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BTO 3.1.2.55 Milestone Report - Shortlist of potential sensors to be used to detect refrigerant maldistribution in HXs

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Energy and Transportation Science Division

BTO 3.1.2.55 MILESTONE REPORT - SHORTLIST OF POTENTIAL SENSORS TO BE USED TO DETECT REFRIGERANT MALDISTRIBUTION IN HXS

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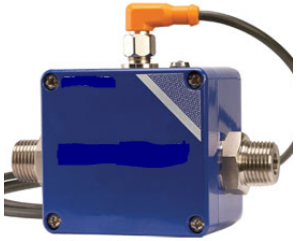
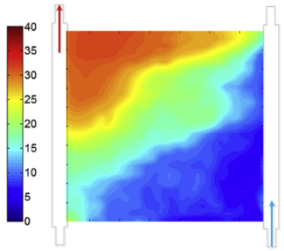
SHORTLIST OF SENSORS USED FOR DETECTION OF REFRIGERANT MALDISTRIBUTION

Table 1 lists the sensors that will be considered for this project to detect refrigerant maldistribution. Along with the measurement method, the table also shows the unique advantages and disadvantages that each sensor has which are relevant to the planned benchtop experimental setup that will be fabricated to study refrigerant maldistribution. The actual setup will likely be fabricated with a combination of the sensors listed.

Table 1. List of sensors used to detect maldistribution

Measurement type	Sensor type	Function	Advantages	Disadvantages
Flow	Ultrasonic flow sensor (external) 	Measurement of flow rate in parallel refrigerant lines in HX	• Commercially available as a component • Inexpensive • Non-intrusive – can be installed directly onto microchannel surface	• Untested - experimental at this stage • Relationship between output signal and actual physical flow is currently being determined • Measurement of two-phase flow unknown
Flow	Ultrasonic flow sensor (in-line) 	Measurement of flow rate in parallel refrigerant lines in HX	• Commercially-available • In-line meters do not obstruct flow	• Costly • Intrusive, cannot easily transition flow channel from microchannel to circular flow meter • Measurement of two-phase flow unknown
Flow	Magnetic flow sensor (in-line) 	Measurement of flow rate in parallel refrigerant lines in HX	• Commercially-available • In-line meters do not obstruct flow • Good accuracy (± 0.3% of range)	• Costly • Intrusive, cannot easily transition flow channel from microchannel to circular flow meter • Measurement of two-phase flow unknown

Pressure	Pressure transducer 	Measurement of pressure drop in parallel refrigerant lines in HX	• Simple operation and measurement • Single- and two-phase pressure drop can be measured	• Flow conditions are unknown • Two-phase flow measurement tends to be inaccurate due to instabilities
Temperature	Thermocouple/RTD 	Measurement of refrigerant superheat at outlet of parallel refrigerant lines in HX	• Inexpensive • High accuracy • Very simple operation and measurement • Widely used in literature as indicator of maldistribution	• Only gives information about temperature • Flow conditions are unknown
Temperature	Infrared thermography 	Measurement of overall external HX temperature distribution to quantify flow distribution	• Non-intrusive • Gives overall picture of temperature distribution in HX • Allows hotspot locations to be found • When added to other measurements and HX model, flow distribution may be found	• Experimental at this stage – accuracy and repeatability not well established • IR-measured temperature distribution alone is insufficient to indicate maldistribution – must be combined with additional measurement • Only works for specific conditions e.g. uniform air flow