PROJECT 2
REGRESSION ANALYSIS

<u>GROUP MEMBER</u>

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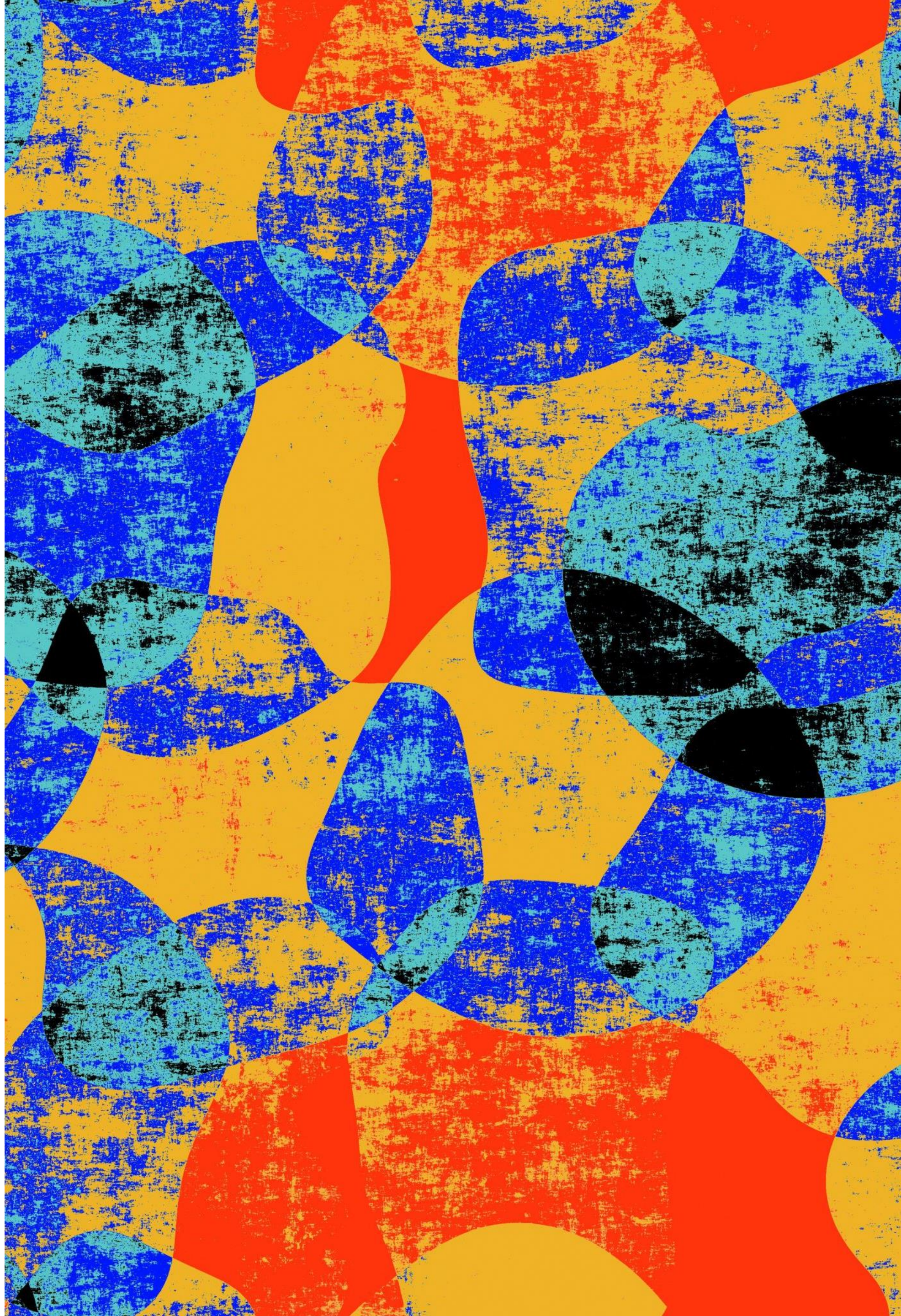


INTRODUCTION

- **Regression Method** is an important concept in Satistics,which is also known as **Linear Curve Fitting.**
- It is used to determine the functional relation from measured values.
- We accomplish this task through a model function

$$\boldsymbol{x} = (x_1, x_2, x_3, ...xn)^T$$

- In this project,we deals with a relation of the measured values with the Heat Flow Curve of different grades of deformed material.
- The Values of the flow tension k_f dependent on deformation φ, deformation speed $\dot{\varphi}$ and the temperature T.
- There is a general form of the mathematical function is given ,which is

$$k_f = g(\boldsymbol{x}, T, \varphi, \dot{\varphi})$$

GIVEN NON-LINEAR MODEL FUNCTIONS

- We have been provided with two model functions,which we have to use for The Regression Analysis,stated below

(1) $$k_f = g(\boldsymbol{x}, T, \varphi, \dot{\varphi}) = x_6 . e^{x_1 . T} . \dot{\varphi}^{x_2 + x_5 . T} . \varphi^{x_3} . e^{x_4 . \varphi}$$

(2) $$k_f = x_5 . e^{x_1 . T} . \dot{\varphi}^{x_2} . \varphi^{x_3} . e^{x_4 . \sqrt{\varphi}}$$

- Now as we can see these functions are non-linear ,so at first, we must linearize those function to perform linear curve fitting.

LINEARISATION OF MODEL FUNCTIONS

- The Function (1) can be linearised by lograthmic function:

$$\ln(k_f) = \ln(x_6) + x_1.T + (x_2 + x_5.T).\ln(\dot{\varphi}) + x_3.\ln(\varphi) + x_4.\varphi$$

- The Function (2) can be linearised by lograthmic function:

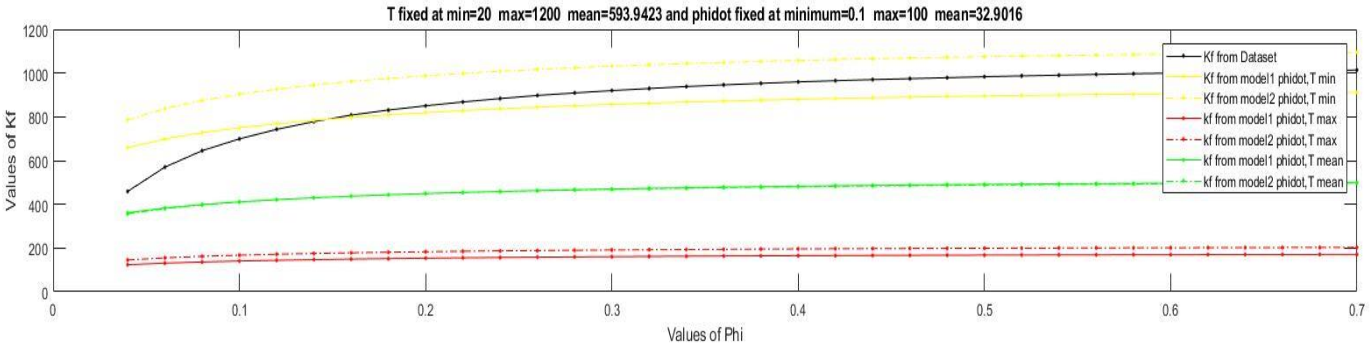
$$\ln(k_f) = \ln(x_5) + x_1.T + x_2.\ln(\dot{\varphi}) + x_3.\ln(\varphi) + x_4.\sqrt{\varphi}$$

