

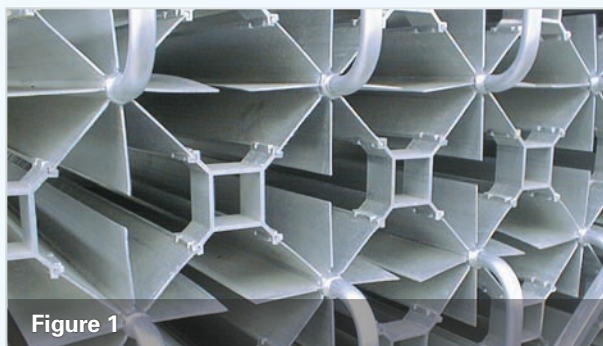
Climate affects the selection of ambient air vaporizers

Many factors need to be considered when designing ambient air vaporizers. The environmental effect is one such criterion. When designing and specifying fan-assisted and natural draft ambient air vaporizers, we use four main climate zones: tropical, Mediterranean, humid continental, and marine. Each of these zones, however, may contain micro climate zones where the climate may be significantly different than the weather around it.

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 typically are 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)

Wide gap natural convection vaporizers generally are 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 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, therefore not relying on gravity.

The following are basic vaporizer design considerations dealing with the location and duration of operation of ambient air vaporizers. Certainly other considerations must also be reviewed, such as electrical/fuel requirements and 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. There typically is not a wide variation in the temperature between night and day, since the high moisture content of the atmosphere tends to trap the infrared radiation emitted by objects at night, not allowing it to escape into outer space.

Both natural and fan-assisted draft ambient air vaporizers should be considered in tropical climates due to the large ambient air temperature driving force available. Flow rates under

57,000 scfh (1500 Nm³/hr) are likely to perform more economically with natural convection units and flow rates over 152,000 scfh (4000 Nm³/hr) with forced convection units. The main advantage of these systems is maximum vaporization capacity at minimal or no operation cost coupled with maximum reliability.

In order to maintain maximum vaporizer capacity from both types of vaporizers in this zone, the 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 growth 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 at night and during the day. This results in greater capacity from a system rated for less in other climate zones.

Mediterranean Climate Zones

Mediterranean climate zones would include areas such as the southern and central coast of California, Greece, the Algerian Coast, and other areas like Italy and Israel. Typically, 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. Generally, the same rules apply with regards to which flow natural

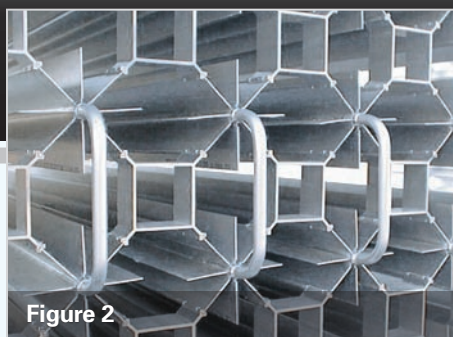


Figure 2

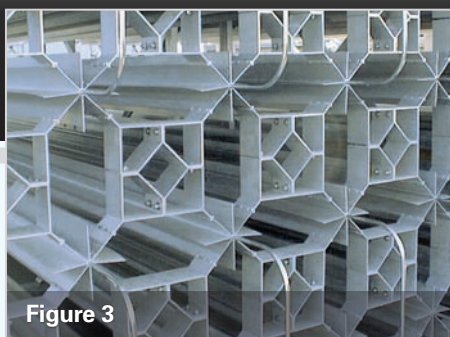


Figure 3

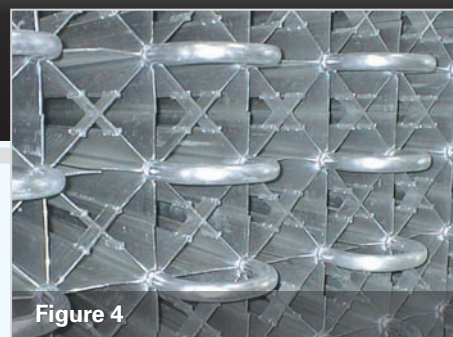


Figure 4

draft and forced draft ambient air vaporizers become economical choices.

The main difference between this climate zone as compared to the tropical zone is the low moisture content that can exist six to nine months of the year. Several unique weather characteristics result from this. Infrared radiation mostly escapes from the atmosphere at night resulting in possible colder nighttime or early morning temperatures—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. Typically, switching less than every eight hours has little benefit, but switching should probably 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.

The point where forced draft ambient air vaporizers become more economical over natural draft vaporizers is much less apparent and 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 specifying.

Typically, fan-assisted vaporizers will 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 than other vaporizers.

Natural draft vaporizers must be sized such that 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 (sometimes as much as 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 of these systems is typically based on summer conditions. Because of the potential for very low temperatures during winter months, special equipment additions like gas superheaters may be required downstream of the ambient units depending on pipeline limitations. 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, the far northeast of the United States, Maine, 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 with dew point temperatures 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 that 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. Often vaporizers must 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. An example is the area downwind of the Great Lakes region in the United States, where major snowfall 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. Other common weather phenomenon, such as 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, may result in special mechanical design requirements or height limitations due to the severe winds caused by the venturi effects of local mountain canyons. Altitude effects need to be considered as well, with appropriate capacity reduction applied to the vaporizer models.

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