THE USE OF COAL WASTES TO PRODUCE ADSORBENTS

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Abstract
This article presents a brief analysis of the problem of clean water shortage and the way of its purification using coal and waste products of Angren coal mine. Authors present characteristics of coal and waste products of industrial coal mining and methods of their application as sorbent agent in filters. The analogues and technologies which are applied in different countries for sorption treatment of water are also presented. The results of tests of filters in laboratory conditions conducted to identify the sorption capacity were presented.

Keywords: coal waste, food and drinking water, coarse purification, pre-treatment, activated carbon, sorption treatment.

Introduction

In recent years, the shortage of clean drinking water has only increased, and while this problem used to be discussed mainly by ecologists and water treatment specialists, today it is one of the main issues in all international organizations, and state programmes are being established to provide clean drinking water to the population. Atmospheric pollution, which has become widespread, has damaged rivers, lakes, reservoirs and soils. Pollutants and products of their transformation sooner or later from the atmosphere reach the surface of the earth. This already big misfortune is considerably worsened by the fact that both water bodies and the ground are directly affected by the waste flow. Huge areas of agricultural land are exposed to various pesticides and fertilizers, landfill areas are growing. Industrial companies discharge waste water directly into rivers.

Runoff from fields also flows into rivers and lakes. Groundwater, the most important freshwater reservoir, is also being polluted. Pollution of freshwater and land boomerangs back to humans in food and drinking water. The shortage of clean drinking water consists of a number of problems: - Polluted drinking water sources; - Inefficiency of existing treatment plants; - Worn out municipal networks. A waterworks is a system of continuous water supply to consumers, designed to carry water for drinking and technical purposes from one location (usually a water intake structure) to another - to the water user (urban and factory premises) mainly through underground pipes or canals; at the final point, often purified from mechanical impurities in a filter system, water is collected at a certain height in tanks or so-called water towers, where it is already distributed through the city water pipes [1].

Outdoor water supply networks can be divided into several types according to their purpose: - Domestic water for pumping drinking water; - Fire (or fire-fighting) water for fire prevention; - Industrial (or

technological) water for pumping technical water: sanitary purposes; cooling of units, machinery, machines; various industrial purposes; - Irrigation/watering water for irrigation/watering of agricultural or decorative plants; - Recycling water supply can also exist for reducing [2].

It is known that water treatment is the process of changing the composition of water by removing organic and mineral impurities and micro-organisms or adding substances to bring its composition and properties into compliance with the requirements of consumers. A distinction is made between water treatment for drinking water (including domestic) and industrial purposes [3].

Currently, with the constant increase in production scale the problem of water treatment comes to the fore. And also methods of water reuse are being improved. There are many methods for purifying water resources. Types of water treatment are designed for specific impurities such as particulate matter:

– Particulate matter such as metal dust, rust, etc.
– Particles from product manufacturing and various chemicals used in the production process.
– Oils and synthetic lubricants of machinery and equipment.

Conventional filtration often only traps coarse particles, but the finer ones pass through the filter and repeated filtration will not have a significant effect. In addition to filters, plants use so-called settling tanks, where the water is left motionless for some time to allow the hard and heavy particles to settle to the bottom, for better water purification. But this is not enough for human reuse.

Materials and Methods

One way of treating water is through sorption. Sorption (from Latin sorbeo - to absorb) is the absorption by a solid or liquid of various substances from the environment. The absorbed substance in the environment is called sorbate (sorbent), the absorbing solid or liquid – sorbent [2]. Sorption purification of waste water is one of the main methods of deep cleaning of water from impurities and dissolved in it organic compounds such as petroleum products, products of pulp, textiles and chemical production. The main task of sorbents is absorption. In modern lines, it is no longer possible to imagine complete water treatment without adsorbents.

It is known, that one of directions of non-fuel use of coals is their processing into sorption materials for treatment of industrial wastewater from various impurities of inorganic and organic origin. Thus, brown coals, subjected to thermal impact, have a developed porous structure, in which pores of all sizes - from micropores to visible large pores - are presented. To the most perspective sources of brown coals as raw material for production of carbon adsorbents can be attributed Angren basin in view of the following reasons: coals are distinguished by low ash content (2-10%), low sulfur content (0,2-1,2%) and low prime cost, because their extraction is large-capacity production and is conducted by open-cast mining at high unit capacity [4].