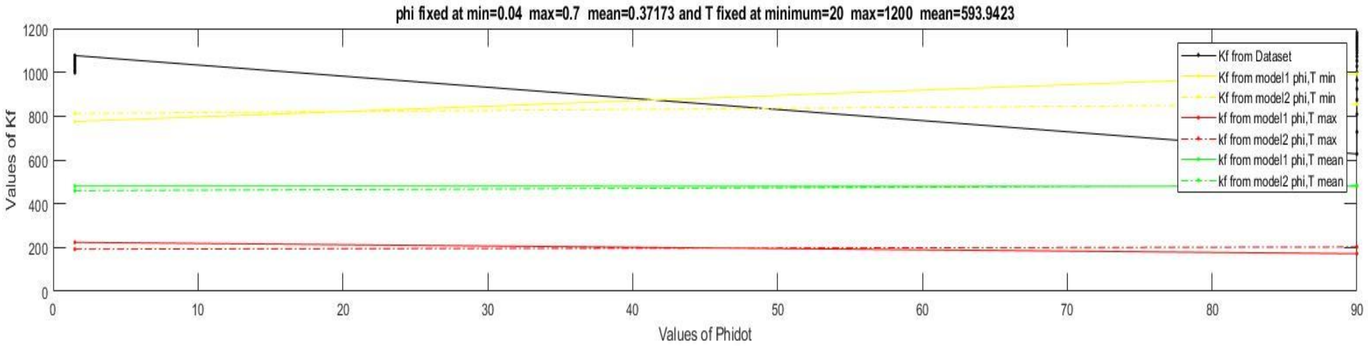
MATLAB

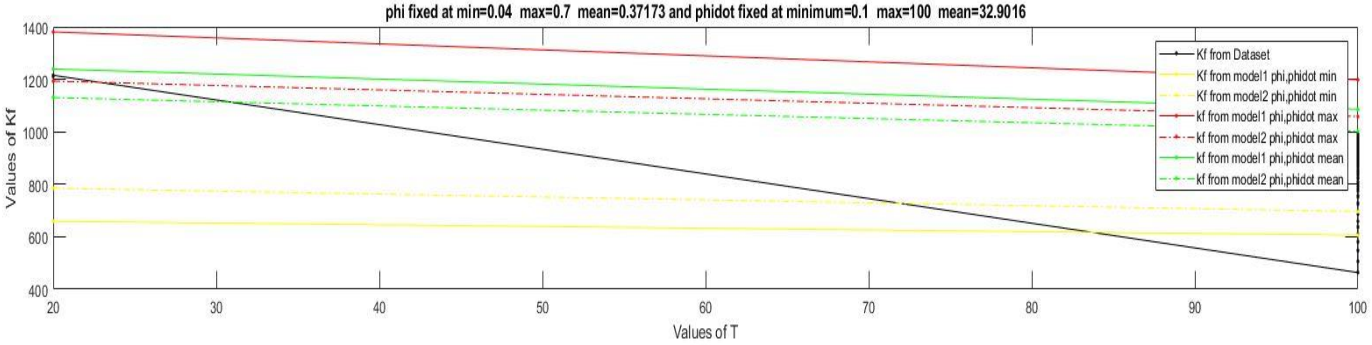
- Using these Mathematical Calculations and methods we can create a program in MatLab that outputs the best approximately fitted Curve based on our chosen Model Function.
- The Program outputs the R^2 measure, the Soultion Matrix $\boldsymbol{x}$ and the model function that best fits the given values.
- From the R^2 measure, it can be determined which model function better suits which grade of deformed material and which Fitted Curve, best approximates the function of the Heat Flow of the corresponding Grade of deformed material.
- In order to Plot the Function with 4 Variables, we choose two constant value from the variables each time and plot in 2-Dimensional Plane.
- In order to Plot the Function with 4 Variables, we choose a constant value for one of the variables and plot in 3-Dimensional Plane.

GRAPHICAL RESULTS-100Cr6 (2D)

- Here is the graphical result of measured values for the 100Cr6 in 2-Dimension.
- The black lines is for the k_f from database ,all straight line is for Model 1 and all dotted line is for model 2.The yellow line is when variable are fixed at min ,red is when variable are fixed at max and green when variable are fixed at mean.
- We determined 3 graph where first one T and phidot were fixed ,second one phi and T were fixed and the third one phi and phitdot were fixed.

