Journal of Electrotechnology, Electrical Engineering and Management (2023)
Clausius Scientific Press, Canada
DOI: 10.23977/jeeem.2023.060502
ISSN 2560-6697 Vol. 6 Num. 5

# *Research on the Law of Electric Water Conversion Coefficient in Typical Wells of Chayou Middle Banner*

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***Keywords:*** Electricity to water conversion coefficient; law; Water metering; Cha You Zhong Qi

***Abstract:*** "Electricity for water" is an indirect measurement method of agricultural irrigation water. It establishes the quantitative relationship between irrigation electricity consumption and water withdrawal, and uses irrigation electricity consumption data to calculate irrigation water consumption indirectly. The conversion coefficient of electricity and water refers to the ratio of irrigation water to electricity consumption. Through the comprehensive analysis of 56 typical Wells and all irrigation Wells, it can be seen that the electric-water conversion coefficient of camellia Zhongji irrigation machine and electric well presents the following rules: (1) The electric-water conversion coefficient is larger in the high-yield (good water yield) area among different water levels.(2) Within the same water level or between adjacent water levels, when the difference between the water level is small, it is related to the old and new pumps. The newer the pump, the higher the use efficiency, the lower the power consumption, and the greater the water conversion coefficient.(3) Within the same water level or between adjacent water levels, the same depth of the irrigation well is related to the rated water output of the pump. The higher the rated water yield, the better the water yield and the greater the conversion coefficient of water yield. (4) When there is little difference in the amount of water within the same water level or between adjacent water levels, it is also related to the pump head. The smaller the pump head, the greater the power consumption, the greater the water conversion factor. In addition, it is also related to many factors such as line loss and well depth. Through the field measurement and data analysis, it is found that the conversion coefficient of electric water quantity is not only affected by a single factor, but also by the water quantity of each well, well depth, pump type, new and old pumps, pump head, line loss and other factors. Even in the same water level range, the electric-water conversion coefficient cannot show a certain rule on the plane.

Chayouzhong Banner is located in the middle of Ulanqab City, Inner Mongolia, at the north foot of Huitengxile, a branch of Yinshan Mountain, 41°06′-41°29′24″ north latitude, 111°55′45″-112°49

′51″ east longitude, with a total area of 4190.2km2[1] . Kebul Town, where the Qi government is located, is 390km away from the capital Beijing, 100km away from the capital Hohhot and 60km away from Jining District. Chayouzhong Banner is a semi agricultural and semi pastoral banner with Mongols as the main body, most of them are cohabitation of 10 ethnic groups including Han, Mongolian, Han, Hui and Manchu [2].It has jurisdiction over 2 Sumu, 5 towns, 4 townships and 1 park management committee. There are 62000 households and 225000 people in the whole Banner, including 168000 agricultural population, of which 6456 are ethnic minorities, accounting for 2.9% of the total population. Among the ethnic minorities, 4654 are Mongols, the main ethnic group, accounting for 72% of the ethnic minority population[3].

The northern part of the flag is an inland river basin, with a larger Dingji River developing in the Houdatan Basin, which is 40km long and has a drainage area of 1000 km2[4]within the flag.The southwest of the Banner is the Yellow River basin. The Dahei River system is developed in the Datan Datasi hilly area. Two tributaries of the Yellow River system are distributed in Datan Township and Ulansumu. The river is 17~30km long and the drainage area in the Banner is 889.45km2. In addition, there are also some seasonal flood discharge valleys and catchment lakes within the flag. Most of the lakes are distributed on the basalt platform and are recharged by Groundwater recharge, of which more than 30 lakes collect water all the year round [5].

Chayou Middle Banner has an arable land area of 1.4296 million mu, with 4758 irrigation machinery and electrical wells. The total controlled irrigation area is 563900 mu, including 486600 mu for drip irrigation, 77000 mu for sprinkler irrigation, and 0300 mu for pipe irrigation. The main food crops are potatoes, corn, carrots, oilseeds, and miscellaneous grains[6].

According to the "Opinions of The General Office of the State Council on Promoting the Comprehensive Reform of Agricultural Water Price" (GBF [2016] No. 2), relevant departments in Ulanqab, as a crucial agricultural and animal husbandry production base, are guided by the Inner Mongolia Development and Reform Commission and the Department of Water Resources to enhance the management of farm water pricing [7]. The implementation plan for the comprehensive reform of agricultural water pricing in Inner Mongolia, along with the conversion of irrigation well water to hydropower, is being actively pursued by the Inner Mongolia Water Resources Department [8]. At the beginning of 2020, only 168 sets of flow meters were installed in the current agricultural irrigation wells of Chayou Middle Banner, but the wireless remote transmission module and monitoring terminal equipment are not sound, and equipment data is temporarily unavailable, making it impossible to accurately obtain water consumption. Through the method of "electricity converted into water", agricultural water consumption can be converted by multiplying agricultural electricity consumption by the coefficient of "electricity converted into water". The coefficient method of "converting electricity into water" can provide replicable and popularized experience and model for agricultural water price reform, and will realize indirect measurement of Farm water, which is an economic, practical and effective solution.

