



## *Creators of Bubble Slurry™ Ice*

### **About our Bubble Slurry™ Ice Machines**

Producing cold is basically different to and much more difficult than producing heat. People learnt to produce heat 500,000 years ago in the ice ages, whereas refrigeration started only 150 years ago in the 19th century.

To make ice, water needs to be brought down to low temperatures in order to change the liquid state of water into its solid state: ice.

An ice machine needs several electricity-driven components in order to function:

- Water delivery pumps
- One or more compressors
- One or more ice crystallizers (also named evaporator) with a motor to rotate either a drum assembly, or assemblies with scrapers, knives or other cutting devices, depending on the type of ice machine
- One or more fans to enhance heat air-cooled condensers
- A grinder or chopper to crush solid ice, if applicable
- A mixer to blend crushed ice with a salt solution to produce an ice sludge, if applicable
- A slurry ice mixer in storage/mixing tanks, if applicable
- A slurry ice delivery pump or a solid ice conveyor belt, depending on the type of ice machine

Making ice is in general an electricity consuming undertaking. Most ice machines produce between 5 and 12.5 kg of pure ice per kWh (between 0.003 and 0.008 lb per Btu). Crytec's Bubble Slurry™ Ice machine Model CR-004 produces 18.5 kg of pure ice per kW (0.012 lb per Btu), and Models CR-010 and CR-020 17 kg/kW (0.011 lb/Btu). Note that these figures include ALL electrical components necessary to produce Bubble Slurry™ Ice, such as refrigeration compressor, air compressor, process pump, 1 to 4 evaporator wiper motors and the electrical/electronic components.

### **About performance and ice making capacity**

Not all evaporators (or crystallizers) give the same result (ice making capacity). The main obstacle is called "Heat Impedance" (HI), which means "impeding the transfer of heat from one element or ingredient to another". In the case of ice machines it means "from the (warmer) cooling liquid (like seawater) to the (colder) refrigerant".

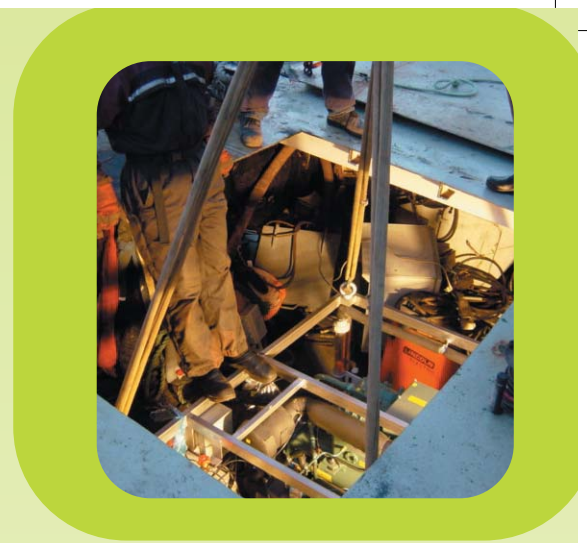
In ice machines the factors that can negatively affect an adequate heat transfer are:

- the HI between refrigerant and the evaporator's wall,
- the HI of the material of the evaporator's wall,
- the HI between the evaporator's inner tube's wall and the formed ice crystal layer,
- the HI of the ice crystal layer itself,
- the HI between the ice crystal layer and the cooled medium.

The design of the first generation crystallizers creates a heat transfer coefficient from 700 to 1,400 W/(m<sup>2</sup>.°C) or 123 to 247 Btu/(h.ft<sup>2</sup>.°F), whilst Crytec's second generation crystallizers realize a heat transfer coefficient of 2,000 to 3,000 W/(m<sup>2</sup>.°C) or 352 to 528 Btu/(h.ft<sup>2</sup>.°F).

Crytec's ice machines offer an optimum performance because their evaporators are:

- made of a top-quality stainless steel alloy with extreme low heat impedance, offering an exceptional heat transfer coefficient;
- precision tooled and polished, so that the inner wall has an optimal smoothness (low roughness), providing minimal adhesion forces on the evaporator's inner wall, hence preventing the formation of ice crystals on the inner wall;
- using Crytec's proprietary, patented technology to produce its unique Bubble Slurry™ Ice: not on the wall of the evaporator's inner tube, but inside the volume of the cooling medium, e.g., seawater.



## About refrigerant

Due to the superior heat transfer efficiency between refrigerant and cooling medium of Crytec Bubble Slurry™ Ice machines, the refrigerant charge is only 1.4 to 4.4 kg/TR or 3 to 9.7 lb/TR, compared to other ice machines: 3 to 10 kg/TR or 6.6 to 22.2 lb/TR (1 TR or "ton of refrigeration" = 3.516 kW cooling capacity).

## About TESS (Thermal Energy Storage Systems)

Since Bubble Slurry™ Ice mix consists of ice crystals, water, and air or gas (CO<sub>2</sub> or O<sub>3</sub>), homogeneity is required to maintain the right concentration in the whole volume of the storage tank. Therefore Crytec has designed special TES systems that function automatically in conjunction with its Bubble Slurry™ Ice machines to obtain and maintain a homogenous Bubble Slurry™ Ice mix at preset temperatures, concentrations and amounts.

The special storage and mixing tank system consists of an insulated tank with a specially designed Bubble Slurry™ Ice-water separator and a mixing engine that rotates specially designed blades to ensure the homogeneity of the Bubble Slurry™ Ice mix. The fully automatic operation (water filling, Bubble Slurry™ Ice making, mixing, pumping, and changes in ice fractions and temperatures) is controlled by a PLC (Programmed Logic Controller).

## Important data on Crytec Bubble Slurry™ Ice machines

Parameters	Factor	CR-004	CR-010	CR-020
Coefficient of Performance	COP*	1.7	1.6	1.6
Energy consumption	kWh/1000 kg pure ice	54	59	60
	kWh/1000 lb pure ice	24.5	26.8	27.3
Rated power	kW	8.9	25.4	44.4
Pure icemaking capacity	kg/h	146	354	646
	lb/h	320	780	1,420

*\*including refrigeration and air compressors, process pump, and evaporator wiper motors*

**See for further details the data sheets with complete specifications**

Specifications are subject to change without notice.

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