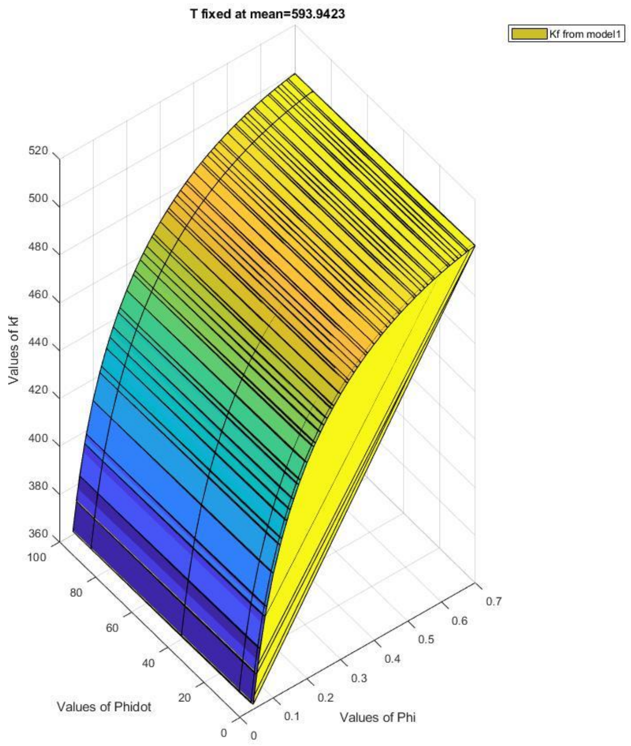


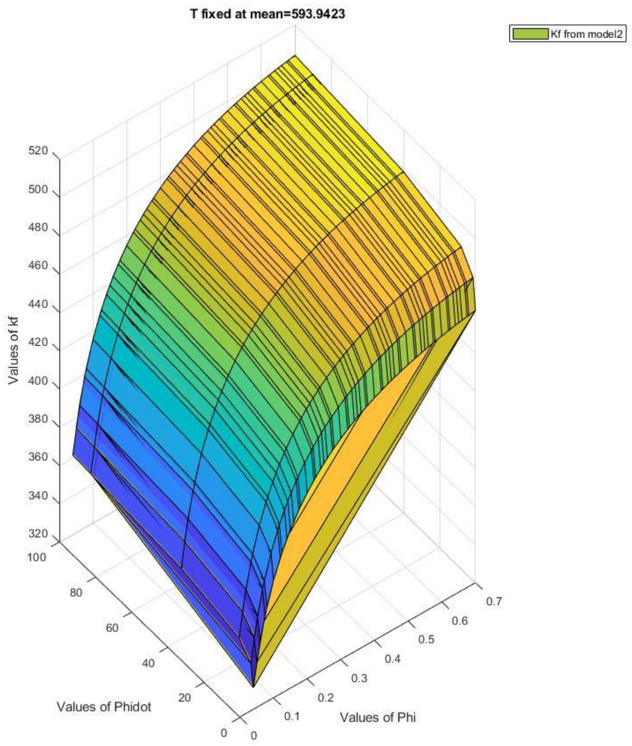




GRAPHICAL RESULTS-100Cr6 (3D) T MEAN

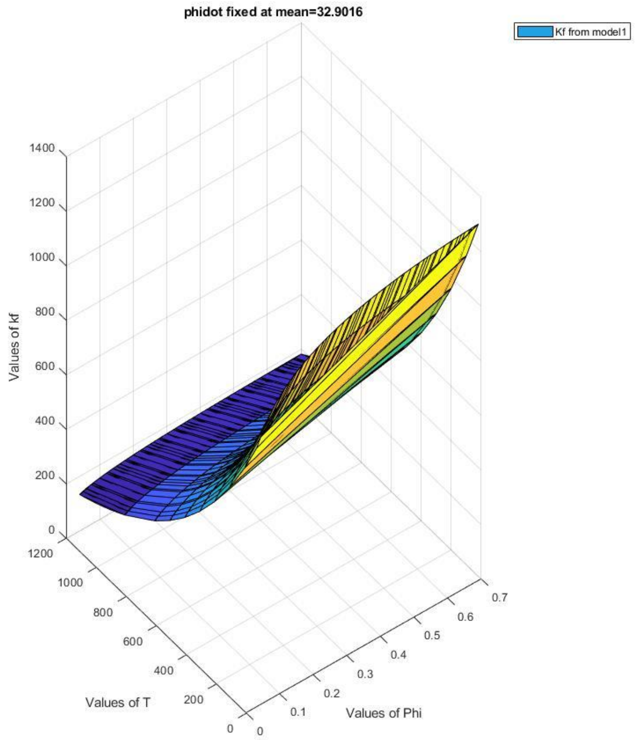
- Here is the graphical result of measured values for the 100Cr6 in 3-Dimension.
- We measured the value while T fixed at mean.
- In the left side we got the graph for model 1 and right side for model 2.

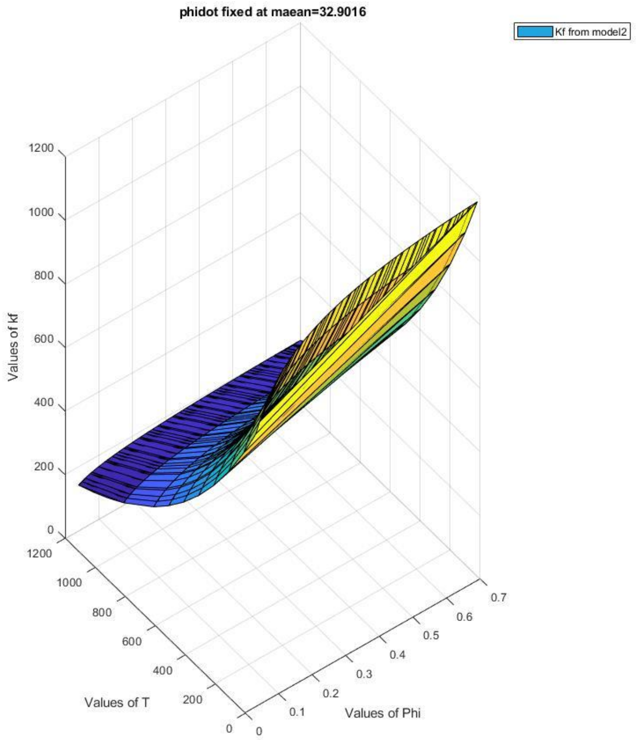




GRAPHICAL RESULTS-100Cr6 (3D) PHIDOT MEAN

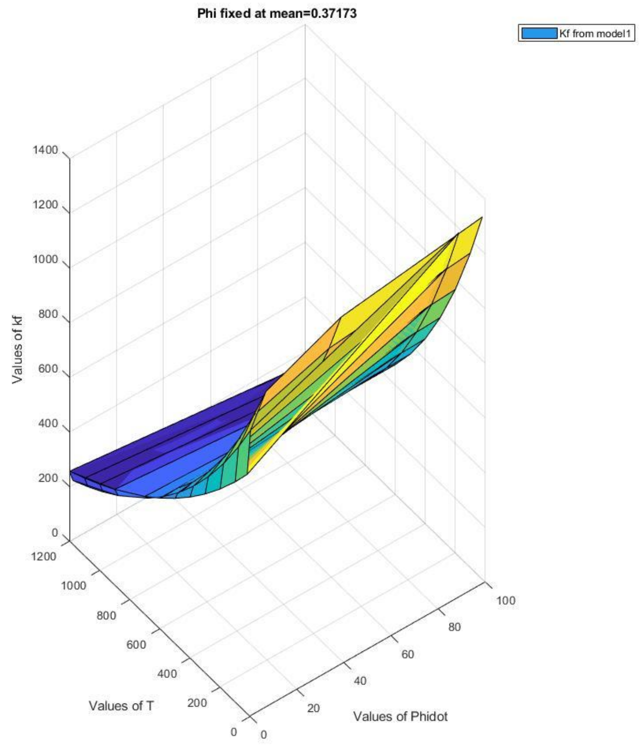
- Here is the graphical result of measured values for the 100Cr6 in 3-Dimension.
- We measured the value while PHIDOT fixed at mean.
- In the left side we got the graph for model 1 and right side for model 2.

