# FLOWCHILLER SINGLE & DOUBLE – DEVELOPMENT OF A PELTIER-ASSISTED COOLING DEVICE FOR BATCH AND **CONTINUOUS FLOW CHEMISTRY**

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4. FlowChiller Double Prototype Performance

The main goal of the FlowChiller project was the development of a compact, easyto-use cooling device for continuous chemical flow-reactors capable of reaching temperatures down to -50°C within a short period of time. Different, state-of-theart technologies were evaluated. Compressor cooling was dismissed due to the substantial noise level and the space requirements while liquid nitrogen cooling (LN<sub>2</sub>) did not fulfill the requirement of 24/7 operation without user interference. As a consequence, Peltier technology was chosen as the most beneficial technology – in terms of simplicity, regulation properties, price and continuous operation.

### 2. Simulation and Prototype Design

Before going into massive prototype manufacturing, a Peltier model was used to simulate the lowest possible temperature to achieve using a single and a double stage Peltier design. To account for realistic values, thermal losses through metal bridges (screws) were considered, as well as a permanent heat transfer of 50W to account for insulation losses. Concluding all those parameters, the following minimum temperatures were predicted:

	Single-stage design	Double-stage design
Simulated T <sub>min</sub>	-34°C	-57°C

Continuing with the knowledge and the success of the single stage unit, the double stage prototype was manufactured. Here, even more attention was paid to the accurate choice of combined Peltier elements. To precisely tune and monitor all the system parameters (such as currents, voltages, temperatures, flow rates, etc.), a LabView<sup>®</sup> interface was programmed, which allowed for a rapid performance evaluation and optimization. Finally, also the double stage unit was realized as a compact module (220 x 140 x 75mm), being capable of cooling down to -53°C.



FlowChiller Double final prototype (with sensor cables, Peltier power cables and cooling water tubing)

1. Project Aim



Starting from those promising simulation results, CAD models for both, the single and the double stage unit were designed and the first prototypes were manufactured in-house using high precision CNC milling, being easily scaled up to small series preproduction scale.

Furthermore, step-wise parameter

tuning was precisely carried out

to achieve cooling performance

close to the simulated values.

CAD model of the FlowChiller Single cooling block

#### 3. FlowChiller Single Prototype Performance

After tedious optimization of the Peltier element type, watercooler design, thermal grease, mounting options as well as inner and outer insulation, we were able to reach temperatues as low as -34°C. With this value, we were on par with the simulations carried out before. Furthermore, the compactness of the design was proved by a unit measuring only 140 x 140 x 60mm. As external components, only the power supply with control electronics and a cooling water circulation was necessary.

#### 5. CapDisc – Capillary Disc Reactor

As an additional feature, a series of capillary reactors ("CapDiscs") was developed, ranging from 125µL to 2000µL reactor volume. The reactors feature the same 100 x 100mm dimensions as the FlowChiller cold plates, enabling seamless integration of the cooling devices into a state-of-the-art flow-chemical reactor setup. Additionally, replacement of the capillary tubing can be done by end-users keeping the devices and the budgets going.



CapDisc Capillary Reactor (reaction capillary not shown)



FlowChiller Single final prototype (with sensor cables, Peltier power cables and cooling water tubing)

#### 6. Conclusions & Acknowledgements

	Single-stage design	Double-stage design
Achieved T <sub>min</sub>	-34°C	-53°C

Concluding the FlowChiller research, we were able to transfer our in-depth simulations into highly integrated, superbly performing prototypes ready for implementation into commercial devices. We kindly thank the technology transfer department of Vienna University of Technology for support during the patent filing period and for financial contribution in form of the "FlowChiller Microgrant" program. Austrian patent A1007/2011 is announced for assignation and PCT patent application was filed under PCT/AT2012/050093.