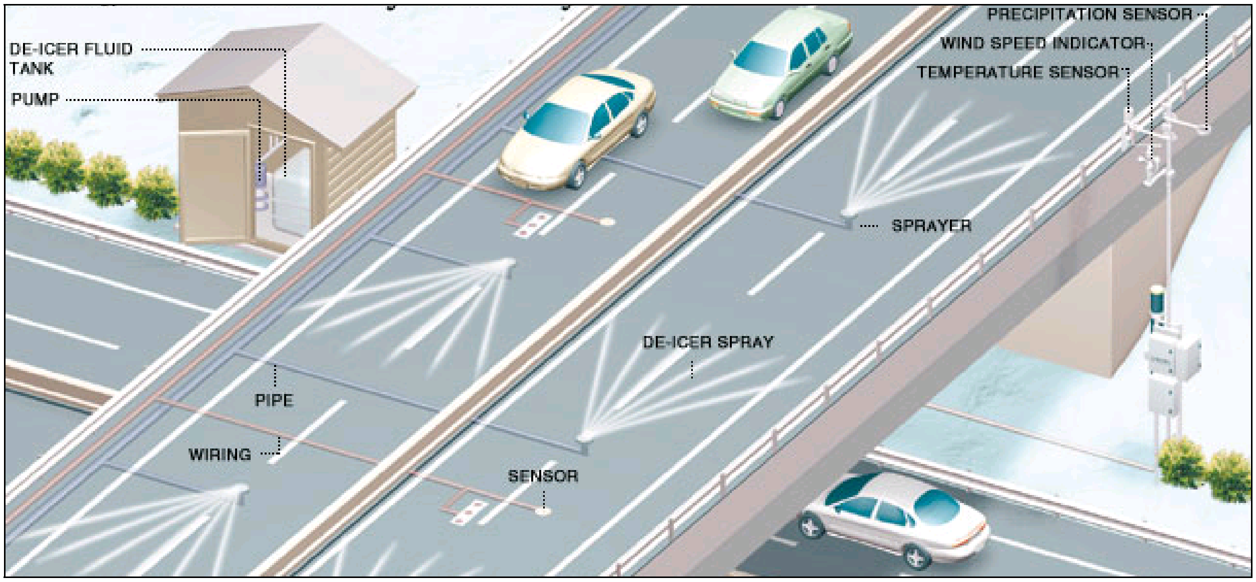
Minnesota DOT Anti-Icing/Deicing System

Several Minnesota Department of Transportation (DOT) districts have installed fixed maintenance systems on curved and super-elevated bridges that are prone to slippery pavement conditions. On Interstate 35 an automated anti-icing system was installed on a 1,950-foot (594-meter), eight-lane bridge near downtown Minneapolis. The bridge deck was susceptible to freezing due to moisture rising from the Mississippi River below. On average 25 winter crashes occurred on the bridge each year causing significant traffic congestion.

System Components: The automated anti-icing system is comprised of a small enclosure, storage tanks, a pump and delivery system, environmental sensors, four motorist warning signs with flashing beacons, and a control computer located in the district office. The enclosure houses the pump, a 3,100-gallon (11,734-liter) chemical storage tank, a 100-gallon (379-liter) water storage tank, and control mechanisms. Liquid potassium acetate is pumped through the delivery system to 38 valve bodies installed in the median barrier. The valves direct the anti-icing chemical to 76 spray nozzles. Sixty-eight nozzles are embedded in the bridge decks of both northbound and southbound lanes. These nozzles are installed in the center of travel lanes at a spacing of 55 feet (16.8 meters). Eight barrier-mounted nozzles are located at the north end of the bridge to spray approach and exit panels.



Minnesota DOT Bridge Anti-icing System Components

Two types of environmental sensors that are installed on the bridge. An Environmental Sensor Stations (ESS) is equipped with air and subsurface temperature sensors, pavement temperature and pavement condition sensors, as well as precipitation type and intensity sensors. The second sensor site includes only pavement temperature and condition sensors. These environmental sensors determine whether the pavement is wet or dry and whether the pavement temperature is low enough for surface moisture to freeze. System components are depicted in the figure.