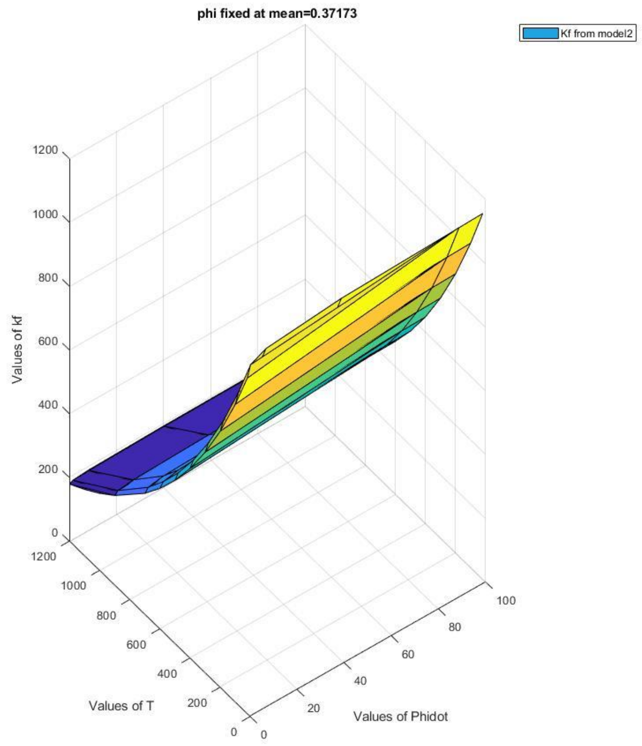




GRAPHICAL RESULTS-100Cr6 (3D) PHI MEAN

- Here is the graphical result of measured values for the 100Cr6 in 3-Dimension.
- We measured the value while PHI fixed at mean.
- In the left side we got the graph for model 1 and right side for model 2.





RESULTS-100Cr6

Model 1

RSquared: **0.6145**

Transformed parameters for the non linear model function:

x1 = -0.0013

x2 = 0.0623

x3 = 0.1520

x4 = -0.1681

x5 = -0.0001

x6 = exp(7.1509)=1275.25

$$k_f = g(\boldsymbol{x}, T, \varphi, \dot{\varphi}) = (1275.25).e^{(-0.0013).T}.\dot{\varphi}^{(0.0623+(-0.0001)).T}.\varphi^{(0.1520)}.e^{(-0.1681).\varphi}$$

Model 2

RSquared: **0.6003**

Transformed parameters for the non linear model function:

x1 = -0.0015

x2 = 0.0125

x3 = 0.2023

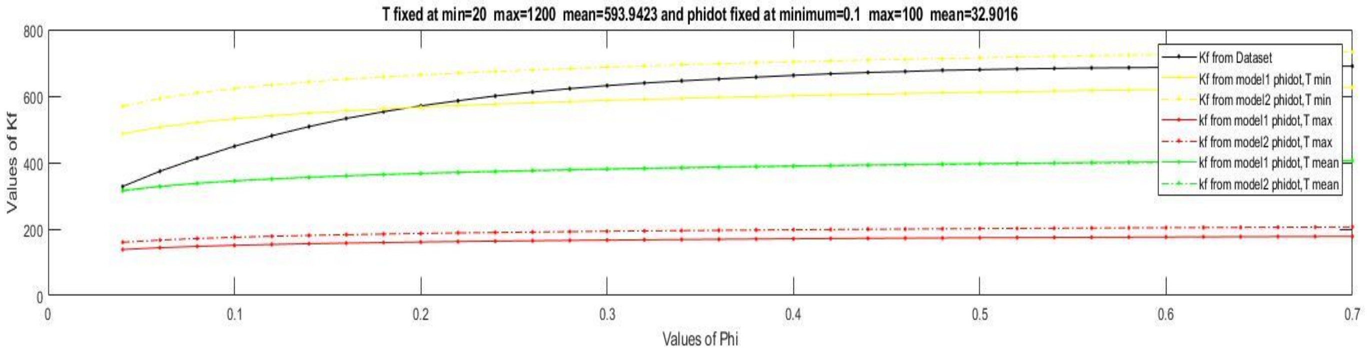
x4 = -0.3873

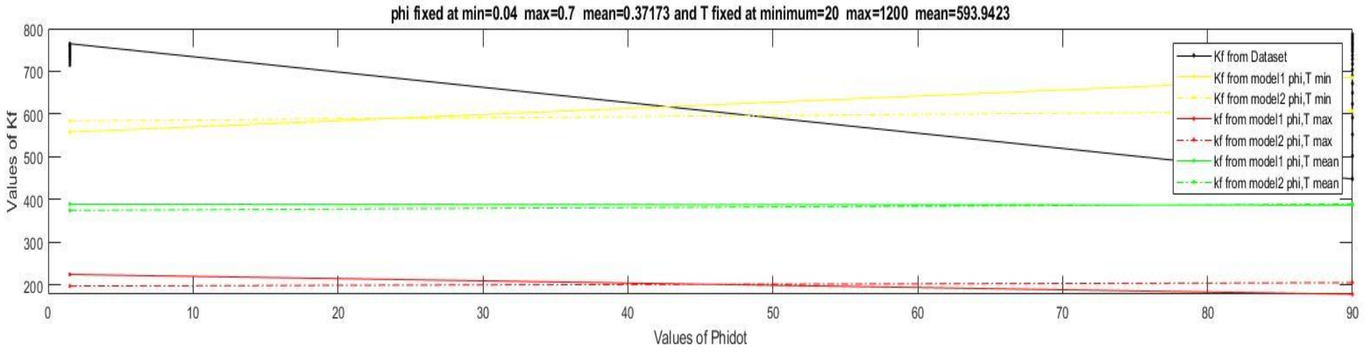
x5 = exp(7.4531)=1725.20

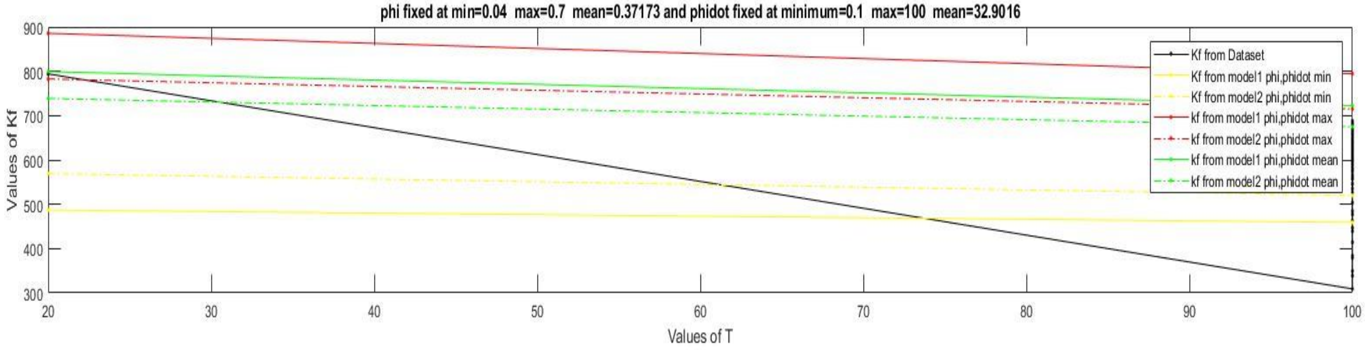
$$k_f = (1725.20).e^{(-0.0015).T}.\dot{\varphi}^{(0.0125)}.\varphi^{(0.2023)}.e^{(-0.3873).\sqrt{\varphi}}$$

GRAPHICAL RESULTS-C15 (2D)

- Here is the graphical result of measured values for the C15 in 2-Dimension.
- The black lines is for the k_f from database ,all straight line is for Model 1 and all dotted line is for model 2.The yellow line is when variable are fixed at min ,red is when variable are fixed at max and green when variable are fixed at mean.
- We determined 3 graph where first one T and phidot were fixed ,second one phi and T were fixed and the third one phi and phitdot were fixed.

