

## REGRESSION MODELLING FOR THE THERMAL EFFECT OF SOLAR RADIATION ON SALINITY AND BIOLOGICAL CONTAMINATION FREE WATER OUTPUT OF ASYMMETRICAL GREENHOUSE TYPE SINGLE BASIN SOLAR STILL

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### **Abstract**

*In this paper, We tried to find out how Solar Radiation affects the output of the desalinated water of so Asymmetrical Greenhouse Type Solar Still. For this, I applied linear regression model and other statistical methods. I fitted different regression curves such as Linear, Logarithmic, Inverse, Quadratic, Compound, Power, S, Growth, Exponential, and Logistic curves on the experiment data set and found the most suitable model*

**Keywords:** Ambient temperature, Solar Still, Regression, Curve Fitting, Solar radiation.

### **1 Introduction :**

#### **1.1 Solar Radiation and Water Production of water**

As discussed in the previous chapter Solar radiation signifies the most important factor vis-a-vis still productivity. Many researchers have studied relation between still productivity and by effect of solar radiation, and their study shows that the productivity of solar still increases when the incidence of solar radiation increases (Safwat Nafey A, 2000). It has been, reported that the received solar radiation warms up basin water, which evaporates them (Okeke CE, 1990). The transfer of energy that distills water in the system of a solar still comprehends the supply of evaporating heat and its removal from condensed vapor. Incidentally, the rise in yield is associated with an increase in the energy transfer rates. Morse and Read applied analytical expressions to highlight the effect of different parameters, such as solar radiation, ambient temperatures, heat, and other climatic factors

The results suggest that solar radiation is unquestionably vital to the process (Morse RN, 1968). Kamal magnificently established that productivity is highly dependent on the input, which is solar energy hence solar radiation. (Kamal, 1988).

### **2 Experiment Setup**

Asymmetrical greenhouse type (ASGHT) with mirrors, and the second Asymmetrical greenhouse type

(AGHT). Basin-type solar stills (Figs. 1) given in Chapter 2 were designed. The bases of the stills were dyed black with Aerosol black paint on their interior surfaces to enable maximum absorption of Solar Radiation (Sr). The base and sides of all six solar stills were insulated from the outer side with 110 mm rock wool and covered in a wooden box to minimize heat loss the surrounding whole hole setup of all stills is made airtight with the help of a "DuPont 07871 10.1-Ounce Airtite Sealant" and rubber gasket. Thermocouples were attached in different positions to measure the inside and outside glass cover. The measure of the temperature of solar basin water, ambient air, and vapor temperatures is taken periodically every half hour from all stills. The distillate yield was measured and noted by a scaled flask every half hour. These experiments were conducted during April. Collected data were used to compare the relative performances of all six stills. The angle of the solar still glass covers  $35^\circ$  (Akash, Mohsen, & Nayfeh, 2000) and the water depth in the basin was initially maintained at 2 cm. This experiment was also conducted with different water depths. Daily collection of fresh water can range from 3.1 to 5.5  $l/m^3$ . The present ASGHT has a top cover made of (1) glass. They still have mirrors that reflect Solar Radiation (Sr) incident on them onto the basin. The transparent cover allows the Solar Radiation (Sr) (shortwave) to reach into the still. Most of its thermal energy is absorbed by the blackened d surface of the base. The water temperature increases and the moisture content (vapor) of the air stays between the water surface and the glass cover. This way, the transparent cover traps the solar energy inside the still and creates a greenhouse effect. The heated base also radiates the energy of the infrared region (long wavelength); this energy is also reflected onto the basin of the interior mirrors and concentrates thermal energy at the base. The temperature of water is increased, and it evaporates from the basin and condenses on the inner surface of the glass cover. Salts, impurities, and microbes present in the water are left behind in the water. The condensed water drips down the incline to cover an interior and is collected from an outlet point. The still is recharged with water each morning, and the total water production for the day is collected in the late evening. Water is added Through a supply fill port to the stills. Model In this study, an attempt was made to create a mathematical model for predicting the "total amount of water distillate produced", which is the dependent variable here, and trying to create a mathematical model by Response Surface Methodology (RSM) using variable independent variable related to solar stills. The methodology used was to develop a model.