## 1. Data and Methods

### 1.1 Delineation of zones for water conversion testing using electricity

Based on the field survey of Chayouzhong Banner, taking into account the landform, geological structure, formation lithology, aquifer distribution, groundwater yield, recharge, runoff and drainage conditions, distribution of agricultural irrigation wells, current situation of groundwater exploitation, and combined with the Report on Groundwater Survey and Zoning in Qahar Right Middle Banner, the groundwater type can be divided into six major test areas, which are Neogene Clastic rock type fissure pore confined water area I Neogene basalt pore fissure confined water zone II, Quaternary loose rock pore phreatic water zone III, Neogene Clastic rock fissure pore phreatic water zone IV, Neogene basalt pore fissure phreatic water zone V, bedrock fissure water zone VI.

### 1.2 The principle and calculation method of using electricity to convert water

The overall idea of using electricity to calculate water is to "calculate everything based on typical examples". Firstly, based on the data of previous hydrogeological exploration results, the experimental area is designated taking into account the terrain, geological structure, stratigraphic lithology, aquifer distribution, groundwater richness, runoff and drainage conditions, distribution of agricultural irrigation wells, and current status of groundwater exploitation. Secondly, based on the investigation of each experimental area, typical wells are selected from each experimental area to conduct irrigation methods, irrigation conditions, irrigation systems, farming methods, and planting structures of typical wells Conduct on-site detailed exploration of soil, measure the water output per unit time of mechanical and electrical wells, and collect data from specialized transformers and independent electricity meters supporting agricultural irrigation mechanical and electrical wells. On this basis, we can calculate the water exchange coefficient of typical Wells, and according to the calculation results of typical Wells, comprehensive analysis to determine the water exchange coefficient of the test area.

After the pumping is stabilized, the relevant personnel read the water output per unit time of the mechanoelectric well on the ultrasonic flow meter, and read the change value of the total positive active power on the meter, and multiply it by the transformer multiple of the meter to obtain the electricity consumption per unit time. The ratio of unit time water output to electricity consumption is the electricity conversion coefficient of a typical well.

The calculation formula is as follows:

$$\mathrm{Tc} = \frac{\mathrm{W}}{\mathrm{E}} = \frac{\mathrm{Qt}}{\mathrm{E}} = \frac{3600\eta 1 \cdot \eta 2}{\mathrm{gH}}$$

In the formula: Tc - Water and electricity conversion coefficient, m3/kW • h; Total water output during the W-t period, m3; Q-t period of water extraction flow, m3/h; η Power supply efficiency in 1-t period mainly reflects voltage stability; η Efficiency of water pump usage during 2-t period; Energy consumption during the E-t period, kW • h; H - Water pump head, m.

## 2. Result and Analysis

### 2.1 Calculation of water conversion coefficient for typical wells using electricity

It can be seen from Table 1 that there are 44 typical wells in Neogene Clastic rock fissure pore confined water zone I, and the range of electric water break coefficient is 0.31-3.89. The maximum value of electric water conversion coefficient is 3.89 at point Z11, Dongtan Village, Tieshagai Town. This point is located in the Neogene Clastic rock fissure pore confined water rich area, with a water yield of about 55.98m3. The well was completed in 2018. The pump is relatively new, and the pump efficiency is high. The high water volume and relatively low power consumption may be the reasons for the high value of this point. The minimum point is 0.31 at Z68, Dingjihe Village, Guangyi Long Town. The stratum lithology at this point is Neogene Oligocene grey shale mixed with Oil shale and glutenite, with small water bearing capacity. The coefficient value at this point is small due to small water volume.

There are two typical wells in the Neogene basalt pore fissure confined water zone II, with an electric water permeability coefficient ranging from 0.41 to 1.84. The coefficient of 1.84 is mainly distributed in the eastern part of the Qiandatan Basin's current map - Yanhaizi area, with a relatively abundant water volume (>1000m3/d) in Zone II 1. 0.41 is mainly located in the areas with weak water abundance and water scarcity in the Houdatan Basin, with a single well inflow of less than 100m3/d.

There are two typical wells in Zone III of Quaternary loose rock pore phreatic water, of which point Z57 has an electrical conductivity coefficient of 0.08 and point Z73 has an electrical conductivity coefficient of 1.63. Point Z57 is located in Huagetai Village, Datan Township. According to on-site investigation and pumping test data, there is an abnormality at this point. The pump model at this point is 200QJ50-65, with an hourly power consumption of 36.6 degrees Celsius, but the hourly water output is only 2.8m3. After continuous pumping for half an hour, black muddy water appears, and this point is not representative. Therefore, this point is excluded. Finally, it was determined to use point Z73 as a typical well in Zone III of Quaternary loose rock pore phreatic water with an electric water conversion coefficient.

