Overview

- Thermal Energy Storage (TES) Concept
- TES Tank Options
- Innovations In Tank Technology
- Example TES Projects
Energy Storage Concept

- Energy is stored during “off-peak” periods, then distributed during “peak” periods.

- Examples of energy storage systems:
  - Batteries in a mobile phone
  - The human body
  - Thermal Energy Storage (TES)
Thermal Energy Storage

- Commercialized over 30 years ago
- Thousands of installations throughout the GCC, world, and the U.S.
- Adaptable to almost any chilled water district cooling system
Predominantly Two Types of Commercial TES Systems

Ice Storage
- Energy stored in a solid or ice phase
- Relatively small footprint, ideal for small work areas

Chilled Water
- Energy in the chilled water liquid phase
- Economical in larger applications

BIG “rechargeable batteries”
Tank Building Experience

- 3,000+ tanks designed and built world-wide
- Prestressed concrete tanks
- 87 years of tank experience

- 34 years of TES tank experience
- 48 tanks in Middle East
- 40 crews building tanks throughout the world
Our Capabilities

- Circular concrete TES tanks
- Custom built up to 160,000 m³ (35 MIG) & beyond
- Heights up to 30m (98.5 feet)
- Design / Build capabilities
TES Tank Options

- Welded Steel
- Conventionally Reinforced Concrete
- Internal Post Tensioned Concrete
- External Prestressed Concrete
Welded Steel

- **Advantages:**
  - Low initial cost

- **Disadvantages:**
  - Maintenance costs
  - Corrosion
  - Out of service time
Conventionally Reinforced Concrete

• **Advantages:**
  - Concrete likes water
  - Availability of material
  - Widely used in the area

• **Disadvantages:**
  - Concrete in tension
  - Congestion of rebar
  - Liners and coatings
  - Rectangular shape
Internal Post Tensioned Concrete

- **Advantages:**
  - Concrete in compression

- **Disadvantages:**
  - Tendon ducts
  - Base joints
  - Liners
  - Repair is difficult
External Prestressed Concrete

- **Disadvantages:**
  - Potential for higher initial cost

- **Advantages:**
  - Lowest total cost of ownership
  - Complete compression
  - No maintenance
  - Speed of construction
Examples of TES Tanks

University Campuses

Los Angeles, CA - USC
Riverside, CA - UC
Orlando, FL - UCF

Government and Municipalities

Lackland AFB, TX
San Antonio, TX - Airport
Raleigh, NC

Private Industry, Power Plants, and Data Centers

Brooks, CA – CCC Resort
Santa Clara, CA – DFP
Escondido, CA – SDG&E
TES with Chilled Water District Cooling Systems
Chilled Water TES Concept

Tank
“Charging”
- Night mode

Tank
“Cooling the Building”
- Day mode
Stratified Chilled Water
Daily Operation of a TES Tank
Typical Performance of a Properly Functioning TES Tank

1 Hour into the Test

Thermocline

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Electric Load Profile

With TES:

- permanent electric load shift from peak periods to off-peak periods
- energy consumption reduction by taking advantage of cooler ambient conditions at nighttime when chillers run more efficiently
Financial Benefits

All TES systems provide owners with financial benefits – some examples:

- **Energy Cost Savings** – using electrons wisely
- **Cost Avoidance** – when expanding the campus
- **Insurance** – no downtime of critical processes
TES Tank Design – Typical Plan

- Octagonal diffuser piping
- Distribution piping
TES Tank Design – Typical Elevation

- Diffuser and distribution piping
- SS hangers and supports
- Flat roof
Upper Diffuser Piping

SS PIPE HANGERS

DIFFUSER PIPE

DISTRIBUTION PIPE
Diffuser Piping
AWWA D110 Type 1 PRESTRESSED CONCRETE TANKS

- Inner Concrete Core
- Horizontal Prestressing
- Vertical Post-Tensioning
- Flexible Floor-Wall Connection
Wall Construction
- AWWA D110 Type 1
Wall Detail
Cast-in-Place
Vertical Post Tensioning
- AWWA D110 Type 1
Continuous Electronic Monitoring
78 tons force – 36 mm

Electronic Recorder

Hydraulic Ram
Electronic Recording
Circumferential Prestressing
- AWWA D110 Type 1
  Machine Wrapped Strand
Water blasting

Water Blasting VIDEO
Automated Shotcrete

Automated Shotcreting VIDEO
Exterior Insulation & Finishing System (EIFS)
Blend in with the Campus
Industrial
Multi-Color
Partially Buried with Flat Roof / Multi-Use

2 Nos. X 19,000 m³ (4.2 MIG) Tanks
Fully Buried with Flat Roof / Green Space  4,500 m³ (1.0 MIG) Tank
Advantages: AWWA D110 Type 1

- Superior track record of performance
- Concrete in biaxial compression
- No maintenance – no cracks, no leaks
  - No internal coatings
  - No corrosion
  - No measurable leakage
- Quicker construction time
- Singular responsibility: design, diffuser & tank building

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