DRAFT

ASHRAE WORK STATEMENT

FROM

TC 10.5, Refrigerated Distribution and Storage Facilities

TITLE

Comparison of Refrigerated Warehouse Dock Dehumidification Techniques

STATE-OF-THE-ART (BACKGROUND)

Infiltration of moisture into a frozen food warehouse is costly to the operation of the facility. The infiltrated moisture deposits on the evaporator surfaces in the form of frost, decreasing the system efficiency. Periodically, the coils must be defrosted to remove the accumulated moisture. To reduce the frequency of this cycle, refrigerated warehouse loading docks are often conditioned to moderate the infiltration of moisture into the freezer. Due to air exchange driven by the temperature difference between the freezer and the dock, the freezer is typically protected from the dock with an infiltration-reducing device (i.e. strip curtain, rapid-action door, air curtain, door vestibule, etc.) and a heat source to prevent frost on freezer surfaces near the door.

Modern cold storage warehouse docks are typically operated in the range of 35°F to 45°F using mechanical refrigeration evaporators. Dock operation has a significant impact on total system energy use. The conditioning of the dock requires energy, but it lessens the energy required to condition the freezer. However, the dock operation that offers the lowest total system energy use is likely dependent on the refrigeration system that is meeting the loads, the presence of a supplemental dehumidifier, and the required heat addition at the freezer door to eliminate "snowing" in the freezer.

Under most ambient conditions, the conventional system is sufficient to prevent the infiltration of significant amounts of moisture into the freezer. In certain instances, particularly in high humidity locations, it may be necessary to supplement the mechanical refrigeration system with a desiccant dehumidifier or an aggressive system to prevent infiltration through the freezer door (i.e. door vestibule, reheat coils, etc.).

ADVANCEMENT TO THE STATE-OF-THE-ART (JUSTIFICATION)

There is debate in the industry regarding which technology is appropriate and under what conditions. It is also uncertain what the best operating conditions are to apply these technologies. Many variables come into play: ambient conditions, freezer temperature, dock construction, freezer- and load out-door effectiveness (infiltration), incoming product conditions and evaporator placement. A literature search by members of ASHRAE Technical Committee 10.5 has found very little evidence in support of the use of any one technology above the others.

It is proposed to determine the impact of dock conditions on the total system energy use for a range of dock conditioning and freezer door systems at several North American locations under varying ambient conditions and document the benefit/cost relationship for design of future applications in new or retrofit facilities. The impact of this research will impact both the design and operation of refrigerated storage facilities.

OBJECTIVE

The objective is to develop a set of recommendations for the optimal design and operation of dock conditioning and freezer door systems for refrigerated warehouse loading docks. The report shall examine variations in ambient conditions, freezer temperature, dock construction, freezer- and load out-door effectiveness, incoming product conditions and refrigeration system specifics. The refrigeration system specifics are necessary to determine the energy consumption of the alternatives. The bidder should include descriptions of the system to be modeled (e.g. one system may be two-stage compression with liquid overfeed evaporators and two stages of liquid expansion).

The report shall provide guidance in selection of technology for loading docks that minimizes energy consumption on the loading dock and in the freezer for design and off-design days at various locations throughout North America.

SCOPE

The final report shall include:

1. The results of a literature review, manufacturer contact and other research methods to determine the state-of-the-art in loading dock dehumidification and infiltration prevention techniques employed by mechanical refrigeration systems, desiccant dehumidification systems, freezer door vestibules, air curtains and other commercially available methods. Additionally, the engineering aspects of the problem, operational and product requirements must be understood in order to bound the research.
2. Results of the model(s) developed to study each dock dehumidification and infiltration prevention technique to determine energy consumption by the technology and the consequential effect on the freezer refrigeration system at varying dock and ambient temperatures and relative humidities.
3. Results of the developed model(s) that detail optimal operating conditions for each dock dehumidification and infiltration prevention technique/technology examined during the study.
4. A simplified methodology for comparing the advantages and disadvantages of each dock dehumidification and infiltration prevention in various regions of North America and a broad range of electric and gas cost that can be amended to the Refrigerated Warehouse Design Guide (ASHRAE 1214-RP) and Chapter 13 of the ASHRAE refrigeration handbook.