There are 8 typical wells in Neogene Clastic rock fissure pore phreatic water zone IV, and the range of electric water break coefficient is 1.11-1.83. The minimum value of 1.11 is at point Z33, and the maximum value of 1.83 is at point Z63. The formation lithology at both points is Neogene Baogedawula Formation red mudstone mixed with glutenite, sandstone, and Marl. However, point Z63 is in the transition zone between medium and rich water volume, point Z33 is in the medium water volume zone, and the water volume at point Z63 is relatively large. The well depth of point Z63 is 100m. The well was completed in 2018, and the well depth of point Z33 is 150m. The well was completed in 2011, and the water pump at point Z63 has high efficiency, short head, and low power consumption. Water volume and power consumption are the main reasons for the difference in the values of the two coefficients.

There are a total of 25 irrigation electromechanical wells in the Neogene basalt pore fissure phreatic water zone V. Due to the small number of wells and the lack of independent electricity meters, it is not possible to obtain water and electricity data simultaneously. Therefore, no typical wells are arranged in this experimental area. Considering that the formation lithology of this area is the same as that of Zone II of Neogene basalt pore fissure confined water, both of which are Neogene basalt pore fissure water, but with different hydraulic properties. The water level of the aquifer is buried at a depth of+7.23~11.80m, with a unit water inflow of 0.094~4.735 l/s.m, and a medium to strong water yield. Therefore, this area is similar to the typical well of Zone II of Neogene basalt pore fissure confined water with an electric water conversion coefficient.

Table 1 Calculation of Water Conversion Coefficient for Typical Wells Using Electricity

