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Four steps to heaven

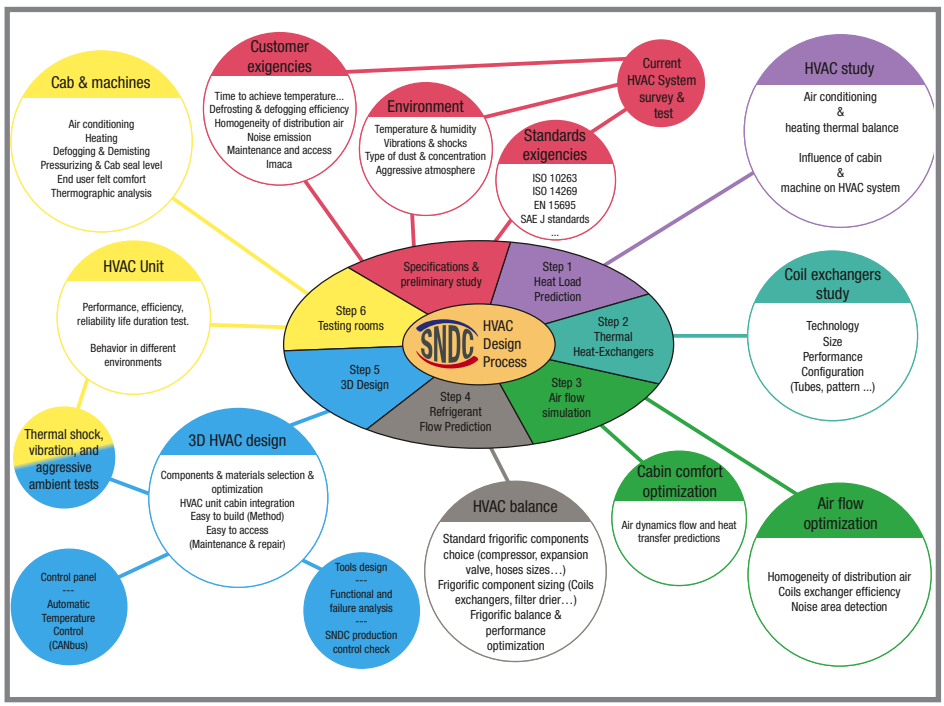
TAKING THE OPERATOR FROM THE HELL OF EXTREME TEMPERATURES TO DIVINE COMFORT REQUIRES THE USE OF A HANDFUL OF CUTTING-EDGE SIMULATION TOOLS, AS PART TWO OF OUR GUIDE TO DESIGNING THE OPTIMUM CUSTOM-BUILT HVAC SYSTEM EXPLAINS

As highlighted in the June 2014 issue (p72), it is very important to gather knowledge of the application and the most severe circumstances in which an off-highway HVAC system will operate. When operating in the Middle East, USA or the south of Europe in particular, the system will be challenged!

In order to ensure it is designing the right system, SNDC's engineering team therefore invariably goes through four steps, beginning with the heat load prediction (HLP) program. In order to maintain the comfort condition inside the cab, an HVAC system's cooling and heating capacity unit – including air intake (filter system) and air distribution (cab dashboard and ducts) – has to deliver, despite being challenged by a constant heat load from the outside.

Data from the 3D cab (windows and walls) and the material used (insulation and glass coefficient) is then entered in the HLP program. The extreme conditions of use, including temperature, windspeed and humidity will, together with the desired comfort temperature inside the cab, lead to a calculation of: the heat entering the cab in summer or leaving it in winter, via conduction and convection; the fresh air intake; sun and machine radiation (from the engine compartment and hydraulic system) etc; and human body heat and the resulting humidity generation.

The values obtained under those conditions will be the minimum HVAC system expected performance. Note, however, that when converted to the IMACA standard (used to compare units tested under the same conditions), the air in +35°C/50% RH for air-con or -20°C for heater will provide a higher kW result than calculated with cab equilibration at 25°C or lower.



Steps 2 and 3

With the required performance now specified, the coils (evaporator, heater and condenser) can then be designed. On the basis of the available HVAC unit envelope, the thermal heat exchanger (THE) software determines the dimensions and characteristics of all coils, although it primarily takes into account the flow conditions of the air crossing the coil, using data provided by the HLP results.

The sheer variety of possible coil patterns, tube sizes, circuits, configurations and fin spacing requires a special emphasis to be placed on design. For an evaporator, the main conditions to consider include:

- The air velocity through the evaporator, which could potentially lead to spitting water droplets;
- The fin spacing that is required to obtain optimum condenser water drainage;
- The air pressure drop that can restrict the final airflow of the unit.

The third step involves the use of airflow simulation (AFS) software, which provides a good picture of HVAC acoustics and performance in terms of driver comfort, including in-cab air distribution, temperature balance, and windscreen defrosting and defogging.

The AFS permits full analysis of the airflow loop using a 3D design file. The tool ensures that each air loop component, such as coil heater, coil evaporator, casing, air flaps, air deflectors, ducts and louvers are properly sized and provide acceptable pressure drop.

Step 4

Of course, knowing the required performance (Step 1), developing high-quality exchangers (Step 2) and ensuring the air distribution quality (Step 3) are all necessary steps – but it should not be forgotten that the refrigerant loop plays one of the most important roles in an HVAC system.

The refrigerant flow prediction (RFP) software used by SNDC takes into account each component of the loop, and checks that:

- The minimum performance requirements (HLP) will be provided and frigorific balance will be maintained across all the conditions;
- Evaporator performance is relative to the speed compressor and its discharge pressure and suction;
- Compressor capacity will increase lifetime.

Clearly, then, SNDC's 28 years of experience in HVAC systems for OEM markets is invaluable. These two articles have been designed to educate readers on the complexity of HVAC, because building an HVAC system is rather like being a one-man band: knowing the music is not enough – you must also know how to play several instruments. This is the price of driver cab comfort! **iVT**

Jean Marc Guittard, president, founded SNDC in 1986