



DLR

Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

ENSIAME

JENNY Charline

Confidential

**Determination of the liquidus of the system
 Ca^{2+} , K^+ , Li^+ , Na^+ // NO_2^- , NO_3^-
by means of differential scanning calorimetry and
melting point devices.**

Academic tutor: M. Daniel COUTELLIER, ENSIAME

Industrial tutor: Dr. Thomas BAUER, Institute of Technical Thermodynamics, DLR

German Aerospace Center, DLR, Stuttgart, Deutschland.
(Deutsches Zentrum für Luft und Raumfahrt e.V. in der Helmholtz-Gemeinschaft)

Period: 05.09.2011 to 20.01.2011

Table of contents

Acknowledgements	1
Table of contents	2
List of images	4
List of tables	5
I. German Aerospace Center, DLR	6
DLR at a glance	6
DLR site Stuttgart	6
Institute of Technical Thermodynamics.....	8
Thermal process technology	8
II. Theory of inorganic salt as heat carrier	9
1. <i>Heat carrier in solar power plant</i>	9
2. <i>Salts as heat carriers</i>	11
3. <i>Theory of molten salts</i>	12
3.a. Latent heat.....	12
3.b. Supercooling	12
3.c. Phase diagrams overview	13
Binary System.....	14
Ternary additive system.....	15
Ternary reciprocal system.....	17
Ternary reciprocal system.....	18
Quaternary additive system.....	19
Quaternary reciprocal system.....	20
Quinary reciprocal system	21
4. <i>Project and aims</i>	22
III. Analyses of molten salts	23
1. <i>Object of study</i>	23
2. <i>Representation of a quinary system</i>	24
Ratio nitrite/nitrate fixed	24
Without lithium	26
3. <i>Methodology</i>	27
3.a. Product characteristic and purity.....	27
3.b. Preparation	27
3.c. Measurement and results interpretation.....	29
Differential Scanning Calorimetry (DSC)	29
Automated Melting Point System (MPS)	32
4. <i>Data evaluation</i>	34
Matlab “ <i>Edit and plot</i> ” program	34
IV. Results and conclusions	36
1. <i>State of the art</i>	36
2. <i>Known diagrams</i>	37
3. <i>Study of the 3D-tetrahedron diagram Ca, K, Li, Na // NO₂, NO₃ 65/35</i>	39
Slices of the tetrahedron	39
Study of the four 3D-tetrahedrons	40

4. Adaptation and improvement of the "Edit and plot" program on Matlab.....	42
5. Ideas to develop	44
V. Conclusion.....	44
Bibliography	45
Appendix.....	47
Salt characteristics	47
List of samples.....	62
Tetrahedron pattern of P3	64