CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

2019 Title 24, Part 6 Codes & Standards Enhancement (CASE) Proposal

Hybrid Condensers for Refrigerated Warehouses and Commercial Refrigeration (Supermarkets)

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Proposed Code Change Overview

- Types of building impacted
  - Refrigerated warehouses
  - Supermarkets
- Building system impacted
  - Refrigeration
- Anticipated type of change
  - Mandatory
- Description of change
  - Add hybrid condensers (not currently mentioned in the code) in addition to existing requirements for air cooled and evaporative condensers

Proposed Code Change Overview (Cont'd)

- Definition of hybrid condensers
  - A refrigeration system component that condenses refrigerant vapor by rejecting heat to air mechanically circulated over its heat transfer surface, causing a temperature rise in the air, with the additional capability to utilize evaporative precooling of the entering air, for operation only during high ambient temperatures, and accomplished as part of a single factory-made unit.
- Proposed Code Change
  - Include mandatory variable speed fan control
  - Include variable set point control at least for dry mode operation
  - Include floating head pressure control requirements
  - Establish minimum specific efficiency (Btu/W-h) for dry mode
  - Establish maximum TD (size) for dry mode operation
  - Define SCT for glide refrigerants (?)

Proposed Code Change History

- Why are we proposing this measure?
  - Discussed for 2013 code but product information and adoption was limited at that time
  - Greatly increased market interest due to:
    - Large water savings compared with evaporative condensers
    - Large kW savings and potential kWh savings compared to air-cooled condensers
  - Reduce code enforcement conflicts and confusion
  - Establish a baseline against which high efficiency choices can be evaluated and incentives provided
  - Now at least three vendors vs. one vendor in 2010

Current Code Requirements

- Existing Title 24, Part 6 Requirements
  - No requirements for hybrid condensers (not mentioned in code)
- Existing Model Code Requirements
  - None
- Other regulatory considerations
  - None, water use?

Typical Practices

- Current practices
  - Refrigerated Warehouses
    - Historic use of only evaporative condensers for ammonia systems
    - Recent potential for air cooled ammonia systems (reference IIAR Technical Paper)
    - Recent development of low-charge packaged ammonia systems
  - Supermarkets
    - Balance of air-cooled and evaporative condensers throughout California with some use of hybrid condensers beginning with market entry approximately 5 years ago
- Do you agree with this description?
- What trends are you seeing in practice?

Market Overview and Analysis

- Initial products and studies
  - Potential for “best of both worlds”: balancing advantages of air-cooled and evaporative condensing
  - First cost premium: tendency to undersize condenser surface, less efficient than standard air cooled in dry mode
  - Benefits overstated, energy use may increase vs. code compliant air-cooled in a cool coastal climates, climate is important to savings
  - Increased need for water savings in California
  - Refrigerant charge also a factor on commercial (HFC) systems
    - Existing condensers have high charge
    - Hybrid condensers with microchannel have an extremely low charge
    - Hybrid condensers with mini-tubes have greatly reduced charge (although not as much as microchannel condensers)
    - CARB interest in low charge to reduce GHG emissions
  - Hybrid condensers “go with” CO_2 transcritical systems in CA climates

Market Overview and Analysis

- Market barriers
  - High first cost
  - Limited number of suppliers
  - Performance uncertainty
  - No incentives
- Other market information sources we should know about?

Incremental Cost Estimation

- How we plan to collect costs of base case technology and proposed technology
  - Hybrid condenser cost is available using vendor list prices and estimated multipliers and contractor mark-ups
  - Incremental cost is obtained by adjusting the condenser size, expressed as the applied TD (approach) temperature

- Are there components of costs that we left out?

Methodology for Savings Analysis

- Methodology for energy and demand Impacts
  - Use DOE2.2R with external processing
    - DOE2.2R is a component level mass flow based refrigeration simulation tool
  - Build on existing models for 2013 T24, Part 6 work
  - Prototype Buildings
    - 2 refrigerated warehouse sizes (ammonia and small halocarbon systems)
    - 1-2 supermarket sizes
  - Gather information from select operating hybrid condenser installations in California

Assumptions for Energy Impacts Analysis

- Key assumptions
  - Operating hours: 8760
  - Fraction of refrigerated warehouses and supermarket specifying and installing hybrid condensers: TBD
  - Energy savings fraction: TBD
  - Benefit of water savings: TBD
- Data sources
  - Previous T24 models and installations
  - Surveys and operating data
    - Discussion with California chains and contractors
    - Site visits and snapshots of key operating parameters and load balance
    - Data collection via remote access through existing network/EMS

Incremental Cost Savings

- Approach
  - Incremental cost savings are calculated based on TDV cost savings associated with energy savings over the entire period of analysis.
    - Determine the base case hybrid condenser sizing that results in nominal TDV equivalence with air-cooled condensing
    - Evaluate step-wise incremental larger hybrid condenser sizing, based on dry-mode TD, with other variables fixed
  - Present TDV cost multiplier ($/TDV kBTU)
  - In addition to incremental hybrid condenser analysis, compare TDV for proposed hybrid condenser requirements with minimum code compliant air-cooled and evaporative cooled

Cost Effectiveness Estimate Example

	Benefit (2020$)	Cost (2020$)
Total Per Unit Incremental Cost over Period of Analysis		$500
• **Incremental first cost (supplies, equipment, installation)**		• $600
• **Incremental maintenance cost (replacement equipment, regular maintenance) over period of analysis**		• ($100)
Per Unit TDV Cost Savings over Period of Analysis	$750	
TOTAL	$750	$500
Benefit/Cost Ratio	1.5	

Compliance and Enforcement- Market Actors

- Who would be involved in implementing this measure?
  - Owners
  - Condenser manufacturers and representatives
  - Refrigeration system engineers, designers and specifiers
  - Refrigeration system installation contractors
  - Building department staff
  - Energy efficiency program implementers

- Others?

Compliance and Enforcement- Tasks

Market Actor	Task(s)	Success Criteria
Refrigeration systems designers/specifiers	- Specify the products, and performance requirements (if any) - refrigeration system design drawings, specifications (and sometimes installation)	- Success is a design that cost-effectively meets the refrigeration needs of the client, and meets code reqts
Refrigeration systems installers	- Coordinate with designer to properly install equipment according to specifications	- Success is equipment that meets the specifications provided, installation meets the building refrigeration needs
Building department staff	- Review the permit submittal for code compliance, review installation - Building department staff seem to have little understanding, based on feedback from contractors	- Success is confirming equipment is compliant with Section 120.6 - Need to get things right the first time to avoid re-inspection
Energy efficiency program implementers	- Advise the design team on program reqts - SBD program staff have limited involvement in compliance of mandatory refrigeration measures	- Success is ensuring program submittal is correct

Strawman Code Change Language

- Title 24, Part 6 Standards: Refrigerated Warehouses 120.6(a)4 and Commercial Refrigeration 120.6(b)1 and 2.
  - Include mandatory variable speed fan control
  - Include variable set point control at least for dry mode operation
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