| Test Area | Motor well Location | Township | Test well number | Water pump model | Determination of water yield(m$^3$/h) | Initial degree of electricity meter | Meter termination degree | Transformer multiple | Measuring electricity consumption(°/h) | Water conversion coefficient based on electricity(m$^3$/°) |
|---|---|---|---|---|---|---|---|---|---|---|
| Zone I of Neogene Clastic rock fissure pore confined water | I1 | Tieshagai Village Xiashagai Village | Z49 | 200QJ50-104 | 34.43 | 4104.96 | 4106.13 | 30 | 35.10 | 0.98 |
| | | Wusu Town Competition Wusu | Z04 | 200QJ40-117 | 33.40 | 8630 | 8631 | 30 | 30.00 | 1.11 |
| | I2 | Sixingzhuang Village, Hongpan Township | Z65 | 200QJ60-89 | 42.45 | 167.05 | 168.01 | 20 | 19.20 | 2.21 |
| | | Yanfangfang Village, Tieshagai Town | Z12 | 200QJ80-120 | 60.93 | 2082.45 | 2082.74 | 60 | 23.20 | 2.63 |
| | I3 | Shicaozi Village, Datan Township | Z24 | 200QJ32-91 | 37.07 | 1083.14 | 1083.46 | 30 | 19.20 | 1.93 |
| | | Shicaozi Village, Datan Township | Z58 | 200QJ32-78 | 29.06 | 158.92 | 159.40 | 60 | 28.80 | 1.01 |
| | | Yanfangfang Village, Tieshagai Town | Z13 | 200QJ50-104 | 55.39 | 2337.84 | 2338.39 | 30 | 49.50 | 1.12 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Wusutu Village, Wusutu Town | Z47 | 200QJ20-130 | 29.63 | 11371.86 | 11389.47 | 0 | 17.61 | 1.68 |
| | | Xishuiquan Village, Bayin Township | Z48 | 200JJ40-114 | 54.53 | 413.75 | 415.31 | 20 | 31.20 | 1.75 |
| | | Xishuiquan Village, Bayin Township | Z74 | 200JJ40-114 | 41.64 | 3726.74 | 3727.81 | 30 | 32.10 | 1.30 |
| | I4 | Dongda Yushu in Hongpan Township | Z51 | 200QJ32-104 | 47.96 | 953.52 | 954.60 | 20 | 21.60 | 2.22 |
| | | Dongfanghong Village, Hobor | Z61 | 200QJ32-117 | 39.65 | 9739.07 | 9744.00 | 5 | 24.65 | 1.61 |
| | | Red Flag Temple in Tieshagai Town | Z01 | 200QJ40-104 | 55.06 | 1172.20 | 1175.00 | 10 | 28.00 | 1.97 |
| | | Dongtan Village, Tieshagai Town | Z11 | 200QJ80-120 | 55.98 | 733.75 | 734.23 | 30 | 14.40 | 3.89 |
| | | Dafangzi Village, Wusutu Town | Z41 | 200QJ30-118 | 46.46 | 3045.09 | 3046.55 | 30 | 43.80 | 1.06 |
| | | Detailu Village, Huangyang Town | Z72 | 200QJ50-90 | 33.59 | 1511.36 | 1511.62 | 60 | 15.60 | 2.15 |
| | | Banliang Village, Tuchengzi Township | Z69 | 200QJ20-132 | 38.19 | 2090.59 | 2091.13 | 30 | 16.20 | 2.36 |
| | | Kulun Sumu First Gacha | Z44 | 200QJ32-104 | 32.55 | 564.15 | 574.17 | 0 | 10.02 | 3.25 |
| | | No. 4 North, Guangyilong Town | Z54 | 200QJ40-104 | 19.25 | 23937.50 | 23957.20 | 0 | 19.70 | 0.98 |
| | I5 | He Longgui Village, Tieshagai Town | Z50 | 200QJ30-158 | 46.03 | 10108.77 | 10109.99 | 30 | 36.60 | 1.26 |
| | | Dafangzi Village, Wusutu Town | Z42 | 200QJ50-117 | 35.25 | 2354.70 | 2355.18 | 30 | 14.40 | 2.45 |
| | | Xishanwan Village, Tuchengzi Township | Z70 | 200QJ63-96 | 10.85 | 5636.29 | 5636.89 | 30 | 18.00 | 0.60 |
| | | Kulun Sumu Third Gacha | Z43 | 200QJ40-91 | 37.59 | 1404.54 | 1405.48 | 20 | 18.80 | 2.00 |
| | | Xiaohaizi Village, Bayin Township | Z45 | 200QJ32-130 | 33.10 | 69459.07 | 69485.63 | 0 | 26.56 | 1.25 |
| | | Nanbei Village, Guangyi Long Town | Z56 | 200QJ32-114 | 18.80 | 5.40 | 21.69 | 0 | 16.29 | 1.15 |
| | | Tuchengzi Village, Guangyilong Town | Z67 | 200QJ32-114 | 53.70 | 9537.29 | 9537.84 | 30 | 16.50 | 3.25 |
| | | Usutu Saiwusu | Z02 | 200QJ40-117 | 48.11 | 5961.00 | 5962.00 | 30 | 30.00 | 1.60 |
| | | Tata Village, Guangyi Long Town | Z09 | 200QJ32-175 | 15.40 | 4211.95 | 4213.13 | 50 | 33.50 | 0.46 |
| | | Weizi Village, Guangyi Long Town | Z66 | 200QJ20-117 | 10.85 | 5635.91 | 5636.89 | 10 | 6.00 | 1.81 |
| | | Dingjihe Village, Guangyilong Town | Z68 | 200QJ20-200 | 6.13 | 21850.31 | 21870.46 | 0 | 20.15 | 0.31 |
| | | Miao Village, Datan Township | Z25 | 200GJ50-97 | 17.97 | 573.48 | 574.46 | 30 | 29.40 | 0.61 |
| | I6 | Xiaohezi Village, Huangyang Town | Z27 | 200QJ50-78 | 29.85 | 897.88 | 898.15 | 60 | 16.20 | 1.84 |
| | | Chenjia Village, Huangyang Town | Z71 | 200QJ30-91 | 42.49 | 5654.59 | 5655.31 | 30 | 21.60 | 1.97 |
| | | Dayingzi Village, Huangyang Town | Z30 | 200QJ32-105 | 17.52 | 2901.10 | 2902.73 | 10 | 16.30 | 1.07 |
| | | Xibugai Village, Tuchengzi Township | Z28 | 200QJ25-130 | 25.45 | 966.89 | 967.98 | 30 | 32.70 | 0.78 |
| | | Bugai Village, Tuchengzi Township | Z29 | 200QJ50-91 | 49.21 | 1889.48 | 1889.97 | 30 | 14.70 | 3.35 |
| | | Xiaohaizi Village, Bayin Township | Z06 | 200QJ20-78 | 10.42 | 945.07 | 945.45 | 30 | 11.40 | 0.91 |
| | | Dabei Village, Bayin Township | Z46 | 200QJ32-130 | 34.61 | 3802.97 | 3803.60 | 30 | 18.90 | 1.83 |
| | | Xiliang Village, Guangyi Long Town | Z14 | 200QJ20-270 | 20.48 | 5831.21 | 5831.58 | 30 | 19.59 | 1.04 |
| | | Xiliang Village, Guangyi Long Town | Z15 | 200QJ25-156 | 29.30 | 5296.40 | 5297.20 | 10 | 18.46 | 1.59 |
| | | Pianguan Village, Guangyi Long Town | Z16 | 200QJ25-268 | 37.69 | 13115.25 | 13115.96 | 30 | 21.30 | 1.76 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Pianguan Village, Guangyi Long Town | Z17 | 200QJ20-224 | 34.02 | 13115.96 | 13116.37 | 30 | 18.45 | 1.84 |
| | | Sanchengdian Village, Tuchengzi Township | Z19 | 200QJ32-117 | 26.43 | 7241.00 | 7242.00 | 30 | 30.00 | 0.88 |
| | | Caomaoshan, Guangyi Long Town | Z55 | 200QJ50-91 | 54.84 | 3085.85 | 3099.95 | 0 | 14.10 | 3.89 |
| Neogene basalt pore fissure confined water zone II | II1 | Hongpan Township Liu Tianbao Camp | Z52 | 200QJ40-91 | 38.71 | 102.45 | 103.50 | 20 | 21.00 | 1.84 |
| | II2 | Ulan Sumu Middle Ulan Village | Z62 | 200QJ32-105 | 5.53 | 1642.11 | 1655.61 | 0 | 13.50 | 0.41 |
| Quaternary loose rock pore phreatic water zone III | III | Huagetai Village, Datan Township | Z57 | 200QJ50-65 | 2.80 | 390.05 | 393.71 | 10 | 36.60 | 0.08 |
| | | Ulan Sumu Middle Ulan Village | Z73 | 200QJ20-78 | 33.79 | 842.56 | 843.58 | 30 | 20.70 | 1.63 |
| Neogene Clastic rock fissure pore phreatic water zone IV | IV1 | Erdaogou, Hongpan Township | Z64 | 200QJ40-132 | 16.24 | 7724.64 | 7725.35 | 20 | 14.20 | 1.14 |
| | | Hobor Damakulun | Z60 | 200QJ50-82 | 83.53 | 1748.93 | 1749.76 | 60 | 49.80 | 1.68 |
| | IV2 | Xihaoyu Village, Hobor | Z63 | 200QJ32-104 | 41.08 | 969.81 | 970.56 | 30 | 22.50 | 1.83 |
| | IV3 | Dadongbu Village, Huangyang Town | Z08 | 200QJ50-90 | 60.62 | 3544.76 | 3545.95 | 30 | 35.70 | 1.70 |
| | | Badaogou Village, Hongpan Township | Z33 | 200QJ32-130 | 28.78 | 3520.53 | 3521.40 | 30 | 26.10 | 1.11 |
| | | Toudaogou Village, Hongpan Township | Z34 | 200QJ32-104 | 38.28 | 3790.36 | 3791.44 | 30 | 21.60 | 1.77 |
| | | Yuanshanzi Village, Hobor | Z59 | 200QJ40-91 | 40.16 | 881.85 | 882.74 | 30 | 26.70 | 1.50 |
| | IV4 | Toudaogou Village, Hongpan Township | Z32 | 200QJ32-91 | 33.19 | 815.09 | 816.28 | 20 | 23.80 | 1.39 |

