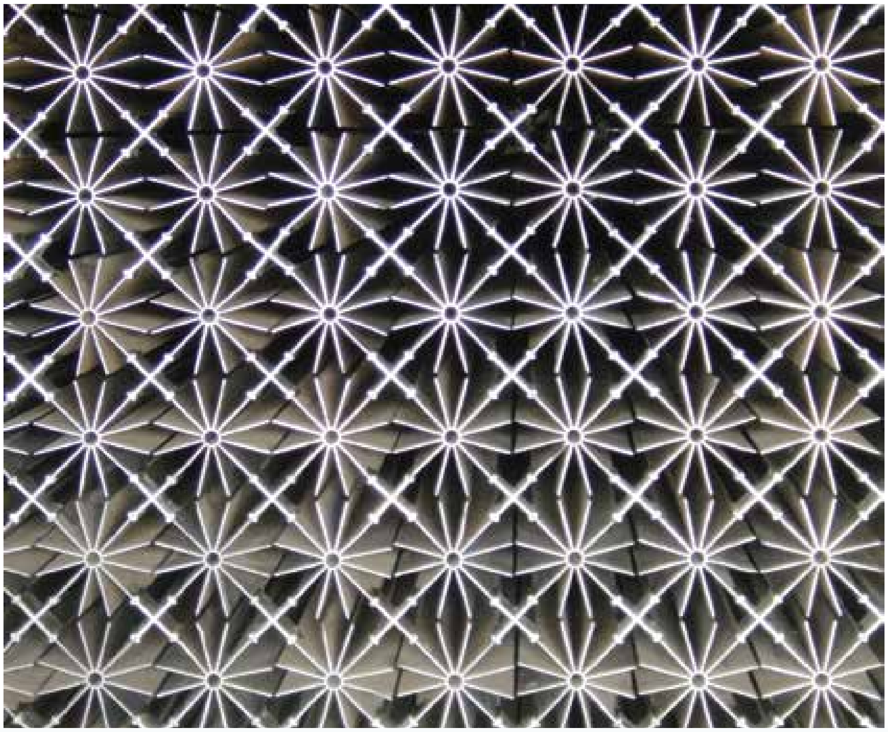

Figure 4

The main difference from the tropical zone is the low moisture content here can exist six to nine months of the year. Several unique weather characteristics result from this. Infrared radiation which escapes from the atmosphere at night often results in colder nighttime or early morning temperatures. This is a consideration when designing approach temperatures for this period and ensuring minimum temperatures remain above minimum values. The benefit of this drier climate is longer switching cycles. Switching less than every eight hours usually has little benefit, but switching in this zone should be done before 24 hours to obtain maximum efficiency from the units.

Humid Continental Climate Zones

The humid continental climate zone covers a vast area. In the Northern Hemisphere, typical areas include the interior United States, Southern Canada, Central Europe and Central Asia. These areas are characterized by somewhat tropical dew point temperatures in the summer and extended cold, dry periods in the winter, with a combination of the two in spring and fall.

In this zone, the point where forced draft ambient air vaporizers become more economical than natural draft vaporizers is much less apparent. It must be analyzed more rigorously due to the larger variations in ambient conditions. A phenomenon known as the freeze period (the period of time in which ambient temperatures remain below freezing) is one key to vaporizer specifications.

Fan-assisted vaporizers typically require an external energy source in order to defrost during their off period. Electrical heater assemblies, or gas fired external air heaters, can be used. Because of these additional requirements, the fan ambient vaporizers become less attractive over other vaporizers.

Natural draft vaporizers must be sized so each bank of on-stream and off-stream vaporizers is capable of operating for one-half the freeze period. This could be up to several months in parts of Canada or North Central Asia, thus requiring much more surface area (up to four times more) than in other climate zones. Due to the tropical nature that may exist in these areas during the summer, the switching cycles are typically based on summer conditions. Because of the potential for very low temperatures during winter months and depending on pipeline limitations, special equipment additions like gas super-heaters may be required downstream of the ambient units. Lower approach temperatures are often required during winter months. Fluids such as carbon dioxide and propane that may be vaporized in tropical zones by utilizing ambient units should not be considered in humid continental climates, since it is more likely you will be subcooling during winter periods.

Marine Climate Zones

Marine climate zones pose a unique challenge to ambient air vaporizer designers. Some areas included in this zone are Britain, the Northwest coast of the United States, British Columbia, Canada, Maine and the far Northeast of the United States, Norway, New Zealand and the Southern coast of Argentina. Although ambient temperatures remain relatively mild throughout the year, usually between 23°F (-5°C) and 70°F (21°C), the climate is very moist. Dew point temperatures are commonly very close to the dry bulb temperatures as well as the freezing point of water. What tends to result is a substantial amount of condensation and added precipitation on vaporizer surfaces which quickly freeze into dense pockets of ice, reducing vaporizer capacity. Extra surface area must be added to reduce the effects of this atmospheric phenomenon. Likewise, the vaporizers need to be switched much more often to prevent the formation of very dense ice that will not defrost during off periods if levels get too substantial. Vaporizers must often be sized based on two to three day ratings, but switched every two to six hours to prevent ice buildup.

Micro Climate Zones

Micro climate zones exist in every one of the zones discussed. They are defined as zones that may result in substantially different weather conditions and may exist at distances as close as 31 miles (50 km) from one to the other. Micro climate zones may have unique wind or precipitation design requirements. The phenomenon of severe winds (caused by the venturi effects of local mountain canyons), may result in special mechanical design requirements or height limitations. One example is the area downwind of the Great Lakes region in the United States, where major snow fall accumulations can occur when dry cold winds move over warmer moist lake air, causing the air to become saturated and creating localized "lake effect" snow. Severe wind effects can also be found in the Chinook winds of Montana, the buran winds of Russia and Central Asia, the bora winds of the Northern Adriatic coast of Yugoslavia, and the Santa Ana winds of Southern California. Altitude effects also need to be considered, with appropriate capacity reduction applied to the vaporizer models.

For further information, visit www.Cryoquip.com

Upcoming Events

World LNG Fuels
Houston, Texas
Feb. 2-4, 2015
Exhibiting - LNG products for trucking, marine, rail and fracking

L-NGV
San Diego, California
April 27-29, 2015
Exhibiting - NGV and LNG applied to transportation

Offshore Technology Conference (OTC)
Houston, Texas
May 4-7, 2015
Exhibiting – LNG Pumps

Alternative Clean Transportation (ACT) Expo
Dallas, Texas
May 4-7, 2015
Exhibiting – LNG Pumps