System Operations: The control computer continuously polls the environmental sensors to gather data used to predict or detect the presence of black ice or snow. When predetermined threshold values are met, the computer automatically activates flashing beacons on bridge approach ramps to alert motorists, checks the chemical delivery system for leaks, and initiates one of 13 spray programs. Each program activates different valves, in various spray sequences, at different spray frequencies based upon prevailing environmental conditions. An average spray cycle dispenses 34 gallons (128.7 liters) of potassium acetate (i.e., 12 gallons or 45.4 liters per lane mile) over ten minutes. Conventional treatment strategies (e.g., plowing, sanding, and salting) supplement automated anti-icing when slush or snow accumulates on the bridge deck.

At the end of each winter season the anti-icing system is inspected and reconfigured to spray water instead of potassium acetate. Over the summer, the system is manually activated on a monthly basis to ensure proper operation of the pump and delivery. The system is re-inspected in the fall before being configured for anti-icing during winter operations.

Transportation Outcome: In the first year of operation the automated anti-icing treatment strategy significantly improved roadway safety through a 68-percent decline in winter crashes. Mobility enhancements resulted from reduced traffic congestion associated with such crashes. Installing the bridge anti-icing system also improved productivity by lowering material costs and enhancing winter maintenance operations throughout the district.

Implementation Issues: The Minnesota DOT conducted a feasibility analysis to assess potential benefits and to estimate the costs of deploying an automated anti-icing system on the Interstate 35W bridge. The DOT then contracted with a private vendor to design and install the proprietary hardware and software components, as well as to provide system documentation, training, and support. System installation was completed in December 1999 and calibration and testing was conducted during the 1999/2000 winter season.

Minor hardware and software issues precluded automatic operation until the winter of 2000. Barrier-mounted nozzles were frequently blocked by plowed snow and other nozzles were clogged by sand. Negligible leaking was discovered around some valves. A filter failure in the pump enclosure caused a chemical spill, which reacted with galvanized metals and seeped through the building foundation. The ESS malfunctioned and had to be replaced. Potassium acetate was purchased and delivered in 4,400-gallon quantities necessitating the purchase of an additional chemical storage tank. Software issues included difficulty accessing data and modifying operational parameters. As part of system support, the vendor diagnosed and remedied these problems.

In order to evaluate the anti-icing system, the DOT analyzed weather conditions to identify prior winters that were comparable to the 2000/2001 season. The system evaluation included an analysis of environmental detection capabilities, delivery system pressures, spray characteristics, software alarms, and effects on traffic flow. The evaluation found that the system was activated 501 times, dispensing over 17,000 gallons (64,000 liters) of potassium acetate during winter 2000/2001.

Contact(s):

- Cory Johnson, Minnesota DOT, Office of Metro Maintenance Operations, 651-582-1431, cory.johnson@dot.state.mn.us.

Reference(s):

- Johnson, C., "I-35W & Mississippi River Bridge Anti-Icing Project: Operational Evaluation Report," Minnesota DOT Office of Metro Maintenance Operations, Report No. 2001-22, July 2001, http://www.dot.state.mn.us/metro/maintenance/Anti-icing%20evaluation.pdf.
- Selingo, J., "Black Ice, Wise Bridge: Repelling the Foe Before It Forms" The New York Times, Late Edition, Section G, Page 7, Column 1, December 13, 2001, www.nytimes.com/2001/12/13/technology/circuits/13HOWW.html.
- "High-Tech Bridge Set to Improve Lifestyle, Support Sustainability," Northern Intercity News, Volume 11, No. 2, December 2000, http://www.city.sapporo.jp/somu/nic/nic11-2/11p.htm.
- Keranen, P. F., "Automated Bridge Deicers in Minnesota," presented at the 5th International Symposium on Snow and Ice Control Technology, September 2000.

Keywords: ice, snow, winter storm, pavement condition, pavement temperature, anti-icing/deicing system, freeway management, traveler information, advisory strategy, winter maintenance, treatment strategy, chemicals, bridge, environmental sensor station (ESS), crashes, safety, mobility, productivity