## 2.2 Electricity conversion coefficient for irrigation wells

There are a total of 4758 irrigation mechanical and electrical wells in Chayou Middle Banner. Based on the idea of using electricity to calculate water, "calculate all wells based on typical data." Firstly, the electric-water coefficient of a typical well is measured and calculated. On the basis of comprehensive analysis of the calculation results of typical Wells, the researchers determined the electric-water coefficient of the experimental area, and also determined the electric-water coefficient of each township, administrative village and all agricultural irrigation Wells according to the electric-water coefficient of the experimental area. 4758 irrigation wells have an electric water conversion coefficient ranging from 0.41 to 2.42.

## 2.3 The experimental area is determined by the water conversion coefficient of electricity

In each of the six major experimental areas, the average value of the electric water conversion coefficient of all typical wells in the small experimental area is used as the electric water conversion coefficient of the small experimental area. The electric water conversion coefficient of each experimental area is shown in Table 2.

It can be seen from Table 2 that the range of electric water conversion coefficient in Zone I of Neogene Clastic rock fissure pore confined water is 1.05-2.42: the maximum value is Zone I2, and the minimum value is Zone I1. Both Zone I1 and Zone I2 are located in areas with abundant water content, with well depths of around 100m. However, the typical completion time of the two wells in Zone I1 was in 2008, and the completion time was earlier. The pump models were 200QJ50-104 and

200QJ40-117. Due to the low efficiency and high power consumption of the old pump, the rated water output was relatively small, resulting in a relatively small coefficient in this area; The two typical wells in Zone I2 were relatively late in completion, with pump models 200QJ60-89 and 200QJ80-120. The pump has a high rated water output, high efficiency, low power consumption, and a relatively high coefficient in this area; The range of the electrical conductivity coefficient of the confined water II in the pores and fractures of the Neogene basalt is between 0.41 and 1.84. Among them, Zone II1 is 1.84, Zone II2 is 0.41. Zone II1 is mainly distributed in the eastern part of the Qiandatan Basin's current map - Yanhaizi area, with abundant water volume (>1000m3/d). Zone II2 is mainly located in the area of Houdatan Basin with weak water abundance and poor water volume, with a single well inflow of less than 100m3/d; The pore phreatic water coefficient of Zone III in Quaternary loose rocks is 1.63; In the Neogene Clastic rock fissure pore phreatic water zone IV, the range of electric water break coefficient is 1.39-1.83. Zone IV is divided into four small experimental areas. Zone IV1 has an electric water conversion coefficient of 1.41, Zone IV2 has an electric water conversion coefficient of 1.83, Zone IV3 has an electric water conversion coefficient of 1.52, and Zone IV4 has an electric water conversion coefficient of 1.39. The difference in electric water conversion coefficients among the four small experimental areas is relatively small; The water and electricity data cannot be obtained simultaneously in the Neogene basalt pore fissure phreatic water zone V. Considering that it has the same lithology as the Neogene basalt pore fissure confined water zone II, this zone is similar to the typical well in the Neogene basalt pore fissure confined water zone II with an electric water conversion coefficient. The water conversion coefficient of electricity in this area ranges from 0.41 to 1.84; The water inflow of a single well in Zone VI of bedrock fissure water is generally less than 100m3/d, with weak water abundance and water scarcity. The electric water coefficient can be compared to Zone II2 of Neogene basalt pore fissure confined water with small water volume. The electric water coefficient range in this area is 0.41.

