Abstract: The aim of the research was to study the quality of drinking water in the agricultural region. Determination of the quality of water which is for immediate consumption by farmers who have not very deep wells is a very important problem. Farmers usually estimate the quality of water in their wells on the basis of subjective sensations – most frequently taste and flavour, without any professional control. Therefore, our tests had control and educational aspects.

The control tests were made for different 10 wells from Stara Wies in February, April and June 2010. The following parameters were taken into account: nitrates, nitrites, chlorides, chromium, copper, iron, manganese, hardness, pH, conductance, etc. Analysis were carried out by means of Spectrophotomer DR/2010 (Hach). The results were compared with the actually Polish Standards and EU Directive.

It was concluded that water quality was affected by climatic conditions and season of the year. Unfortunately in this region appearance local floods generated by intensive rainfalls.

Keywords: wells, water quality, standards

Introduction

Water is an indispensable element in human life and economy. It is the subject of consumption, a prerequisite for hygiene and health and, above all, it is the basis for the development of industry, agriculture and other sectors of the economy. The main factor that determines the usefulness of natural water for a particular purpose is its quality. Particular attention should be paid directly to water intended for human consumption. Drinking water consumed for many years and sometimes for life from a single source must be subject to special control. Potential pollutants occurring in the excessive amounts are potentially harmful to health, especially those that accumulate in the body and can lead to pathological changes [1].

1 Faculty of Process and Environmental Engineering, Technical University of Lodz, ul. Wólczańska 215, 90–924 Łódź, Poland, phone: +48 42 631 37 88, email: tomczak@wipos.p.lodz.pl
One of the important indicators of water quality is the presence of metals, especially heavy metals. Both deficiency and excess are detrimental to human health. Heavy metals can penetrate into the body in different ways (through the respiratory, digestive system, skin etc), but accepting them with water can lead to accumulation in the body.

The quality of groundwater is a function of many parameters, whose share in terms of the volume is variable in time. The composition of water is dependent on the characteristics of the area (geological structure, sorption properties of the medium, the processes of weathering and dissolution) processes in the water, deep wells and their location in relation to pollution sources. In the well water one can expect agricultural pollution, which mainly consist of plant protection products, fertilizers derived from surface runoff from fields and meadows, compounds derived from dunghill and animal farming areas [2].

Wells capture water from the first and the most shallow aquifer. The presence of contaminants can result in noticeable organoleptic changes and unpleasant taste, odor or color of the water and then more easily react to changing water quality and take appropriate preventive steps. It is worse when changes are physicochemical, undetectable by the consumer which directly can cause qualitative composition of drinking water being more significant in human health effects.

It should be noted that the safest solution for households is to connect the home to the local water supply as this water must be checked for quality by specialized units in order to minimize the risk of contamination.

**Scope of experiments**

The aim of this study was to determine the quality of water consumption, exploited from brick-lined wells in rural households. To determine the quality of water from the above-mentioned sources there was selected an agricultural area located in the south-eastern province of Lodz. In the spring season 2010 (February, April, June) there has been periodically collected water from selected ten brick-lined wells (water injection) with an average depth of 5 m to 10 m at different points in Stara Wies (Rozprza community, Piotrkow District). Wells were spaced apart from a few to several hundred meters. Weather conditions occurring on a day of water sample collection were as follows:

1. February: –10 °C, cloudy, snow cover thickness of 30 cm;
2. April: 3 °C, cloudy, without rain, the week after thaw;
3. June: 12 °C, overcast, drizzle, four weeks after the local flooding.

Wells 1–10 were located on farms in the Stara Wies in succession under the numbers “42”, “44”, “166”, “180”, “181”, “182”, “185”, “189”, “192”, “194”.

Using a spectrophotometer RD/2010 there was performed a qualitative analysis of water. There were identified 13 indicators adequately characterizing the water quality. Final results were expressed as mean of three determinations. In accordance with the procedures attached to the camera recommended by the U.S. Environmental Protection Agency there were determined:

- **Hardness of water** – (0 to 4.0 mg/dm³ Ca and Mg as CaCO₃),
- **Iron** – (0 to 3.0 mg/dm³ Fe),
– Sulphate – (0 to 70 mg/dm$^3$ SO$_4^{2-}$),
– Chlorine – (0 to 2.0 mg/dm$^3$ Cl$_2$),
– Chloride – (0 to 20 mg/dm$^3$ Cl$^-$),
– Chromium – (0 to 6 mg/dm$^3$ Cr$^{3-}$),
– Copper – (0 to 5 mg/dm$^3$ Cu),
– Manganese – (0 to 0.7 mg/dm$^3$ Mn),
– Nitrate – (0 to 4.5 mg/dm$^3$ N-NO$_3^-$),
– Nitrites – (0 to 3.0 mg/dm$^3$ N-NO$_2^-$),
– Turbidity – (0 to 450 FAU),
– Conductivity – ($\mu$S/cm at 20 °C),
– pH – (1 to 14).