DELIVERABLES

a. Progress and Financial Reports shall be made to the Society through its Manager of Research at quarterly intervals; specifically on or before each January 1, April 1, June 1 and October 1 of the contract period.

b. The Principal Investigator shall report in person to TC 10.5 at the annual and winter meetings, and answer such questions regarding the research as may arise.

c. A final report shall be prepared and submitted to the Manager of Research by the end of the contract period covering complete details of all research carried out on the project. Unless otherwise specified, six draft copies of the final report shall be furnished for review by the Project Monitoring Subcommittee (PMS).

Following approval by the PMS and the full TC 10.5, final copies of the final report shall be furnished as follows:

- An Executive Summary suitable for wide distribution to the industry and to the public.
- Six bound copies.
- One unbound copy, printed on one side only, suitable for reproduction.
- Two copies on diskette(s); one in ASCII format and one in Microsoft Word.

d. One or more Technical Paper(s) shall be submitted in a form suitable for presentation at a Society meeting. The Paper(s) shall conform to the Society's "Submitting Manuscripts for ASHRAE Transactions" which may be obtained from the Special Publications Section.

e. All papers or articles submitted for inclusion in any ASHRAE publication shall be made through the Manager of Research and not to the publication's editor.

f. All documents shall be prepared in conformance with the ASHRAE Metric Policy using dual units; rational inch-pound with equivalent SI units shown parenthetically. SI usage shall be in accordance with IEEE/ASTM Standard SI-10.

g. A Technical Article suitable for publication in the *ASHRAE Journal* may be requested by the Society. This is considered a voluntary submission and not a deliverable.

LEVEL OF EFFORT

The level of effort is anticipated to be 10 man-months with the total project to be completed within 24 months after the initiation of work. A total cost of $75,000 is anticipated.

OTHER INFORMATION FOR BIDDERS

Each proposal shall include resumes of the Principal Author and primary support personnel, as well as a schedule for completion. Resumes should highlight similar work in modeling refrigeration systems and facilities.

All scope items must be included and addressed in the proposal. If any scope item is not included, the proposal will be considered non-responsive.

PROPOSAL EVALUATION CRITERIA

Research proposals from bidders on this project will be evaluated based on the following criteria:

1. Contractor's understanding of Work Statement as revealed in proposal. – 20%
    a. Logistical problems associated
    b. Technical problems associated
2. Quality of methodology proposed for conducting research. – 15%
    a. Organization of project
    b. Management plan

3. Contractor's capability in terms of facilities. – 20%
    a. Managerial support
    b. Data collection
    c. Technical expertise
4. Qualifications of personnel for this project. – 20%
    a. Project team 'well rounded' in terms of qualifications and experience in related work
    b. Project manager person directly responsible; experience and corporate position
    c. Team members' qualifications and experience
    d. Time commitment of Principal Investigator
5. Student involvement – 5%
    a. Extent of student participation on contractor's team
    b. Likelihood that involvement in project will encourage entry into HVAC&R industry
6. Probability of contractor's research plan meeting the objectives of the Work Statement. – 10%
    a. Detailed and logical work plan with major tasks and key milestones
    b. All technical and logistic factors considered
    c. Reasonableness of project schedule
7. Performance of contractor on prior ASHRAE projects or other energy projects. (No penalty for new contractors.) – 10%

Following this, the proposal score will be compared to the bid price to determine the value/cost ratio.

REFERENCES

No references were found.

AUTHORS

Daniel Dettmers, Todd Jekel – Industrial Refrigeration Consortium