Table 2 Water Conversion Coefficient by Electricity in the Experimental Area

| number | test zone | | The number of electric folding water system |
|---|---|---|---|
| 1 | Zone I of Neogene Clastic rock fissure pore confined water | $I_1$ | 1.05 |
| | | $I_2$ | 2.42 |
| | | $I_3$ | 1.47 |
| | | $I_4$ | 2.17 |
| | | $I_5$ | 1.4 |
| | | $I_6$ | 1.75 |
| 2 | Neogene basalt pore fissure confined water zone II | $II_1$ | 1.84 |
| | | $II_2$ | 0.41 |
| 3 | Quaternary loose rock pore phreatic water zone III | III | 1.63 |
| 4 | Neogene Clastic rock fissure pore phreatic water zone IV | $IV_1$ | 1.41 |
| | | $IV_2$ | 1.83 |
| | | $IV_3$ | 1.52 |
| | | $IV_4$ | 1.39 |
| 5 | Neogene basalt pore fissure diving zone V | $V_1$ | 1.84 |
| | | $V_2$ | 0.41 |
| 6 | Bedrock fissure water zone VI | VI | 0.41 |

## 3. Measures and suggestions for ensuring the work plan of converting electricity into water

### 3.1 Measures to ensure the work plan of converting electricity into water

#### 3.1.1 Strengthen organizational leadership and implement reform tasks

In order to promote the sustainable development of agricultural production and the rational development and utilization of water resources, it is necessary to establish a new mechanism for the management of well irrigation areas and establish a leadership group for the implementation of electricity for water conversion. The leadership group has an office located in the Water Resources Bureau. Departments such as water conservancy, development and reform, finance, and agriculture and animal husbandry in Chayou Middle Banner should assume their respective responsibilities, collaborate and cooperate with each other, carefully organize and strengthen guidance, and jointly promote the implementation of the work of converting electricity into water.

The Water Conservancy Bureau should solidly promote the construction of farmland irrigation and drainage engineering system and water supply metering facilities focusing on water conservation, determine the total amount of regional Farm water and the decomposition of indicators, issue water intake permits in irrigation areas, clarify the water rights of water users, establish a water rights trading system, and be responsible for the organization, implementation and daily work of converting electricity into water; Guide the pilot project area to innovate the management system for agricultural water conservancy engineering construction, improve irrigation engineering measurement facilities, and strengthen the supervision and management of construction funds for water conversion projects with electricity; The development and reform departments should coordinate and guide the establishment of a water price formation mechanism, and do a good job in the cost calculation, supervision, and verification of agricultural water prices under their own management; The finance department is responsible for integrating funds for agricultural, animal husbandry, and water related projects, providing specific opinions on the use plan of funds for irrigation engineering construction and supporting water supply measurement facilities, and implementing the sources of precise subsidies and water-saving reward funds; The agricultural and animal husbandry departments should focus on adjusting and optimizing the planting structure, actively promoting the integration of water and fertilizer technology, agricultural machinery water-saving, and dry farming technology, strengthening the promotion, training, and technical guidance of agricultural water-saving technology, conducting water-saving agricultural technology experiments and demonstrations, and improving farmers' awareness and technical level of scientific and water-saving water use.

### 3.1.2 Implement the reform funds to ensure the implementation of the reform

All relevant departments should fully implement their responsibilities and tasks, serve the reform of agricultural water prices, strictly implement the "accountability system", and adopt various forms of leadership supervision to implement the responsibility system. The financial department should manage the allocation of funds and ensure that investment is in place. Relevant departments should establish agricultural water price reform fund accounts, ensure that local supporting funds and project integration funds are in place on time and in full, ensure that funds are used exclusively, and do a good job in auditing special funds and strictly supervise the use of project funds.

### 3.1.3 Strengthen reform publicity and promote water-saving technology

Relevant departments can actively carry out the publicity and report of the electricity to water pilot through a variety of media and ways.

The first step is to strengthen water education. The basic water situation is widely publicized to water users, so that they can understand local water problems and their important impact on economic and social development and people's lives, and promote the establishment of awareness of water conservation and emission reduction.