## 2.1 Experimental Data

| Time  | Solar Radiation (SR) | Production of distilled water in ML |
|-------|----------------------|-------------------------------------|
| 8.30  | 447.87               | 132.94                              |
| 9.00  | 529.75               | 171.28                              |
| 9.30  | 611.90               | 217.26                              |
| 10.00 | 685.61               | 240.43                              |
| 10.30 | 753.15               | 267.44                              |
| 11.00 | 785.57               | 336.04                              |
| 11.30 | 820.69               | 408.48                              |
| 12.00 | 861.19               | 560.32                              |
| 12.30 | 899.04               | 704.69                              |

|       |        |         |
|-------|--------|---------|
| 13.00 | 898.02 | 731.64  |
| 13.30 | 896.34 | 758.64  |
| 14.00 | 866.86 | 880.18  |
| 14.30 | 842.31 | 1016.99 |
| 15.00 | 773.37 | 888.79  |
| 15.30 | 699.12 | 760.71  |
| 16.00 | 609.97 | 560.70  |
| 16.30 | 496.50 | 360.70  |
| 17.00 | 407.93 | 312.02  |
| 17.30 | 301.98 | 255.75  |
| 18.00 | 199.31 | 229.75  |
| 18.30 | 96.65  | 192.44  |
| 19.00 | 70.82  | 162.66  |

## 2.2 Variable Used in The Study

The variable used is as follows

### Independent Variable

SR                      Solar Radiation (Sr)

### Dependent Variable

PR                      PRODUCTION RATE OF WATER ML/HR

Or

PR(est)                Estimate of the production rate of water ML/HR

We aim to create a mathematical model that can explain the Independent Variable PR (PRODUCTION RATE OF WATER ML/HR(PREST) (PR)) by using dependent variables,

Hence, mathematical models that will be created are such that they can explain the impact of Independent Variables " Solar Radiation (Sr)" separately for dependent variables PR (Production rate of Water ML/hr). This variable will be gauged to check how many roles they play in the "Production rate of Water ML/hr."

Several possible models can be used and we will identify the best Model with the highest  $R^2$  value. The mathematical model used is as follows

## 3 Factors Affecting the Production of Distillate

The saline/Briskish water temperature affects the evaporation rate solar still helps to increase its temperature. Significant amounts of energy are needed to increase the temperature of the entire solar still water. The evaporation rate is unswervingly proportional to the water's available surface area temperature. Therefore, Also increasing the difference in temperature between the glass cover and the brine causes an increase in productivity [1]

mathematical Model using Regression analysis

#### 4 Effect Solar Radiation on The Production of Water

**Solar radiation signifies an essential factor vis-a-vis still productivity. Many researchers have studied the relationship between still productivity and the effect of solar radiation. Their study shows that solar productivity still increases when solar radiation increases (Safwat Nafey A, 2000). It has been reported that the received solar radiation warms up basin water, which evaporates them (Okeke CE, 1990). The transfer of energy that distills water in the solar system still comprehends the supply of evaporating heat and its removal from condensed vapor. Incidentally, the rise in yield is associated with increased energy transfer rates. Morse and read applied analytical expressions to highlight the effect of different parameters, such as solar radiation, ambient temperatures, heat, and other climatic factors**

The results suggest that solar radiation is unquestionably vital to the process (Morse RN, 1968). Kamal magnificently established that productivity is highly dependent on the input, which is solar energy hence solar radiation. (Kamal, 1988).

For this purpose, we try to construct the following regression line by finding Unknown Beta values for the following relationship and also look at that

- Is the model statistically significant?
  - We will check the F statistic at the bottom of the summary table calculated below.
- Are the coefficients significant?
  - In summary, we will check the coefficients t statistics and p-values or their confidence intervals calculated below.
- Is it a helpful model?
  - We will also check the R<sup>2</sup> near the bottom of the summary. This R<sup>2</sup> also suggests which Model has better predictability; in other words, The R<sup>2</sup> effect size value measures the share of the variance of the independent variables accounted to the dependent variable, that is, approximately given percentage of the variance in PR is accounted for by independent variable calculated below.
- Gauge the model's statistical significance
  - The ANOVA function can also construct the ANOVA table of a linear regression model, which includes the F statistic needed to gauge the model's statistical significance

