

### **322d Modeling Freeze Start of Fuel Cell Stacks**

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Freeze start is a key requirement for fuel cell stacks that operate in locations with potentially cold climate. Recent achievements in the design of fuel cell stacks and operating strategies made possible very fast freeze starts with little or no performance loss. To speed up the development of the optimum freeze start strategy for a fuel cell stack, a freeze start model is developed that includes critical effects of ice and water management during startup as well as the temperature effects on the critical performance parameters. The fuel cell stack performance during freeze start is found to be in reasonable agreement with the model results.