

# Toro **GreenTech** India

## Frequently Asked Questions

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### Product

## Toro ID Pre Cooler (Patent Pending)

## COOLING POTENTIAL

Cooling potential varies with the specific climate existing in each country, depending on altitude, closeness, to sea and seasons etc. Generally, the difference between dry and wet bulb temperature is the potential of evaporative cooling, i.e. the difference in temperature, and 90-95 % of this potential can be achieved by using an Evaporative Pre Cooler. This means, that the conventional Pre Coolers can reduce a given ambient temperature by 80 to 85 % of the potential using the latent heat of the water which is evaporated.

## LATENT HEAT DEFINITION

Latent heat, defined as the quantity of heat absorbed or released by a substance undergoing a change of phase, i.e. from water to vapor or vice versa, at constant temperature and constant pressure.

By using the latent heat of water, air is cooled by evaporating water into the air. This means that energy from the air is transferred into the water to evaporate the water and to cool the air down towards the wet bulb temperature.

Generally, in the night and during monsoons, there is the smallest potential for direct evaporative air cooling technology, being in the range of only 2-3°C, while over the day and during summer months the peak potentials can be around 10-25°C at the hottest time of the day.

On average, during daytime, 4-5°C can be assumed for countries like Indonesia, Malaysia, and Thailand. However, in southern Europe like Spain, peak potentials are up to 20°C in southern Spain (inland), approximately 14-16°C in areas located close to the sea.

Toro ID Pre Coolers using a combination of sensible and adiabatic cooling, achieve higher efficiencies often exceeding 100% or more. TORO ID Pre Coolers can consistently provide cold air at 26°C (or less) during all climatic conditions throughout the year.

In North America, the situation is similar to southern Europe, potential is between 12°C in the North and more than 20°C in southern regions like Arizona, New Mexico, Texas. The largest potential exists in the deserts, for example Saudi Arabia, or also in dryer spots of Australia, India and Pakistan. Cooling potentials are up to 30°C and it is possible to bring down temperatures from 55°C to around 25°C. Average cooling potentials of 6-7°C on a 24 h, 365 days basis are existing, so that also the average cooling potential, not only the peak cooling potential, is enormous.

## COOLING EFFICIENCY

*How can an evaporative cooling work in countries, where the relative humidity is high, for example in the tropics, where the relative humidity is 80-90%?*

Relative humidity is not constant, it is rather fluctuating very much, and this depends very much on the absolute ambient temperature. Air of low temperature (5-10°C) can become saturated with a few grams of water/kg of air, air of higher temperatures (20-40°C) needs much more water to become saturated. With increasing temperatures, the energy saving and capacity enhancement potential gets larger, because the absolute portion of water in air does not exceed 23 g/kg air at the most humid conditions (Dubai) at 45°C and 31°C wet bulb at 38 % Relative humidity and rarely exceeds 20g/kg air (tropical countries, 28°C wet bulb temperature).

In a certain environment, at highest ambient temperatures, the RH is always low, i.e. always provides enough potential for at least 10°C anywhere on earth. To express that simply means that at high temperatures the relative humidity is always low.

The best examples are the tropics, where the maximum difference between dry and wet bulb are the lowest on earth. Every night Relative humidity goes up to 85 -95 %,but over the daytime, at temperatures exceeding 32°C, it goes below 65 % r. H., often down to 55 %!

At relatively low temperatures, compared to the other temperatures at a certain place and at a certain period of the year, the likelihood that the evaporative cooling potential is low, is relatively high. However, at low temperatures the condensers do not need additional cooling, because their capacities are near the design point or near the ARI rated output, i.e. they meet the design criteria.

## TYPICAL MISCONCEPTIONS

The highest humidity happens at the highest ambient temperature. It is easy to assume the above, but actually, as explained earlier, at highest ambient temperature, the relative humidity is the lowest and vice versa. Highest relative humidity occurs at lowest ambient temperatures. If weather data seem to indicate more than 23 g water in 1 kg of air, it cannot be correct. Difference in achieving wet bulb and dew point temperature (from a given ambient temperature and given relative humidity) Wet bulb temperature is achieved by humidifying air of certain condition by evaporating water until the air is 100 % saturated, without any further exchange of energy.

Dew point temperature is achieved by cooling air of a certain conditions by means of sensible heat exchange (at no exchange of phase) until the air is 100 % saturated. Psychrometric diagram in the product literature shows the process.

## GENERAL QUESTIONS

### ***Can the output of a condensing unit be kept constant at ARI conditions by using the TORO Pre Cooler?***

TORO ID Pre Coolers can keep the condensing unit output constant, while reducing the operating energy input even at high ambient temperatures. Typically the maximum annual condenser intake temperatures can be maintained near 23-27°C in Europe, most parts of Asia and the US.

