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# DETERMINATION OF WELL EFFICIENCY USING ARTIFICIAL NEURAL NETWORK

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**Abstract:** This paper demonstrates the application of Artificial Neural Networks (ANNs) in determination of well efficiency. Well efficiency is defined as the ratio of the theoretical drawdown in the formation to the actual drawdown in the well. The difference between the two is caused by frictional energy losses of the water as it moves from within the formation to the pump intake. Thus, well efficiency describes the effectiveness of a well in yielding water. Well efficiency should not be confused with pumping-plant (motor and pump) or "wire-to-water" efficiency used to measure pumping-plant performance. Well efficiency is related to the cost of pumping and the use of energy. If efficiency improves, pumping costs and energy consumption will drop. Present method uses ANN to calculate Aquifer loss coefficient and this value is used to calculate well losses, both of which are required to determine well efficiency. Thus, an approach to determine well efficiency is developed which also allows a proper check on the values obtained i.e. the value obtained using the present approach and the value obtained using the analytical Bierschenk method. The purpose of this method is to avoid the cumbersome curve matching method and to obtain a result that lies within the acceptable range of error.

**Keywords:** Artificial Neural Network, Well efficiency, Aquifer loss coefficient, Well losses.

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## INTRODUCTION

## PREVIOUS METHOD

## STEP DRAWDOWN TEST

A step drawdown test is a single well pumping test designed to investigate the performance of a pumping well under controlled variable conditions. In a step drawdown test, the discharge rate in the pumping well is increased from an initially low constant rate through a sequence of pumping intervals (Steps) of progressively higher constant rates. Thus, the data obtained using a step drawdown test is generally time, drawdown and the corresponding discharge rate. Jacob(1947) proposed the following drawdown equation

$S_w = BQ+CQ^2$

Where,

$S_w$ is the drawdown, B is the aquifer loss coefficient, C is the well loss coefficient and Q is the discharge rate.

Thus, the above equation can also be written as

$S_w/Q = B + CQ$

Above equation thus becomes the equation of a straight line and can be solved by plotting a curve in which y-axis is represented by $S_w/Q$ (also known as specific drawdown) and x-axis is represented by Q (discharge rate). The intercept on y axis is generally known as aquifer loss coefficient and the slope is known as well loss coefficient. Using this two parameters well efficiency is calculated.

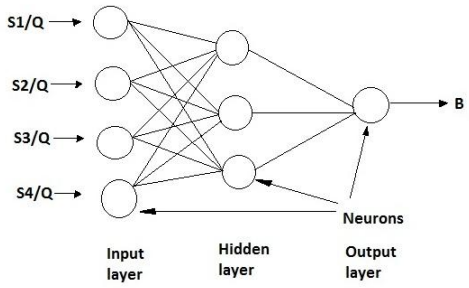
Well Efficiency $=BQ/ (BQ+CQ^2) \times 100$.

## PRESENT METHOD

Present method uses the application of Artificial Neural Network to determine the aquifer loss coefficient. The model to determine aquifer loss coefficient uses the equation of drawdown given by Jacob (1947). The model uses a set of specific drawdown as input and produces aquifer loss coefficient as output. A total number of 54 datasets were used to estimate the aquifer loss coefficient from this approach.

Thus the obtained value of aquifer loss coefficient was used to calculate the well losses and thus was further used to calculate the well efficiency.

**MODEL FOR ESTIMATION OF AQUIFER LOSS COEFFICIENT**




**CALCULATIONS**

**USING BIERSCHENK CURVE METHOD**

**Table-1 Data obtained from 'EMCHI' pumping test**

| Steps | $S_w$ (m) | Q ($m^3$/day) | $S_w/Q$ (days/$m^2$) |
|---|---|---|---|
| I | 6.47 | 224.64 | 0.028802 |
| II | 10.84 | 340.416 | 0.031843 |
| III | 14.11 | 425.088 | 0.033193 |
| IV | 17.53 | 490.752 | 0.035721 |

Thus plotting the curve $S_w/Q$ vs. Q

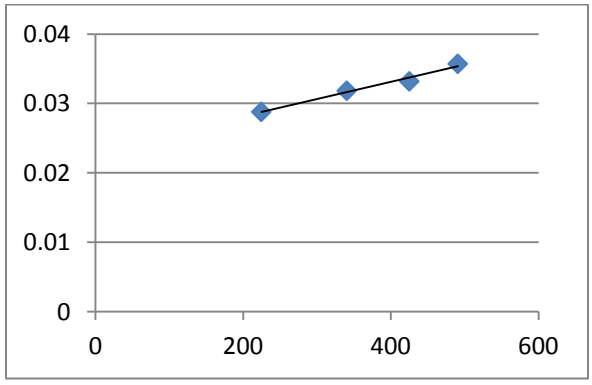



**Fig. 1. Plot of $S_w/Q$ vs Q**

Thus we get, B = 0.023 days/$m^2$ and C=0.00002811 $days^2/m^5$.

Using the above values we can determine the well efficiency.

**Table-2 determination of BQ and $CQ^2$**

| Q | B | C | BQ | $CQ^2$ |
|---|---|---|---|---|
| **224.64** | 0.023 | 0.00002811 | 5.16672 | 1.418519 |
| **340.416** | 0.023 | 0.00002811 | 7.829568 | 3.257473 |
| **425.088** | 0.023 | 0.00002811 | 9.777024 | 5.079472 |
| **490.752** | 0.023 | 0.00002811 | 11.2873 | 6.769943 |

**Table3- determination of average well efficiency.**

| $BQ+CQ^2$ | Well efficiency(%) | Average well efficiency |
|---|---|---|
| **6.585239** | 78.46 | |
| **11.087041** | 70.62 | 69.35 % |
| **14.856496** | 65.81 | |
| **18.057243** | 62.51 | |

**USING PRESENT APPROACH**

Obtained value of B using ANN is 0.021 days/$m^2$.

Using B to calculate C we get

**Table-4 determination of C**

| steps | C | Average C |
|---|---|---|
| I | 0.000034729 | |
| II | 0.000031853 | 0.00003131 |
| III | 0.000028683 | |
| IV | 0.000029996 | |

**Table-5 determination of BQ and $CQ^2$**

| Q | B | C | BQ | $CQ^2$ |
|---|---|---|---|---|
| **224.64** | 0.021 | 0.00003131 | 4.7174 | 1.58 |
| **340.416** | 0.021 | 0.00003131 | 7.1487 | 3.63 |
| **425.088** | 0.021 | 0.00003131 | 8.9268 | 5.65 |
| **490.752** | 0.021 | 0.00003131 | 10.3057 | 7.54 |

**Table-6 determination of average well efficiency.**

| $BQ+CQ^2$ | Well efficiency (%) | Average well efficiency |
|---|---|---|
| **6.2974** | 74.91 | |
| **10.7787** | 66.33 | 65.055% |
| **14.5768** | 61.24 | |
| **17.8457** | 57.74 | |

## RESULTS

The two efficiencies calculated using two different approaches are given below

| Method | Well efficiency |
|---|---|
| **Bierschenk** | 69.35% |
| **ANN** | 65.055% |

## CONCLUSION

An approach to the determination of well efficiency has been developed that uses the artificial neural network to calculate aquifer loss coefficient and thus is used further to calculate the well efficiency. The present approach is proposed because of its simplicity and because it avoids the curve method.

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