Agricultural Irrigation System Capacity Formulas

US & Metric

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Estimating total system flow requirement is always a challenge in agriculture. Since the well and pump will be sized based on crop demand, it is crucial to be able to estimate this number with a fair degree of accuracy. The problem is that many times this flow number is needed long before a system design is completed.

Formula #1 below is one of the most commonly used in center pivot design and it can be used for other types of Ag systems as well. The problem with this first formula is that it does not factor in how many hours a day the system will actually be used. It is not always 24 hours a day. Due to field access, load control limitations, and system maintenance & repair, quite often it is less than 24 hours a day. In addition, it does not factor in system efficiency. Since no system irrigates at 100% efficiency, some allowances for less than perfect coverage needs to be planned for.

The second formula incorporates both time and efficiency resulting in a more accurate flow number (flow per acre or hectare). However, it can be a little cumbersome because the hours per day is a separate calculation done by dividing the actual hours irrigated by 24 hours. This is so that a decimal can by inserted into the calculation.

The third formula allows for the time to be directly inserted into the calculation as actual hours irrigated per day which makes the calculation easier and quicker. The 4th formula is simply a "short cut" by automatically assuming 22 hours per day of available irrigation time, and 90% efficiency, thereby simplifying the calculation even more. This 4th version will only be useful for those specific site conditions.

US Units

1.

$$Q_a = \frac{ET_p}{.053}$$

Where:

Q_a = Flow in gpm per acre

ET_p = Peak daily ET in inches per day

.053 = Constant = depth of water in inches at 1 gpm in one day (24 hrs) over 1 acre

US Units cont.

2.

$$Q_{adj} = \frac{ET_p}{.053 * t * E}$$

Where:

Q_{adj} = Flow in gpm per acre adjusted for time and efficiency as decimal

ET_p = Peak daily ET in inches per day

.053 = Constant = depth of water in inches at 1 gpm in one day (24 hrs) over 1 acre

t = Factor for time = hours irrigated per day/ 24 hrs as a decimal (i.e. 16/24 = .66)

E = System efficiency as a decimal

3.

$$Q_{adh} = \frac{ET_p}{.0022 * h * E}$$

Where:

Q_{adh} = Flow in gpm per acre adjusted for time in actual hours, and efficiency as decimal

ET_p = Peak daily ET in inches per day

.0022 = Constant to reconcile time in hours instead of a decimal

h = Actual hours irrigated per day

E = System efficiency as a decimal

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Metric Units

1.

$$Q_a = \frac{ET_p}{2.4}$$

Where:

Q_a = Flow in m^3/hr per hectare

ET_p = Peak daily ET in millimeters per day

2.4 = Constant = depth of water in millimeters at 1 m^3/hr in one day (24 hrs) over 1 hectare

2.

$$Q_{adj} = \frac{ET_p}{2.4 * t * E}$$

Where:

Q_{adj} = Flow in m^3/hr per hectare adjusted for time and efficiency as decimal

ET_p = Peak daily ET in millimeters per day

2.4 = Constant = depth of water in millimeters at 1 m^3/hr in one day (24 hrs) over 1 hectare

t = Factor for time = hours irrigated per day/ 24 hrs as a decimal (i.e. 16/24 = .66)

E = System efficiency as a decimal

3.

$$Q_{adh} = \frac{ET_p}{.1 * h * E}$$

Where:

Q_{adh} = Flow in m^3/hr per hectare adjusted for time in actual hours, and efficiency as decimal

ET_p = Peak daily ET in millimeters per day

.1 = Constant to reconcile time in hours instead of a decimal

h = Actual hours irrigated per day

E = System efficiency as a decimal

System Formulas for Typical Systems:

(22 hours per day, 90% efficiency)

English Units

4.

$$Q_a = \frac{ET_p}{.0436}$$

Where:

Q_a = Flow in gpm per acre

ET_p = Peak daily ET in inches per day

.0436 = Constant to use for 22 hours per day irrigation and 90% system efficiency

Metric Units

4.

$$Q_a = \frac{ET_p}{2.0}$$

Where:

Q_a = Flow in m^3/hr per hectare

ET_p = Peak daily ET in millimeters per day

2.0 = Constant to use for 22 hours per day irrigation and 90% system efficiency