#### 5 Curve Estimation method: Relationship between a Dependent and an Independent Variable

The Curve Estimation method provides regression statistics and their respective plots for 10 different curve estimations of the regression models. For each pair of dependent and independent Predictor variables for a separate model. These good or bad models depend on the underlying relationship between the pair of dependent and independent, which needed to be identified by fitting the known regression model. It also needed to be identified which Model is best among them. For this, we may use the adjusted R<sup>2</sup> effect size value to measure the share of the variance of the independent variables accounted to the dependent variable. That is, approximately (value of R<sup>2</sup>)% of the variance in PR is

accounted for by the independent variable.

**5.1 Regression Models for Solar Radiation and desalination**

1. Linear. A model whose equation is  $PR = \beta_0 + (\beta_1 * SR)$ . The series values are modeled as a linear function of SR.
2. Quadratic whose equation is  $PR = \beta_0 + (\beta_1 * SR) + (\beta_2 * SR^2)$ . The series values are modelled as a linear function of AT.
3. Logarithmic. A model whose equation is  $\beta PR = 0 + (\beta_1 * \ln(SR))$ .
4. Inverse. The model whose equation is  $PR = \beta_0 + (\beta_0 / SR)$ .
5. Power. The model whose equation is  $PR = \beta_0 * (SR^{**}\beta_1)$  or  $\ln(PR) = \ln(\beta_0) + (\beta_1 * \ln(SR))$ .
6. Compound. The model whose equation is  $PR = \beta_0 * (\beta_1^{**}SR)$  or  $\ln(PR) = \ln(\beta_0) + (\ln(1) * SR)$ .
7. S-curve. Model whose equation is  $PR = e^{**}(\beta_0 + (\beta_1/SR))$  or  $\ln(PR) = \beta_0 + (\beta_1/SR)$ .
8. Logistic. Model whose equation is  $PR = 1 / (1/u + (\beta_0 * (\beta_1^{**}SR)))$  or  $\ln(1/y-1/u) = \ln(\beta_0) + (\ln(\beta_1) * SR)$  where u is the upper boundary value. After selecting Logistic, specify the upper boundary value to use in the regression equation. The value must be a positive number greater than the largest dependent variable.
9. Growth. Model whose equation is  $PR = e^{**}(\beta_0 + (\beta_1 * SR))$  or  $\ln(PR) = \beta_0 + (\beta_1 * SR)$ .
10. Exponential. The model whose equation is  $PR = \beta_0 * (e^{**}(b_1 * SR))$  or  $\ln(PR) = \ln(\beta_0) + (\beta_1 * SR)$ .

For Regression Model required calculations are done using SPSS 26 on the data set section 3 of chapter 2. The results of all model summary, ANOVA, and Coefficient are shown in the following tables

**5.2 Linear Model Summary**

Table 1

|                     |                             |                           |             |                            |      |
|---------------------|-----------------------------|---------------------------|-------------|----------------------------|------|
| R                   | R Square                    | Adjusted Square           | R           | Std. Error in the Estimate |      |
| .719                | .517                        | .494                      |             | 202.551                    |      |
| <b>ANOVA</b>        |                             |                           |             |                            |      |
|                     | Sum of Squares              | df                        | Mean Square | F                          | Sig. |
| Regression          | 921039.722                  | 1                         | 921039.722  | 22.450                     | .000 |
| Residual            | 861564.325                  | 21                        | 41026.873   |                            |      |
| Total               | 1782604.047                 | 22                        |             |                            |      |
| <b>Coefficients</b> |                             |                           |             |                            |      |
|                     | Unstandardized Coefficients | Standardized Coefficients | t           | Sig.                       |      |

|  | B       | Std. Error | Beta |       |      |
|--|---------|------------|------|-------|------|
| PRODUCTION RATE OF WATER ML/HR PR(est) | .726    | .153       | .719 | 4.738 | .000 |
| (Constant)                             | 266.590 | 80.496     |      | 3.312 | .003 |