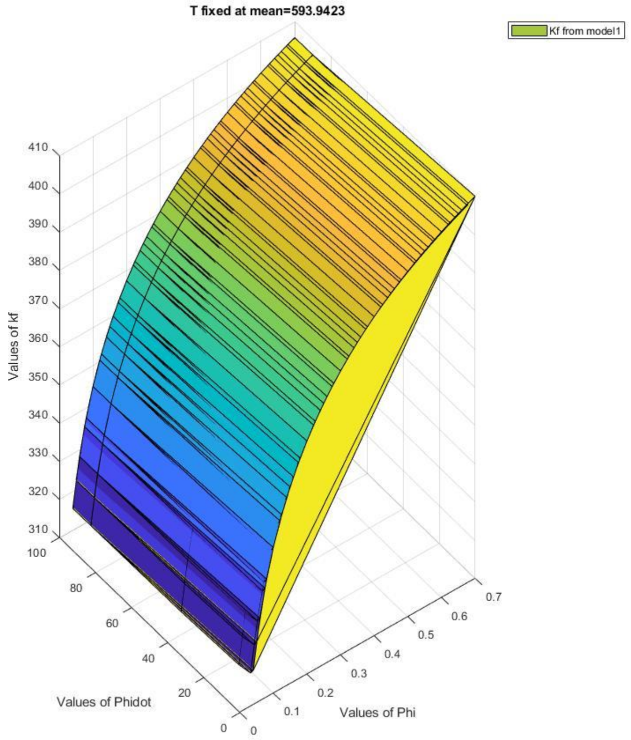


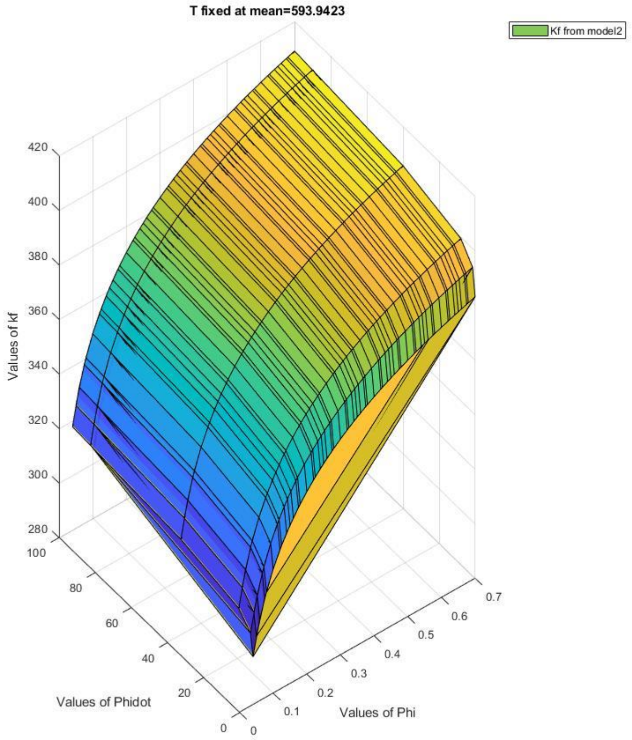




GRAPHICAL RESULTS-C15 (3D) T MEAN

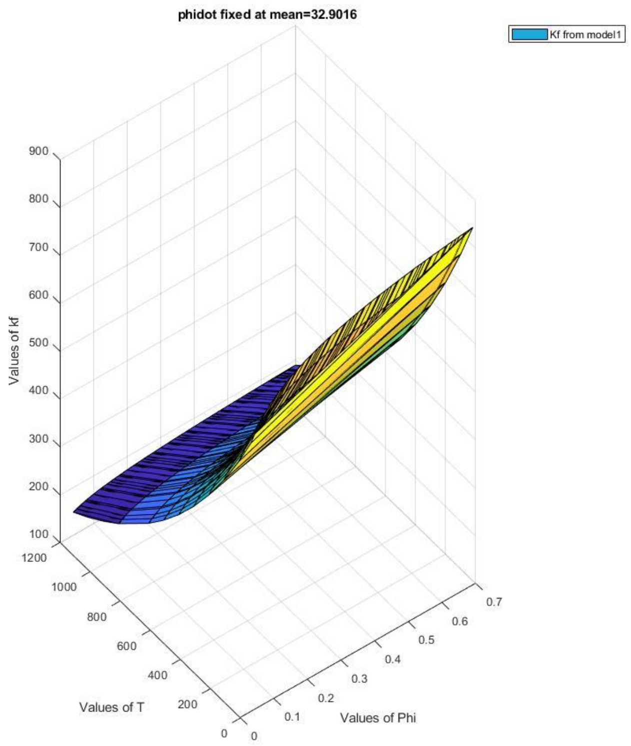
- Here is the graphical result of measured values for the C15 in 3-Dimension.
- We measured the value while T fixed at mean.
- In the left side we got the graph for model 1 and right side for model 2.