In addition, the significance of reform should be clearly and widely publicized. We should give full play to the role of newspapers, radio, television and modern distance education networks, thoroughly publicize the relevant spirit at the central and local levels, earnestly strengthen publicity and guidance, and expand coverage and influence. To sum up and promote good experience and practices, promote the use of electricity instead of water through radio, television, Internet, newspapers and other channels, as well as through popular means such as hanging banners, Posting slogans, distributing materials and conducting technical training. Promote the new content of electricity for water to the general public in a timely manner, so that the whole flag has a preliminary understanding of the goal, principle and content of this electricity for water. In addition, some employees from various townships and water conservancy departments were selected to go deep into village groups and farmers' homes to give strong lectures, and the LED display screens within the jurisdiction were fully utilized to play the determination of water rights, initial allocation of water rights, how to trade water volume, how to determine differentiated water prices, levy water fees based on the quantity of agricultural irrigation water, and pay compensation fees for water resources beyond the quota of contracted land and for water use beyond the contracted land. The relevant departments pay attention to the timing, intensity and effect of public opinion guidance in the publicity and explanation, and strive to create a good atmosphere for activities through various forms such as news reports, speech comments, work reviews, and special interviews to ensure the smooth and orderly implementation of the electronic discount level.

#### 3.1.4 Establish an assessment mechanism to ensure the effectiveness of the reform

Relevant departments should establish an assessment mechanism based on self-evaluation, incorporate the assessment results into the most stringent water resources management system assessment, and link them to the allocation of financial incentives and subsidies. The establishment of an assessment mechanism can effectively promote the progress of converting electricity into water and achieve results as soon as possible.

### 3.2 Suggestions for promoting the work plan of converting electricity into water

The Planning and Implementation Outline of Groundwater Ecological Protection and Treatment in Inner Mongolia (NSZ [2019J 163]) and the Notice of the Water Resources Department of Inner Mongolia on Printing and Distributing the Guiding Plan for the Pilot Work of Converting Electricity into Water in Inner Mongolia (NSZ [2020] 143) need to actively carry out the calculation of converting electricity into water. In order to ensure the smooth implementation of this work, the following suggestions are proposed:

#### 3.2.1 Cooperation from the power supply department.

The work of converting electricity into water must be carried out with the cooperation of the power department. There are four situations for the whole flag's well, the first one is that there are water conservancy measuring facilities and electric power IC card meters, which are chosen by the village committee or water use association to use; The second scenario is where there are water metering facilities and there is no electricity IC card meter available, the implementation of a water and electricity one card system can be implemented; In the third scenario, there is an electric power IC card meter, but there is no metering facility. An intelligent communication gateway is used to collect user electricity consumption and convert electricity into water; The fourth type is the situation where there is no power IC card meter or metering facility, and the water pump is added through an intelligent communication gateway to control the electrical switch and control the circuit equipment to convert electricity into water.

Determine water rights. Relevant departments shall reasonably determine water rights according to natural conditions, irrigation methods, national irrigation quotas and local economic development.

Safeguarding the interests of village committees or village water use associations. The relevant departments shall clarify the specific amount, assessment methods and distribution process of the award and subsidy funds of the association. Truly benefiting well managed and highly coordinated water use associations. At the same time, we will gradually achieve the development of irrigation trusteeship business through market-oriented means, increase the economic income of the association, promote the full play of the role of grassroots organizations with economic benefits, and fully ensure the implementation of electricity for water.

The cashing out of the village committee, village water use association, and farmers' compensation funds will have a driving effect on the implementation of electricity to water conversion in the entire flag, win the support of the people and associations, and cooperate with public opinion guidance to achieve twice the result with half the effort.

### 3.2.2 Water fee calculation and collection

#### 3.2.2.1 Collection of water fees within the limit

The collection of water fees within the quota shall be calculated and collected by the Farmers' Water Cooperative Organization. According to the calculated operation and maintenance cost price, grain crops are subsidized by the government. Adopting the form of swiping cards, farmers go to water user cooperative organizations to swipe cards to pay fees.

#### 3.2.2.2 Method for calculating and collecting water fees beyond the limit

The collection of water fees beyond the quota is also uniformly calculated and collected by the Farmers' Water Cooperative Organization. According to the irrigation quota determined by the water conservancy department, an additional fee system will be implemented for water quantities exceeding the water usage quota. If the amount exceeds the planned limit by less than 20%, an additional fee of 0.3 yuan/m3 will be levied; For those exceeding the plan by 20% to 40%, an additional 0.5 yuan/m3 will be charged; For those exceeding 40%, in addition to charging water fees according to regulations, water supply can be restricted or even stopped in accordance with relevant national and provincial laws and regulations. The excessive fines are managed and distributed by the farmers' water cooperation organization themselves, as a source of maintenance and reward funds.

The Planning and Implementation Outline of Groundwater Ecological Protection and Treatment in Inner Mongolia (NSZ [2019J 163]) and the Notice of the Water Resources Department of Inner Mongolia on Printing and Distributing the Guiding Plan for the Pilot Work of Converting Electricity into Water in Inner Mongolia [10] (NSZ [2020] 143) need to actively carry out the calculation of converting electricity into water. In order to ensure the smooth implementation of this work, the following suggestions are proposed.

