Experience Incorporating Desiccant Dehumidification into an HVAC Course

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ABSTRACT

This paper reports on experiences in using a desiccant module in the air conditioning course at Mississippi State, on lessons learned, and on modifications incorporated for subsequent distribution of the module. Following a brief summary describing the main features of desiccant dehumidification, experiences using the desiccant module in the MSU air conditioning course are described and analyzed. Revisions that have been made to the curriculum module as a result of the experiences using it in class in its final form are presented. These include adding study/review questions, expanding the quantitative examples and exercises, and including reduced size copies of the figures suitable for student handouts. Other revisions are also described. Conclusions drawn from using the desiccant module in class included the need for extra care in pacing the material presentation in technical areas, the importance of properly presenting the motivation and context of desiccant dehumidification, and the possible beneficial use of student copies of the overheads. It is recommended that some type of 'hands-on' experience related to desiccant dehumidification be provided for the students.

INTRODUCTION

A previous paper (Stevens et.al.) described a desiccant dehumidification curriculum module that was developed at Mississippi State University and distributed to any interested engineering/technology curriculum. The desiccant module is intended to supply introductory-level information on desiccant dehumidification to an existing air conditioning or HVAC course. The material supplied is enough for two to seven lectures, depending on instructor preferences. The module is structured for maximum flexibility and includes full size figures that can be made into overheads. An extensive bibliography is included to provide a starting place for an instructor or students to find additional information. This paper reports on experiences in using the desiccant module in the air conditioning course at Mississippi State, on lessons learned, and on modifications incorporated for subsequent distribution of the module.

BACKGROUND

Traditional cold coil air conditioning systems remove moisture from air by cooling the air below its dewpoint and removing the liquid condensate. Desiccant dehumidification devices employ absorption or adsorption processes for the removal of water vapor. In solid desiccant systems the water vapor from the process air stream is adsorbed by a dry desiccant material. The moisture is released from the desiccant material as it is heated by a regeneration air stream. The desiccant material is normally recharged by a low cost heat source. The technology has been around for a long time, and has traditionally been applied in areas such as marine transport and

humidity-sensitive manufacturing processes. In recent years, it has been making increasing inroads into more mainstream HVAC applications including supermarkets and office buildings. Greater concern about indoor air quality, and revisions in ventilation air standards promise to add additional impetus to the growth of desiccant dehumidification. Benefits of incorporating desiccant dehumidification into HVAC designs can include higher levels of occupant comfort, reduced maintenance costs or improved product quality or appearance. Increased flexibility in energy management that comes from separating the latent and sensible cooling loads can lead to lower operating costs, as well.

Growing interest in more precise humidity control is apparent from the 1997 ASHRAE Handbook of Fundamentals. For the first time additional moisture data have been included in the design weather data of chapter 26. In addition to the traditional extreme dry bulb, mean coincident wet bulb specifications, new data include extreme dew point, mean coincident dry bulb and extreme wet bulb, mean coincident dry bulb specifications. In most cases, the highest enthalpy occurs with the extreme dew point specification.

Most traditional air conditioning textbooks have not yet begun to include sections which treat desiccant dehumidification. The curriculum module produced at Mississippi State was created to provide introductory material that could be easily adapted to fit into existing HVAC courses. The module grew out of a two week segment on desiccant dehumidification that was included in the MSU air conditioning course in the spring semester of 1996. The module was produced and disseminated in the fall of 1996 and used in its final form in the MSU air conditioning course in the spring of 1997. This paper reports on that experience, and on the changes that will be incorporated into the module for future distribution.

EXPERIENCE

As our class entered the desiccant dehumidification portion of the course (scheduled for six, 50 minute lectures), it was apparent that while the students were interested in the subject, there was a strong need to provide both motivation and context for the material. The desiccant section was scheduled near the end of the air conditioning course, and by that time the students had a very good feel for psychrometric processes and air conditioning systems. They had both the capacity and desire to understand how desiccant dehumidification fits within the larger picture of HVAC design. The desiccant module does a good job of providing material for this area. A full lecture was devoted to describing the strengths and limitations of desiccant systems, the motivations for including desiccant dehumidification in an air conditioning system, and qualitatively, how desiccant systems work in conjunction with other elements of an HVAC system. The material was well received, as well as well understood.

As we moved into more technical descriptions of how desiccant dehumidification systems function, student questions showed that it was necessary to slow down, and traverse the progression from basic through complex systems in a very deliberate way. In our case, we ended up going over some material twice, but this could probably have been avoided by slowing the original presentation down. The module itself seemed to contain adequate detail in this area, but with ready-made overheads of equipment configurations, and pre-drawn psychrometric charts illustrating processes, there is a tendency to speed up the presentation beyond the comfort level

of most students.

A related issue involved providing copies of overheads for student use. Some students found that taking complete notes from the overheads was burdensome and felt that it would be helpful to provide printed copies of the overheads. That way, additional notes could concentrate on the additions or clarifications that the instructor made on the overhead or chalkboard rather than trying to reproduce the original figure. In order to minimize paper costs, a reduced size (4 figures per page) set of overheads was distributed to students who requested them.

The bulk of the material in the curriculum module contains qualitative information. This is appropriate for the introductory level at which it is intended to function. However, it was found that for the purposes of classroom presentation and evaluation, there was a need for review questions on the qualitative material, and a greater range and depth of calculation-type examples. At the technical level of the module, the calculation examples are primarily psychrometric processes occurring around and through desiccant systems, but they still serve to familiarize the students with the desiccant dehumidification process and with typical system parameters and capacities.

Finally, it was felt that a 'hands-on' experience would be a valuable addition to the course. All students had seen air conditioning systems; some had even worked with HVAC consultants and contractors. None had seen a desiccant dehumidification system, and most were not even familiar with the idea prior to that section of our course. Thus, while a laboratory set-up might not be typically feasible, even a field trip to visit an installed and functioning system would be helpful and interesting to most students.

REVISIONS IN THE CURRICULUM MODULE

As a result of using the desiccant dehumidification curriculum module in its final form, several revisions were made to make the module more useful for a classroom environment. Some small changes for clarification were made in the text. The section of example problems has been expanded significantly. This includes a broader range of problem types as well as a greater number of problems. A section of review questions has been added. Student handouts of the overheads are included. The bibliography has been expanded and updated, and a page of Internet links has been included.

CONCLUSIONS AND RECOMMENDATIONS

Overall, our experience with using the desiccant dehumidification module in the Mississippi State air conditioning course was very good. We found that one consequence of the pre-made overheads was that care must be taken with the pace of presentation in order to avoid moving too fast. Attention to making clear the motivation for desiccant dehumidification, as well as the relationship to broader air conditioning issues is essential. Depending on instructor preference, student handouts of the overheads may be helpful. It is recommended that some arrangement for a 'hands-on' type of experience be provided for the students since none had previously seen a desiccant dehumidification system.

REFERENCES

J.W. Stevens, B.K. Hodge, and A. Jalalzadeh-Azar, 1997, "A Desiccant Instruction Module for HVAC Courses,"

1997 ASEE Annual Conference Proceedings, Session 2333-Energy Courses, Projects and Curricula I, June 15-18, 1997, Milwaukee, WI, also in *Proceedings 1997 ASEE Southeastern Section Meeting*, April 13-15, 1997, Marietta GA, pp. 123-130.

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