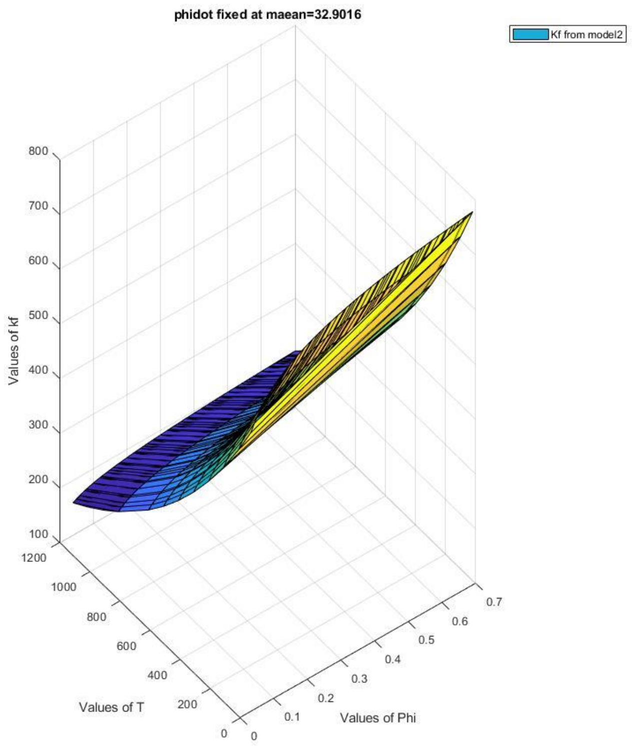




GRAPHICAL RESULTS-C15 (3D) PHIDOT MEAN

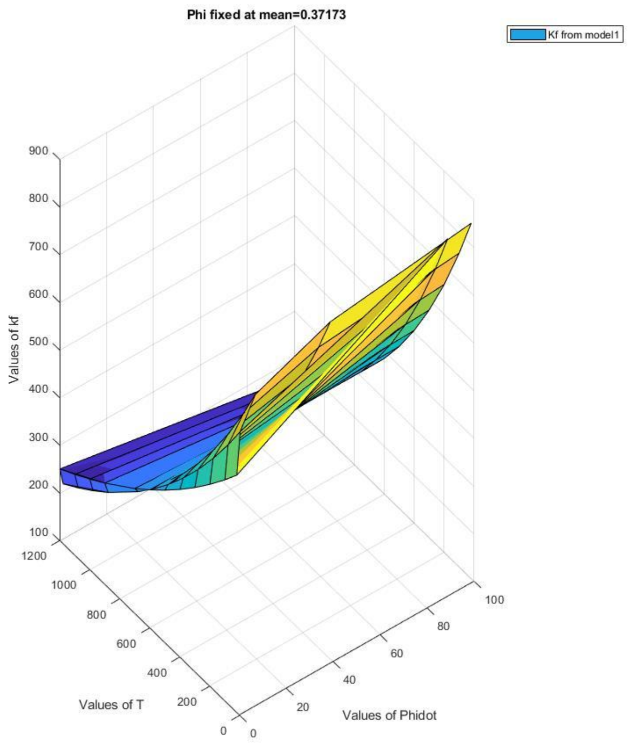
- Here is the graphical result of measured values for the C15 in 3-Dimension.
- We measured the value while phidot fixed at mean.
- In the left side we got the graph for model 1 and right side for model 2.

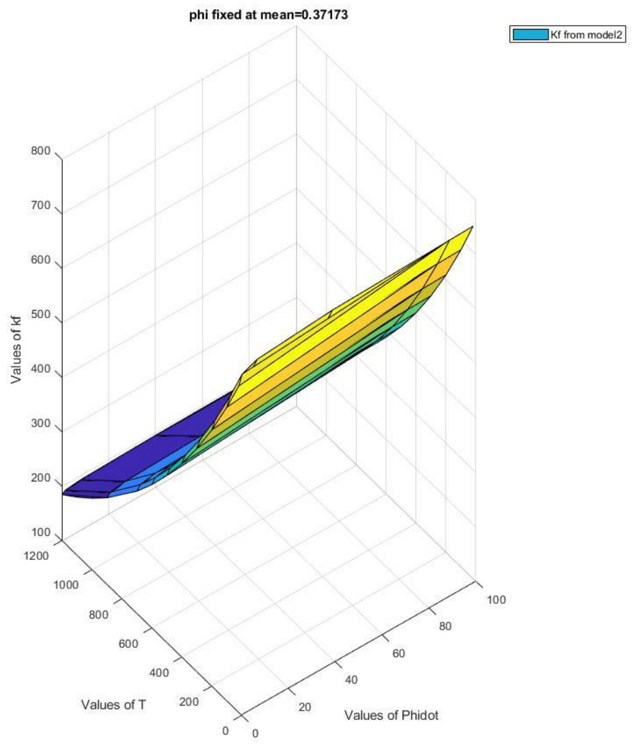




GRAPHICAL RESULTS-C15 (3D) PHI MEAN

- Here is the graphical result of measured values for the C15 in 3-Dimension.
- We measured the value while phi fixed at mean.
- In the left side we got the graph for model 1 and right side for model 2.





RESULTS-C15

Model 1

RSquared: **0.4425**

Transformed parameters for the non linear model function:

x1 = -0.0009

x2 =   0.0520

x3 =   0.0987

x4 = -0.0476

x5 = -0.0001

x6 = exp(6.6426)=767.087

$$k_f = g(\boldsymbol{x}, T, \varphi, \dot{\varphi}) = (767.087).e^{(-0.0009).T}.\dot{\varphi}^{(0.0520+(-0.0001)).T}.\varphi^{(0.0987)}.e^{(-0.0476).\varphi}$$

Model 2

RSquared: **0.4294**

Transformed parameters for the non linear model function:

