HI-MAX Air Cooled Condensers

Introduction:

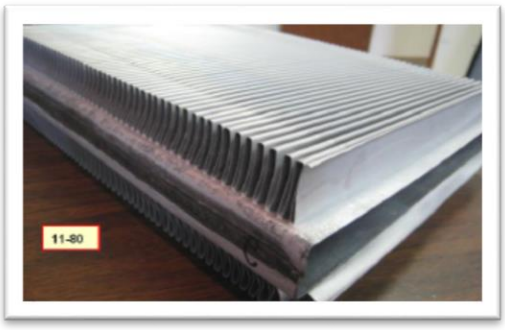
HOLTEC INTERNATIONAL ACC AT SCATTERGOOD

Holtec's HI-MAX (**H**oltec **I**nternational **MAX**imum reliability) is a transformative air cooled condensing (ACC) technology characterized by a stainless steel obround tube (referred to as the Core tube) whose flat stainless steel surfaces are equipped with closely spaced aluminum fins oriented in the transverse direction to the axis of the tube. The uniqueness of HI-MAX lies in the strength of the bond between the aluminum fins and the stainless steel core tube. The thickness, height and spacing of the fins have been optimized using state-of-the art computational fluid dynamics codes to provide maximum fin efficiency for air flow parameters.

HOLTEC INTERNATIONAL ACC AT FORT NELSON

HI-MAX represents the culmination of industry's decades old quest to eliminate carbon steel from the wetted surfaces of the ACCs. The migration of iron ions into the condensate over the large inside wetted surface of the Core tubes in ACCs has been a nagging condensate water chemistry problem that has dogged the power industry ever since dry cooling by air was introduced in the late 1930s. At this time, HI-MAX is power industry's first and only finned tube that does not have any carbon steel. The patents that protect Holtec's intellectual property imbedded in the HI-MAX technology are in the process of being issued by the USPTO.

Thanks to HI-MAX, preservation of condensate purity is a problem no more!



HI-MAX TUBES: ALUMINUM FINS BONDED TO STAINLESS OBROUND TUBES

HI-MAX PRESSURE CYCLING TEST EQUIPMENT

Qualification tests: The HI-MAX tube has been subjected to a battery of tests to establish its performance, viz:

- Accelerated Corrosion Testing: The accelerated corrosion test, conducted in accordance with ASTM B117-07(also known as "the Salt Spray test") showed HI-MAX's corrosion resistance to be incomparably superior to the tubes made of galvanized carbon steel.

- Brazed joint strength test: Subjecting the finned obround tube to an elevated internal pressure provides a direct measure of the bond strength between the tube and the fin. In the destructive tests, the HI-MAX tube begins to lose bond integrity at 35 psig which is comparable to finned carbon steel tubes. These pressure tests indicate that the fin to tube joint strength in HI-MAX is as high as a conventional steel tube used in the industry.

- Cyclic Fatigue tests: The State of vacuum in the HI-MAX tube varied to emulate cyclic loading on the HI-MAX brazed joints at varying power levels and start up/shutdown conditions. The Joint passed 30,000 cycles of pressure cycling equivalent to over 80 years of service assuming one plant start up and shut down every day.

CYCLIC FATIGUE TESTING OF HI-MAX TUBE

Codes and Consensus Standards:
Holtec utilizes an array codes and consensus standards in the design of ACCs. Holtec is a founding member of the HEI standards for ACCs. The table blow provides a succinct summary:

No.	ACC Component	Publisher of the standard
1	Structural Steel	AISC
2	Ducting	ASME
3	Tube Bundles	ASTM
4	Motors	NEMA
5	Gearbox	AGMA
6	Fan	CTI
7	Deaerator	HEI
8	SJAE/LRVP	ACC HEI
9	Valves	ASME

Advantages of HI-MAX:

Historically, the ACC tube bundle becomes a veritable source of iron contamination of the circulating condensate forcing the plant owner to use 100% condensate polishing to prevent internal corrosion of the power cycle components. Replacing carbon steel tubes with stainless steel in HI-MAX eliminates the principal source of corrosion species which makes a polishing system superfluous. Users have gone to the extent of replacing carbon steel ducting and headers with stainless steel, to eliminate the threat of internal corrosion. Removing the polisher has the salutary advantage of simplified piping and reduced operating costs (resin replacement and disposal). Thus, a HI-MAX equipped ACC will help a power plant avoid ageing from corrosion and promote a longer service life.

