UN/SCETDG/19/INF.15

Sub-Committee of Experts on the Transport of Dangerous Goods
(Nineteenth session,
2-6 July 2001, agenda item 8 (d))

Transmitted by the International Council of Chemical Associations (ICCA)

Study Report

WD-SI VA 1
Laboratorien für sicherheitstechnische
Kenndaten und Messungen
51368 Leverkusen, Geb. B 407 ☎ 62666/27970 Fax: 56713

DAC-P-0028-97-00

Dr. D. Heitkamp

Report No.: 98/10547
Leverkusen, 2001-06-20

Thermal Properties of Azodicarbonamide Formulations

Distribution:

Contens:

Cover leaf
Safety Assessment
3 Diagrams

Safety Assessment

Dr. D. Heitkamp

1. Assessment Task

A wide range of azodicarbonamide (AC) formulations were to be tested with respect to their thermal properties. The influence of their ingredients on the decomposition behavior was to be studied, and a correlation between the azodicarbonamide content and the decomposition energy was to be found.

2. Assessment

This is a short version (summary) of the study report for public purposes (presentation to the UN). All confidential information is disclosed.

The 22 formulations investigated cover a wide range of AC concentrations, activators and inert material (inorganic, organic, polymer). The overall decomposition energy was obtained from DSC measurements using the same machine (see below) and plotted against the known AC content. Activated and non-activated AC formulations were first treated separately.

A linear regression was performed on each group with the y intercept set to zero. The upper and lower confidence limits (95 % probability) were calculated and added to the plot.

The data obtained are as follows:

Correlation: (Decomposition energy) [J/g] = slope * (AC content) [%]

	Pure AC formulations	Activated AC formulations	All AC formulations
Observations	10	12	22
Multiple correlation coeff (R)	0,982	0,987	0,985
R^2	0,965	0,974	0,971
Intercept (set)	0	0	0
Slope	11,8	12,0	11,9
Standard error (regression)	52,8	58,4	54,9
Analysis of variation (ANOVA)			
Sums of squares (regression)	684012	1413343	2099992
Sum of squares (residue)	25072	37507	63315
Aver. sum of quares (residue)	2786	3410	3015
Standard error (slope)	0,38	0,35	0,25
Lower 95 % (slope)	10,9	11,3	11,4
Upper 95 % (slope)	12,6	12,8	12,5

Since no significant differences between the 2 groups could be detected, they were united and a third regression calculation was performed. The results are given in the table. The corresponding plot is shown in diagram 3.

The regression line may be calculated from the formula

(Decomp. energy) [J/g] = 11,9 * AC content [%].

Upper (UCL) and lower (LCL) confidence limits are obtained from the following equation

UCL = (Decomp. energy) + 2,08 * (cl)^{0,5}

LCL = (Decomp. energy) - 2,08 * (cl)^{0,5} , with

(cl) = 3015 * (1/21 + ((AC content) – 37,773)^2 / 16508,2)

From these data one may calculate that for AC formulations containing less than 40 % AC, the decomposition energy will not exceed 500 J/g. According to the UN Manual of Tests and Criteria, Appendix 6, paragraph 3.3, for such formulations the acceptance procedure for Class 1 explosives need not be applied.

3. Notes

All measurements were performed in Bayer's Process and Plant Safety Lab using a DSC instrument of Bayer's own design that had previously been carefully calibrated.