x1 = -0.0011

x2 =   0.0095

x3 =   0.1106

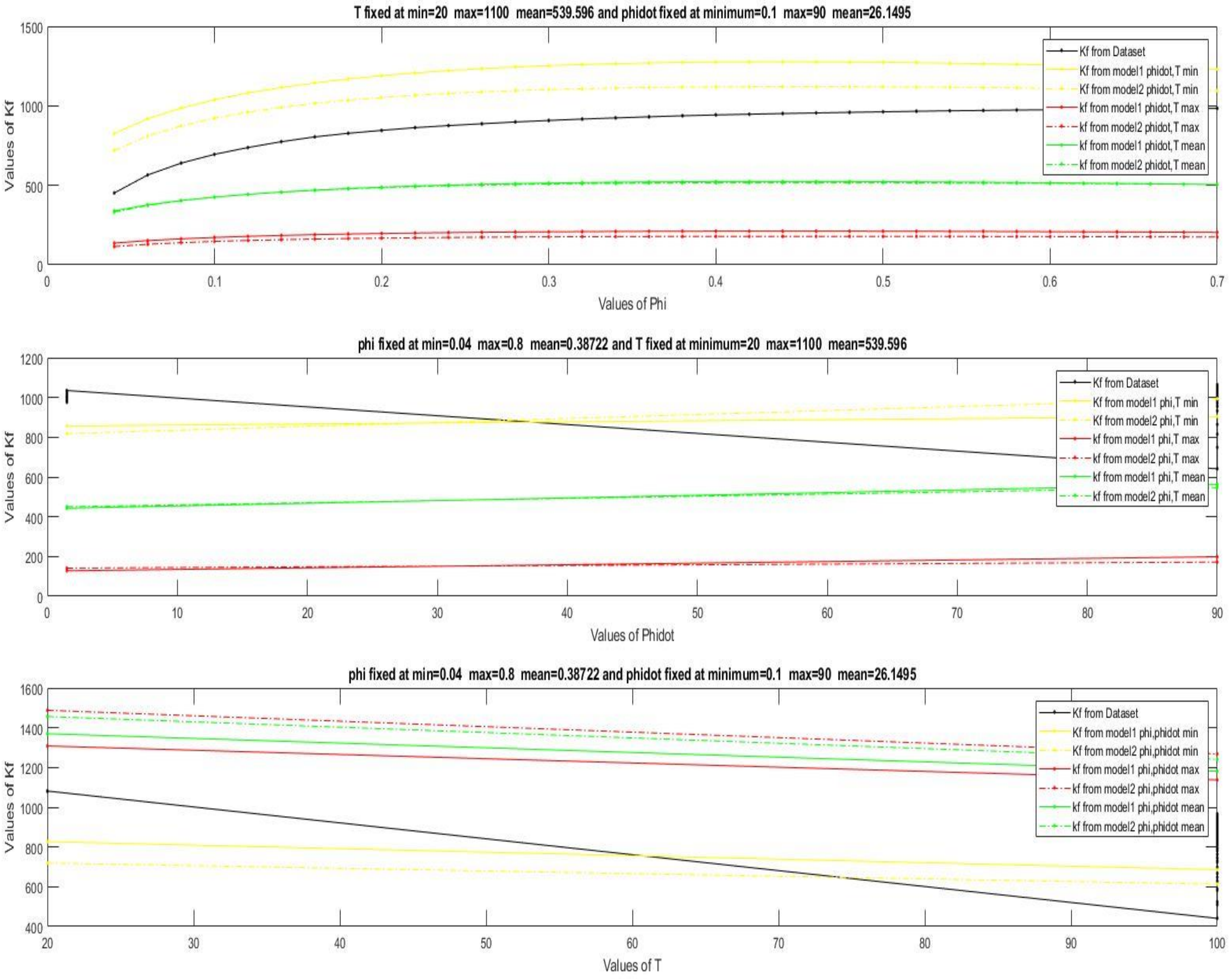
x4 = -0.1008

x5 =   exp(6.7652)=867.14

$$k_f = (867.14).e^{(-0.0011).T}.\dot{\varphi}^{(0.0095)}.\varphi^{(0.1106)}.e^{(-0.1008).\sqrt{\varphi}}$$

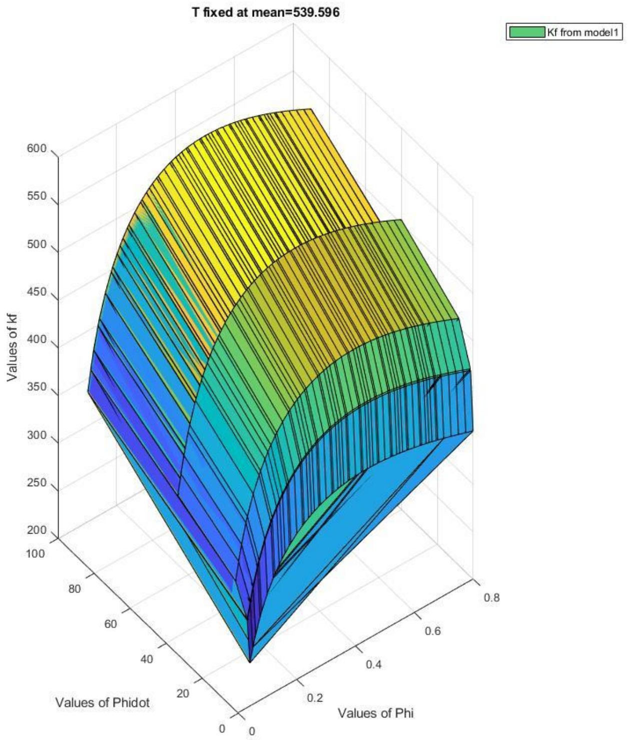
GRAPHICAL RESULTS- C60 (2D)

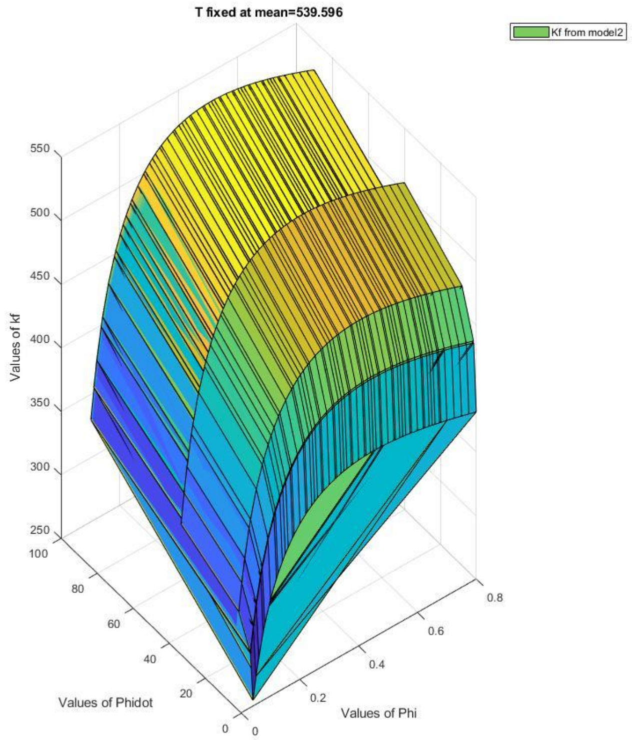
- Here is the graphical result of measured values for the **C60** in 2-Dimension.
- The black lines is for the k_f from database ,red for k_f from model 1 and green for k_f from model 2.
- We determined 3 graph while T and phidot were fixed at minimum, maximum and mean.



GRAPHICAL RESULTS-C60 (3D) T MEAN

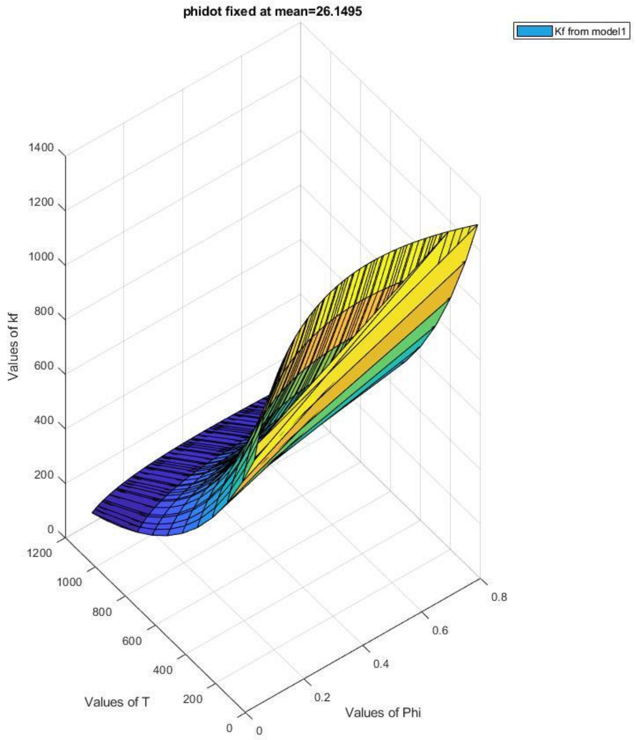
- Here is the graphical result of measured values for the C60 in 3-Dimension.
- We measured the value while T fixed at mean.
- In the left side we got the graph for model 1 and right side for model 2.