**Water supply network in the community of Rozprza**

The primary source of income of Rozprza community is agriculture. It is mainly dominated by the cultivation of cereals and the breeding of pigs and cattle. Agricultural land has an area of 10704 ha, or 65.8 % of total area of the commune. They are dominated by private farms 7–15 ha. The community has 12115 inhabitants, who live in the area of 163 km$^3$.

Within the borders of Rozprza community, underground waters are mainly connected with the Quaternary and upper-cretaceous forms.

Basic utility Upper Cretaceous aquifer is a water-bearing floor and is formed by marls, limestone and tufa. This level is mainly at a depth of several to 60 m below the ground level. The quaternary aquifer is associated with fluvio-glacial sands and it occurs at a depth of several meters to 40 m below ground level. For municipal water intakes this level is of subordinate meaning.

Water intakes are located in towns: Bialocin, Milejow and Mierzyn (showing the operation of Upper Cretaceous aquifer) and in Lubien (quaternary aquifer). In the area of municipality there are 41 villages and a number of buildings connected to the network is 3200.

Acceptability of water supplied by the public does not relieve companies of water supply and sanitary inspection authorities from the obligation to monitor water quality. Depending on the type of water supply and the determined index there exists variation in the frequency of controls and water outlets. In case of the microbial assays (*Escherichia coli* and *fecal streptococci – enterococci*) sampling should take place on the length of the whole water supply system. Consumers should continue to have access to information and to obtain advice on the potential for improving water directly consumed. The guarantee of health security is the implementation of Water Safety Plans, which is the proper water quality management.

Control of water quality for drinking water supply system in the municipality is conducted on an ongoing basis by the District Sanitary and Epidemiological Station in Piotrkow. The frequency of sampling and testing of water are carried out 5 times a year with an average frequency of once every 3 months.
The work is acquainted with the reports of studies conducted in 2009 for drinking water intake located in Białocin and Milejów. The water was characterized by good quality except for excess of levels of bacteriological indicators for inclusion in Milejów (19.01.2009). The results are shown in Table 1.

**Table 1**

<table>
<thead>
<tr>
<th>Test</th>
<th>Unit</th>
<th>Result</th>
<th>Limit value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>mgPt/dm³</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>0.35</td>
<td>1</td>
</tr>
<tr>
<td>Reaction</td>
<td>pH</td>
<td>7.1</td>
<td>6.5–9.5</td>
</tr>
<tr>
<td>Conductivity</td>
<td>S/cm at 25 °C</td>
<td>830</td>
<td>2500</td>
</tr>
<tr>
<td>Smell</td>
<td>organoleptically</td>
<td>none</td>
<td>accept.</td>
</tr>
<tr>
<td>Taste</td>
<td>organoleptically</td>
<td>nb</td>
<td>accept.</td>
</tr>
<tr>
<td>Ammonia ion</td>
<td>mgNH₄⁺/dm³</td>
<td>&lt; 0.10</td>
<td>0.50</td>
</tr>
<tr>
<td>Nitrates</td>
<td>mgNO₃⁻/dm³</td>
<td>1.6</td>
<td>50</td>
</tr>
<tr>
<td>Nitrites</td>
<td>mgNO₂⁻/dm³</td>
<td>0.007</td>
<td>0.50</td>
</tr>
<tr>
<td>Manganese</td>
<td>mgMn/dm³</td>
<td>&lt; 0.020</td>
<td>0.050</td>
</tr>
<tr>
<td>Iron</td>
<td>mgFe/dm³</td>
<td>&lt; 0.020</td>
<td>0.200</td>
</tr>
<tr>
<td>Fluorides</td>
<td>mg/dm³</td>
<td>0.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Chromium</td>
<td>mgCr/dm³</td>
<td>&lt; 0.005</td>
<td>0.050</td>
</tr>
<tr>
<td>Cadmium</td>
<td>mgCd/dm³</td>
<td>&lt; 0.001</td>
<td>0.005</td>
</tr>
<tr>
<td>Lead</td>
<td>mgPb/dm³</td>
<td>&lt; 0.010</td>
<td>0.025</td>
</tr>
<tr>
<td>Chlorides</td>
<td>mgCl⁻/dm³</td>
<td>33.0</td>
<td>250</td>
</tr>
<tr>
<td>Sulphates</td>
<td>mgSO₄²⁻/dm³</td>
<td>9.6</td>
<td>250</td>
</tr>
<tr>
<td>The number of microorganism in 1 cm³ on an agar at temperature of 22 °C after 72 h</td>
<td>cfu</td>
<td>ca 400</td>
<td>100</td>
</tr>
<tr>
<td>The number of microorganisms in 1 cm³ on an agar at the temperature of 36 °C after 48 h</td>
<td>cfu</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Bacteria coli</td>
<td>cfu</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Escherichia coli</em> in 100 cm³</td>
<td>cfu</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Enterococci</em> in 100 cm³</td>
<td>cfu</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Results and discussion**