### 5.3 Logarithmic Model Summary

Table 2

| Model Summary                              |                             |                 |                           |                            |      |
|--|-----------------------------|-----------------|---------------------------|----------------------------|------|
| R  | R Square                    | Adjusted Square | R                         | Std. Error in the Estimate |      |
| .776                                       | .603                        | .584            |                           | 183.663                    |      |
| ANOVA                                      |                             |                 |                           |                            |      |
|  | Sum of Squares              | df              | Mean Square               | F                          | Sig. |
| Regression                                 | 1074231.386                 | 1               | 1074231.386               | 31.846                     | .000 |
| Residual                                   | 708372.661                  | 21              | 33732.031                 |                            |      |
| Total                                      | 1782604.047                 | 22              |                           |                            |      |
| Coefficients                               |                             |                 |                           |                            |      |
|  | Unstandardized Coefficients |                 | Standardized Coefficients | t                          | Sig. |
|  | B                           | Std. Error      | Beta                      |                            |      |
| ln(PRODUCTION RATE OF WATER ML/HR PR(est)) | 334.918                     | 59.349          | .776                      | 5.643                      | .000 |
| (Constant)                                 | -1385.324                   | 352.347         |                           | -3.932                     | .001 |

### 5.4 Inverse Model Summary

Table 3

| Model Summary |                |                 |             |                            |      |
|---------------|----------------|-----------------|-------------|----------------------------|------|
| R             | R Square       | Adjusted Square | R           | Std. Error in the Estimate |      |
| .781          | .611           | .592            |             | 181.801                    |      |
| ANOVA         |                |                 |             |                            |      |
|               | Sum of Squares | df              | Mean Square | F                          | Sig. |

|  |                             |            |                           |        |      |
|--|-----------------------------|------------|---------------------------|--------|------|
| Regression                                 | 1088518.308                 | 1          | 1088518.308               | 32.934 | .000 |
| Residual                                   | 694085.739                  | 21         | 33051.702                 |        |      |
| Total                                      | 1782604.047                 | 22         |                           |        |      |
| <b>Coefficients</b>                        |                             |            |                           |        |      |
|  | Unstandardized Coefficients |            | Standardized Coefficients |        |      |
|  | B                           | Std. Error | Beta                      | t      | Sig. |
| 1 / PRODUCTION RATE OF WATER ML/HR PR(est) | -107876.112                 | 18797.683  | -.781                     | -5.739 | .000 |
| (Constant)                                 | 950.662                     | 73.204     |                           | 12.986 | .000 |

### 5.5 Quadratic Model Summary

Table 4

|   |                             |                   |                               |        |      |
|---|-----------------------------|-------------------|-------------------------------|--------|------|
| R   | R Square                    | Adjusted R Square | Std. An error in the Estimate |        |      |
| .786  | .617                        | .579              | 184.696                       |        |      |
| <b>ANOVA</b>                                |                             |                   |                               |        |      |
|   | Sum of Squares              | df                | Mean Square                   | F      | Sig. |
| Regression                                  | 1100350.823                 | 2                 | 550175.411                    | 16.128 | .000 |
| Residual                                    | 682253.224                  | 20                | 34112.661                     |        |      |
| Total                                       | 1782604.047                 | 22                |                               |        |      |
| <b>Coefficients</b>                         |                             |                   |                               |        |      |
|   | Unstandardized Coefficients |                   | Standardized Coefficients     |        |      |
|   | B                           | Std. Error        | Beta                          | t      | Sig. |
| PRODUCTION RATE OF WATER ML/HR PR(est)      | 2.355                       | .724              | 2.331                         | 3.253  | .004 |
| PRODUCTION RATE OF WATER ML/HR PR(est) ** 2 | -.002                       | .001              | -1.643                        | -2.293 | .033 |
| (Constant)                                  | -36.892                     | 151.358           |                               | -.244  | .810 |