In extreme cases such as Dubai, for a few days of the year 28°C must be accepted. But for the rest of the year, even at extreme ambient conditions, the intake temperatures after TORO ID Pre Coolers remain less than 27°C.

### ***How is wet bulb temperature measured?***

Wet bulb temperature is measured by using a wet wick that is wrapped around a tip of the thermometer. Out of the wet wick, the water will evaporate and create thereby the cooling effect which cools the thermometer down to the wet bulb temperature. It has to be taken care that the thermometer is fully wrapped and the cloth is fully wet, otherwise the measuring result may not be correct.

### ***When are TORO ID Pre Coolers switched off?***

The Coolers are switched off either during very humid conditions with cooling potentials of less than 2°C or at significantly lower temperatures often below 10°C. Reason for this is that at small temperature difference like 2°C, evaporative cooling is not effective and below 10°C, no cooling is desirable.

### ***What controls are used in TORO ID Pre Coolers?***

One of the most important controls is the water quality. Water quality needs to be kept under control, i.e. the minerals shall not concentrate due to constant evaporation, because this will damage the plate heat exchanger and deterioration evaporator pad surface. The integral controller provides required programme to reduce the salt concentration. Optional controls for fan and compressors can be offered on request.

### ***What is the maximum air velocity possible?***

Due to use of special Indirect direct Heat exchangers and droplet eliminator offered by TORO GreenTech, the allowable air velocities can be as high as 3.5 m/s, which decreases the necessary cross-sections for a given condenser air flow. Pre Coolers are offered for any size of condenser or air flow depending on the air flow through the cooler.

### ***What are the typical dimensions of a TORO ID Pre Cooler?***

Toro ID Pre Coolers are designed for heights not exceeding 3 meters. All modules are 0.6 meters wide. The depth of the Pre Coolers depends on access and on droplet separator type selected. The depth normally is between 0.2 meters to 0.5 meter max.

### ***How much power is required to operate the TORO ID Pre Cooler?***

Power consumption depends on the design of the Pre Cooler, but is typically between 2-3 Watts per TR for large condensing units to about 5-10 watts for units below 60 TR. Depending on the height difference between tank and media banks, up to 1 kW may be necessary for the biggest Pre Cooler.

### ***How is the relative humidity controlled by a Pre Cooler?***

With a TORO ID Pre Cooler, the relative humidity is controlled within a range. The TORO ID Pre Coolers operates on Indirect and Direct evaporative cooling principle. Indirect evaporative cooling efficiency is 60% and direct adiabatic efficiency is designed to reach 80% or less to conserve water. The TORO ID Pre Coolers are dew point Coolers unlike the conventional Direct Evaporative Pre Coolers which are wet bulb dependent.

Toro ID Pre Coolers outlet humidity will be in the range 70 to 98% and will always be non-condensing. For example, if ambient air at 47°C and 15 % Relative humidity is taken into the conventional Pre Cooler, it will leave with 80 % RH and at a temperature of 27°C having specific moisture content of 18 grams/kg of air. Whereas the TORO ID Pre Coolers will provide 27°C air at 60% humidity and having 13 grams of water per kg of air.

That is a saving of more than 5 grams of water/Kg of air. This translates to 60 Ltrs/Hr water saving for a 10 TR unit having a Toro ID Pre Coolers installed instead of conventional pad type pre Cooler.

### ***What are the maximum velocities acceptable and what is the maximum pressure drop?***

Net average velocity (deducting the cross-sections for bracings, flanges etc.) should be lower than 3.0 m/s. For higher average velocities, TORO can provide specially designed media up to 3.5 m/s in special cases. Pressure loss mainly depends on the air velocity and on the thickness (efficiency) of the media. Low pressure losses are 50 Pa at coolers with approximately 2.5 m/s air velocity and reach up to approximately 140 Pa at 3.5 m/s. However, this also depends on the droplet separator, if and of which type installed.

### ***What is the retrofit cost for a Pre Cooler?***

Erection cost strongly depends on type and size of Pre Coolers and location. Typically, for retrofit costs, 8-20 % of the Pre Cooler's price can be assumed for the erection only, leaving out costs for rearranging the condensing unit access etc. Installation costs for factory fitted Pre Coolers for new condensing units are only about 60% of this amount.

***What is the Water Consumption for TORO pre Cooler?***

Water consumption depends on the cooling potential, i.e. the difference between wet bulb and dry bulb temperature, the combined efficiency of the staged ID Pre Cooler, which is generally exceeds 100%, and the air flow of the respective condensing unit. In any case, water use by TORO ID Pre Coolers does not exceed 2.3 to 3.5 Ltrs/Tonne hour.