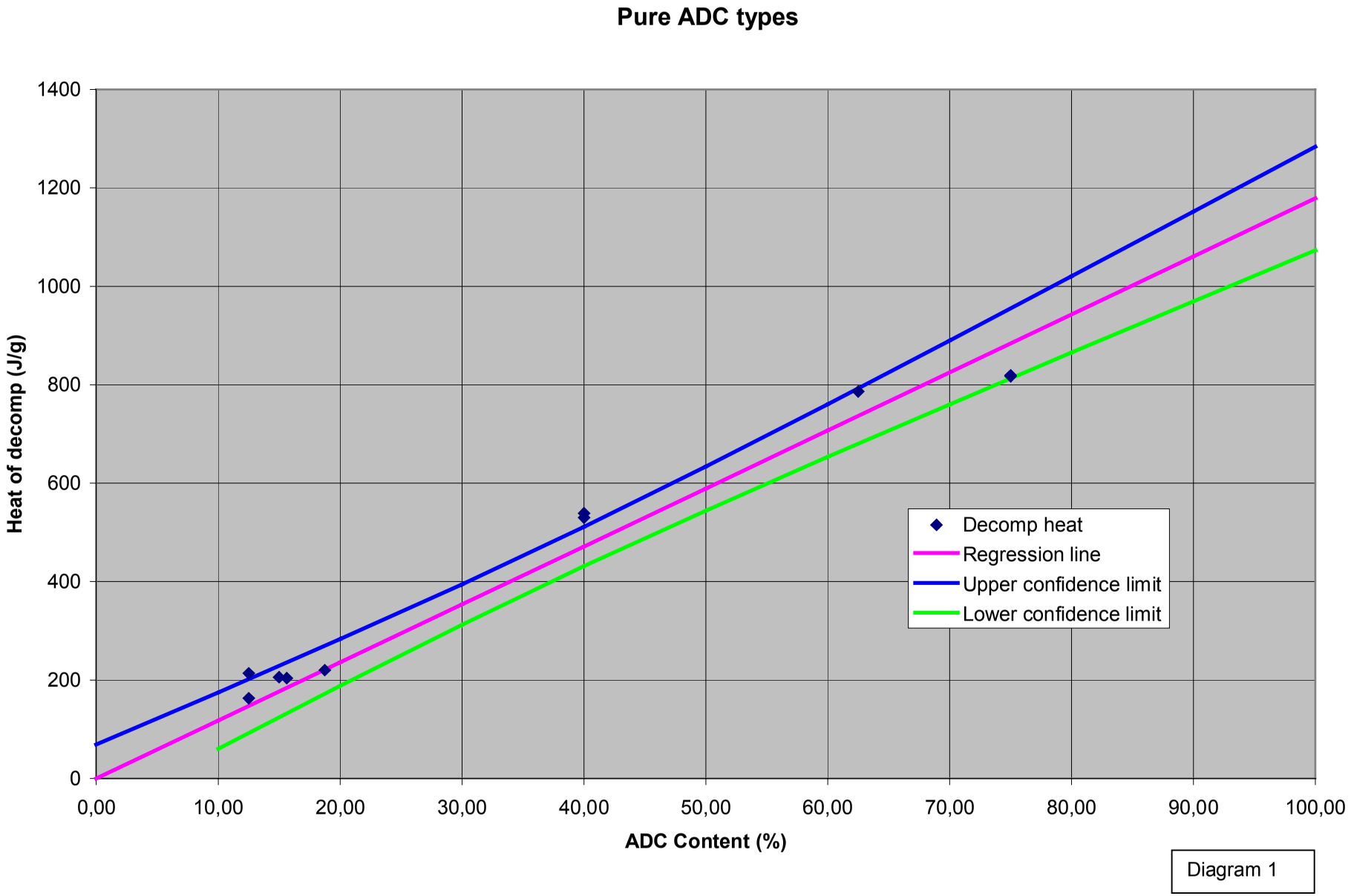
Pure ADC types
Heat of decomp (J/g)
1400
1200
1000
800
600
400
200
0
0,00
10,00
20,00
30,00
40,00
50,00
60,00
70,00
80,00
90,00
100,00
ADC Content (%)
Decomp heat
Regression line
Upper confidence limit
Lower confidence limit

