

# Content

<b>Acknowledgements .....</b>	<b>v</b>
<b>Abstract .....</b>	<b>vii</b>
<b>Resumen.....</b>	<b>ix</b>
<b>Resum.....</b>	<b>xi</b>
<b>List of figures.....</b>	<b>xvii</b>
<b>List of tables .....</b>	<b>xxiii</b>
<b>Nomenclature .....</b>	<b>xxvii</b>
<b>1. Introduction.....</b>	<b>1</b>
1.1 Motivations.....	1
1.2 Working principles of a household refrigerator .....	3
1.2.1 Refrigerant loop.....	3
1.2.2 Air loop.....	5
1.3 CT-LSHX in household refrigerator system .....	8
1.3.1 Definition.....	8
1.3.2 Types of CT-LSHX .....	10
1.3.3 Refrigerant flow through the capillary tube .....	11
1.3.4 Parameters influencing the mass flow rate.....	13
1.3.5 Problems and consequences of using CT-LSHX .....	25
1.3.6 Recondensation and reverse heat transfer .....	25
1.3.7 Flow hysteresis .....	28
1.3.8 Noise.....	29
1.4 The importance of subcooled conditions.....	30

1.5	What are the actual conditions at the capillary tube inlet?.....	32
1.6	Objectives and structure of the work.....	34
<b>2.</b>	<b>Visualisation of the refrigerant flow at the capillary tube inlet of a household refrigerator.....</b>	<b>35</b>
2.1	Objectives.....	35
2.2	Experimental set up.....	35
2.2.1	Original apparatus .....	35
2.2.2	Modifications of the original apparatus.....	41
2.3	Experimental Campaign.....	51
2.3.1	Overall procedure .....	51
2.3.2	Refrigerant charge procedure .....	51
2.3.3	Find the optimal charge of refrigerant.....	51
2.3.4	Results and discussion.....	55
2.4	Conclusions .....	64
<b>3.</b>	<b>Experimental assessment of vapour quality at the condenser outlet of a household refrigeration system.....</b>	<b>65</b>
3.1	Objective .....	65
3.2	Experimental set up.....	66
3.2.1	General overview of the tests bench.....	66
3.2.2	Instrumentation.....	67
3.3	Experimental campaigns .....	78
3.3.1	Procedure.....	78
3.3.2	PID set point.....	79
3.3.3	Reference conditions with air condenser.....	80
3.3.4	Tests repeatability .....	83

3.3.5	Reproduction of optimal charge air condenser test without heater in the FZ.....	90
3.3.6	Reproduce test conditions with refrigerant-to-water HX .....	92
3.4	Analysis of the results and discussion .....	93
3.4.1	Visualisations .....	93
3.4.2	Determination of capillary tube inlet conditions .....	94
3.4.3	Possible explanation of vapour at the capillary tube inlet ..	102
3.5	Conclusions .....	103
<b>4.</b>	<b>How to get full liquid conditions at the capillary tube inlet? .....</b>	<b>105</b>
4.1	Objectives.....	105
4.2	Modification of the test bench.....	105
4.2.1	Temperature regulation .....	107
4.2.2	Temperature at the filter inlet .....	108
4.3	Experimental campaign.....	111
4.3.1	Tests conditions.....	111
4.3.2	Flow visualisation varying compressor speed .....	112
4.3.3	Results and discussion.....	116
4.4	Conclusions .....	128
<b>5.</b>	<b>Performance comparison between liquid and vapour conditions at the capillary tube inlet .....</b>	<b>131</b>
5.1	Objectives.....	131
5.2	Experimental campaign.....	132
5.2.1	Procedure.....	132
5.2.2	Determination of optimal charges with 0.55 and 0.6 mm capillary tubes.....	132
5.3	Conclusions .....	138

<b>6. Conclusions and future works .....</b>	<b>139</b>
6.1 Conclusions .....	139
6.1.1 On the actual conditions at the capillary tube inlet .....	139
6.1.2 On the design improvement to ensure liquid conditions at the capillary tube inlet .....	140
6.2 Future works.....	142
<b>References.....</b>	<b>143</b>
<b>Publications .....</b>	<b>147</b>