***What water quality is necessary to operate the evaporative cooler?***

The incoming water should be of the following quality:

Operating fluid is water with the following recommended specifications (incoming water):

Description	Lower	Upper	Unit
Conductivity	50	450	Micro Siemens/cm
Calcium Hardness (as CaCO <sub>3</sub> )	45	170	ppm
Chlorides (as Cl)	3	<50	ppm
Total Alkalinity (as CaCO <sub>3</sub> )	45	170	ppm
pH	7	8.5	
Silica (as SiO <sub>2</sub> )		<25	ppm
Iron (as Fe)		<0.2	ppm
Oil and grease		<2	ppm
Total dissolved solids		<550	ppm
Suspended solids		<5	ppm

The analysis of water which does not fulfill this specification must be given to our Business Associates in order to determine whether or to which extent the water can be used for operating the TORO Pre Cooler.

**CAPACITY INCREASE**

***What is the capacity increase due to Toro ID Pre Cooler?***

The maximum output increase of condensing units is around 1.8 %/°C due to cooling of the inlet air cooling of the ambient air.

***What is the input power saving due to TORO ID Pre cooler?***

This energy saving may vary from 10 to 17.5% depending on the type of condenser and the ambient dew point. Another saving is in demand charges due to peak shaving. Demand charges and power tariffs vary from state to state and from industry to industry.

### ***How much does the Compressor head pressure decrease by using TORO ID Pre Cooler?***

Head pressure of refrigeration compressors is dependent on the refrigerant and condenser design besides the evaporator duty. As a thumb rule, for a Refrigerant R-22 refrigeration system designed for high back pressure duty, the head pressure will increase at the rate of 1.8 Kg/cm<sup>2</sup> per degree increase in the condenser inlet temperature.

### ***Does the TORO ID Pre Cooler's efficiency decrease after a period of time?***

Mostly it is the Adiabatic cooling media that gets affected due to evaporation of moisture from the extended surface. If the water is in accordance with specifications, cooling media has a long operating life. There are cases of media being in service for more than 5 years. Media may be paper (inflammable) or if grass fiber (non combustible) substrate.

But if the media is in contact with water containing too much calcium or magnesium, the media can be destroyed within weeks by accumulating magnesium or calcium which blocks the structure, so that the adiabatic cooling process is thwarted and the pressure drop is increased. Typically, the adiabatic cooling media may have life of 5 to 6 years with reasonably good water quality.

### ***Are droplet separators required?***

At velocities higher 2.5 m/s, we do install a droplet eliminator, also called droplet separator or mist eliminator, in order to protect the condenser fins from any drop of liquid water. There is a variety of different TORO droplet separator types, depending on space available to install the Pre Coolers and the air velocity through the cooler.

### ***What is the Erection time & Erection procedure for new units and retrofits?***

Erection time depends on the size of the units. Small units of 10 to 60 TR are usually retrofitted within 1-2 days while bigger units for 100-500 TR chillers do require a week or little longer. However no downtime is required for installation.

### ***What is the Return on Investment (ROI)?***

Due to the increased output at higher ambient temperatures, the chillers offer higher capacity with lower use of input energy. For instance, system using TORO ID Pre Coolers show the COP improvement is in excess of 30% or better compared to operation on high temperature condenser air inlet conditions. At common electrical tariff of INR 5 to 6/ kWhr TORO ID Pre Coolers do often earn the investment back within months.

### ***Are there O&M Savings over the Life cycle?***

Further to the increased capacity available at higher ambient temperatures and reduction of input energy, the maintenance costs are drastically reduced as the system head pressures

remain lower and the component temperatures remain below the design limits. The process also enhances the life of all materials used in the system.

***Is the operation cost higher than regular pre coolers?***

Water costs do form over 90 % of the operation cost of any pre cooler. Water is the main consumable, the cost for it vary usually worldwide between INR 30/m<sup>3</sup> to 50/m<sup>3</sup> for cleaned river water or potable water. Please ask us to provide details of water consumption at continuous operation at different locations with for you installation.

Demineralized water can also be used, but is of higher cost compared to normal water. Toro ID Pre Coolers use 50to 60% less water compared to any evaporative pre cooler. Water costs incurred by TORO ID Pre Coolers are negligible against the savings.

***Are the operation and Maintenance manpower costs high with Toro ID Pre Coolers?***

TORO does build fully automatic or semi-automatic ID Pre Coolers, which do not require any manpower to operate. Maintenance and service does also not require much manpower, because only regular checks and some cleaning (at least once a year during winter) have to be done, however, total man-hours for maintenance and service of a pre cooler should be between 10-50 man-hours/year, if the pads are not taken out during the cold season (if any). Water quality has to be checked regularly.

***What makes up the spare part cost for ID Pre Coolers?***

Spare parts costs mainly consist of new adiabatic cooling media every few years. Other costs are negligible. Very little manpower is necessary to check and maintain the Pre Cooler.

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