Requirements for the quality of water intended for human consumption until recently were defined by the *Ministry of Health of 29 March 2007 on the quality of water intended for human consumption*. On 20 April of 2010 the Minister of Health Ewa Kopacz, has signed a regulation amending the aforementioned Regulation (*Decree of the Minister of Health of 20.04.2010 amending Regulation on the quality of water intended for human consumption – O.J. no. 72, item. 466*). The amendment was carried
to full and proper implementation of Directive 98/83/EC on the observations of the European Commission [3]. This authority previously noted that Polish legislation does not transpose the Directive requirements in relation to the number of such microorganisms at 22 °C, turbidity, total organic carbon and color, taste and smell. These parameters are mainly used to determine the correctness of the process of water treatment and distribution without having a direct impact on consumer health, but they play an important role in the perception of water quality. Other observations/comments on amendments to existing legislation, de facto leading towards the security of consumers’ health can be found in Wichrowski et al [4].

Figures 1–4 show examples of changes in water quality indicators by comparing them with the current regulatory framework.

Analyzing the results obtained it can be concluded that in most wells, there was a suspension of fine organic and inorganic particles, hence water was thus characterized by a different color, from transparent to yellow.

Fig. 1. Nitrite content in well water (standard 0.5 mg/dm³)

Fig. 2. Copper content in well water (standard 2.0 mg/dm³)
All water samples were characterized by high turbidity above 1 NTU value. The pH of water was maintained at a constant level, within pH 7–8.

In two cases, for wells No. 6 and 8, the value of conductivity has been slightly exceeded.

In June for wells 5–8, there have been exceeded acceptable levels of manganese, in addition to the well no. 7 which was found to exceed the value of iron, but in other waters, these indices remained constant at a low level, not exceeding the standards. There was no excess of indicators such as nitrites, nitrates, copper, chlorides, sulfates, chlorine. In the case of nitrates and nitrites they have increased after the spring fertilization.

The final conclusion is that the worst water quality was characterized by well no. 7, while the best water came from well no. 10 and about the results of the studies there were informed the property owners in the area where water samples for quality assessment were collected.
Conclusions

Until recently, on agricultural land the well was the only source of drinking water. At present, despite the significant water service coverage of rural areas, there are still places where people use well water. This is due to economic reasons, from the lack of access to water supply system or unprofitability of its supply, and therefore, the problem of water quality derived from these shots is still very important. However, please note that access to clean drinking water is a fundamental right and need of every man in the world. According to the EU Water Framework Directive, water should not only be a commercial commodity like any other good natural resources, but the legacy of generations must be protected and appreciated. 22 March 2010 – World Water Day was celebrated under the theme “Clean water for the health of the world”. The ideas promoted in the framework of the celebrations aim to raise awareness that water quality has a direct impact on human health.

In rural areas, the greatest threat to groundwater quality is agriculture and the associated use of pesticides and fertilizers. Another source of water pollution may be inappropriate location of wells in relation to the collection tanks of liquid and solid.

There are also unforeseen natural phenomena with a random character, which may locally result in a significant deterioration in water quality. This group includes the floods and inundation. They may also be the result of human activity through the disruption of normal phenomena, or the result of technical failure of equipment. But the main cause of flooding is more rainfall in relation to the possible infiltration of the soil per unit time.

In the course of research in water in the area of water sample collection there was local flooding. The land was flooded to a height of 50–100 mm. This situation was related to the occurrence of floods throughout the country, causing a significant change in the organoleptic characteristics of water. In some wells there was observed the increase in turbidity, color from yellow to brown and smell, as well as the presence of numerous microflora and fauna.

Fortunately, the owners of wells intuitively abandon using that water for any purpose.

References

JAKOŚĆ WÓD STUDZIENNYCH W STAREJ WSI W POWIECIE PIOTRKOWSKIM

Wydział Inżynierii Procesowej i Ochrony Środowiska
Politechnika Łódzka


Stwierdzono, że jakość wody zależy od warunków klimatycznych i pory roku. Niestety na tym terenie w okresie badań wystąpiły lokalne podtopienia wywołane znacznymi opadami, co skutkowało pogorszeniem jakości wody.

Słowa kluczowe: studnie, jakość wody, normy