Diagram 1

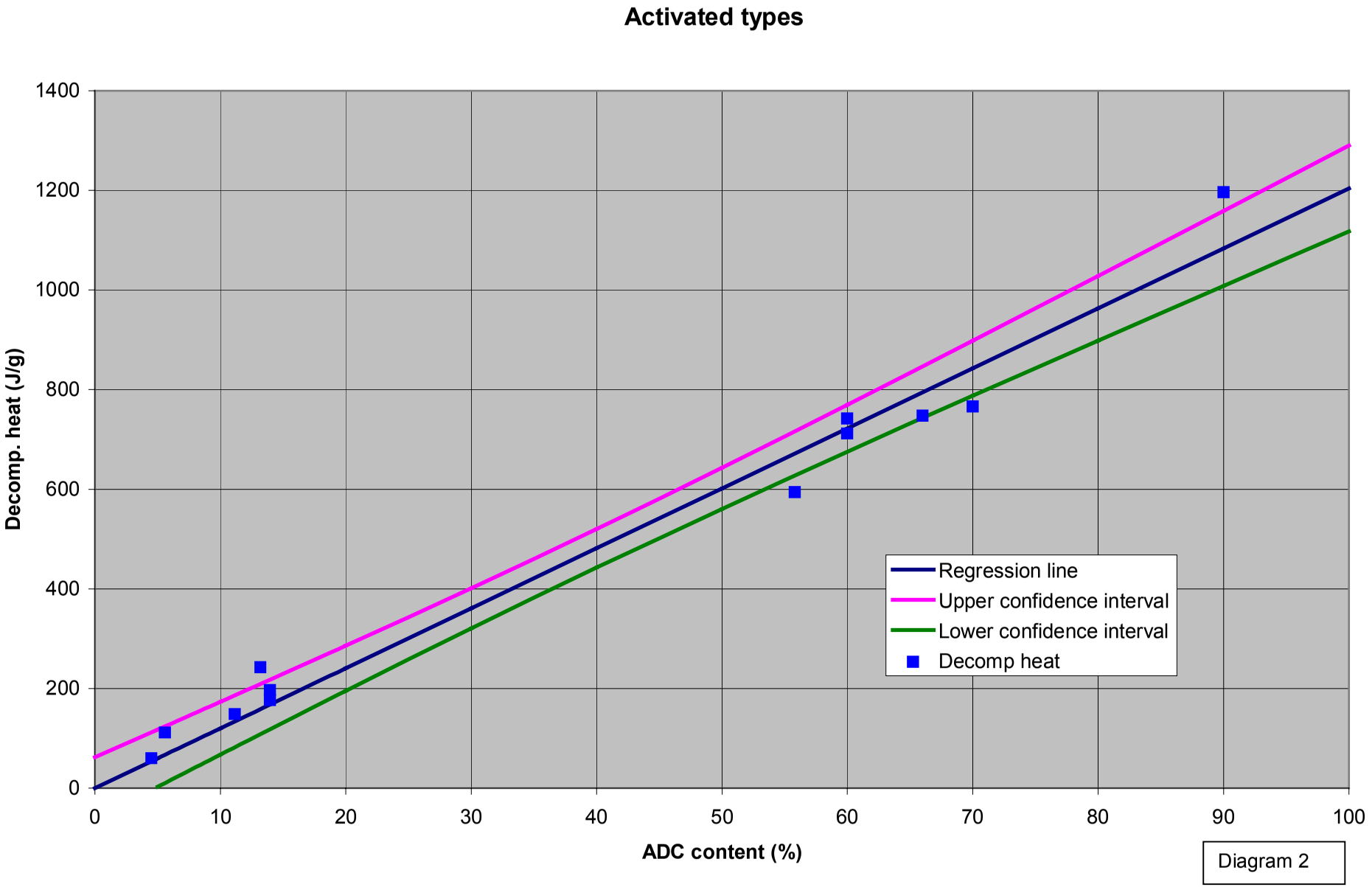
Activated types
Decomp. heat (J/g)
ADC content (%)
0
200
400
600
800
1000
1200
1400
0
10
20
30
40
50
60
70
80
90
100
Regression line
Upper confidence interval
Lower confidence interval
Decomp heat