**5.6 Compound Model Summary**

Table 5

| R    | R Square | Adjusted R Square | Std. Error in the Estimate |
|------|----------|-------------------|----------------------------|
| .605 | .366     | .336              | .702                       |

| ANOVA      |                |    |             |        |      |
|------------|----------------|----|-------------|--------|------|
|            | Sum of Squares | df | Mean Square | F      | Sig. |
| Regression | 5.990          | 1  | 5.990       | 12.147 | .002 |
| Residual   | 10.356         | 21 | .493        |        |      |
| Total      | 16.346         | 22 |             |        |      |

| Coefficients                           |                             |            |                           |          |      |
|--|-----------------------------|------------|---------------------------|----------|------|
|  | Unstandardized Coefficients |            | Standardized Coefficients | t        | Sig. |
|  | B                           | Std. Error | Beta                      |          |      |
| PRODUCTION RATE OF WATER ML/HR PR(est) | 1.002                       | .001       | 1.832                     | 1881.832 | .000 |
| (Constant)                             | 204.942                     | 57.194     |                           | 3.583    | .002 |

The dependent variable is ln(Solar Radiation).

**5.7 Power Model Summary**

Table 6

| R    | R Square | Adjusted R Square | Std. Error in the Estimate |
|------|----------|-------------------|----------------------------|
| .688 | .474     | .449              | .640                       |

| ANOVA      |                |    |             |        |      |
|------------|----------------|----|-------------|--------|------|
|            | Sum of Squares | df | Mean Square | F      | Sig. |
| Regression | 7.741          | 1  | 7.741       | 18.893 | .000 |
| Residual   | 8.605          | 21 | .410        |        |      |
| Total      | 16.346         | 22 |             |        |      |

| Coefficients |  |  |  |  |  |
|--------------|--|--|--|--|--|
|--------------|--|--|--|--|--|

|  | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|--|-----------------------------|------------|---------------------------|-------|------|
|  | B                           | Std. Error | Beta                      |       |      |
| ln(PRODUCTION RATE OF WATER ML/HR PR(est)) | .899                        | .207       | .688                      | 4.347 | .000 |
| (Constant)                                 | 2.327                       | 2.858      |                           | .814  | .425 |

**5.8 S Model Summary**

Table 7

| Model Summary |                |                 |             |                            |      |
|---------------|----------------|-----------------|-------------|----------------------------|------|
| R             | R Square       | Adjusted Square | R           | Std. Error in the Estimate |      |
| .735          | .540           | .518            |             | .598                       |      |
| ANOVA         |                |                 |             |                            |      |
|               | Sum of Squares | df              | Mean Square | F                          | Sig. |
| Regression    | 8.825          | 1               | 8.825       | 24.643                     | .000 |
| Residual      | 7.521          | 21              | .358        |                            |      |
| Total         | 16.346         | 22              |             |                            |      |

| Coefficients                               |                             |            |                           |        |      |
|--|-----------------------------|------------|---------------------------|--------|------|
|  | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|  | B                           | Std. Error | Beta                      |        |      |
| 1 / PRODUCTION RATE OF WATER ML/HR PR(est) | -307.163                    | 61.876     | -.735                     | -4.964 | .000 |
| (Constant)                                 | 7.174                       | .241       |                           | 29.772 | .000 |

**5.9 Growth Model Summary**

Table 8

| Model Summary |          |                 |                               |
|---------------|----------|-----------------|-------------------------------|
| R             | R Square | Adjusted Square | Std. An error in the Estimate |
|               |          |                 |                               |

| .605       | .366           | .336 | .702        |        |      |
|------------|----------------|------|-------------|--------|------|
| ANOVA      |                |      |             |        |      |
|            | Sum of Squares | df   | Mean Square | F      | Sig. |
| Regression | 5.990          | 1    | 5.990       | 12.147 | .002 |
| Residual   | 10.356         | 21   | .493        |        |      |
| Total      | 16.346         | 22   |             |        |      |

| Coefficients                           |                             |            |                           |        |      |
|--|-----------------------------|------------|---------------------------|--------|------|
|  | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|  | B                           | Std. Error | Beta                      |        |      |
| PRODUCTION RATE OF WATER ML/HR PR(est) | .002                        | .001       | .605                      | 3.485  | .002 |
| (Constant)                             | 5.323                       | .279       |                           | 19.073 | .000 |