## 3.3 Suggestions for implementing the work-plan of converting electricity into water

### 3.3.1 Cooperation from the power supply department.

The work of converting electricity into water must be carried out with the cooperation of the power department. There are four situations for the whole flag's well, the first one is that there are water conservancy measuring facilities and electric power IC card meters, which are chosen by the village committee or water use association to use; The second scenario is where there are water metering facilities and there is no electricity IC card meter available, the implementation of a water and electricity one card system can be implemented; In the third scenario, there is an electric power IC card meter, but there is no metering facility. An intelligent communication gateway is used to collect user electricity consumption and convert electricity into water; The fourth type is the situation where there is no power IC card meter or metering facility, and the water pump is added through an intelligent communication gateway to control the electrical switch and control the circuit equipment to convert electricity into water.

### 3.3.2 Determine water rights.

Relevant units shall reasonably determine water rights according to natural conditions, irrigation methods, national irrigation quotas and local economic development.

### 3.3.3 Safeguarding the interests of village committees or village water use associations.

The relevant departments shall clarify the specific amount, assessment methods and distribution process of the award and subsidy funds of the association. Truly benefiting well managed and highly coordinated water use associations. At the same time, we will gradually achieve the development of irrigation trusteeship business through market-oriented means, increase the economic income of the association, promote the full play of the role of grassroots organizations with economic benefits, and fully ensure the implementation of electricity for water.

The cashing out of the village committee, village water use association, and farmers' compensation funds will have a driving effect on the implementation of electricity to water conversion in the entire flag, win the support of the people and associations, and cooperate with public opinion guidance to achieve twice the result with half the effort.

### 3.3.4 Water fee calculation and collection

#### 3.3.4.1 Collection of water fees within the limit

The collection of water fees within the quota shall be calculated and collected by the Farmers' Water Cooperative Organization. According to the calculated operation and maintenance cost price, grain crops are subsidized by the government. Adopting the form of swiping cards, farmers go to water user cooperative organizations to swipe cards to pay fees.

#### 3.3.4.2 Method for calculating and collecting water fees beyond the limit

The collection of water fees beyond the quota is also uniformly calculated and collected by the Farmers' Water Cooperative Organization. According to the irrigation quota determined by the water conservancy department, an additional fee system will be implemented for water quantities exceeding the water usage quota. If the amount exceeds the planned limit by less than 20%, an additional fee of 0.3 yuan/m3 will be levied; For those exceeding the plan by 20% to 40%, an additional 0.5 yuan/m3 will be charged; For those exceeding 40%, in addition to charging water fees according to regulations, water supply can be restricted or even stopped in accordance with relevant national and provincial laws and regulations. The excessive fines are managed and distributed by the farmers' water cooperation organization themselves, as a source of maintenance and reward funds.


### Acknowledgement

This work was supported by. China Finland International Cooperation Project (2017YFE0114800), Optimization and Integration Demonstration of Ecological Environment Comprehensive Management Technology for Typical Lakes in the Yellow River Basin of Inner Mongolia (2021GG0089), and National Natural Science Foundation Project (52260028) * * Joint funding.

## References


*[1] Chang Wenping. Analysis of the River Chief System Work in Chayou Middle Banner from Seeing River Chief, Seeing Action to Seeing Results Inner Mongolia Water Conservancy, 2018, (12): 66-67*

*[2] Zhang Shaohui. Truthfully spreading the rain and dew of justice, meticulously cultivating the flower of unity [N]. 2020-09-08*

*[3] Lin Yuancong, Liu Zhiwei. Analysis of poverty alleviation development of photovoltaic industry in Inner Mongolia under the background of Targeted Poverty Alleviation Inner Mongolia Science and Technology and Economy, 2018, (07): 3-6*

*[4] Cao Hongxia, Han Qi, Chai Lihua, etc. Research on Agricultural Development and Water Strategy in Chayou Middle Banner Inner Mongolia Water Conservancy, 2011, (01): 45-46*

*[5] Gao Lifen, Wang Lixia, Wu Zishen, etc. The development and application effect of "Yongye Brand" plant growth nutrient solution Inner Mongolia Petrochemical, 2007, (02): 9-11+14*

*[6] Zhang Jianbin, Feifei Li, Zhu Xuemin. The practical progress, practical difficulties, and current responses of the comprehensive reform of agricultural water prices - based on a case study of Hetao Irrigation District in Inner Mongolia Price Monthly, 2021, (03): 42-51 DOI: 10.14076/j.issn.1006-2025. 2021.03.07*

*[7] Chen Weiguo. Analysis and research on the relationship between the efficiency of water pump equipment and the water conversion coefficient using electricity Haihe Water Conservancy, 2021, No. 227 (01): 123-126*

*[8] Zhou Yuan, Wang Haiyan. Discussion on the Countermeasures and Effects of Overextraction of Groundwater in Our District Inner Mongolia Water Conservancy, 2020, (07): 16-17*