Diagram 2

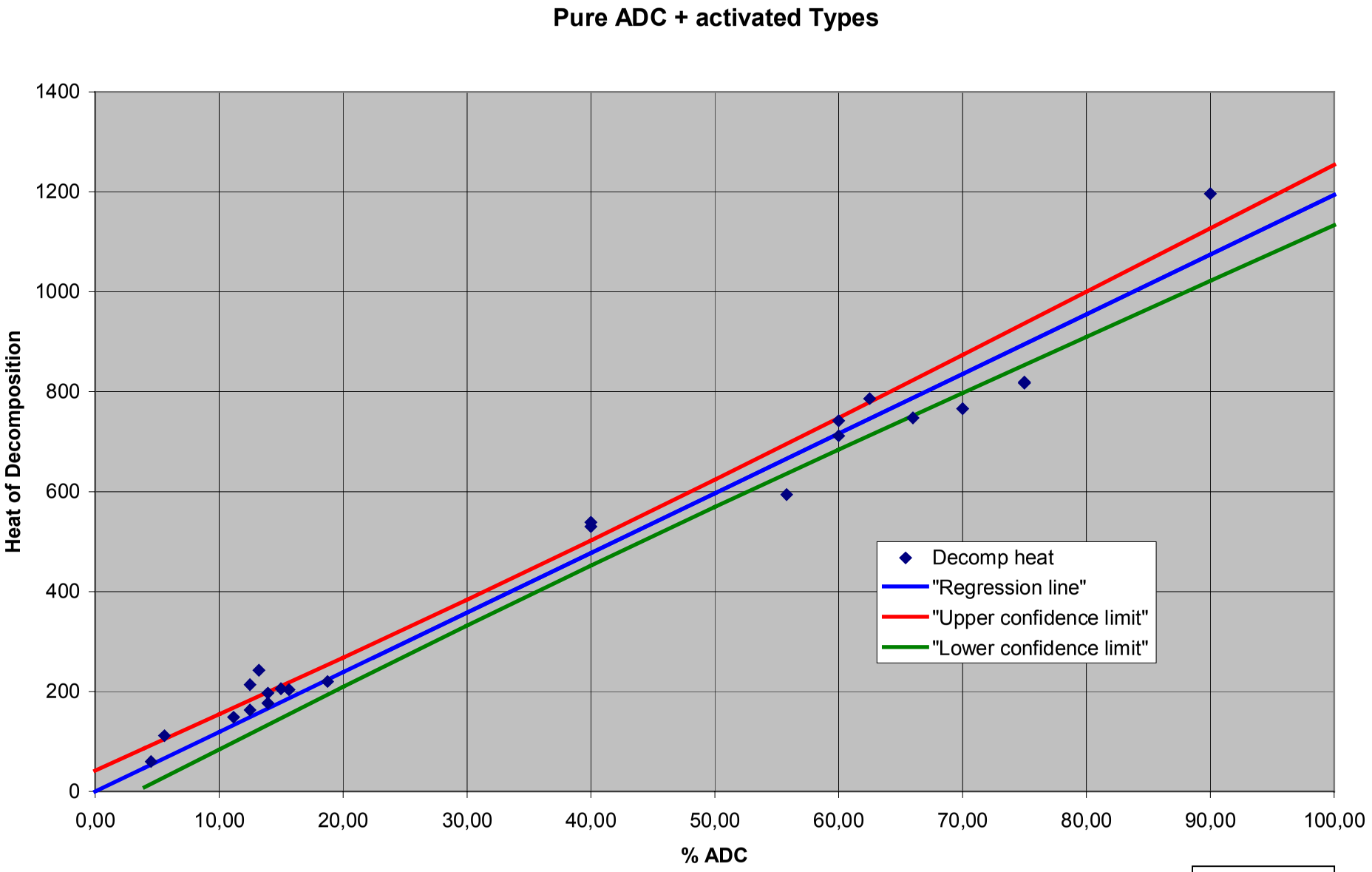
Pure ADC + activated Types
Heat of Decomposition
% ADC
1400
1200
1000
800
600
400
200
0
0,00
10,00
20,00
30,00
40,00
50,00
60,00
70,00
80,00
90,00
100,00
Decomp heat
"Regression line"
"Upper confidence limit"
"Lower confidence limit"

Diagram 3