Nowadays, filters for domestic use are so common: filter-pitcher, filter under the sink, filters of different directions (coarse purification, pre-treatment, back inspection, etc.). if you look at it this way, such filters have their drawbacks that stop residents from buying: high cost of the filter or its filtering parts - cartridges, not expedient installation, for example not all house residents agree with installation of such filters at the water supply system in the house or the water supply system in the house has not been changed.

But let's take a look at some filters for example and compare their performance, pros and cons. Carbon filter. The basis of operation of such filter is based on carbon. The sorption qualities of charcoal, the

ability to absorb various components from water due to its porous structure, are the basis of the filter element. The nature of binding substances in the aqueous medium, activated carbon refers to adsorbents - substances that concentrate sorbate on the interface (the boundary between the solid surface of carbon particles and the liquid) or absorb it with its surface layer.

Advantages: simple construction; effectively removes dissolved organic substances and chlorine, unpleasant odours and taste, hardness, sediment; long service life; possibility to combine several types of filtering material, extensive application sector.

Disadvantages: with long-term use (more than 3 months) a large amount of bacteria accumulates; high price of filter media (briquetted/compressed activated carbon) or filter cartridges; this type of filter absorbs from water not only viruses and bacteria, but also some useful microelements; inability to use filter in hot water supply; filters are effective only in case of low water head.

Consider how the cleaning process works in sorption filters. Different sorbents have their own filtration process. It mainly depends on the technology chosen and the type of sorbent. When considering a charcoal filter, the following cleaning process is distinguished. The main role in filtration is played by the sorbent carbon load. But the filtration process itself is divided into several stages.

1) Mechanical filtration. This filtration is necessary for removing especially coarse impurities. It can be sand, suspended solids, sludge and other substances.

2) Sorption filtration. Water flow is passed through activated carbon and all impurities and bacteria are removed. The treated water is delivered to the consumer.

The activated carbon consists of granules with a porous surface. When the water passes through, all impurities get stuck in the pores. That is, the charcoal soaks up the impurities. The pores may have different diameters, as well as the granules themselves. It depends on the constituents of the charging material and the type of impurities. Coal, like any other sorbent, needs to be cleaned. And, just because of its absorbency, it becomes full of impurities rather quickly. Therefore, it needs periodic cleaning. In order to do so, the charge material is rinsed with a reverse flow of water to loosen it. In this process, the granules come into contact with each other, as if knocking out impurities. The charge material is reassembled by the direct flow of water. The sorbent must be replaced every 6-9 months. It depends on the contamination of the treated water and the capacity [5].

The task of this work is to compare two methods of thermal treatment of lignite to obtain carbon adsorbents. Lignite from Angren deposit of the following grades were used with the following characteristics:

- 2 BPB (%): Wr - 25; Ad - 13.8; Cdaf - 72.4; Hdaf - 4.8; Ndaf - 0.8; S - 1.3.
- 2 BP (%): Wr - 25; Ad - 21; Cdaf - 72.3; Hdaf - 4.9; Ndaf - 1; S - 1.2.
- 2BP B-1 (%): Wr - 35; Ad - 25; Cdaf - 70; Hdaf - 7.2; Ndaf - 1; S - 1.2.

The adsorbent in a layer with up to 8-10 kg of feedstock in terms of dry solids (process temperature 730-750 °C, water vapor concentration 30 vol.%, oxygen concentration in vapor-gas mixture 4,5 vol.%, holding time of coal particles in the reactor 13-15 min).

Conclusion

The produced carbon adsorbent has: specific surface area 485-560 m^2/g; total pore volume 0.49-0.51 cm^3/g, including: micropore volume 0.09-0.13 cm^3/g, mesopore volume 0.33-0.38 cm^3/g; adsorption capacity by iodine 46-48%. Nitrogen adsorption isotherms on the above adsorbents obtained by

volumetric adsorption of nitrogen vapours in a vacuum adsorption unit at liquid nitrogen temperature - nitrogen adsorption isotherms belong to type II of the BET classification. The abrasion resistance of carbon adsorbent produced in fluidized bed reactor is slightly higher than that of adsorbent produced in stationary bed reactor - 68 and 53% respectively.

Carbon adsorbents were tested in the laboratory conditions for purifying water environments from a number of organic compounds in a wide range of concentrations (mg/l): phenols 20-5600, oil products 80-1030, surfactants (anionic and cationic) 50-130, volatile aliphatic acids 765-6000.

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