**5.10 Exponential Model Summary**

| Model Summary |          |                   |                               |
|---------------|----------|-------------------|-------------------------------|
| R             | R Square | Adjusted R Square | Std. An error in the Estimate |
| .605          | .366     | .336              | .702                          |

Table 9

| ANOVA                                  |                             |            |                           |        |      |
|--|-----------------------------|------------|---------------------------|--------|------|
|  | Sum of Squares              | df         | Mean Square               | F      | Sig. |
| Regression                             | 5.990                       | 1          | 5.990                     | 12.147 | .002 |
| Residual                               | 10.356                      | 21         | .493                      |        |      |
| Total                                  | 16.346                      | 22         |                           |        |      |
| Coefficients                           |                             |            |                           |        |      |
|  | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|  | B                           | Std. Error | Beta                      |        |      |
| PRODUCTION RATE OF WATER ML/HR PR(est) | .002                        | .001       | .605                      | 3.485  | .002 |

|            |         |        |  |       |      |
|------------|---------|--------|--|-------|------|
| (Constant) | 204.942 | 57.194 |  | 3.583 | .002 |
|------------|---------|--------|--|-------|------|

### 5.11 Logistic Model Summary

Table 10

| Model Summary |                |                   |                               |        |      |
|---------------|----------------|-------------------|-------------------------------|--------|------|
| R             | R Square       | Adjusted R Square | Std. An error in the Estimate |        |      |
| .605          | .366           | .336              | .702                          |        |      |
| ANOVA         |                |                   |                               |        |      |
|               | Sum of Squares | df                | Mean Square                   | F      | Sig. |
| Regression    | 5.990          | 1                 | 5.990                         | 12.147 | .002 |
| Residual      | 10.356         | 21                | .493                          |        |      |
| Total         | 16.346         | 22                |                               |        |      |

| Coefficients                           |                             |            |                           |          |      |
|--|-----------------------------|------------|---------------------------|----------|------|
|  | Unstandardized Coefficients |            | Standardized Coefficients | t        | Sig. |
|  | B                           | Std. Error | Beta                      |          |      |
| PRODUCTION RATE OF WATER ML/HR PR(est) | .998                        | .001       | .546                      | 1881.832 | .000 |
| (Constant)                             | .005                        | .001       |                           | 3.583    | .002 |

### 5.12 Comparison of Type Of Fitted Curve, Adjusted R Square, Standardized Coefficients Beta B1, Standardized Coefficients Beta B2

In the following table, we investigate the Adjusted R Square value of all models Comparison summary of all models.: In the following table Comparison summary of all model.is given in which we identify the model having the highest Adjusted R square value. The model which has the highest value may be considered the best model among all of them.

Table 11

| Type Of Fitted Curve | Adjusted R Square | Standardized Coefficients Beta B1 | Standardized Coefficients Beta B2 |
|----------------------|-------------------|-----------------------------------|-----------------------------------|
| Linear               | .494              | .719                              |                                   |
| Logarithmic          | .584              | .776                              |                                   |

|                    |      |       |        |
|--------------------|------|-------|--------|
| <b>Inverse</b>     | .592 | -.781 |        |
| <b>Quadratic</b>   | .579 | 2.331 | -1.643 |
| <b>Compound</b>    | .336 | 1.832 |        |
| <b>Power</b>       |      | .449  | .688   |
| <b>S</b>           | .518 | -.735 |        |
| <b>Growth</b>      | .336 | .605  |        |
| <b>Exponential</b> | .336 | .605  |        |
| <b>Logistic</b>    | .336 | .546  |        |