State-of-the-art design methods:

Holtec utilizes the Computational Fluid Dynamics (CFD) code FLUENT to predict thermal-hydraulic performance of its ACCs to quantify effects of chronic factors such as wind. Design measures developed using FLUENT have been incorporated in Holtec ACC design methods thus insuring Holtec ACCs the performance certainty that was beyond the reach of the classical empirical (Bernoulli) solution methods still used by many in the industry. Finite Element Analysis Code ANSYS or STAAD-PRO is used to study the effects of wind loading and earthquakes on ACCs. Holtec's use of these state-of-the-art tools makes HI-MAX the industry's only ACC whose reliability and operability are rigorously validated by the same tools that are used to design Holtec's SMR-160 reactor and used nuclear fuel storage and transport casks

Standardization:

Holtec's HI-MAX is industry's first standardized ACC designed to meet any site requirements without extensive custom engineering. The pre-engineered, standard cell can be designed to meet the performance specification and erection strategy at any site. The result is an efficient design process that is fully informed by the Company's Lessons Learned database. The benefits of standardization include:

MODULAR CELL BEING HOISTED INTO POSITION.

- Reduced lead-times.
- Flexibility in the field during construction.
- Shorter overall project schedule.

Modularization:

Holtec's standard ACC cell is designed is guided by the goal to minimize the total installed cost to the owner. Modularization can reduce construction time and cost by as much as 40%. Traditionally, ACCs have been erected in a stick built fashion, where field construction costs can exceed the cost of the equipment. Holtec's engineers have reduced the number of pieces shipped to site by optimizing the modular ACC erection sequence. For instance, Holtec's engineers have reduced the fan deck from thirty pieces to four subassemblies shipped to the site. On site work that is normally performed at elevations as high as 130 feet, can now be completed at grade. Since assembly at elevation is limited by the reach and lifting capacity of the site's crane, an entire fully loaded cell can be assembled at grade and placed on the support structure in a single lift.

HI-MAX MANUF. FACILITY IN DAHEJ, INDIA

Vertical integration:

Like all Holtec's systems and components, the supply of the ACCs is vertically integrated

HI-MAX MANUF. FACILITY IN DAHEJ, INDIA

The design work is carried out in the Company's Marlton ,NJ and San Diego, CA operation centers with participation from Pune', India in the structural analysis and CFD analysis areas.

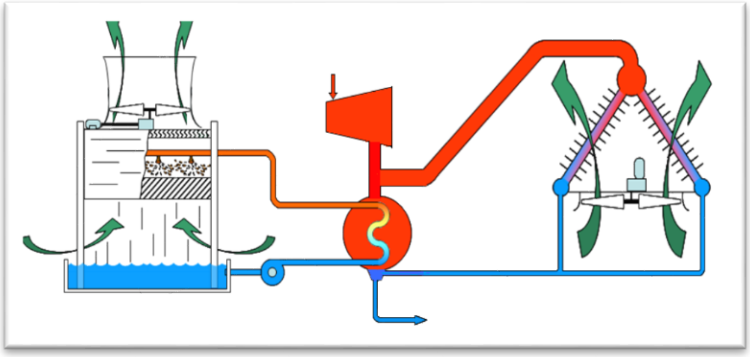
Holtec's new fabrication facility in Dahej, India produces HI-MAX fin tubes and assembles the tubes into bundles using techniques that ensure the highest levels of quality, performance, and cost competitiveness on the global market. Stainless steel (HI-MAX) is the preferred heat transfer surface for most applications. The plant is focused on making HI-MAX tubes but can be re-fixtured in a short time to produce conventional carbon steel tubes with aluminum fins, offered under the trade name HI-MAX CAL (**C**arbon steel/**Al**uminum).

Culture of Quality

The entire ACC design/manufacturing life cycle occurs under a stringent culture of quality assurance that has helped the Company become America's leading supplier of engineered equipment and systems to the world's power industry. Holtec's high caliber quality assurance program operates under approval from United States Nuclear Regulatory Commission (the Company maintains eight dockets) as well as ASME, ISO-9000, and various other national and international nuclear authorities. Holtec's corporate

quality culture permeates the entire organization; from the design center, to the shop floors, and to the job site. The commercial ISO-9000 program is implemented at the Dahej plant.

Parallel Condensing



As its name implies, parallel condensing refers to condensing the turbine exhaust steam in a water cooled (wet) condenser and ACC in parallel. Holtec's water cooled condenser expertise is well known: The Company has supplied over 120 water-cooled condensers over the past three decades to power plants around the world, garnering an enviable record of performance and reliability. Holtec's expertise in both dry and wet condensing technology has been leveraged to provide dual, parallel condensing solutions that optimize the use of the site's increasingly scarce cooling water supply. Holtec Technology Bulletin HTB-032 provides further details.