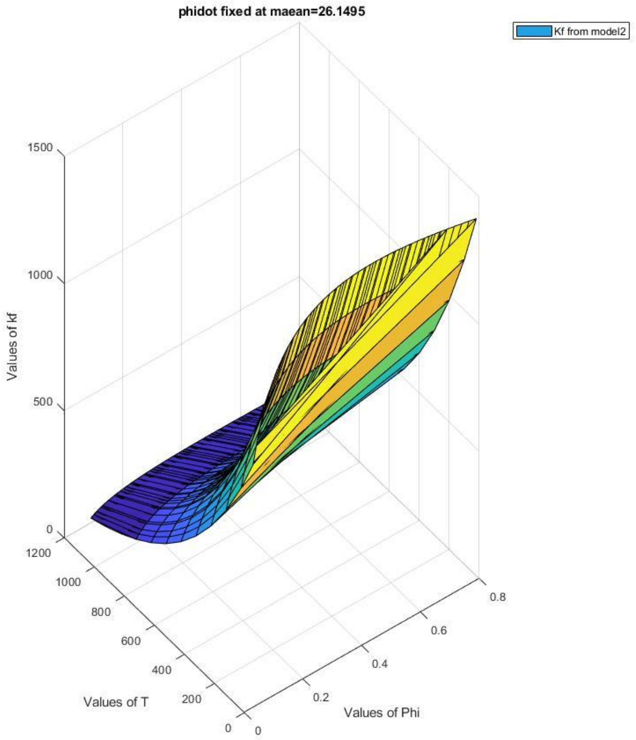




GRAPHICAL RESULTS-C60 (3D) PHIDOT MEAN

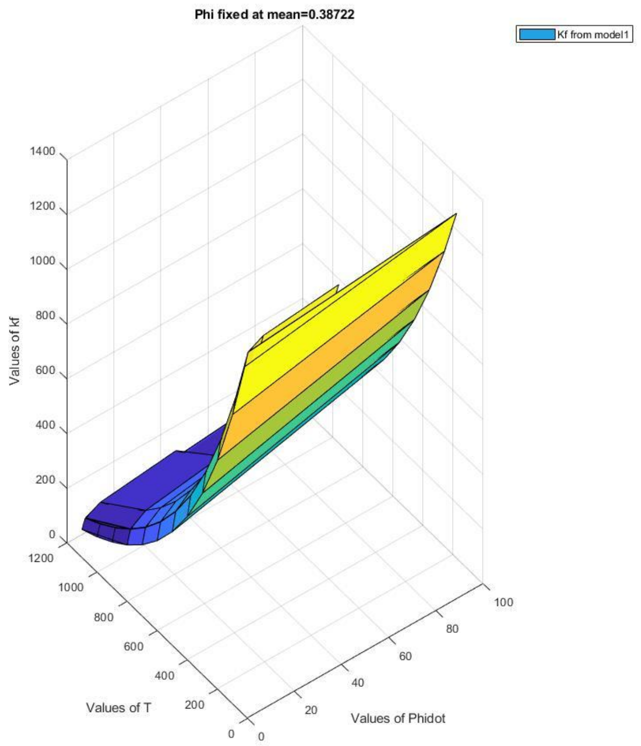
- Here is the graphical result of measured values for the C60 in 3-Dimension.
- We measured the value while phidot fixed at mean.
- In the left side we got the graph for model 1 and right side for model 2.

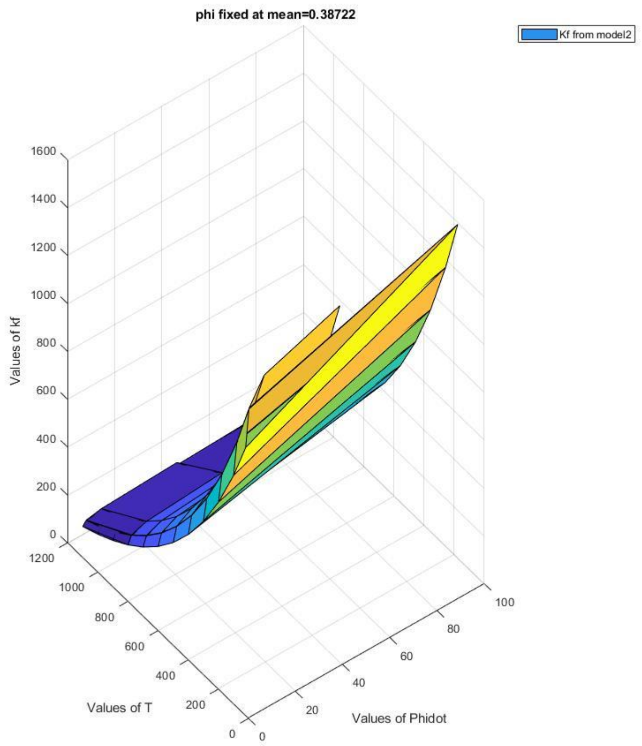




GRAPHICAL RESULTS-C60 (3D) PHI MEAN

- Here is the graphical result of measured values for the C60 in 3-Dimension.
- We measured the value while phi fixed at mean.
- In the left side we got the graph for model 1 and right side for model 2.





RESULTS-C60

Model 1

RSquared: **0.8981**

Transformed parameters for the non linear model function:

x1 = -0.0021

x2 = 0.0114

x3 = 0.2918

x4 = -0.6639

x5 = 0.0001

x6 = exp(7.7565)=2336.71

$$k_f = g(\boldsymbol{x}, T, \varphi, \dot{\varphi}) = (2336.71).\, e^{(-0.0021).T}\,.\,\dot{\varphi}^{(0.0114+(0.0001)).T}.\,\varphi^{(0.2918)}.\,e^{(-0.6639).\varphi}$$

Model 2

RSquared: **0.8907**

Transformed parameters for the non linear model function:

x1 = -0.0020

x2 = 0.0475

x3 = 0.4362

x4 = -1.3008

x5 = exp(8.3921)=4412.07

$$k_f = (4412.07).\, e^{(-0.0020).T}.\,\dot{\varphi}^{(0.0475)}.\,\varphi^{(0.4362)}.\,e^{(-1.3008).\sqrt{\varphi}}$$

CONCLUSION

Here is the comparison between two models while all the variable fixed at mean, min and max.

Model 1

		T	PHIDOT	PHI	R^2
MEAN	**100Cr6**	**593.9423**	**32.9016**	**0.37173**	**0.6145**
	C15	593.9423	32.9016	0.37173	0.4425
	C60	593.596	26.1495	0.38722	0.8981
MIN	**100Cr6**	**20**	**0.1**	**0.04**	**0.6145**
	C15	20	0.1	0.04	0.4425
	C60	20	0.1	0.04	0.8981
MAX	**100Cr6**	**1200**	**100**	**0.7**	**0.6145**
	C15	1200	100	0.7	0.4425
	C60	1100	90	0.8	0.8981

Model 2

		T	PHIDOT	PHI	R^2
MEAN	**100Cr6**	**593.9423**	**32.9016**	**0.37173**	**0.6003**
	C15	593.9423	32.9016	0.37173	0.4294
	C60	593.596	26.1495	0.38722	0.8907
MIN	**100Cr6**	**20**	**0.1**	**0.04**	**0.6003**
	C15	20	0.1	0.04	0.4294
	C60	20	0.1	0.04	0.8907
MAX	**100Cr6**	**1200**	**100**	**0.7**	**0.6003**
	C15	1200	100	0.7	0.4294
	C60	1100	90	0.8	0.8907