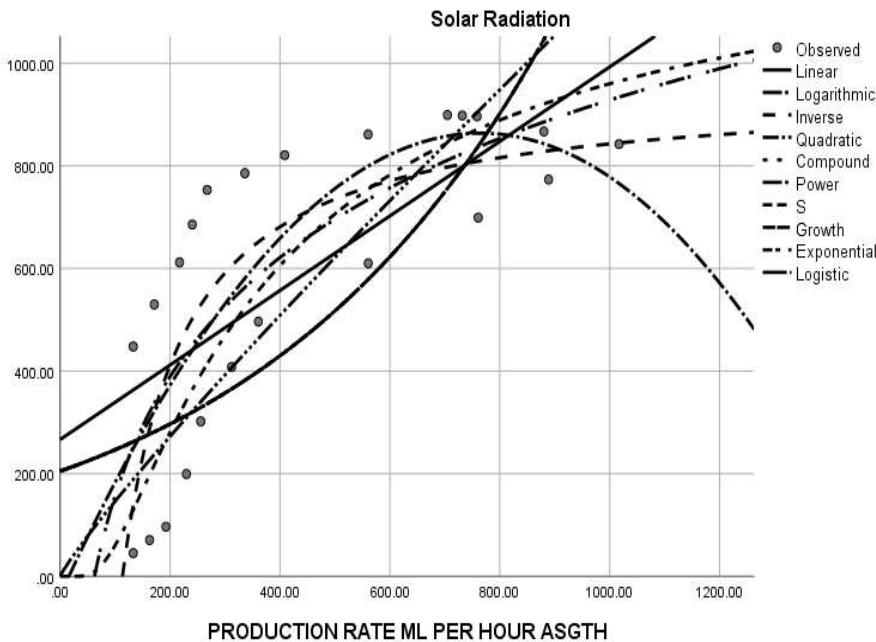


Figure 5.12-1

In the above table the adjusted R2 value corresponds to inverse curve is 0.592 which is highest among all. Therefore inverse curve ( $PR = \beta_0 + (\beta_1 / Tv)$ ) is The best fit curve. Taking the standardization of  $\beta_0$  and  $\beta_1$ . ( $\beta_0 = 0$ )

the equation will be

$$PR = (\beta_1 / Tv)$$

Here calculated table table 3, the Standardized  $\beta_1$  value is -0.781 hence the best fit regression curve will be for this experiment .

$$PR = (-0.78/ T_v)$$

**3.1 Lab Water Quality test results show the quality of water is as per water standards.**

**Table 6**

|    |  | Quality in<br>desalinated<br>water | Quality of<br>brikish<br>water | Desirable<br>limit |
|----|--|------------------------------------|--------------------------------|--------------------|
| 1  | Electrical conductivity, $\mu\text{S}/\text{cm}$ | 50                                 | 1350                           | 750                |
| 2  | pH   | 6.3                                | 9                              | 6.5–8.5            |
| 3  | Calcium, mg/l                                    | 4.4                                | 543                            | 75                 |
| 4  | Magnesium, mg/l                                  | 1                                  | 590                            | 30                 |
| 5  | Sodium, mg/l                                     | 4.5                                | 660                            | 100                |
| 6  | Potassium, mg/l                                  | 1                                  | 400                            | 15                 |
| 7  | Bicarbonate, mg/l                                | 11                                 | 1172                           | 120                |
| 8  | Carbonate, mg/l                                  | 0                                  | 1370                           | 30                 |
| 9  | Sulphate, mg/l                                   | 0                                  | 2710                           | 200                |
| 10 | Chloride, mg/l                                   | 10                                 | 1,350                          | 250                |
| 11 | Nitrate mg/l,                                    | 2                                  | 129                            | 50                 |
| 12 | Total dissolved solids, ppm                      | 33                                 | 75,000                         | 500                |
| 13 | Total hardness as $\text{CaCO}_3$ , mg/l         | 14                                 | 4700                           | 300                |
| 14 | Total alkalinity as $\text{CaCO}_3$ , mg/l       | 11                                 | 2540                           | 200                |
| 15 | Dissolved oxygen, mg/l                           | 7.5                                | 12                             |                    |

## 6. Conclusion:

To summarize, the research highlights the considerable influence of vapor temperature on the efficiency of solar stills used for purifying water. The above table shows that the highest adjusted R square value of the fitted curve is of inverse with the value 0.592. this inverse curve gives the best-fitted curve. Thus, vapour alone can predict 59 percent of the variability. By strategically adjusting the vapor temperature through system design and operational modifications, it is feasible to improve both the amount and quality of the distilled product. Future research should focus on investigating cutting-edge materials and novel design approaches to enhance the effectiveness and expandability of solar distillation technologies in tackling worldwide water issues.

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